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Value Indices of Commercial Real Estate: A Comparison of Index Construction Methods

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Abstract

The purpose of this paper is to shed light on the history of commercial property values over the past decade, and to compare different methods of constructing commercial property value indices and returns series. We examine three types of indices: (i) Indices that attempt to reconstruct *property market* values by "unsmoothing" the appraisal-based Russell-NCREIF Index; (ii) Indices that trace average ex post *transaction prices* of commercial property over time; and (iii) an index based on *unlevering REIT* share prices. By comparing the different historical pictures that result from the various index construction methodologies, one gains insight into the nature of commercial property price and valuation behavior. The REIT-based values lead the other indices in time but display greater short-run volatility. The transactions-based indices lag behind the other series in time, and are consistent with the idea that institutional investors attempt to hold onto properties until they can sell them for a price at least equal to the current appraised value, in effect trading off liquidity for reduced volatility.

Key Words: indices, smoothing, appraisal, hedonic, commercial property

Value indices that trace the peaks and valleys through time of market prices for different asset classes provide useful information not only to historians and economists but also to practitioners and investors dealing with commodities and capital assets of various types. Estimates of the average appreciation return, standard deviation, and the correlation of returns across asset classes are important variables in models that are used to price assets and make investment decisions. Yet a reliable historical value index is not available to those who study commercial real estate even though the market value of this asset class is measured in the trillions of dollars and represents a significant share of the national wealth and productive capital.

There are two major purposes of this paper. The first is to shed light on the history of commercial property values in the United States over the past decade or so. When were values rising, when were they falling, and, at least relatively speaking, how high did they rise and how far did they fall? The second purpose is to compare and contrast different methods of constructing commercial property value indices. Because any single index construction method has conceptual or practical weaknesses, we examine five alternative indices, based on different assumptions, methods, and data, and compare all of these to the *de facto* "industry standard" Russell-NCREIF Index, which is appraisal-based. The indices we explore include 1) A Full-Information Value Index created by "unsmoothing" the Russell-NCREIF Index under the assumption that the underlying property values behave stochastically as if properties were traded in an informationally efficient market (i.e., returns are unpredictable across time); 2) a Market Value Index also created by unsmoothing the Russell-NCREIF, but without making the assumption that the property market is efficient; 3) a shortcut transactions-based index, labelled the NOI/Cap Index, created using publicly available data by dividing the Russell-NCREIF Net Operating Income by the transaction-based cap rates reported by the American Council of Life Insurers; 4) a more econometrically sophisticated transactions-based index, which we label our Hedonic Index, created using proprietary data by regressing the actual transaction prices of properties sold out of the Russell-NCREIF database onto a vector of hedonic variables and time dummy variables, thereby controlling for qualitative differences across time in the sample of sold properties; and 5) a REIT-based index, created by "unlevering" the NAREIT Index.

Our purpose in comparing and contrasting these various indices is not to simplistically claim that one method is right or better than another but rather to see what insights we gain by observing the historical value profile that is implied by the assumptions and methodology lying behind each index. Also, since the conceptual weaknesses and assumptions in each index are generally different, we may take any common message that emerges across all the indices as indeed being a fairly robust indicator of historical reality. The main focus of the paper is therefore on the visual picture that emerges in the historical value profile implied by each index. In the world of commercial real estate, where time series data is severely limited in both quantity and quality, we regard such visual/historical comparisons as an important, albeit informal, test of the validity of returns data series.

The paper is organized as follows: the industry benchmark Russell-NCREIF Index is described in Section 1, the two unsmoothed versions of the Russell-NCREIF Index in Section 2, the two transactions-based indices (the NOI/Cap Index and the Hedonic Index) in Section 3, and the unlevered REIT Index in Section 4. Comparisons across all six indices and overall conclusions are provided in Section 5.

1. The Russell-NCREIF Property Index

Since its inception in 1978, the Russell-NCREIF (RN) Index has become the most widely cited index of institutional-grade commercial property returns in the United States. The RN-Index is based on the appraised values of unlevered properties held for institutional investors in the portfolios of the member firms of the National Council of Real Estate Investment Fiduciaries (NCREIF). The index now includes over 1800 properties appraised at over $23 billion by the fourth quarter of 1992.[1]

Though a rich source of information, practitioners and academics alike have questioned the accuracy of the RN-Index due to its apparent smoothness and the perception that it lags declines in property values.[2] The quarterly RN-Index exhibits much less volatility than market value indices of other asset classes and at times has failed to register movements in real estate values that were widely perceived by market participants. For example, in the late 1980s the RN failed to register significant declines in commercial property values at a time when many financial institutions were being declared insolvent, with sharply falling real estate values often being cited as the primary cause of their insolvency.[3]

These problems with the RN-Index are rather understandable when one considers the nature of the appraisal process, and the effect of the aggregation of individual property values into the index. Appraised values used in the construction of the RN-Index are reported by the asset managers and are relatively stable through time. Miles, Guilkey, Webb, and Hunter (1993) report that 569 properties have been sold from the RN-Index over the entire 1978–1992 period, an average of only 38 properties per year, or less than 5% of the properties in the index. If this sample is representative of how frequently commercial properties transact (once every 20 years on average), then such infrequent transactions leave appraisers little information to work with in determining market value at specific times.

The need to filter out random transaction price noise (e.g., observational error, asymmetric negotiation skills, or unique motivations on the part of the individual participants to a given transaction) leads appraisers to rationally combine indications of value from the most recent comparable sale with past appraised values (previously perceived values) to arrive at the value that is actually reported for a given building each period.[4] This implies that the systematic component to disaggregate level property values will be smoothed over time in the appraised valuations.[5] Geltner (1993a) points out that in addition to any smoothing introduced at the disaggregate level by the appraisal process, aggregation of property values within an index causes additional smoothing. If property values are appraised at different points in time throughout each calendar quarter, yet all these valuations are, in effect, average together in the index to produce the index value attributed to that quarter, then the index value will be a moving average of spot values. This effect is further complicated within the RN-Index by the practice of reappraising properties only once per year, and reporting the last appraised value as the current property value each quarter. In effect, the RN becomes an annual index, partially updated each quarter.

The combined effect of all of these phenomena is seen in the reported RN-Index. We might expect that over sufficiently long periods of time, the average appreciation return displayed by the RN-Index would be a relatively unbiased estimate of the true appreciation in the typical property (of the type represented by the Index). However, the variance of short-interval returns across time, and the covariance of short-interval returns with contemporaneous returns on other assets, will be biased toward zero, and the index will tend to lag underlying property market value changes, due to these sources of smoothing. Furthermore, the smoothing phenomena described above would be expected to add significant positive autocorrelation (that is, apparent inertia or self-predictability) into the RN return series. These biases are the motivating factor for constructing the alternative value indices described below.

2. Unsmoothing the Russell-NCREIF Property Index

A formal smoothing model can be hypothesized to represent the smoothing phenomena described above. Such a model relates the observed RN return in each period to the unobserved true (that is, not smoothed) return that underlies the reported RN return. Depending on the specification of such a model, it may then be inverted to reveal the true return series. The resulting unsmoothed RN-Index is thus a simulated historical return series, based on the reported RN-Index, but with the smoothing (i.e., the inertia and lags) removed.

The nature and interpretation of such a simulated historical value series depends on the assumptions that are imbedded in the smoothing model and unsmoothing procedure. One approach is to rely on the assumption that the underlying true returns are uncorrelated across time, consistent with the classical hypothesis of weak-form informational efficiency in asset markets. This unpredictability assumption has been used previously by Geltner (1989), Ross & Zisler (1991), and Gyourko & Keim (1992), among others, to correct for smoothing in the second moments of the RN-Index returns.[6] However, this is the first time that the simulated historical time series of the underlying returns implied by this assumption has been reported. The advantage of constructing a simulated returns series is that it allows us to see the historical profile of property values implied by the efficient markets assumption. We can see when the peaks and valleys supposedly occurred, and how deep they were, and we may contrast this profile explicitly with what is implied by the unadjusted RN-Index as well as the other indices we shall construct.

It is often argued that real estate markets are not informationally efficient in the same way as securities markets, and that therefore the assumption of unpredictability may not be valid for true real estate returns. We agree that this may be the case, which is one reason for the construction of the other alternative indices. Given the purpose of this paper, we are not expecting any one index to exactly represent the historical truth. Indeed, there are different ways to define true returns. A logical way to interpret the simulated historical values based on the unpredictability assumption is that they are the values that would have prevailed in the private real estate markets if prices in those markets had been informationally efficient in the weak-form sense. They thus may represent a close approximation to full information prices, prices fully and immediately reflecting all available information relevant to the values of the assets. We will therefore refer to this index as the Full-Information Value Index[7].

To see how we derive our Full-Information Value Index consider first the noiseless stationary transfer function model of smoothing, such as that employed by Blundell-Ward (1987), Geltner (1989), and Ross-Zisler (1991), and described in more depth in Geltner (1991). While this model clearly simplifies reality (for example, by assuming stationarity and failing to allow for purely random error in the index), it probably captures much of the essence of the smoothing which occurs in *aggregate* level return indices such as the RN. This smoothing model can be expressed succinctly as

$$r_t^* = w_0 r_t + w(B) r_{t-1}, \tag{1}$$

where r_t^* is the smoothed RN-Index return during period t; r_t is the corresponding underlying true or not-smoothed return during period t; w_0 is a weight between 0 and 1; and w(B) is a polynomial function in the lag operator, B:

$$w(B) = w_1 + w_2 B + w_3 B^2 + \cdots \tag{1a}$$

where B refers to one lag ($Br_{t-1} = r_{t-2}$), B^2 refers to two lags ($B^2 r_{t-1} = r_{t-3}$), and so on.

It can be easily shown that equation 1 implies that the RN return can be represented by an autoregressive model of the form:

$$r_t^* = \phi(B)r_{t-1}^* + e_t \tag{2}$$

where $\phi(B)$ is a lag operator polynomial:

$$\phi(B) = \phi_1 + \phi_2 B + \phi_3 B^2 + \cdots \tag{2a}$$

and e_t is given by[8]

$$e_t = w_0 r_t \tag{2b}$$

The advantage of this representation is that equation 2 can be inverted to obtain an expression for the unobservable underlying return, r_t, as a function of the present and past values of the observable r_t^*:

$$r_t = (r_t^* - \phi(B)r_{t-1}^*)/w_0 \tag{3}$$

With our assumption of unpredictable true returns, $w_0 r_t$ and hence e_t are white noise, so that the autoregressive parameters ϕ can be estimated empirically in equation 2 from the observable data on the r_t^* series. However, an additional condition must be imposed in order to evaluate w_0 and complete the quantification of r_t. The additional condition we have chosen to impose is a volatility condition.[9] It is widely perceived among practitioners that the "true volatility" of commercial property values of the type represented by the RN-Index is approximately half the volatility of the S&P500 Index of stock market values.[10] Here, we assume that the quarterly volatility of the unsmoothed underlying returns equals one-half that of the S&P500:

$$SD[r_t] \equiv (1/2)SD[r_t^{SP}] \equiv \sigma^{SP}/2 \tag{4}$$

where SD[·] represents the sample standard deviation during the historical period considered. During the 1979–1992 period considered in this study, the quarterly volatility of the S&P 500 was 7.98 percent, so (4) implies that we assume the historical volatility of the underlying real estate return was 3.99 percent. This amounts to more than twice the volatility of 1.79 percent reported by the unadjusted RN-Index. Combining (2), (2b), (3), and (4) with the definition of the sample standard deviation, we obtain

$$w_0 = 2\ SD[(r_t^* - \phi(B)r_{t-1}^*)]/\sigma^{SP} \tag{5}$$

where $SD[(r_t^* - \phi(B)r_{t-1}^*)]$ can be quanitified based on the observable historical r_t^* series and the empirical estimation of $\phi(B)$.

The specification of the lag polynomial $\phi(B)$ is based on the following a priori considerations. First, there is a mechanical requirement that the number of lags in the autoregressive model in (2) be not too great, or we will be unable to construct a very long simulated time series, as the RN data only begins in 1978.[11] Second, Quan and Quigley (1989, 1991) have shown that a simple first-order autoregressive representation [AR(1), that is, $\phi(B) \equiv \phi_1$], will capture optimal appraiser behavior at the level of disaggregate (individual property) valuations.[12] Finally, in addition to the first-order relationship, in the quarterly RN-Index returns there is strong evidence also of a fourth-order lag, or seasonality. As noted in Ross and Zisler (1991) and Geltner (1989, 1993b), this is presumably caused by the fact that many properties are effectively reappraised only annually occurring in the fourth calendar quarter. While there are several ways to deal with this seasonality, the approach adopted here is to add a fourth-order AR coefficient in model 2 as well as the first-order coefficient. Thus, our specification for $\phi(B)$ is given by

$$\phi(B) = \phi_1 + \phi_4 B^3 \tag{6}$$

The parameter values in (6) may now be estimated empirically under our efficient market assumption by applying standard univariate time-series estimation procedures to the RN-Index return data. Inflation-adjusted appreciation returns are used since return unpredictability due to weak-form informational efficiency is more theoretically sound for real returns. The results of the regression are as follows (with t-ratios in parentheses):[13]

$$\begin{aligned} r_t^* = \underset{(-1.32)}{-0.0280} + \underset{(1.95)}{0.2030}\, r_{t-1}^* + \underset{(6.27)}{0.6831}\, r_{t-4}^* \end{aligned} \tag{7}$$

The residuals from (7) lack significant serial correlation, and have a volatility of 1.19 percent per quarter, giving a w_0 value of 0.2982 (= 2*1.19/7.98). Thus, the simulated full information real appreciation returns, r_t^F, are given by the following model:

$$r_t^F = (r_t^* - 0.2030\, r_{t-1}^* - 0.6831\, r_{t-4}^*)/(0.2982) \tag{8}$$

The contemporaneous cross-correlation between r_t^F and r_t^* is 66%, but as noted, r_t^F has over twice the volatility, and of course, lacks the strong first- and fourth-order autocorrelation of r_t^*.

The RN-based Full-Information Index of historical property value levels is created by adding historical inflation to the simulated real r_t^F returns, then compounding the returns over time. The quarterly Full-Informaton Index is displayed in Figure 1, along with the original unadjusted RN-Index for comparison purposes. Both indices are set arbitrarily equal to 100 in the fourth quarter of 1982, the earliest time period that all indices in this research can be constructed.[14]

The greater short-run volatility apparent in the Full-Information values in Figure 1 is probably of less significance than the overall historical pattern and profile portrayed across the period covered in the figure. It is notable that the Full-Information values rise higher than the original RN-Index (relative to where they were at the beginning of the 1980s), peak a little earlier (in 1984 instead of 1985) and then fall sharper and faster. The Full-Information value clearly fell in late 1986 and early 1987, a period of major tax reform that was unfavorable for commercial property, when the RN-Index remained nearly constant. The Full-Information values then show another, even more severe fall in 1990, the

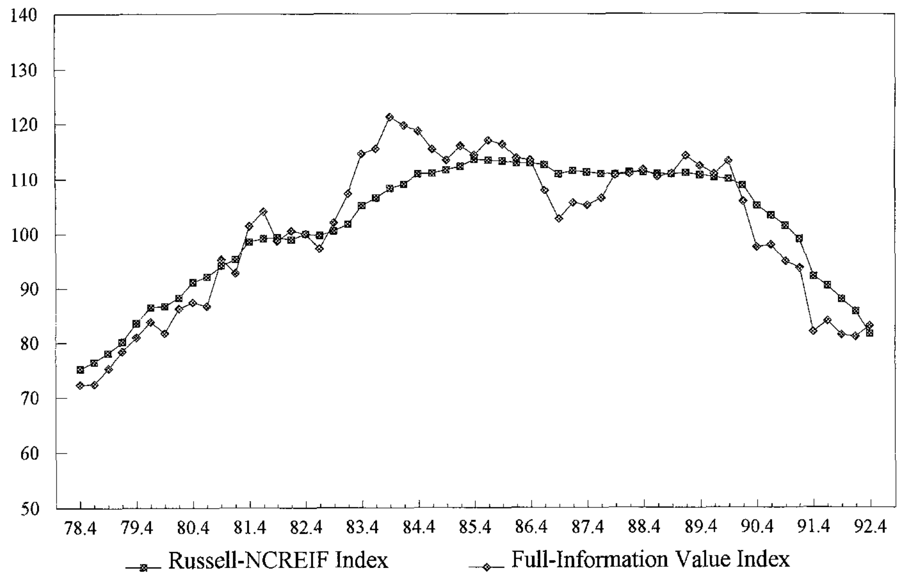

Figure 1. The Quarterly Simulated Full-Information Value Index nominal property value level and the Russell-NCREIF Index.

year the Gulf War recession, the savings & loan crisis, and the credit crunch all hit home and dramatized the excess supply of commercial property. By the end of 1991 the Full-Information Value Index had lost nearly one-third of its mid-1980s peak value, while the RN-Index was less than 20 percent below its peak. If we assume that the Full-Information and RN Index values were indeed equivalent in 1982 (or, roughly equal throughout the first four years depicted in the graph), then the implication of Figure 1 is that the Full-Information values were more than 10 percent below the smoothed appraisal-based index values in late 1991. Interestingly, the simulated property value index suggests that full information values of commercial property may have hit bottom in 1992. The Full-Information Value Index was no longer falling in 1992, while the appraisal-based RN Index was still falling sharply throughout that year.

A previously noted criticism of the Full-Information Value Index is that real estate markets may in fact not be informationally efficient. If not, then *market value,* defined as the most likely price one could reasonably expect to sell a property for in the open market, may not be well represented by an index based on the assumption that property returns are unpredictable. To address this criticism, Geltner (1993b) recently developed another approach to unsmoothing the RN Index, which avoids making the efficient market assumption. By positing a plausible (though subjective) model of appraisal smoothing at the disaggregate level, and incorporating the effect of temporal aggregation and seasonality at the aggregate index construction level, a quantitative structural model of smoothing in the RN Index can be developed without resorting to the unpredictability assumption. Such analysis suggests that *annual* RN Index returns can be unsmoothed to recover underlying market values by applying the following simple first-order autoregressive reverse filter.[15]

$$r_t^M = (r_t^* - (0.6)r_{t-1}^*)/(0.4) \tag{9}$$

where r_t^M refers to the unsmoothed underlying market value appreciation returns in calendar year "t" (fourth quarter to fourth quarter value differences).

We have applied this unsmoothing model to the RN Index annual appreciation returns for the period 1979 through 1992 to obtain the annual (end of year) nominal value level index displayed in Figure 3 together with the original RN Index, both set to have an average value over the 1982–1992 decade equal to 100. (The RN is displayed on this same basis with the previously described Full-Information Value Index in Figure 2, for comparison purposes.) We have labeled this index the Market Value Index, as it is intended to recover the property market values which underlie the RN Index.[16] The Market Value Index is a bit more volatile than the RN Index, with annual volatility of 8.19 percent in the real return, compared to 5.20 percent for the RN.[17] This is only slightly less volatility than the Full-Information Value Index (which has 8.62 percent annual volatility), and the magnitude and timing of the peaks and valleys appear similar between these two versions of the unsmoothed RN Index. An interesting difference occurs in 1992, however. Figure 3 shows the Market Value Index still falling during that year, as was the appraisal-based RN Index, whereas Figures 1 and 2 show that the Full-Information Value Index had stopped falling by that year. While one should not read too much into a single year's datapoint, this may suggest that commercial property market values are indeed sluggish, not efficient in the weak-form sense, and that the Full-Information Value Index may provide a leading indicator of what market values will soon be doing. Such an interpretation would be consistent with the autocorrelation statistics in the returns to the three indices. The Market Value Index displays a rather large and significant first-order autocorrelation coefficient

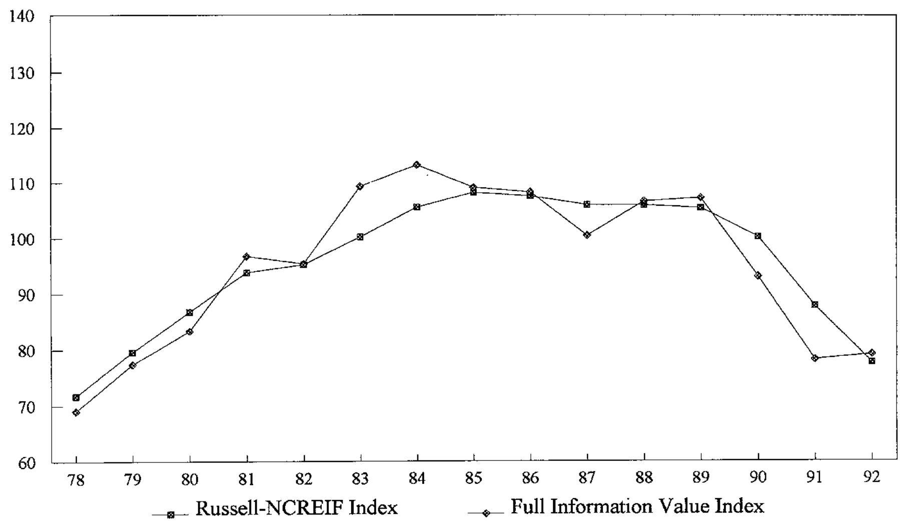

Figure 2. The Annual Full-Information Value Index, and the unadjusted Russell-NCREIF Index nominal property value level (both set to have 1982–1992 average value equal 100).

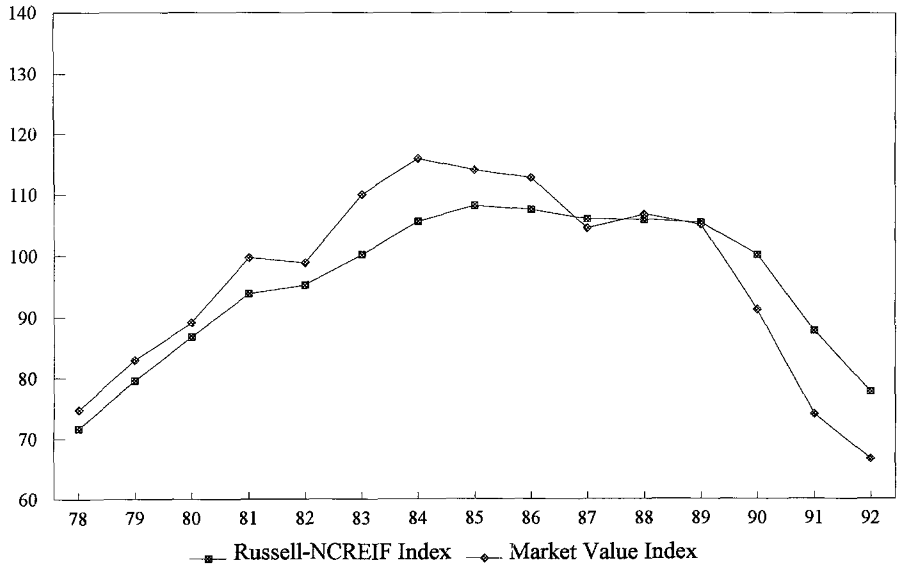

Figure 3. The Market Value Index, and the unadjusted Russell-NCREIF Index nominal property value level (both set to have 1982–1992 average value equal 100).

in its real annual returns equal to 51.5 percent. While this is less than the 72.1 percent found in the unadjusted appraisal-based RN Index, it is much greater than the (by construction) statistically insignificant 16.4 percent autocorrelation in the Full-Information Value Index.

3. Transactions-Based Indices

While all three indices described previously (including the RN Index itself) have as their objective the representation of changes in property market values across time, the indices to be described in this section have a different focus, the description of actual property transaction prices. It is therefore important at this point to clarify the somewhat subtle difference between what is meant by *market value* and *transaction price.*

Market value is a theoretical concept that applies to any property at each point in time, whether or not the property actually is transacted at that point in time. The market value is the expected selling price assuming that the property is to be sold in the open market, without abnormal delay. Market value is thus, by definition, a liquid value, and a market value index should trace out a constant-liquidity value through time.[18] Market value is thus closely akin to the economic notion of opportunity cost.

Transaction price, on the other hand, is an *ex post* empirical observation that exists for a given property only when and if it is transacted. While market value applies conceptually to any and all properties, transaction prices are observed only for the sample of properties that managed to consummate deals during the time period in question. One consequence of this difference is that the quality or characteristics of the properties in the transacting sample may differ from one period of time to the next, with resulting complications in the measurement and interpretation of observed price differences across time. Another consequence is that, unlike the presumption in the market value concept, liquidity is not held constant across time in a transactions price series. This latter consequence is quite important in the interpretation of transaction price indices and in comparing them with other types of indices. For example, suppose sellers choose to sell only when a buyer agrees to pay at least the appraised value of the property, and buyers chose to transact only when a seller agrees to sell at or below the appraised value. Then transactions would be consummated only at appraised values and a perfectly observed and measured transaction price index would be the same as an appraisal-based index. But this would not necessarily imply that the corresponding market value series was well represented by the transaction price or appraisal-based index. The former would trace out a constant-liquidity index, while the latter would trace out values that reflected varying degrees of liquidity over time.[19]

Because of the difficulties of developing transaction price indices with scarce data, we develop two different indices in this section, based on different approaches and data. The first is a cap rate-based index, which is easier to construct and requires only publicly available information, but is less sophisticated from an econometric perspective. The second is an hedonic index, which uses a more formal and theoretically sound but data-intensive approach. We describe each of these in more depth below.

Perhaps the easiest way to construct a transactions-based index for commercial property in the United States is to divide the Russell-NCREIF historical NOI value level series by the transaction-based cap rates reported by the American Council of Life Insurers (ACLI).[20] Each calendar quarter the ACLI reports the cap rates associated with properties for which commercial mortgages were issued in that quarter by the members of the ACLI. The cap rates are defined essentially as the net operating income (NOI) for the property in the upcoming year, divided by the current value (transaction price) of the property. The Russell-NCREIF income and appreciation return series can be used to construct an index of the value level across time in the NOI of institutional grade commercial property.[21] By dividing this NOI index by the ACLI cap rates reported for the previous calendar period, we obtain an estimate of the average transaction price of the commercial properties transacting with ACLI member mortgages during each period of time. To mitigate the temporal aggregation problem, we have applied the ACLI cap rate for the fourth calendar quarter (as opposed to the annual average cap rate), to the Russell-NCREIF NOI for the subsequent calendar year. Thus, our NOI/Cap Rate Index is defined as

$$V_{t.4} = NOI_{t+1}/Cap_{t.4} \tag{10}$$

where $V_{t.4}$ is the implied property nominal value (transaction price) index level; and t.4 refers to the fourth calendar quarter of year *t*. Annual returns are then constructed as the first differences of the logs of the fourth-quarter values. (Note that because of the forward lead in the NOI component, we cannot yet construct the NOI/Cap Rate Index beyond the year 1991.)

Figure 4 shows the NOI/Cap Index nominal property value levels compared with the Russell-NCREIF Index. Again, a broadly similar picture is traced out, in that the magnitude

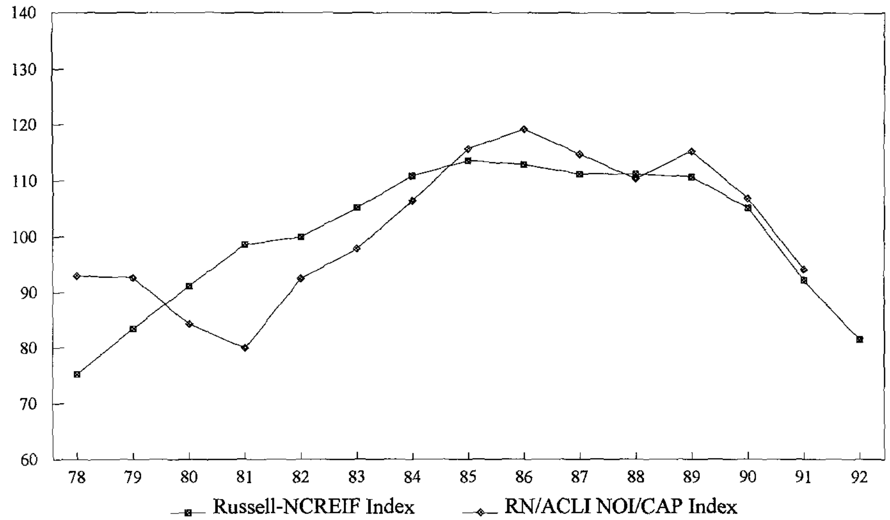

Figure 4. The NOI/Cap Index, and the Russell-NCREIF Index, nominal property value level (both set to have 1982–1992 average value equal 100).

and timing of the rise and fall in property prices during the 80s appears roughly the same. The NOI/Cap Index has annual volatility of 9.36%, with a positive first-order autocorrelation coefficient of 39%. In both these respects the NOI/Cap is similar to the Market Value Index discussed previously. However, comparing Figure 3 with Figure 4, an important difference is noted between the Market Value Index and the transactions-based index. While the former tends to *lead* the appraisal-based RN Index, the NOI/Cap Index appears to be more contemporaneous with, or even to slightly lag behind, the RN Index in time. This suggests that institutional investors attempt to transact only at or near the current (or very recent past) appraised value of the property.[22]

While the NOI/Cap Index has the virtue of being simple, intuitive, and based on publicly available data, it also has several problems which may explain some apparently anomalous behavior in the NOI/Cap Index values, particularly during the late 1970s and early 1980s. First, the sample of properties from which the cap rate information is obtained (the ACLI properties) is not the same as the sample from which the NOI index is derived (the RN properties). Second, there is no control for differences in the quality and characteristics of the sample of transacting properties across time in the ACLI property sample (i..e., we have left out the hedonic issue). Both of these problems would be expected to inject random artificial volatility (noise or observation error) into the resulting returns series and value index.

Another problem is that many of the ACLI-reported cap rates may better represent idealized or expected cap rates rather than actual contemporaneous transaction price cap rates. For one thing, some of the ACLI mortgage issues are not purchase money mortgages but rather are refinancings, so the property value in the denominator of the reported cap rate must be estimated (i.e., appraised) values. Second, even when the mortgage is for purchase money in a property transaction, the ACLI-reported cap rate may be based on an estimate of the stabilized NOI in the numerator of the cap rate calculation, rather than the then-current actual NOI for the property.[23] This may allow the reported cap rate to conform to traditional simplified appraisal rules of thumb, such as the 2-Band or Simple Mortgage-Equity formulation.[24] When applied to actual contemporaneous Russell-NCREIF NOI levels (which include vintage leases), such a cap rate would be excessively sensitive to inflation. This would lead to unrealistically high cap rates during the peak inflation period of the late 1970s and early 1980s, resulting in the anomalous sharp fall in the NOI/Cap Index nominal value level during that high-inflation period.

To address these and other potential problems in the NOI/Cap Index, it would be desirable to develop a transactions-based index that is based on a more sophisticated methodology applied to a sample of actual commercial property transactions for which we have enough data to control for differences from one period to the next in the quality of the properties sold. For this reason we have developed our Hedonic Index. This index is developed from observed transactions prices on properties sold from the Russell-NCREIF Index, controlling for differences in the samples of properties that sell from one period to the next using a hedonic regression methodology that is often used to construct value indices for single-family houses. The essential difference between the Hedonic Index and an appraisal-based index such as the RN Index is that the Hedonic Index seeks to replace the appraisal process with an econometric valuation procedure in which the index value for each calendar period is based only on actual ex post transaction prices of properties sold during that calendar period.

While appraisers also observe transaction prices and take these into account when determining the appraised values which go into the RN-Index, appraisers use a subjective process that may consider other factors as well as observed transactions. Furthermore, as described previously, appraisers may (directly or indirectly) use transaction prices occurring prior to the current calendar period for which the property valuation will be included in the index. At least some of the smoothing in the RN-Index may be attributable to those characteristics of appraisals which the Hedonic Index avoids.

Hedonic indices have not been utilized for commercial real estate in the past due to the thinness of the commercial property market and the proprietary nature of much commercial property transaction price information. As a result, there are typically too few reliably observable transaction prices in most databases. Instead, so-called transactions-driven indices have been developed to maximize the usefulness of the very limited transaction data available. See Hoag (1980), Miles-Cole-Guilkey (1990), and Webb-Miles-Guilkey (1992). The strength of the transactions-driven approach, however, is oriented more toward identifying fundamental characteristics that differentiate property values cross-sectionally (i.e., across properties at a given point in time), rather than toward tracing out changes in property value across time.[25] A transactions-based valuation approach that is more relevant in the present context, and that we therefore use in our Hedonic Index, is the classical hedonic time-series regression approach pioneered by Court (1939), Griliches (1961), and others for the purpose of developing constant-quality price indices for products such as automobiles and computers whose quality tends to improve over time. More recently this approach and related procedures have been applied in the housing literature to develop indices of housing prices, where data is much more plentiful.[26] The present paper is the first use of this type of methodology for commercial property.

In this approach property transaction prices (per square foot) are regressed onto a vector of property characteristics (the hedonic, or cross-section regressors) and a vector of time dummy-variables, one for each calendar period in the historical period being examined. The time dummies assume a value of 1 if the property sold during that period and 0 otherwise. In principle, the hedonic regressors capture the effect that cross-sectional differences in property characteristics have on the transaction prices, so the coefficients on the time dummies capture the pure effect of time on the property prices. Thus, a historical index of property value is obtained directly from the coefficients on the time dummies (for a constant-quality property, to the extent that the effect of quality is captured in the hedonic variables). Note that in this approach the property value index is based on actual transaction prices for sales taking place solely in the calendar period to which the index value applies.

Clapp & Giacotto (1992) and others have criticized the simple application of the hedonic approach because it implicitly assumes that the *relative* value weights (relative coefficients) on the cross-sectional property hedonic variables are constant through time. In the case of commercial properties, however, transactions data are too sparse to allow reestimation of the hedonic coefficients for each period of time. Unlike the transactions-driven approach, in the hedonic approach much of the effect of changing relative coefficients will be captured in the time dummy-variable coefficients (the intercepts in the cross-sectional model). For purposes of constructing a value index (as opposed to analyzing hedonic sources of property value), this is all that is necessary.

The development of our Hedonic Index requires a sample of sold properties that has sufficient numbers of transactions in each period of time to generate a statistically reliable index. For the present study NCREIF provided data on all the properties sold from the set of properties comprising the RN-Index described in Section 1 above. This is probably the largest commercial property transaction database in the United States today. Table 1 indicates the number of usable transaction observations in the Russell-NCREIF database each year from 1979 to 1992. The Hedonic Index is developed for years 1982 through 1992, using the 493 verifiable observations from those years. Thus, our Hedonic Index is derived from a sub-sample of the properties from which the RN and previous unsmoothed RN indices are derived. The 469 transactions represent property valued at over $5 billion. While this is a sufficient database to produce an *annual* index commencing in 1982, there are not sufficient sales to allow the index to be constructed prior to 1982, or on a quarterly basis.

The cross-sectional characteristics we include in the hedonic model are those suggested by Webb, Miles, and Guilkey (1992), with an important difference. As Webb-Miles-Guilkey are modeling both cross-sectional and time-series characteristics, some of their variables contain both aspects. For example, net income is both property and time specific in their model. In the present context where time dummy variables are included in the regression, the time-variation in all other variables is removed by taking, for each property, the average value over time, thus retaining only the purely cross-sectional explanatory role for the variable. The valuation regression model specification we have chosen for the Hedonic Index is the following:

$$\mathrm{LNPSF}_i = \beta_1(\mathrm{OFFICE}_i) + \beta_2(\mathrm{RETAIL}_i) + \beta_3(\mathrm{FUNCT}_i) + \beta_4(\mathrm{LOCATE}_i) + \beta_5(\mathrm{PERSINC}_i) + \beta_6(\mathrm{CPOP}_i) + \beta_7(\mathrm{NISF}_i) + \beta_8(\mathrm{CISF}_i) + \beta_9(\mathrm{Yr82}) + \beta_{10}(\mathrm{Yr83}) + \beta_{11}(\mathrm{Yr84}) + \beta_{12}(\mathrm{Yr85}) + \beta_{13}(\mathrm{Yr86}) + \beta_{14}(\mathrm{Yr87}) + \beta_{15}(\mathrm{Yr88}) + \beta_{16}(\mathrm{Yr89}) + \beta_{17}(\mathrm{Yr90}) + \beta_{18}(\mathrm{Yr91}) + \beta_{19}(\mathrm{Yr92}) + \epsilon_i \quad (11)$$

Table 1. Number of Transaction Price Observations Per Year*.

Year	Sales	Percent**
1979	1	0
1980	3	1
1981	4	1
1982	16	2
1983	27	4
1984	44	5
1985	46	5
1986	56	6
1987	45	5
1988	59	6
1989	74	7
1990	44	3
1991	60	3
1992	22	2
Total	501	Avg. = 4

*A total of approximately 1000 properties have exited the Russell-NCREIF database over the 1979–92 period. Of these, 569 were sales with verifiable arms-length transaction prices. Of these, the 501 indicated above include all the other information necessary to run the hedonic regression to compile the Hedonic Index. These properties are well diversified geographically (40 of the 48 continental states are represented in this sample), by property type (office, retail, and industrial properties) and by investment manager (22 different investment managers).
**Percent of the properties then in the Russell-NCREIF database.

where

$LNPSF_i$	=	Log of the sale price per square foot for property "i."
OFFICE and RETAIL	=	Dummy variables to control for differences in the values per square foot of the three property types in the sample (industrial properties are also included).
FUNCT	=	A measure of the functionality of the property, defined as the quality of construction and amenities. This encompasses both construction and design quality, as well as related considerations such as speed of elevators and height of ceilings. Each building was given a functionality grade from 1 to 10.
LOCATE	=	A measure of the quality of the location of the building within the metropolitan area (again, graded from 1 to 10 for each building).
PERSINC	=	Average level of personal income (in constant 1982 dollars) for the metropolitan area the property is located within over the time period the property was in the database. This variable controls for differences in wealth and aggregate demand across metropolitan areas.
CPOP	=	Average change in population for the metro area where the property is located. This variable controls for differences in demand growth across metropolitan areas.

NISF = Average net income (in constant 1982 dollars) per square foot for property "i" over the time it was in the database (a proxy for otherwise unobservable differences in the ability of a building to generate cash flow).

CISF = Average annual capital improvement expenditure per square foot (in constant 1982 dollars) for property "i" during the time it was in the database (a proxy for otherwise unobservable differences in the growth expectations or ability of the building to improve its cash flow over time.

Yr82 to Yr92 = Time dummy variables (1 if property 'i" sold during that calendar year, 0 otherwise).[27]

Table 2 presents the regression results. The model fits the data well with an adjusted-R^2 of .67, all parameter estimates are of the expected sign, and all are significant at the 5 percent level with the exception of LOCATE (which is significant at the 10% level). Parameter estimates from the year dummy variables provide the time-series value index. Antilogs are taken to convert the index values to straight levels from logs. Figure 5 presents the resulting Hedonic Index along with the unadjusted appraisal-based RN-Index for comparison purposes, with both indices scaled so that the average value of both indices over the 1982–1992 period equals 100.

The hedonic index provides an alternative way of constructing an index that does not rely on appraised values and is therefore not subject to appraisal smoothing. Even with

Table 2. Hedonic model of real estate transactions prices.
$LNPSF_i = \beta_1(\text{Office} + \beta_2(\text{Retail}) + \beta_3(\text{NISF}) + \beta_4(\text{CISF}) + \beta_5(\text{FUNCT}) + \beta_6(\text{PERSINC}) + \beta_7(\text{CPOP}) + \beta_8(\text{Locate}) + \beta_9(\text{YR82}) + \beta_{10}(\text{YR83}) + \beta_{11}(\text{YR84}) + \beta_{12}(\text{YR85}) + \beta_{13}(\text{YR86}) + \beta_{14}(\text{YR87}) + \beta_{15}(\text{YR88}) + \beta_{16}(\text{YR89}) + \beta_{17}(\text{YR90}) + \beta_{18}(\text{YR91}) + \beta_{19}(\text{YR92}) + \epsilon_1.$

Variables	β	T-STAT
Office	0.268132	5.010
Retail	0.196290	3.551
NISF	0.894717	17.359
CISF	0.400121	5.758
FUNCT	0.069095	2.498
PERSINC	0.000619	6.754
CPOP	28.155066	3.885
LOCATE	0.052343	1.700
YR82	1.750558	10.194
YR83	1.853514	11.611
YR84	1.989789	13.901
YR85	2.052328	13.862
YR86	2.178089	14.762
YR87	2.042561	14.100
YR88	1.999977	13.694
YR89	2.018357	13.685
YR90	1.948202	13.026
YR91	2.026683	13.216
YR92	1.712969	10.681

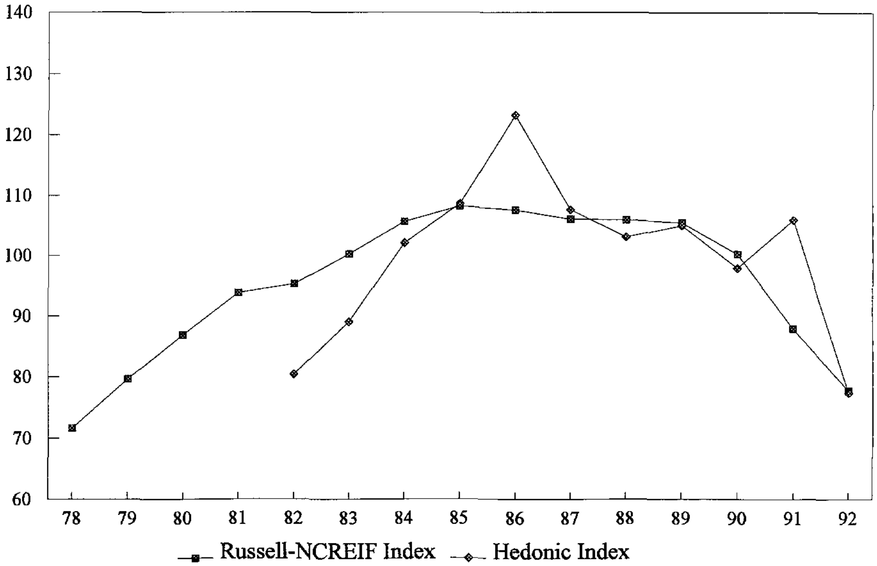

Figure 5. The Hedonic Index and the Russell-NCREIF Index nominal property value level (both set to have 1982–1992 average value equal 100).

a perfect hedonic model, however, smoothing or lagging due to temporal aggregation would still occur in the resulting index, as properties that sell at different times during the year are being used to estimate values as of a single point in time.[28] In addition, estimation error injects random noise into the Hedonic Index, artificially adding nonsystematic volatility into the returns.[29] In interpreting the Hedonic Index, these two artificial phenomena must be considered along with the real price behavior that the index is attempting to model.

With this in mind, the Hedonic Index nevertheless traces out a fairly plausible picture of nominal property values across time, and one that, again, broadly agrees with the previous indices in the approximate timing and magnitude of the rise and fall of property values. The greater short-run volatility (14.42%) and negative first-order autocorrelation (−9.4%) in the annual real returns of the Hedonic Index suggests that the random estimation error noise phenomenon is dominating the temporal aggregation smoothing phenomenon in this case, as far as the short-run volatility or roughness of the index is concerned. This reflects the relative paucity of transaction observations in each year.

The temporal relation between the Hedonic Index and the other indices is particularly intriguing. In common with the NOI/Cap Index, but in contrast to the unsmoothed indices developed in Section 2, the Hedonic Index does *not lead* the appraisal-based RN Index but rather lags behind it in time. (For example, the RN Index peaks in 1985, while the Hedonic Index peaks in 1986). At least some of this lag behind the RN Index is no doubt caused by the temporal aggregation noted previously. However, the time span of the lag caused by temporal aggregation (about a half year) would not appear to be great enough to allow the transaction prices to actually lead the appraisal-based index as the Market Value Index does. Indeed, the temporal pattern of the Hedonic Index suggests that transaction prices are more or less contemporaneous with the appraisal-based index. Thus, like the NOI/Cap Index, the Hedonic Index is consistent with the idea that institutional investors try to avoid selling properties unless and until they can get at least the current or recent past appraised value.[30] This is seen graphically in Figures 6 and 7, which superimpose the RN Index and NOI/Cap Index, respectively, onto the ± 1 standard error bounds around the Hedonic Index. With the exception of 1991, the Hedonic Index appears quite consistent with both of these other indices. As the two transactions-based indices developed in this section depend upon substantially different methodology and data, the similarity and mutual consistency between them contains a certain robustness.

4. A REIT-Based Value Index

A third broadly different approach to gaining some insight into the historical pattern of commercial property values in the United States over the past decade is to observe the returns to relatively pure play common stocks traded on the public stock exchanges. As REIT shares, by virtue of their being traded in small denominations on public exchanges, are always liquid, the values traced out by a REIT-based index will have the constant-liquidity that characterizes what we are defining as a market value index.[31] But REIT values derive from a very different type of market structure than that in which the private property markets operate, and because of this difference REIT prices are also transaction prices. Securities markets, with their double-auction format, great liquidity, and the large role played by small individual investors, exhibit behavior patterns that differ notably from commercial property markets where transactions occur in private deals between large institutional investors.

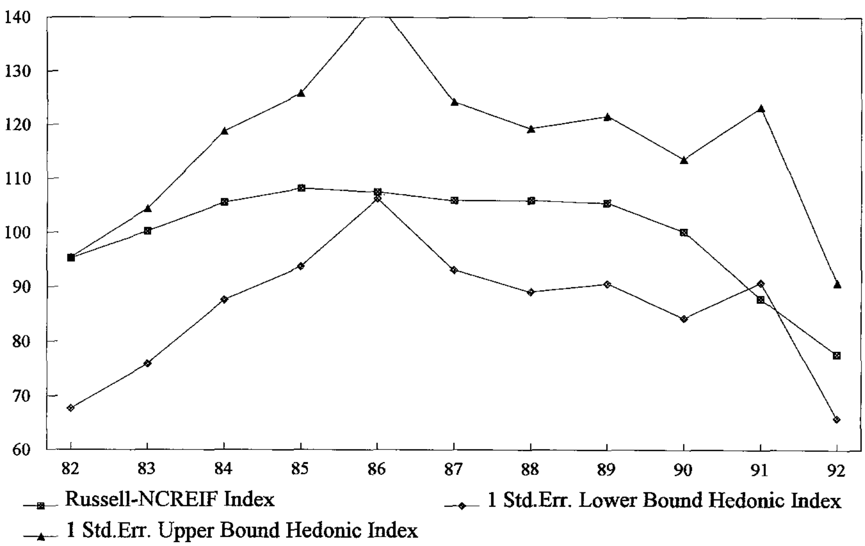

Figure 6. Upper and Lower Bounds around the Hedonic Index (1 Std. Err.) compared to the Russell-NCREIF Index (scaled as before).

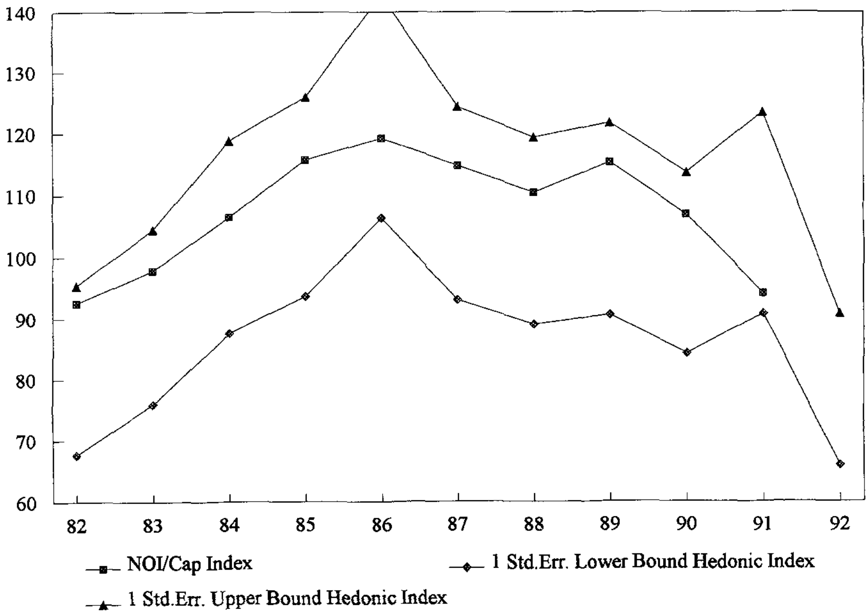

Figure 7. Upper and Lower Bounds around the Hedonic Index (1 Std. Err.) compared to the NOI/Cap Index (scaled as before).

The National Association of Real Estate Investment Trusts (NAREIT) reports the appreciation returns of a value-weighted index composed of all major REITs, based on their share prices traded in the stock market. NAREIT reports that as of 1990 the book value of the equity held by REITs in commercial property was in excess of $16 billion, giving REITs control over commercial property worth in excess of $25 billion (about equal in value to the properties in the RN-Index). Appreciation returns observed for REITs provide a measure of how a liquid public exchange market values, albeit indirectly, the underlying properties held by the REITs. Although there are some differences beween the types of properties held by REITs and those held by institutional investors, taken in the aggregate, REITs hold a large and diverse cross-section of U.S. commercial real estate, as does the RN-Index. Both REITs and the RN Index therefore represent essentially the same asset class.

REITs are generally levered and contain debt on both the asset and liability side of their balance sheets. On the asset side, many REITs hold mortgages as well as property equity, and on the liability side both mortgages and bonds or bank debt (backed, in effect, by property assets) are issued by REITs. In the aggregate across all REITs, the debt on the asset side roughly offsets the debt on the liability side, leaving REIT returns as a reasonable reflection of changes in the value of the properties held by the REITs as a whole. However, this offsetting relationship may not be exact at all points in time. Therefore, we have attempted to unlever the REIT returns by use of a simple weighted average cost of capital (WACC) model, which corrects for the debt on both the asset and liability sides of the balance sheet.

The WACC model we use is based on the accounting identity:

$$P_t + M_t = D_t + E_t, \tag{12a}$$

where P_t = value of property assets held at time t; M_t = value of other assets held at time t (mostly mortgages, with some other debtlike assets); D_t = value of liabilities as of time t (mostly mortgages and other debt backed by property assets); and E_t = value of shareholders' equity at time t. From this identity the return relationship directly follows:

$$r_{E,t} = (P/E)_t r_{P,t} + (M/E)_t r_{M,t} - (D/E)_t r_{D,t} \tag{12b}$$

where $r_{X,t} \equiv \Delta X/X$ refers to the percent change in item X. Assuming that the return to all the REIT debtlike instruments is approximately the same (on either side of the balance sheet):

$$r_{M,t} \approx r_{D,t} \ \forall \ t$$

(12b) becomes:

$$\begin{aligned} r_{E,t} &\approx (P/E)_t r_{P,t} + [(M/E)_t - (D/E)_t] r_{D,t} \\ &= (P/E)_t r_{P,t} + [1 - (P/E)_t] r_{D,t} \end{aligned} \tag{12c}$$

Thus, as an approximation, we can derive the property (unlevered) returns implied by REIT share market values as

$$r_{P,t} = \{r_{E,t} - [1 - (P/E)_t] r_{D,t}\}/(P/E)_t \tag{12d}$$

To quantify (12d) in practice, we have used the annual book values of property assets (P) and shareholders equity (E) reported by NAREIT for the REIT industry each year. To quantify the returns, the debt return ($r_{D,t}$) is represented by the Ibbotson Associates Long-term Government Bond Index, while the REIT equity return ($r_{E,t}$) is represented by the NAREIT All-REIT Index annual capital return.

The resulting unlevered appreciation returns are then compounded to produce the unlevered NAREIT nominal property value index displayed in Figure 8, labeled as the REIT Index. As before, the RN-Index is also shown in the figure for comparison purposes, scaled so that both indices have average 1982–1992 values equal to 100. The REIT Index, even though unlevered, is more volatile (annual real return volatility 14.25%) than the other indices except for the Hedonic Index. As with the Hedonic Index, much of the REIT volatility appears to be short-run or transient in nature (as evidenced by the negative first-order autocorrelation of −16.7% in the annual real returns). Unlike the Hedonic Index, in the case of the REIT Index we cannot attribute the high short-run volatility to observation error or estimation noise. Instead, high short-run volatility in the REIT Index may reflect stock market noise of the type described by Black (1985) and Lee-Schleifer-Thaler (1991), among others.[32] Highly liquid markets such as the public stock exchanges appear to be subject

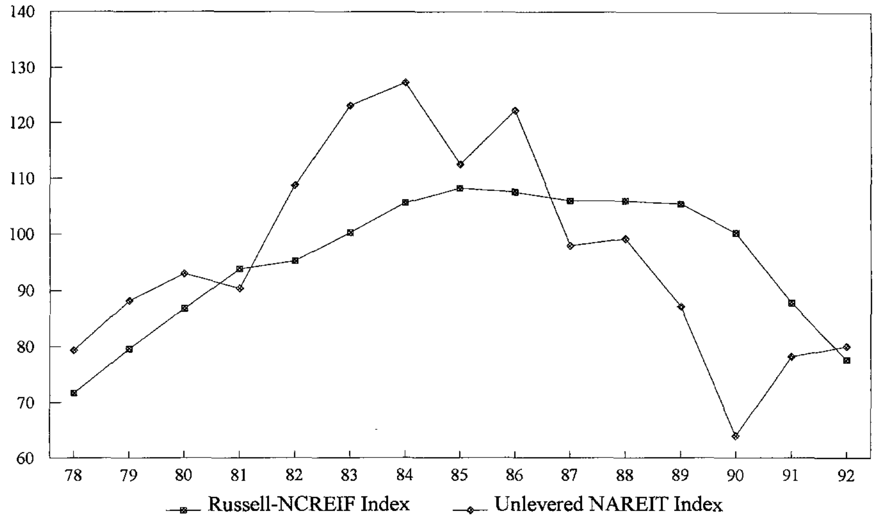

Figure 8. The unlevered REIT Index and the Russell-NCREIF Index nominal value levels (both set to average 1982–1992 value equal 100).

to transient bearish and bullish sentiments that may cause excess volatility. This phenomenon would appear to be particularly strong among small-capitalization stocks whose trading is heavily influenced by small individual investors, such as REITs.

Apart from the stock market noise phenomenon, REIT prices may reflect other shareholder concerns and perceptions besides the contemporaneous value of the underlying property assets held by the REITs. For example, REIT values may reflect investor perceptions of the management and investment timing abilities of the REIT managers, and the current nature of the opportunities and dangers confronting these managers, issues which are somewhat distinct from the current value of the properties presently held by the REITs.

Despite these problems, the REIT Index seems broadly plausible and consistent with the other indices we have examined, particularly with the Full-Information Value Index. The REIT Index peaks in 1984, as do both the unsmoothed RN-based indices, while the RN peaks in 1985 and the transactions-based indices in 1986. Interestingly, the REIT Index bottomed out in 1990, and sustained consecutive increases in 1991 and 1992, rising over 25 percent in the last two years. The Full-Information Value Index apparently reached a (more tentative) bottom a year later, in 1991, while all the other indices examined in this paper were still falling through 1992. If REIT values do indeed lead the property market values, then REIT behavior in 1991–1992 may indicate an imminent rise in property market values beginning perhaps in 1993.

5. Conclusions and Overall Comparison of the Indices

In the preceding three sections five indices of the historical value of commercial property in the United States over the past decade or more have been quantified and compared to the industry benchmark RN-Index. Tables 3 and 4 and Figure 9 summarize this comparison. Figure 9 presents the five derived indices together with the RN Index, all scaled to have a 1982–1992 nominal average property value level equal to 100. Table 3 presents the basic summary time-series statistics of the real (inflation-adjusted) annual appreciation returns, and indicates the timing and magnitude of the peaks and valleys in the nominal property value indices implied by these returns. The index values themselves are reported in the Appendix to this paper.

There are some common messages that emerge from the indices concerning the value of commercial real estate over the past decade. As the indices have been developed using different methodologies and assumptions, and, to some extent, using different data and properties, any common messages may be considered to be fairly robust conclusions regarding the historical pattern of commercial property value in the United States over the period

Table 3. Summary of Six Commercial Property Indices.

Index:	RN	Full-Info Value	Market Value	NOI/Cap	Hedonic	Unlevered REIT	S&P500
Real Annual Appreciation Returns:							
Geom. Mean	0.58%	0.99%	-0.81%	0.10%	-0.38%	0.06%	10.72%
Std. Dev.	5.20%	8.62%	8.19%	9.36%	14.42%	14.25%	12.39%
Autocorr	72.1%	16.4%	51.5%	39.3%	-9.4%	-16.7%	-52.3%
Beta	-0.016	-0.078	-0.045	0.236	0.596	0.503	1.000
Contemp. Cross. Corr:							
RN	100%	68%	92%	50%	61%	3%	-4%
Full-Info	68%	100%	92%	28%	17%	25%	-11%
Market	92%	92%	100%	41%	44%	16%	-7%
NOI/Cap	50%	28%	41%	100%	59%	29%	32%
Hedonic	61%	17%	44%	59%	100%	43%	50%
REIT	3%	25%	16%	29%	43%	100%	44%
SP500	-4%	-11%	-7%	32%	50%	44%	100%
Nominal Property Value Levels:							
% Rise Trough to Peak:	51%	64%	55%	49%	53%	60%	NA
% Fall Peak to Trough:	28%	31%	42%	21%	37%	50%	NA
Year of 1st Trough:	'78?	'78?	'78?	'81	'82?	'78?	NA
Year of Peak:	'85	'84	'84	'86	'86	'84	NA
Year of 2nd Trough:	'92?	'91	'92?	'91?	'92?	'90	NA

Autocorr refers to 1st-order autocorrelation coefficient.

Beta refers to contemporaneous covariance wrt S&P 500, divided by variance of S&P 500

Contemp. Cross-Corr. refers to contemporaneous cross-correlation coefficient.

Return figures are for 1979–1992, except Hedonic 1983–1992, and NOI/Cap 1979–1991.

Value Level figures are for 1978–1992, except Hedonic 1982–1992, and NOI/Cap 1978–1991.

? indicates 1st trough may be sooner or 2nd trough may be later due to end of data series.

Table 4. Correlation Between RN Index and Leading or Lagged Returns of Other Indices.

	Other Index Returns:			
	Leading RN Index by:		Lagging RN Index by:	
	1 Year	2 Years	1 Year	2 Years
Full-Info	72%	42%	18%	11%
Market	77	42	49	27
NOI/Cap	29	-3	41	21
Hedonic	17	25	51	29
REIT	28	55	-14	-1

*Cross-correlations are for annual real appreciation returns, 1979–1992, except 1983–1992 for Hedonic and 1979–1991 for Noi/Cap.

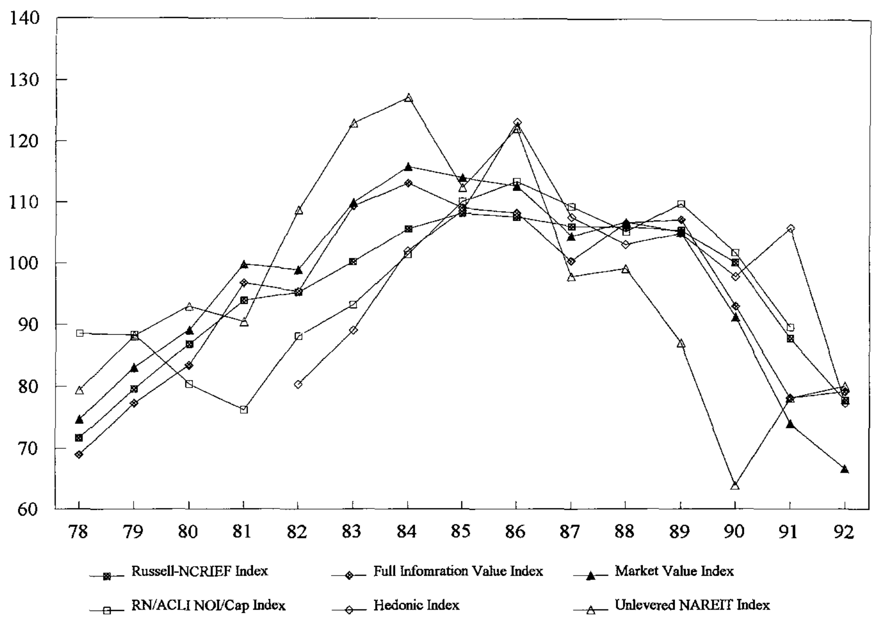

Figure 9. All Five Derived Indices and the Russell-NCREIF Index, nominal property value level (scaled to average 1982–1992 value equal 100).

considered. All indices suggest that property values were rising strongly during the early 1980s, peaked somewhere between 1984 and 1986, and fell sharply by the late 1980s or early 1990s. The rise in value from the previous trough in the late 1970s or early 1980s up to the mid-1980s peak appears to have been around 50 to 60 percent (of the previous trough values), and the subsequent fall appears to be about equal in nominal dollar magnitude, or 30 to 50 percent of the mid-1980s peak values. Two of the five indexes which extend through 1992 suggest that property values may have stopped falling by 1992, bottoming out at a nominal value near where they were at the end of the 1970s. In our historical sample those two indices have tended to be leading indicators of the other indices. At a more detailed level, almost all the indices we examined agree that there was a sharp fall in property values between 1986 and 1987 which was not registered in the appraisal-based RN Index. The same thing happened from 1989 to 1990. After that, even the appraisal-based index began falling rapidly.

Some interesting differences also emerge across the several indices, which reveal and illustrate aspects of the index construction methodology as well as the nature of commercial property markets. All of the indices show greater volatility in their annual real returns than does the appraisal-based RN Index. However, with the exception of the REIT Index and the Hedonic Index, the annual real return volatility is less than twice as much as that of the appraisal-based index.[33] The high volatility on the part of the REIT and Hedonic Indices is largely transient (note that the overall magnitude of the broad-scale rise and fall is not appreciably greater in these indices than it is in the others), and may be attributable to noise in both cases, though for different reasons (estimation error in the case of the Hedonic Index, stock market trading noise in the case of the REIT Index). The fact that the unlevered REIT Index rose as high in the mid-1980s and subsequently fell at least as far as the property market based indices suggests that REITs were not immune to the (in retrospect) "overvaluation" that commercial property experienced in the mid-1980s.

Table 3 shows rather mixed indications regarding the commercial property beta or correlation with the stock market, as represented by the S&P 500. The REIT Index and the transactions-based indices (particularly the Hedonic Index) show rather substantial (for real estate) positive betas, while the RN and unsmoothed indices show virtually no contemporaneous beta.

An interesting pattern appears in the lead/lag relationships among the indices, which we believe tells more about the operation of the property market than the differences in short-run volatility. The lead/lag relationships can be discerned visually in Figure 9, and statistically in Table 4. The table shows the cross-correlation in the annual real returns between the appraisal-based RN Index and the other indices, leading and lagged one and two years. The REIT Index appears to register value changes first, typically two years ahead of the RN Index, and even ahead of the Full-Information Value Index. In fact, though not reported in Table 4, the cross-correlation between the Full-Information Value Index returns and the REIT Index returns one year previous is 48%, suggesting even the Full-Information Value Index property market returns (which were generated under a weak-form efficient markets assumption) are somewhat predictable (inconsistent with semi-strong form efficiency, and hence, not really "full-information" values). The Full-Information Value Index comes next in time, leading the Market Value Index (correlation between the Market Value Index returns and the Full-Information Value returns one year previous is also 48%). Finally, the appraisal-based RN Index and the two transactions-based indices come last, with some evidence that the transactions-based indices actually lag the appraisal-based index. While statistical and data problems in constructing the transactions-based indices may at least partially account for their lagging the appraisal-based index, the data at least suggests that transactions prices do not lead the appraisal-based index.

This pattern of leads and lags suggests that the securitized public exchange markets are quickest at information aggregation (although they are also subject to noise, which tends to obfuscate their information signal), that the private property markets are somewhat sluggish, and that institutional investors in the property market try to hold onto properties and not sell them until and unless they can get buyers to pay appraised values. This latter point is indicated by the fact that transaction prices appear to be contemporaneous with (or slightly lagged behind) appraised values, and above the constant-liquidity market values during the recent down-market. Pension fund investment advisors may generally avoid selling properties when the market is down, to avoid realizing losses. In such an environment, deals may only be able to be consummated in the rare cases where a buyer in effect agrees to "buck the market" and pay a relatively high price for a property. In effect, pension funds (and their advisors) are accepting reduced liquidity in an attempt to reduce volatility (or at least the down-side effect of volatility in property market values), electing to hold onto properties hoping for a turnaround. Table 1 (in Section 3) provides additional evidence that this type of reduction in liquidity was occurring, as indicated by the reduction in frequency of property transactions in the database starting in 1990 (reversing a previous trend).

In summary, it is clear that researchers and investors should not rely on any single index methodology, as each has its strengths and weaknesses. By examining several indices together, an overall impression of the historical reality is obtained, as well as insight on the functioning of the commercial property market, and the characteristics of the different index construction techniques.

Appendix: Derived Index Value Levels

The annual (year-end) nominal property value levels for the five indices derived in this paper are presented below, indexed to 1982 = 1.00:

End of Year	Full-Info	Market	NOI/Cap	Hedonic	REIT
1978	0.7232	0.7556	1.0047		0.7301
1979	0.8106	0.8396	1.0017		0.8110
1980	0.8742	0.9013	0.9118		0.8551
1981	1.0142	1.0086	0.8642		0.8315
1982	1.0000	1.0000	1.0000	1.0000	1.0000
1983	1.1460	1.1119	1.0571	1.1084	1.1310
1984	1.1866	1.1717	1.1507	1.2703	1.1696
1985	1.1434	1.1532	1.2501	1.3523	1.0339
1986	1.1349	1.1397	1.2874	1.5335	1.1229
1987	1.0527	1.0563	1.2403	1.3391	0.9004
1988	1.1176	1.0795	1.1931	1.2833	0.9120
1989	1.1241	1.0633	1.2461	1.3071	0.8019
1990	0.9756	0.9229	1.1553	1.2185	0.5881
1991	0.8200	0.7489	1.0172	1.3180	0.7192
1992	0.8306	0.6742		0.9631	0.7367

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Notes

1. The RN-Index is compiled by the Frank Russell Company for NCREIF, and was formerly known as the FRC Index.
2. See Geltner (1989, 1991), Ross and Zisler (1991), and Webb, Miles, and Guilkey (1992).
3. Indexed to a value of 100 in the fourth quarter of 1978, the RN peaked at 151 in the fourth quarter of 1985, and still hung at 147 in the fourth quarter of 1989. It then fell to 108 by the end of 1992. The RN values are nominal as opposed to real (i.e., in current dollars, not adjusted to remove inflation).
4. See Quan and Quigley (1989, 1991). While these arguments apply most directly to the so-called Market Comparison Approach to appraisal, the Income Approach (more widely used for large commercial properties) indirectly also relies on market comparisons in that the capitalization rate and/or the forecasted income growth rate and discount rate will often be influenced by observable transaction prices of similar properties.
5. Purely random valuation errors will tend to cause individual property valuations to be more volatile across time at the disaggregate level. However, purely random valuation errors cancel out and diversify away in the aggregate, while the smoothing effects of appraisal are systematic and do not diversify away in the index.
6. An earlier application of this approach was by Blundell and Ward (1987), to the Jones-Lang-Wootton Index of British commercial property prices. Blundell and Ward reconstructed a simulated historical returns series as we do in this paper, though they did not report their simulated historical values.
7. We shall see later in this paper that there is evidence that the Full-Information Value Index, though exhibiting weak-form efficiency, may not be efficient in the semi-strong sense, as returns in the REIT-based Index appear to lead even the Full-Information Value Index. In this sense, full-information may be a misnomer. The name of the index should not be taken too literally, but merely as a convenient label that connotes, relatively speaking, a distinguishing characteristic of the index construction method.
8. Note that e_t is not a zero-mean residual, but rather may be viewed as the combination of a constant term with a value equal to $w_0E[r_t]$ plus a zero-mean component equal to $w_0(r_t - E[r_t])$. Note also that (2), with parameters defined as in (2a) and (2b), follows by direct algebraic manipulation from (1), with no additional assumptions.
9. An alternative condition for specifying w_0 is to equate the mean appraisal-based return to the mean underlying return for the sample mean: $E[r_t^*] \equiv E[r_t]$. The results based on this alternative condition are virtually identical to those obtained using the volatility condition reported here.
10. See, for example, Salomon Brothers' periodic surveys of professional investors' expectations about real estate risk and returns (e.g., Salomon Brothers, 1992).
11. In practice, this is not a serious restriction, as longer order autoregressive models can usually be well approximated by shorter order models. This question was explored by experimenting with ARMA specifications, in which it was found that the AR(1, 4) model used here is not significantly improved upon by the addition of MA terms.
12. Optimal behavior is defined based on minimum mean-square-error prediction of disaggregate transaction price based on a "market method" appraisal model. Geltner (1989) suggests a less formal behavioral rationale for the first-order specification, and Clapp and Giacotto (1992) relate this model to the Kahlman Filter. Blundell & Ward (1987) were the first to use the simple exponential smoothing model to unsmoothed appraisal-based returns.

13. The regression is estimated on inflation-adjusted appreciation returns with 56 quarterly observations from 1979.1 through 1992.4, $R^2 = .559$, and $D - W = 2.12$. The model specification and parameter estimates are similar to those reported previously by Ross and Zisler (1991) and Goetzmann and Ibbotson (1990) using similar data.
14. The number of properties sold from the RN-Index are too few to construct the Hedonic Index derived in the following section prior to 1982.
15. This model is based on the assumption that at the disaggregate level appraisers making annual reappraisals of individual properties within the RN Index effectively apply a simple exponential smoothing model with a smoothing parameter of 0.5:

$$V_t^A = (0.5)V_t + (0.5)V_{t-1}^A,$$

where V_t^A is the appraised value of the property at time t, and V_t is the true market value. Because of temporal aggregation (moving average) and seasonality effects, the aggregate smoothing model has a different smoothing parameter (see Geltner, 1993b).
16. Note that the market value concept is to be distinguished from the empirically observed transaction prices that underlie other indices we construct later in this paper. A market value index treats liquidity as being constant across time, whereas transactions price-based indices may reflect changing liquidity across time.
17. It should be noted that the RN Index is, relatively speaking, more volatile at the annual level than at the quarterly level, because of the staggered annual reappraisal of properties bunched in the fourth quarter. Mathematically, the strong positive fourth-order autocorrelation in the quarterly RN returns imparts a more than proportional increase in the variance as one moves from quarterly to annual frequency returns series. In other words, working with annual instead of quarterly returns gets rid of some smoothing.
18. This definition of market value is essentially the same as that applied by appraisers, and therefore should be reflected in the values that underlie an appraisal-based index such as the Russell-NCREIF. Thus, if the previously described Market Value Index has correctly recovered these underlying values from the RN Index, then it represents such a "constant-liquidity" index.
19. The difference may be explained by analogy to the stock market. Suppose all sellers of a given stock placed limit orders in which the limit price was above the then-current market value (i.e., there were many fewer bids at the limit price than there were offers). Very few transactions would take place and the market for that stock would lose its liquidity. But all the (few) transactions that did take place would occur at the limit price, which would be the observed closing price for the stock that day.
20. This is essentially the same type of approach as that used by Liu et al. (1990a, b) to correct for appraisal smoothing in their studies applying the CAPM to real estate.
21. In essence, the NOI value level index is created by multiplying the RN income return times the RN Index appreciation value level the previous period. Given the definition of the income return (NOI divided by the previous period property value), and assigning an arbitrary initial value to the resulting implied NOI series, this will result in a sort of constant property NOI level index.
22. One explanation for a slight lag behind appraised values is that the transactions in the ACLI data may have been agreed upon several months prior to the time of closing and reporting into the ACLI database. Thus, some transactions reported in the fourth quarter may actually reflect deals struck in the third or second quarter.
23. The "stabilized NOI" is meant to represent the level at which the NOI of the building will ultimately stabilize for a long period of time, for example, after a lease-up or re-leasing period is completed.
24. According to this formula, the cap rate equals the loan/value ratio times the annual mortgage constant, plus the equity/value ratio times a subjectively estimated equity dividend rate required by investors. The ACLI cap rate is in fact closely approximated by this formula (with a constant equity dividend rate of 10 percent) during the late 1970s and early 1980s.
25. In the transactions-driven approach, coefficients on the independent variables are not re-estimated in each period of time, and time dummy variables are also not included in the model. Instead, the values of the independent variables are updated each period and the transactions-driven index is constructed by applying the same valuation model (same regression coefficients) to the updated independent variable values each period. As the independent variables are largely cross-sectional in nature, they tend to remain relatively constant over time, resulting in the very smooth value index found by Webb-Miles-Guilkey (1992).

26. See, for example, Bailey, Muth, and Nourse (1963), Bryan and Colwell (1982), Pollakowski (1987), Case and Shiller (1989), Clapp and Giacotto (1992).
27. See Webb-Miles-Guilkey (1992) for further description of the cross-sectional variables. We thank a reviewer for pointing out that some of our cross-sectional regressors, although constant across time for each property during the period when the property remained in the database, may vary across time in the sense that different properties are in the database at different times. Thus, our cross-sectional variables are not pure hedonic variables in that some time-variation in value may be picked up in our cross-sectional regressors and omitted from the coefficients on the time dummies, biasing our Hedonic Index to show less variation across time. We agree that this is a potential concern. However, after experimentation with alternative model specifications, we believe that in this case the nature of our cross-sectional variables does not seem to be causing a major problem in this regard. In an alternative specification omitting all cross-sectional variables except the property type dummies, functionality, and location (leaving only variables that could not possibly change with the period of time in which the property remained in the database), the resulting index returns were highly contemporaneously correlated with the reported Hedonic Index (over 91%), and with virtually equal volatility, but much higher negative first-order autocorrelation (over 46%), and a historical profile of implied property values that seemed less realistic (peaking in 1991 instead of 1986). This suggests that the more purely hedonic specification results in an excessively noisy value index. Accordingly, we have based our Hedonic Index on the specification in Table 2.
28. In other words, the Hedonic Index portrays an annual average transaction price, averaged across the entire calendar year. Equating the calendar year value of the Hedonic Index to those of the other indices (which are end of year spot, or fourth quarter, values) will result in some apparent lagging in the Hedonic Index (theoretically about a half year) relative to the other indices. A slight additional lag may be caused, as with the NOI/Cap Index, by the fact that the transaction observations are dated at the time of the transaction closing, rather than at the time when the deal was struck.
29. Recall that the time dummy coefficients are realizations of random variables, estimated from the sample of transactions which our database happens to include in each year. Price estimation errors that are purely random (independent across time), impart negative first-order autocorrelation into the returns series.
30. Recall that the deals in our transaction sample consist only of properties sold from the Russell-NCREIF database. It is thus a sample of sells with no buys included. As pension funds are tax-exempt, there is no tax incentive to realize losses through sales, while there may be agency incentives to avoid loss realization by avoiding sales, for example, if the advisor's compensation is based on performance in capital preservation or appreciation. Unfortunately, we have no information on the opposite parties (on the buy side) of the transactions in our database.
31. Although some REITs are less liquid than large capitalization stocks, all publicly traded REITs are much more liquid than property traded directly in the private markets.
32. The volatility is transient in the sense that the REIT values seem to be varying around the same long-run trend values as those that underlie the other indices, with the REITs apparently leading that trend in time.
33. This is less smoothing than has been found in some previous studies, in part because of the use of annual as opposed to quarterly returns, and in part because by 1992 the appraisers were catching up with the fall in property values, greatly increasing the volatility in the appraisal-based index.

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