

Estimating Market Values from Appraised Values without Assuming an Efficient Market

David Geltner*

Abstract. This paper presents an approach to recovering the underlying market value returns from observable appraisal-based index returns, without presupposing or constraining the market value returns to be unpredictable or uncorrelated across time. A structural/behavioral model is developed relating the publicly reported index returns to the underlying market returns. The procedure presented here explicitly corrects for appraisal smoothing at the disaggregate level, as well as for the aggregate index construction effects of temporal aggregation and seasonality of reappraisals. This procedure is applied to the Russell-NCREIF and Evaluation Associates Index returns to generate estimated series of market values and market returns for unsecuritized institutional-grade commercial properties in the United States.

Introduction

Appraisal-based indices such as the Russell-NCREIF Index (RNI) and the Evaluation Associates Index (EAI) are the major source of empirical time-series data on unsecuritized commercial property returns in the United States.¹ It has long been recognized that indices such as these are “smoothed” and/or “lagged” due to the combined effects of appraisers’ partial adjustments at the disaggregate level plus temporal aggregation in the construction of the index at the aggregate level. This causes second moments of such series to be generally biased toward zero, thwarting the analysis of the risk characteristics of commercial property.

Previous researchers have attempted to correct for the smoothing in appraisal-based indices by invoking the assumption that the true underlying property returns series is uncorrelated and unpredictable across time, as would be suggested by efficient market theory. Under this assumption empirical statistical techniques can be used to recover relatively unbiased estimates of the second moments of the true returns (see Geltner, 1989, 1991; Ross and Zisler, 1991; Gyourko and Keim, 1992; Fisher et al., 1993).

The purpose of the present study is to describe an approach to correcting the smoothing and lagging in the publicly reported appraisal-based indices *without assuming a priori* that the true market returns are uncorrelated or unpredictable. Instead of assuming that the true returns are unpredictable, we model the structure of the publicly reported index returns, including explicit consideration of the effects of

*Department of Finance, College of Business Administration, University of Cincinnati, Cincinnati, Ohio 45221-0195.

Date Revised—October 1992; Accepted—May 1993.

appraisal smoothing, temporal aggregation, and seasonality of reappraisals. We quantify the model using plausible assumptions about rational appraisal behavior and what we know about how the appraisal-based indices are constructed. This quantitative structural model relating the reported index returns to the market returns can then be "inverted" and applied to the reported index returns to recover the implied market returns.²

The reason for pursuing this alternative approach is that unsecuritized property markets may not be informationally efficient, and may have returns series that are somewhat predictable. Findings by Case and Shiller (1989, 1990) regarding returns to single-family homes show considerable evidence of inertia and predictability in the returns to that type of property in several U.S. cities during the 1970s and early 1980s.³ Regarding commercial properties, conventional wisdom has long held that real estate values are cyclical, tending to follow a long cycle of approximately a decade in duration (see Pyhrr et al., 1989; Wheaton, 1987; among others). Recent studies by Giliberto (1990) and Gyourko and Keim (1992) have found evidence that REIT returns in the U.S. stock markets predict unsecuritized returns to commercial properties traded in private markets, a finding that may cast doubt on the notion of semi-strong form efficiency in the private property markets.⁴ Hendershott and Kane (1992) have also suggested that the long fall in commercial property values that has occurred since the mid-1980s was (or should have been) predictable.

The Nature of the Appraisal-Based Indices

In order to recover the market return series that underlie the reported returns in appraisal-based indices such as the RNI or EAI, we need to consider in some depth the structure of the reported index returns. The RNI and EAI are quite similar and include substantial duplication of properties. The EAI begins in 1968, whereas the RNI begins in 1977. However, the RNI reports income and appreciation return components separately, while it is necessary to approximate the price appreciation of the EAI by estimating from other sources the income return or yield component each period.⁵ The RNI also provides more information about the properties it includes. The RNI currently includes over 1500 properties with an aggregate appraised value of over \$22 billion. The EAI currently includes over one hundred all-equity property funds each of which contains multiple properties. Both indices report unlevered property values, not the value of levered equity positions in properties. The properties in both indices are widely diversified both geographically and by property type.

Each index is compiled and reported quarterly. However, it is important to note that the valuations of most individual properties included in the indices are effectively updated only annually. Each quarter some properties have their valuations updated, and others do not. Properties whose values are not updated in a given quarter are reported in the index that quarter as having the same value they had the previous quarter. More properties are revalued in the fourth calendar quarter than in other quarters. This tends to cause fourth-quarter returns in both indices to be of greater absolute magnitude during periods when property prices are moving consistently in one direction (either up or down).

Because of the generally annual reappraisal of most individual properties in the

RNI and EAI, it seems difficult and perhaps even slightly misleading to attempt to derive quarterly appreciation return series from these indices. In addition, treatment of the effect of appraisal and aggregation smoothing is facilitated by working with annual returns. Therefore, in the present paper we shall work with annual returns derived by taking the annual percentage change in the index value levels from the fourth quarter of one calendar year to the next.

The relationship between the reported index returns and the underlying market returns is affected at two levels in the construction of the index returns. First, at the disaggregate or individual property level, the valuations are appraised values rather than actual transaction prices or market values. Second, at the aggregate or index construction level, the appraised values of individual properties made as of various points in time are averaged together to produce an index value reported for a specific calendar quarter. This averaging across time, or "temporal aggregation," further affects the temporal structure of the relationship between the reported returns and the underlying market returns. These effects are considered in depth in the following sections.

Appraisal Smoothing at the Disaggregate Level

At the disaggregate level the reported appraised values are appraisers' estimates of the market value or most likely transaction price of each property at some specified point in time. Purely random errors in value estimates of individual properties should largely cancel out and diversify away in an index composed of a large cross-section of many individual properties, as is the case for the RNI and EAI. However, it is widely believed by practitioners that appraisers tend to "smooth" or only "partially adjust" property values over time. This type of valuation error would be systematic, and not tend to diversify away in the index. For the properties in the RNI and EAI it is common for the same appraiser or appraisal firm to perform the valuation of a given property year after year. Thus, the appraiser will typically be aware of the previous appraised value. Many practitioners believe that it is more difficult for the appraiser to report and explain or justify a large change in value from the previous year than a small change.⁶

Whatever institutional incentives exist for appraisers to only partially adjust for value changes, there is in fact also good theoretical reason for a conscientious appraiser to engage in this type of behavior. To get an idea of what is the current market value of a property they are appraising, appraisers depend on empirical observations of the transaction prices of other similar properties as well as of other relevant data. Such empirical observation will never give a perfectly clear or definitive indication of exactly what the current market value is for the subject property (or even for a comparable property that actually transacted, as one party in the transaction may have "erred" in the price he agreed to pay). Thus, there will (and *should*) always be some uncertainty in the appraiser's mind as to what is the current market value of the subject property.

In these circumstances, as pointed out by Quan and Quigley (1989, 1991), it is rational (that is, it minimizes the mean squared difference between the appraised value and the market value) for the appraiser to use a simple Bayesian updating rule, which

amounts to a partial adjustment or adaptive expectations approach to estimating the property value at each point in time.

This "rational appraisal" model can be represented formally as follows. Let V^*_{t-1} be the previous appraised value made in year " $t-1$ ". Let V^E_t be the current imperfectly observable empirical indication of the market value, V_t .⁷ Thus

$$V^E_t = V_t + e_t, \quad (1a)$$

where e_t is a purely random error. Then the optimal or rational appraised value for year " t ," is given by

$$V^*_t = \alpha V^E_t + (1 - \alpha)V^*_{t-1}, \quad (1b)$$

where α is a fraction between 0 and 1 given by the following ratio

$$\alpha = \text{VAR}[r_t] / (\text{VAR}[r_t] + \sigma_e^2), \quad (1c)$$

where σ_e^2 is the instantaneous variance in the empirical observation error e_t as a percent of V_t ; and $\text{VAR}[r_t]$ is the variance per year in the market return: $r_t = (V_t - V_{t-1})/V_{t-1}$.

Note from (1a) and (1b) that

$$V^*_t = \alpha V_t + \alpha e_t + (1 - \alpha)V^*_{t-1}. \quad (1d)$$

In this form the intuition behind this appraisal rule is clear to see. If one sets α too large (near unity), too much weight will be attached to the spurious factor e_t , causing a large potential error in the appraised value for the property. If α is set too small (near zero) then not enough weight is attached to the current true market value V_t (or, in particular, to the *change* in market value since time " $t-1$," as V_{t-1} embedded in V^*_{t-1}).

It is important to note that in an aggregate index e_t will largely diversify away across properties. The result is that the following model, which leaves out the e_t term, will well represent the effect within an aggregate index of appraisal smoothing at the disaggregate level.

$$V^*_t = \alpha V_t + (1 - \alpha)V^*_{t-1}. \quad (1e)$$

Thus, for our purpose of modelling the appraisal-based aggregate index return structure, (1e) will serve to represent the relation between property appraised value and market value.

Equation (1e) also demonstrates an important point with some practical implications for appraisal policy. Clearly the optimal level at which to set α for purposes of appraising an individual property is not the same as the optimal level for purposes of constructing an aggregate index where the random individual property errors will diversify away. In (1e) it is apparent that the optimal level for α is unity. Nevertheless, under present policy appraisers are hired to produce optimal appraisals for *individual* properties, for which the optimal level of α is clearly less than unity.

The Structure of the Reported Index Returns

The effect of this "appraisal smoothing" is to reduce the volatility and increase the positive autocorrelation in the index return series. This effect from the disaggregate or

individual property level is compounded at the aggregate or index level by temporal aggregation, as some properties have not been reappraised at all during the current quarter, so their values are reported as unchanged (actually, as the appraised values from previous quarters). On the other hand, quarterly volatility is increased and fourth-order autocorrelation introduced in quarterly index returns series by the fact that more properties are reappraised in the fourth calendar quarters than during other quarters. Indeed, it appears from the magnitude of the fourth-order autocorrelation in the quarterly return series than within the RNI and EAI more properties are generally reappraised during the fourth calendar quarter than during all three preceding quarters combined.⁸

The effect that these aggregation phenomena have on the relationship between the reported index returns and the underlying market returns is developed quantitatively in Appendix A. There, it is argued that the relationship of the reported index annual return to the underlying market annual return is well modelled by the following infinite-order transfer function.

$$\begin{aligned} r^{**}_t = & (\alpha/2) (2 - 3f)r_t^U + (\alpha/2) (2 - 2\alpha + 3\alpha f)r_{t-1}^U \\ & + (\alpha/2) (2 - 2\alpha + 3\alpha f) (1 - \alpha) r_{t-2}^U \\ & + (\alpha/2) (2 - 2\alpha + 3\alpha f) (1 - \alpha)^2 r_{t-3}^U + \dots, \end{aligned} \quad (2)$$

where:

- r^{**}_t = the publicly reported index return for year "t";
- r_t^U = the underlying market return in the unsecuritized property market;
- f = the fraction of properties in the index reappraised in each of the first *three* calendar quarters of the year;
- α = the disaggregate level appraisal smoothing factor (confidence factor) as defined in equation (1) above.

Equation (2) allows us to note the effects in the observed index returns caused by the three "behavioral" phenomena: appraisal smoothing at the disaggregate level, temporal aggregation, and seasonality of reappraisals. For example, suppose there were no appraisal smoothing at the disaggregate level ($\alpha = 1$) and no seasonality in the reappraisal of properties ($f = 1/4$), then we would observe the "pure" effect of temporal aggregation in the annual returns (the fact that properties are reappraised only once per year staggered at the ends of the four calendar quarters). Substituting $\alpha = 1, f = 1/4$ into (2) would give

$$r^{**}_t = (5/8)r_t^U + (3/8)r_{t-1}^U, \quad (2a)$$

which is a simple finite-order moving average of the market return.⁹

On the other hand, suppose there were no temporal aggregation, with all properties reappraised as of the end of the calendar year ($f = 0$), then we would observe the pure affect of appraisal smoothing. substituting $f = 0$ into (2) gives

$$\begin{aligned} r^{**}_t &= \alpha r_t^U + \alpha(1 - \alpha)r_{t-1}^U + \alpha(1 - \alpha)^2 r_{t-2}^U + \dots \\ &= \alpha r_t^U + (1 - \alpha)r^{**}_{t-1}, \end{aligned} \quad (2b)$$

which is classical simple exponential smoothing and closely akin to a first-order autoregressive function of the observed index return. Note that (2b) is the same as the

aggregate level as the disaggregate appraisal smoothing model (1e) at the individual property level.

The combined effect of appraisal smoothing and temporal aggregation (with no seasonality) is given by substituting $f=1/4$ into (2)

$$r^{**}_t = (5\alpha/8)r^U_t + \alpha(1 - 5\alpha/8)r^U_{t-1} + \alpha(1 - 5\alpha/8)(1 - \alpha)r^U_{t-2} + \alpha(1 - 5\alpha/8)(1 - \alpha)^2r^U_{t-3} + \dots \quad (2c)$$

The effect of seasonality in the reappraisals (that is, the bunching of reappraisals in the fourth calendar quarter) is to shift the transfer function toward the first-order autoregressive (2b) from the infinite-order moving average (2c).

Recovering the Underlying Market Returns from the Reported Index Returns

Because (2) is generally of infinite order without a regular pattern in the transfer weights, it is impossible to express r^{**}_t as a purely autoregressive function. (We saw above that this would be possible in the special case where $f=0$, but we know this is not the case in the real world appraisal-based indices.) This is unfortunate as a practical matter, because we need to be able to express r^{**}_t as a finite-order autoregressive function in order to be able to “invert” (2) to recover the underlying unsecuritized market return series $\{r^U_t\}$ implied by the reported index returns $\{r^{**}_t\}$. However, it is clear that in practice (2) is *very similar* to a first-order autoregressive representation of r^{**}_t , because the lag zero transfer coefficient will normally be larger than the lag 1 coefficient, and all coefficients beyond lag 1 are exponentially declining. Thus, for a suitably chosen value of the parameter “ a ,” relation (3), below, will have transfer weights very similar to (2)

$$\begin{aligned} r^{**}_t &= ar^U_t + (1 - a)r^{**}_{t-1} \\ &= ar^U_t + a(1 - a)r^U_{t-1} + a(1 - a)^2r^U_{t-2} + \dots \end{aligned} \quad (3)$$

Relation (3) is easily inverted to recover the market return series from the observable index returns

$$r^U_t = (r^{**}_t - (1 - a)r^{**}_{t-1})/a. \quad (3a)$$

Exploitation of the “nearness” of the actual transfer function model (2) to the first-order autoregressive function (3) is the basis upon which we propose to recover an estimate of the actual unsecuritized market returns series values, $\{r^U_t\}$, from the publicly reported appraisal-based index returns data, $\{r^{**}_t\}$.

To implement the above-described procedure we must choose plausible values of the disaggregate-level appraiser “confidence factor,” α , and of the seasonality factor, “ f ”. We can then quantify the transfer coefficient weights in (2), so that we may pick a value of “ a ” in equation (3) that yields weights similar to those of (2).

The seasonality factor ‘ f ’ is relatively easy to quantify for the RNI and EAI indices. Both these indices are characterized by high fourth-order autocorrelation in their quarterly returns and by average quarterly returns during the fourth quarter greater than that during the other quarters. The period 1978.1 through 1985.4 was a

period during which the level of both the RNI and EAI was consistently rising, indicating consistently positive appraisal-based appreciation returns. The fact that the fourth-quarter mean is nearly 3.5 times greater than the quarterly mean for the other quarters during this period suggests that some 3.5 times more properties are typically appraised during the fourth quarter than in each of the other quarters. This suggests that we apply a value of $f=.15$ in equation (2). This would imply that effectively 55% of all properties are reappraised during the fourth calendar quarter.

Putting a plausible value on the appraisers' confidence factor α is a bit more difficult. Clearly α will not be very near to either 0 or 1 for the reasons discussed earlier. Furthermore, there is a strong argument that for annual reappraisals the "rational" or "optimal" level for α , according to formula (1c) described previously, is near $\alpha=(1/2)$. The standard deviation of e_t may be approximated by the spread of transaction prices around recent appraised values for individual properties. That is, if we take the difference between the transaction price and the most recent appraised value for a cross-sectional sample of properties that sold shortly after being appraised, then the standard deviation of this difference (as a fraction of the appraised value), should well represent the magnitude of σ_e . Empirical evidence of this statistic for properties in the RNI is reported in Miles et al. (1991) to be slightly less than 10%. Thus $\sigma_e \approx 10\%$, or $\sigma_e^2 \approx .01$, would seem to be a good estimate for application of formula (1c).

Conventional wisdom among institutional investors has it that the volatility of commercial property returns is about one-half that of the stock market.¹⁰ Annual volatility in the stock market is about 20%, suggesting that a plausible figure for $\text{VAR}[r_{jt}]$ in formula (1c) is also about $(10\%)^2$, or .01.

We may thus quantify the "optimal" or "rational" value for α as given approximately by formula (1c) as

$$\alpha = \text{VAR}[r_{jt}] / (\sigma_e^2 + \text{VAR}[r_{jt}]) \approx (.01) / (.01 + .01) = (1/2).$$

In the absence of concrete evidence to the contrary, it would seem reasonable to assume that appraisers do indeed behave optimally or rationally in this sense, suggesting that we apply a value of $\alpha=.50$ in equation (2).

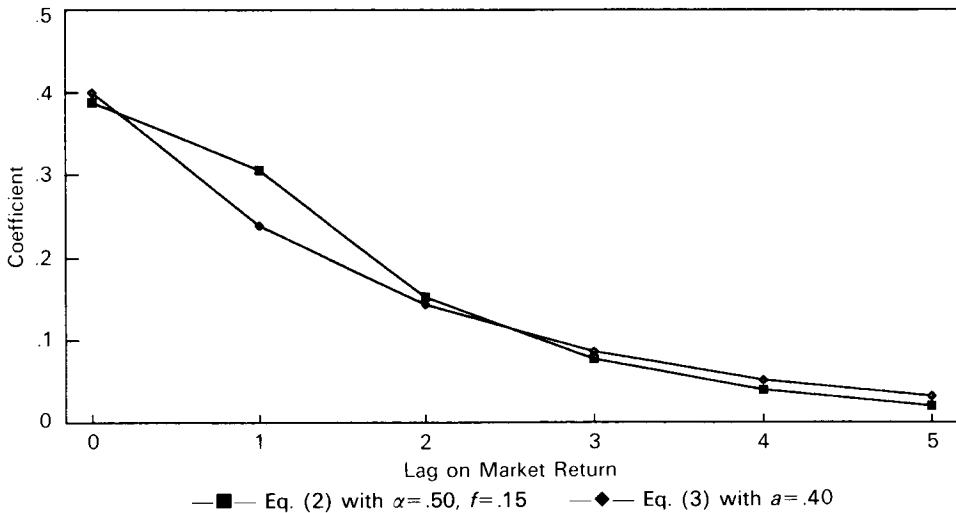
Using equations (2) and (3) it is straightforward to find the value of the parameter "a" in (3) which minimizes the difference between the transfer coefficients in (2) and those in (3). Assuming $\alpha=.5$ and $f=.15$, $a=.40$ will give transfer function lag weights in (3) that are very similar to those in (2), as shown in Exhibit 1. It is clear from the figure that equation (3) with $a=.40$ is very similar to equation (2) with $\alpha=.5$ and $f=.15$. In other words, if we set $a=.40$, we may use (3) as an approximation of (2) with $\alpha=.5$ and $f=.15$.

To summarize the proposed procedure for recovering an estimate of the underlying market return from the publicly reported index returns, we would define a simulated series, labelled $\{r^U_t\}$ defined according to equation (3a) as

$$r^U_t = (r^{**}_t - (1 - a^\circ)r^{**}_{t-1}) / a^\circ, \quad (4)$$

where: $\{r^{**}_t\}$ is the reported returns series for either the RNI or EAI; and $a^\circ=.40$ in this case (under the assumption that $\alpha=.50$ and $f=.15$). This $\{r^U_t\}$ series would be our estimate of the underlying market returns series for the unsecuritized properties market index, $\{r^U_t\}$.

Exhibit 1

Transfer Function Lag Weight Coefficients for Equation (2) with $\alpha = .50$ and $f = .15$, versus Equation (3) with $a = .40$ 

Expressing this procedure as a “model” of the true return in terms of the observed index return, with an explicit random error term, we have

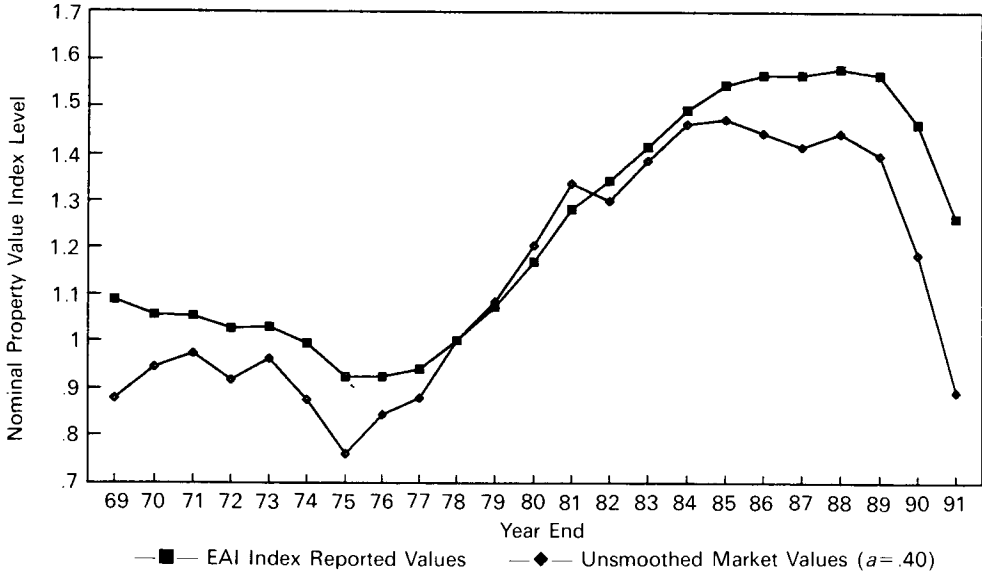
$$r^U_t \equiv (r^{**}_t - (1 - a^\circ)r^{**}_{t-1})/a^\circ = r^U_t + v_t. \quad (5)$$

The error term, v_t , reflects various sources of error, including:

- (i) purely random appraisal error represented by the e_t term dropped out between equations (1d) and (1e);
- (ii) the approximation of the “true” (and probably nonstationary) values of α and f by the assumption that $\alpha = .50$ and $f = .15$, leading to the fixing of $a^\circ \equiv .40$;
- (iii) the simplifying assumption made in Appendix A that the returns to the first “q” quarters in each calendar year deterministically equalled $(q/4)$ times the annual return for that calendar year; and
- (iv) the approximation of the noninvertible infinite-order moving average equation (2) by the first-order autoregressive equation (3).

Error source (i) is purely random and almost certainly minor in an aggregate index, where individual property random errors tend to cancel out and diversify away.¹¹ Extensive simulation analysis of the effects of error sources (ii), (iii) and (iv) suggests that these sources of error do not cause major problems in recovering a good estimate of the true returns. In the simulations the recovered series were very highly correlated with the true returns (over 90%), and had volatility and autocorrelation nearly identical to the true series, whether or not the true series was unpredictable or highly autocorrelated.¹² However, in order to explicitly recognize the possibility of error

Exhibit 2
Smoothed and Unsmoothed EAI-Based Historical Property Values



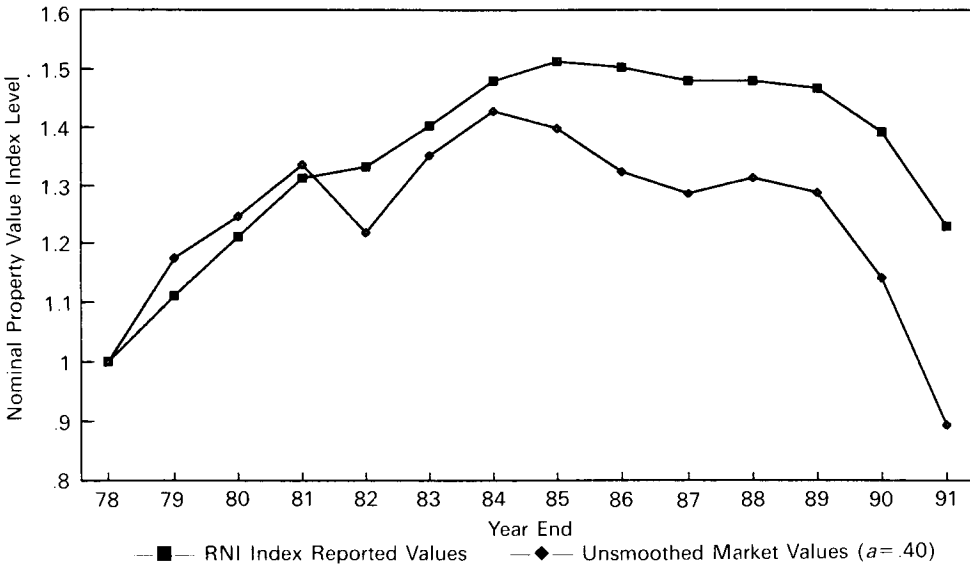
source (ii), “upper bound” and “lower bound” series will also be developed, assuming $a = .33$ and $a = .50$, respectively. This will provide some sensitivity analysis allowing, in effect, for alternative values of α and f .

Applying the Procedure to the RNI and EAI Indices

Exhibits 2 and 3 show the nominal property value levels implied by applying the above-described procedure, based on equation (4) with $a^0 = .40$, to the EAI and RNI respectively. Equation (4) has been applied to the real appreciation return component of the reported appraisal-based indices to generate estimated market value real return series. To these returns inflation has been added, and the resulting nominal returns have been compounded to produce the value-level indices shown in the exhibits. The graphs show the original appraisal-based value levels and the corresponding estimated implied market value levels. The indices show the value levels as of the fourth quarter of each year, and have been arbitrarily set to equal 1.00 in 1978, the first year of the RNI.

Not surprisingly, the estimated market value series display more volatility than the original appraisal-based indices. The market value indices also suggest that real estate values began falling early in the second half of the 1980s decade, before the appraisal-based indices indicated much of a decline, and the market value indices show a more dramatic fall in real estate values from their peak in the mid-1980s than do the appraisal-based indices. According to the estimated market value indices, by 1991 commercial property values had fallen more than 35% from their peak values while the unadjusted appraisal-based indices were indicating a fall of only around 18%.

Exhibit 3
Smoothed and Unsmoothed RNI-Based Historical Property Values



To allow for the possibility of error in the smoothing parameter values implied by our $a = .40$ assumption, Exhibits 4 and 5 show the unsmoothed market values implied by alternative assumptions of $a = .50$ (less smoothing) and $a = .33$ (more smoothing). The alternative historical value series are all highly correlated and appear visually to tell essentially the same story. The values displayed in Exhibits 4 and 5 are presented numerically in Appendix B.

Statistical Characteristics and Comparison with REIT-Based Values

It may be informative to compare our estimated market values for unsecuritized properties with the more readily observed market values and returns of securitized commercial properties represented by REITs traded on the stock exchanges, as represented by the NAREIT Index.¹³ To do this, we need to “unlever” the NAREIT Index returns, to remove the effect of debt on both the asset and liability sides of the REIT balance sheets. This unlevering has been accomplished by the use of the following simple weighted average cost of capital (WACC) model:¹⁴

$$r_{p,t} = \{r_{E,t} - [1 - (P/E)]r_{D,t}\} / (P/E)_t, \quad (6)$$

where:

$r_{p,t}$ = unlevered property return during year t ;

$r_{E,t}$ = market return to REIT shareholders during year t , as measured by NAREIT share price index;

$r_{D,t}$ = market return to long-term Government bonds during year t , as measured by Ibbotson & Associates;

Exhibit 4
Effect of Alternative Unsmoothing Parameter Assumptions on EAI-Based Values

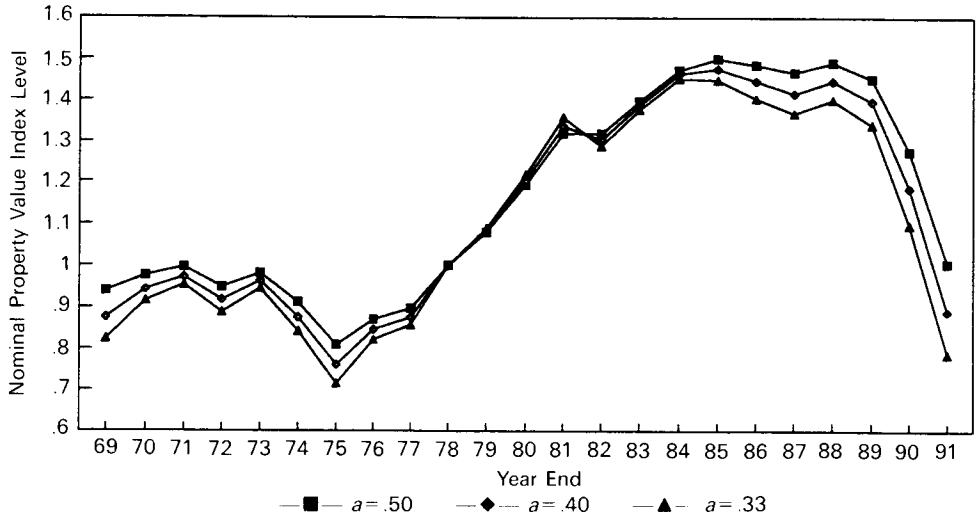


Exhibit 5
Effect of Alternative Unsmoothing Parameter Assumptions on RNI-Based Values

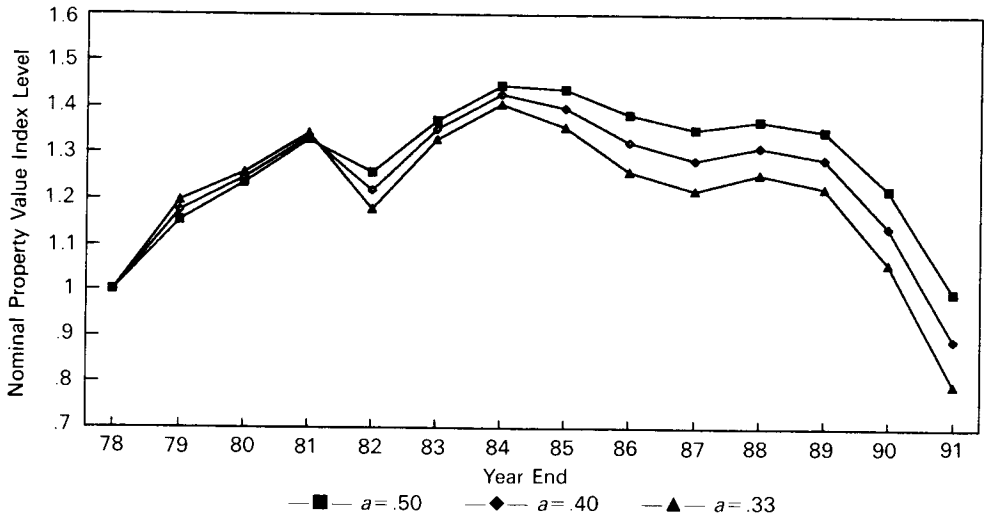
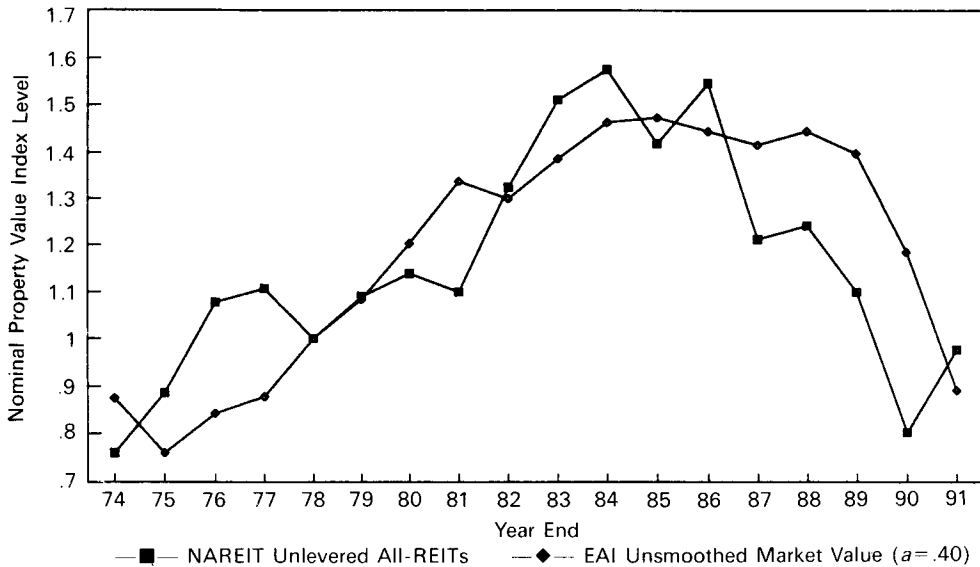


Exhibit 6
Unlevered NAREIT and Unsmoothed EAI-Based Property Values



$(P/E)_t$ = the ratio of the NAREIT composite book value of property assets divided by the book value of net shareholders' equity for all REITs at the end of year t .

It is interesting to note the broad similarity between the REIT-based historical value index and the unsecuritized market value indices recovered from the EAI and RNI Indices. Exhibits 6 and 7 display the securitized and unsecuritized property value-level indices together. The securitized values are represented by the unlevered NAREIT All-REIT Index.¹⁵ The unsecuritized values are represented by the unsmoothed EAI and RNI indices with $a = .40$ in equation (4). While the unsecuritized market values appear to have less short-run (i.e., annual) volatility, and to lag the REIT values slightly, both types of markets portray a broadly very similar picture. The relative amount of rise and fall appears to be quite similar between the REIT-based indices and the unsecuritized market value indices.¹⁶

Exhibit 8 displays the annual time-series statistical characteristics of the RNI and EAI real appreciation returns series, together with those of the recovered market value series based on equation (4) with $a = .40$. The statistics for the unlevered NAREIT return index are also shown, in the first column of the exhibit. The unadjusted appraisal-based series show relatively low volatility (around 5% per year) and very pronounced positive autocorrelation (with declining coefficients as the lags increase, similar to what we would expect with a first-order autoregressive process). This is in sharp contrast to the unlevered NAREIT returns, which have volatility nearly 15% and no clear evidence of any strong positive autocorrelation. The recovered unsecuritized market return series display substantially greater volatility than the unadjusted index returns, though only a little over half the volatility of the NAREIT

Exhibit 7
Unlevered NAREIT and Unsmoothed RNI-Based Property Values

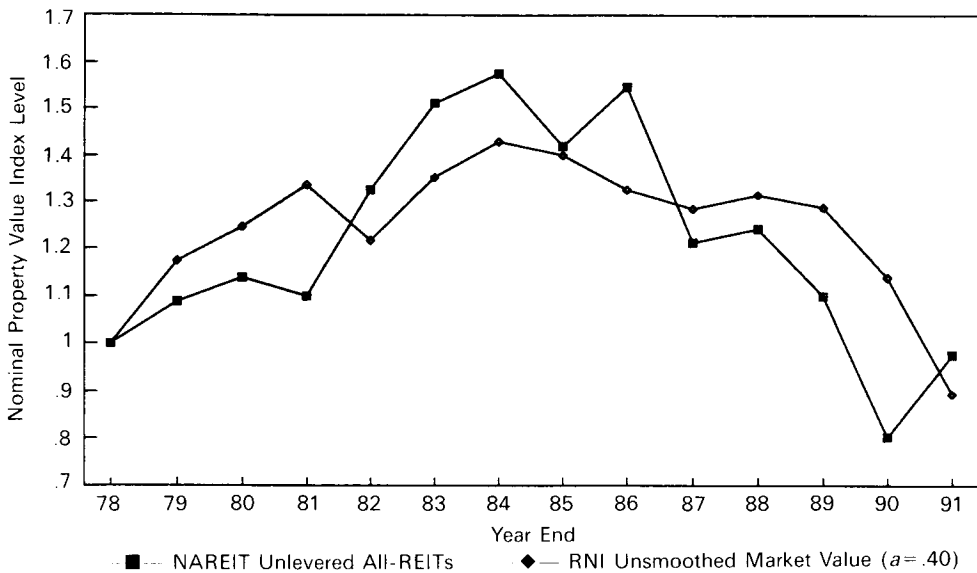


Exhibit 8
Annual Return Characteristics of RNI, EAI and NAREIT Indices*

Statistic:	Series				
	NAREIT r_t^P Unlevered	EAI-Based r_t^{**} Reported	Market r_t^U Market	RNI-Based r_t^{**} Reported	Market r_t^U Market
Arith. Mean	-.0312	-.0496	-.0524	-.0371	-.0579
Std Dev.	.1459	.0518	.0871	.0450	.0828
Autocorr. Lag 1	-.075	.634	.328	.572	.223
Autocorr. Lag 2	-.065	.320	.045	.286	.012
Autocorr. Lag 3	.060	.156	-.020	.168	-.119
Autocorr. Lag 4	-.291	.080	-.162	.058	.201
Autocorr. Lag 5	-.111	-.030	.008	-.140	.155
Std. Error	(.243)	(.213)	(.213)	(.277)	(.277)

All returns are inflation-adjusted, appreciation returns. The NAREIT returns are based on the NAREIT All-REIT index return for 1975-91, unlevered for debt on both the asset and liability sides. The EAI returns are for 1970-91. The RNI returns are for 1979-91. The unsmoothed recovered market returns are based on equation (4) with $a^ = .40$. Figures in parentheses at the bottom of each column are the standard errors of the autocorrelation coefficients.

returns. The recovered series show much less autocorrelation than the publicly reported appraisal-based index returns, but do show some evidence of positive first-order autocorrelation. The sensitivity analysis presented in Exhibit 9 generally confirms these findings.

Exhibit 9
Sensitivity Analysis: Three Alternative Unsmoothing Assumptions

Statistic:	Unsmoothed Return Series:					
	$a = .50$	EAI-Based $a = .40$	$a = .33$	$a = .50$	RNI-Based $a = .40$	$a = .33$
Arith. Mean	-.0515	-.0524	-.0534	-.0510	-.0579	-.0649
Std Dev.	.0728	.0871	.1027	.0686	.0828	.0977
Autocorr. Lag 1	.399	.328	.282	.307	.223	.164
Autocorr. Lag 2	.096	.045	.017	.075	.012	.031
Autocorr. Lag 3	-.009	-.020	-.017	-.048	-.119	-.168
Autocorr. Lag 4	-.124	-.162	-.179	.167	.201	.225
Autocorr. Lag 5	-.008	.008	.022	.102	.155	.187
Std Error	(.213)	(.213)	(.213)	(.277)	(.277)	(.277)

*Returns and periods covered are as defined by Exhibit 8.

Exhibit 10
Contemporaneous and One-Year Lagged *Betas* with Respect to the S&P500 Stock Index

Statistic:	Real Estate Series:				
	NAREIT r_t^p Unlevered	EAI-Based r_t^{**} Reported		RNI-Based r_t^{**} Reported	
		Market	Market	Market	Market
<i>Beta</i> S&P _t	.509	.044	.058	.041	.078
(Std Error)	(.262)	(.033)	(.085)	(.045)	(.176)
<i>Beta</i> S&P _{t-1}	-.067	.094	.246	.082	.302
(Std Error)	(.217)	(.035)	(.090)	(.054)	(.203)
Total <i>Beta</i>	.442	.138	.304	.123	.380
(Std Error)	(.397)	(.057)	(.146)	(.094)	(.337)

*Returns and periods covered are as defined in Exhibit 8. *Betas* are estimated in a multiple regression of the real estate returns onto the contemporaneous and lagged S&P 500 returns. The Total *Beta* refers to the sum of the contemporaneous and one-year lagged *beta*.

Exhibit 10 uses the unsmoothed market value returns developed here to shed some light on the question of the "beta" of commercial property returns with respect to the stock market. Fundamental links to the real economy suggest that both stocks and real estate ought to move generally together, suggesting that a positive *beta* should exist between real estate and stocks. However, previous studies have found that, while REITs have a positive *beta* of around one-half, unsecuritized commercial property returns seem to be uncorrelated with the stock market. The exhibit reports the contemporaneous and one-year-lagged *betas* of the real estate returns with respect to the S&P500 Stock Market Index. Exhibit 10 reveals that, based on the unsmoothed market returns, even the unsecuritized property returns may have a small, but sub-

stantially positive *beta*, at least if one includes both the contemporaneous and one-year-lagged *betas* together. The one-year-lagged *betas* shown here are noticeably larger than any *betas* previously found between unsecuritized property returns and a broad stock market indicator such as the S&P500.

Summary and Conclusions

This paper has presented an approach to recovering the underlying market value returns from publicly reported appraisal-based index returns, without presupposing or constraining the market value returns to be unpredictable or uncorrelated across time. The procedure uses a structural/behavioral smoothing model, with judgmentally estimated parameters, to correct for appraisal smoothing at the disaggregate level, as well as for the aggregate index construction effects of temporal aggregation and seasonality of reappraisals. This procedure has been applied to the RNI and EAI returns to generate estimated series of market values and returns for unsecuritized commercial properties in the United States. These "unsmoothed" values are presented in Appendix B.

The recovered unsecuritized market value returns show about twice the annual volatility of the unadjusted appraisal-based indices, and get rid of most, though not all, of the positive autocorrelation in the appraisal-based returns. The unsecuritized market-value returns show only about half the volatility of unlevered REIT returns, and more positive autocorrelation. Unsecuritized commercial property market values appear to closely track those of securitized properties represented by unlevered REIT values. However, the REIT values appear to be more "noisy" in the short run and to lead the unsecuritized property values by about a year. The unsmoothed returns developed here display a much larger positive "*beta*" with respect to a broad stock market index (the S&P500) than previous studies of unsecuritized property markets have suggested. However, this *beta* is largely lagged by one year. While statistical findings in this paper are not generally significant in the classical sense (which is perhaps not too surprising given the paucity of observations), the overall impression both visually from the graphs and from the statistics, is that unsecuritized market returns may be somewhat predictable.

Finally, one advantage to the structural approach taken in this paper is that the analysis can be "reversed" to shed light on appraiser behavior. That is, if we *start* from the assumption that the underlying market value returns in the unsecuritized market do indeed look like the simulated series developed here, then the structural model shows us what this implies about appraiser behavior. In particular, it suggests that appraisers use procedures which, in effect, are well approximated by the adaptive expectations/simple exponential smoothing model in equation (1), with a "confidence factor" (α) equal to about one-half (say, between 1/2 and 2/3). As noted, such procedures may indeed be optimal from the disaggregate perspective of individual property appraisal, but suboptimal from the aggregate perspective of portfolio or index performance measurement. The graphs in Exhibits 6 and 7 suggest that, from the latter perspective, appraisers might pay more attention to unlevered REIT values in the stock market, and less attention to unsecuritized property market information such as past sales of comparable properties.

Appendix A

Modelling the Effect of Temporal Aggregation and Reappraisal Seasonality within the Aggregate Reported Index

In this appendix we consider the effect of properties being revaluated only annually at different times within the calendar year. As we will be using annual returns produced from the fourth calendar quarter value levels of the RNI and EAI, we will focus on the effect of temporal aggregation in annual returns, rather than the quarterly returns reported by the indices. However, to analyse this phenomenon we need to break each year “*t*” down into four quarters.

Let $V_{t,4}^i$ represent the market value of individual property “*i*” in the fourth quarter of year “*t*”. The annual return to property “*i*” during year “*t*” is the sum of the four quarterly returns

$$r_t^i \equiv V_{t,4}^i - V_{t-1,4}^i \equiv r_{t,4}^i + r_{t,3}^i + r_{t,2}^i + r_{t,1}^i. \quad (\text{A1a})$$

If we took the annual return during the year preceding the third quarter of year “*t*”, this would be given by

$$V_{t,3}^i - V_{t-1,3}^i \equiv r_{t,3}^i + r_{t,2}^i + r_{t,1}^i + r_{t-1,4}^i, \quad (\text{A1b})$$

and so on

$$V_{t,2}^i - V_{t-1,2}^i \equiv r_{t,2}^i + r_{t,1}^i + r_{t-1,4}^i + r_{t-1,3}^i \quad (\text{A1c})$$

$$V_{t,1}^i - V_{t-1,1}^i \equiv r_{t,1}^i + r_{t-1,4}^i + r_{t-1,3}^i + r_{t-1,2}^i. \quad (\text{A1d})$$

Now for analytical tractability let us represent the above relationship between four-quarter value differences and annual calendar years returns by the following simplified model:

$$V_{t,4}^i - V_{t-1,4}^i \equiv r_t^i \quad (\text{A2a})$$

$$V_{t,3}^i - V_{t-1,3}^i \equiv (3/4)r_t^i + (1/4)r_{t-1}^i \quad (\text{A2b})$$

$$V_{t,2}^i - V_{t-1,2}^i \equiv (2/4)r_t^i + (2/4)r_{t-1}^i \quad (\text{A2c})$$

$$V_{t,1}^i - V_{t-1,1}^i \equiv (1/4)r_t^i + (3/4)r_{t-1}^i \quad (\text{A2d})$$

In effect, we are supposing that if a four-quarter value difference includes “*q*” quarterly components from the calendar year (*CY*) “*t*” return and “*4-q*” components from the *CY* “*t-1*” return, then that four-quarter value difference equals (*q*/4) fraction of the *CY* “*t*” return plus (*4-q*)/4 fraction of the *CY* “*t-1*” return.^a

At this point it is convenient to simplify notation by defining a polynomial function of the “backshift operator,” let “*B*” be the backshift operator defined by

$$B^L x_t \equiv x_{t-L}.$$

Now let α be as defined in the main body of the text and define the following lag function of α , $L_q(\alpha)$, where $L_q(\alpha)$ is a polynomial in *B* whose coefficients differ for each of the four quarterly reappraisal cohorts indexed by “*q*”

$$L_q(\alpha) \equiv (q/4) + \sum_{L=1}^{\infty} [(1-\alpha)^{L-1}((4-q)/4) + (1-\alpha)^L(q/4)]B^L.$$

Now consider the annual appraisal-based return to property “*i*” in the index for *CY* “*t*” where “*i*” is reappraised once per year, in the *q*th quarter every year. The return will be given by

$$V_{t,q}^{i*} - V_{t-1,q}^{i*} = \alpha L_q(\alpha) r_t^i, \quad q = 1, 2, 3, 4. \tag{A3}$$

In an actual index the cohort of properties reappraised every first quarter will be composed of different properties than those reappraised every second quarter, for example. So we need to consider the relationship between individual property returns and the general aggregate return to commercial property which an index such as the RNI or EAI is trying to represent. Let the return to any individual property “*i*” during year “*t*” be given by the following “market model”:

$$r_t^i = c^i + b^i r_t^U + \varepsilon_t^i, \tag{A4}$$

where r_t^U is the return to the unsecuritized commercial property “market index,” a common commercial property return component shared by all unsecuritized commercial property; and ε_t^i is a component of property *i*’s return that is orthogonal to r_t^U .^b

Substituting (A4) into (A3) the return of each cohort within the aggregate index is expressed in terms of the true commercial property return index.

$$V_{t,q}^{i*} - V_{t-1,q}^{i*} = c^i + b^i \alpha L_q(\alpha) r_t^U + \alpha L_q(\alpha) \varepsilon_t^i, \quad q = 1, 2, 3, 4. \tag{A5}$$

Now for expositional convenience let $i = q$, so the superscript will identify the quarterly reappraisal cohorts. Dropping the constant term and assuming that the idiosyncratic component of the individual property returns largely cancel out across properties, (A5) expresses the annual return to each cohort within the aggregate index as

$$r_t^{q*} = b^q \alpha L_q(\alpha) r_t^U. \tag{A5a}$$

Now suppose that a fraction “*f*” of all the properties is reappraised in each of the first three calendar quarters, so that the fraction $(1-3f)$ of the total number of properties is reappraised in the fourth calendar quarter.^c Then the observed annual return to the aggregate index (i.e., the return on the RNI or EAI), labelled r_t^{**} , would be given by

$$\begin{aligned} r_t^{**} &= (1-3f)r_t^{4*} + (f)(r_t^{1*} + r_t^{2*} + r_t^{3*}) \\ &= b^U \alpha \{ (f)[L_1(\alpha) + L_2(\alpha) + L_3(\alpha)] + (1-3f)L_4(\alpha) \} r_t^U, \end{aligned} \tag{A6}$$

where

$$b^U = (1-3f)b^4 + (f)(b^1 + b^2 + b^3).^d$$

The Structure of the Aggregate Index

With the relationship (A6) we now have a structural model relating the observable appraisal-based index returns series $\{r_t^{**}\}$ to the unobservable underlying un-

securitized property market returns series $\{r_t^U\}$. This model accounts for: (i) appraisal smoothing at the disaggregate level (represented by $0 < \alpha < 1$); (ii) temporal aggregation of annual reappraisals occurring at different quarters within the year; and (iii) seasonality of the reappraisals (represented by $0 < f < .25$).

The equation (A6) expresses the observed appraisal-based index returns as an infinite-order noiseless transfer function of the annual underlying market returns to unsecuritized commercial property, $\{r_t^U\}$. After the first lag the transfer weight coefficients in this transfer function are exponentially declining at the rate of α , for any values of α and f . The expansion of (A6) is given by

$$\begin{aligned} r_t^{**} = & (\alpha/2)(2-3f)r_t^U + (\alpha/2)(2-2\alpha+3\alpha f)r_{t-1}^U \\ & + (\alpha/2)(2-2\alpha+3\alpha f)(1-\alpha)r_{t-2}^U \\ & + (\alpha/2)(2-2\alpha+3\alpha f)(1-\alpha)^2r_{t-3}^U + \dots, \end{aligned} \quad (\text{A6a})$$

which is equation (2) in the main body of the text.

Appendix Notes

^aClearly relationship (A2) is a simplification of reality. While this relationship would hold in expectations across time-series samples, it does not hold deterministically or exactly within any sample. However, simulation analysis indicates that, as used in the present context, relationship (A2) allows the true underlying market return to be well modelled in the sense that the resulting derived returns are highly contemporaneously correlated with the true underlying returns and have volatility and autocorrelation very similar to the true returns.

^bIn this model: b^i would be like the property "beta" with respect to unsecuritized commercial property in general; c^i is a constant that would represent an incremental risk premium in the expected return (above or below that of commercial property in general); and ε_t^i would be an "idiosyncratic" return component that might be unique in part to the individual property "i" or to a class of properties of which "i" is a member.

^cIt is clear in the RNI and EAI that more properties are reappraised in the fourth quarter, so: $0 < f < .25$.

^d b^U is thus a weighted average beta among the unsecuritized properties in the RNI or EAI index with respect to the market index of all unsecuritized commercial properties. In fact, we would expect: $b^1 \approx b^2 \approx b^3 \approx b^4 \approx 1$. Thus $b^U \approx 1$ for any f .

Appendix B

Estimated Unsmoothed Market Value Series

Value at End of Year	Unsmoothed Nominal Property Value Level Indices:					
	RNI-Based Values:			EAI Index-Based Values:		
	$a = .33$	$a = .40$	$a = .50$	$a = .33$	$a = .40$	$a = .50$
1969				.8228	.8773	.9388
1970				.9142	.9439	.9775
1971				.9547	.9743	.9971
1972				.8892	.9180	.9501
1973				.9457	.9626	.9822
1974				.8414	.8749	.9114
1975				.7137	.7593	.8089
1976				.8201	.8442	.8694
1977				.8582	.8770	.8965
1978	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1979	1.1960	1.1746	1.1533	1.0874	1.0838	1.0802
1980	1.2576	1.2468	1.2355	1.2172	1.2047	1.1923
1981	1.3419	1.3353	1.3282	1.3553	1.3364	1.3177
1982	1.1777	1.2178	1.2568	1.2856	1.3008	1.3151
1983	1.3290	1.3511	1.3705	1.3744	1.3859	1.3964
1984	1.4052	1.4275	1.4469	1.4500	1.4620	1.4730
1985	1.3549	1.3979	1.4386	1.4476	1.4734	1.4983
1986	1.2612	1.3231	1.3839	1.4020	1.4437	1.4849
1987	1.2187	1.2845	1.3497	1.3645	1.4148	1.4651
1988	1.2544	1.3123	1.3689	1.3980	1.4437	1.4891
1989	1.2248	1.2864	1.3470	1.3387	1.3947	1.4512
1990	1.0603	1.1407	1.2227	1.0985	1.1844	1.2736
1991	.7953	.8938	.9987	.7867	.8916	1.0050

Notes

¹The former is published by the Frank Russell Company of Tacoma, Washington for the National Association of Real Estate Investment Fiduciaries (NCREIF). The latter is published by Evaluation Associates Incorporated of Norwalk, Connecticut.

²To clarify terminology, we define the "market return" as the return that actually prevailed in the market between two specified points in time, or that most likely would have prevailed if the asset class had transacted at those times. The market return may thus be viewed as the relative change in the "liquid value" or the "bid price" of the asset class between two points in time, that is, the price at which assets could be sold reasonably quickly.

³The much larger population of single-family properties enables repeat-sales transaction-based indices to be constructed, avoiding the appraisal smoothing problem. Case and Shiller also largely avoid the problem of temporal aggregation by using a reduced-frequency returns series. (Geltner (1993) points out that use of annual returns constructed from a quarterly value series largely eliminates temporal aggregation smoothing.)

⁴Gilberto and Gyourko-Keim regress appraisal-based index returns onto securities returns. It is unclear to what extent the predictability or lead/lag relationships that they find are attributable to the underlying market returns or merely to the lag in the appraisal-based index.

⁵In the present paper this has been done by applying a spliced series of estimated income returns. For the period 1969-77 we used the average capitalization rate (defined as operating income divided by property value) each period from commercial properties obtaining mortgages that period, as reported by the American Council of Life Insurers (ACLI). For the period

1978-91 we used the income return component reported by the RNI. It should be noted that income returns are relatively constant over time, so that the volatility and stochastic characteristics of the appreciation returns series closely resemble those of the total returns reported directly by the RNI and EAI.

⁶In addition, the appraiser generally works for or is hired by an investment manager whose compensation may be proportional to the appraised value of the property, thus providing a disincentive to find a lower value than the previous year, at least on the part of the agent who is paying the appraiser. During periods of falling property prices this could cause appraised values to lag and overstate actual market values.

⁷Presumably, V^E_t would be based primarily on observations of current transaction prices of properties similar to the subject property, while V_t represents the *ex ante* most likely transaction price for the subject property. V^E_t gives a "noisy" signal about the value of V_t .

⁸This phenomenon may be difficult to document, as often there are "inside" appraisals and "outside" appraisals. The inside appraisals, by the portfolio manager's own staff, may be made quarterly or more frequently than annually, but often with little real adjustment to the most recent outside appraisal, done usually annually by an independent firm hired by the portfolio manager.

⁹We have assumed that all reappraisals made in each quarter are made as of the last date in that quarter. If in fact the appraisals were spread out evenly throughout each quarter, this would add some additional temporal aggregation. The effect would be slight on annual returns, modifying (2a) to the following:

$$R^{**}_t = (4/8)r^U_t + (4/8)r^U_{t-1}.$$

¹⁰See Salomon Brothers (1992).

¹¹One reason for believing random errors are largely diversified away in the aggregate appraisal-based return indices is that these indices have very low volatility and strong positive autocorrelation. The effect of random valuation error in a returns index is to increase volatility and inject negative first-order autocorrelation.

¹²An appendix describing this simulation analysis is available from the author upon request.

¹³The NAREIT Index is published by the National Association of Real Estate Investment Trusts, Washington, DC.

¹⁴The rationale for this unlevering model is explained more fully in an appendix available from the author on request. While this formula is somewhat crude, it serves to remove the major effects of leverage in the REIT returns. The All-REIT Index is used rather than the Equity REIT Index for two reasons. The All-REIT Index includes a larger sample of properties, and is less distorted by the "health care REITs" which are prominent among the Equity REITs. As we are removing the "pure debt" (i.e., interest-rate risk based as opposed to default risk based) return component from both sides of the balance sheet by means of our unlevering formula, there is no reason not to include the Mortgage REITs in our sample.

¹⁵The NAREIT Index actually begins in 1972. However, the first two years appear anomalous. The REIT returns would suggest that property values fell more than 75% from the end of 1972 to the end of 1974. Yet it seems likely that this performance did not reflect stock market perceptions of what was actually going on with the values of properties held by REITs at that time. During this early period the NAREIT Index was dominated by the bankruptcies of a few large mortgage REITs that were caught in an interest-rate squeeze. For a few years prior to 1972 there had been a frenzy of growth in REITs, with most REITs highly levered with short-term debt, investing the bulk of their assets in long-term mortgages. With the dramatic rise in inflation and short-term interest rates in the 1972-73 period, a number of large REITs were wiped out, even though the properties that secured the mortgages they held, and indeed the mortgages themselves, were generally still sound. The dramatic impact that these failures and near-failures had on the NAREIT Index would not seem to be indicative of the property

values that are the focus of the present study. Therefore, we subsequently confine our analysis of REIT returns to the period beginning at the end of 1974.

¹⁶As both REITs and properties themselves pay out almost all of their earnings, it is not surprising that the values traced out in the figures show little long-run growth.

References

- Case, E. and R. Shiller, The Efficiency of the Market for Single-family Homes, *American Economic Review*, 1989, 79:1, 125-37.
- , Forecasting Prices and Excess Returns in the Housing Market, *AREUEA Journal*, 1990, 18:3, 253-73.
- Fisher, J., D. Geltner and R. B. Webb, Value Indices of Commercial Real Estate: A Comparison of Index Construction Methods, *Journal of Real Estate Finance & Economics*, forthcoming 1994.
- Geltner, D., Estimating Real Estate's Systematic Risk from Aggregate Level Appraisal-Based Returns, *AREUEA Journal*, 1989, 17:4, 463-81.
- , Smoothing in Appraisal-Based Returns, *Journal of Real Estate Finance & Economics*, 1991, 4:3, 327-45.
- , Temporal Aggregation in Real Estate Return Indices, *Journal of the American Real Estate and Urban Economics Association*, 1993, 21:2.
- Giliberto, S. M., Equity Real Estate Investment Trusts and Real Estate, *Journal of Real Estate Research*, 1990, 5:2, 259-64.
- Gyourko, J. and D. Keim, What Does the Stock Market Tell Us About Real Estate Returns?, *Journal of the American Real Estate and Urban Economics Association*, 1992, 20:3, 457-86.
- Hendershott, P. and E. Kane, Office Market Values During the Past Decade: How Distorted Have Appraisals Been?, Ohio State University College of Business Working Paper WPS 92-68, July 1992.
- Miles, M., D. Guilkey, B. Webb and K. Hunter, An Empirical Evaluation of the Reliability of Commercial Appraisals, NCREIF research paper, 1991.
- Pyhrr, S., J. Cooper, L. Wofford, S. Kaplin and P. Lapidés, *Real Estate Investment: Strategy, Analysis, Decisions*, New York: John Wiley, second edition 1989.
- Quan, D. and J. Quigley, Inferring an Investment Return Series for Real Estate from Observations on Sales, *AREUEA Journal*, 1989, 17:2, 218-30.
- , Price Formation and the Appraisal Function in Real Estate Markets, *Journal of Real Estate Finance & Economics*, 1991, 4:2, 127-46.
- Ross, S. and R. Zisler, Risk and Return in Real Estate, *Journal of Real Estate Finance & Economics*, 1991, 4:2, 175-90.
- Salomon Brothers, Inc., Real Estate Risk & Return: 1991 Survey Results, March 31, 1992.
- Wheaton, W., The Cyclic Behavior of the National Office Market, *AREUEA Journal*, 1987, 15:4, 281-99.

The author would like to thank Evaluation Associates Inc., the National Association of Real Estate Investment Trusts, and the National Council of Real Estate Investment Fiduciaries for supplying data. The author appreciates the assistance and comments of Bonnie Roberts, Patric Hendershott, the participants in the Homer Hoyt Advanced Studies Institute Institutional Investment Seminar, and an anonymous reviewer. This research has been partially funded by the Real Estate Research Institute. The opinions expressed in this paper are those of the author, who is alone responsible for any mistakes.