CHAPTER

15

PUBLIC AND PRIVATE REAL ESTATE

Performance Implications for Asset Allocation

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1. BACKGROUND AND OBJECTIVES OF THIS CHAPTER

1.1 What is "Public" and "Private" Real Estate?

Pension funds and other institutional investors have long invested most of their capital in domestic stocks and bonds, the dominant asset classes in the public capital markets in the United States. The stock and bond markets are referred to as "public" markets because stocks and bonds are generally traded on public exchanges, such as the New York Stock Exchange (NYSE), American Stock Exchange (AMEX), or NASDAQ, which provide easy and inexpensive access to all investors, large and small. Public markets are characterized by the trading of small homogeneous units, or shares, of the underlying assets and by a high degree of oversight by both government agencies and the securities industry to insure fairness and openness in trading procedures, information revelation, and corporate governance.

The public capital markets are noted for generally high levels of *liquidity* and *informational efficiency*. "Liquidity" refers to the ability of the investor/owner of the asset to quickly and inexpensively convert the asset into cash at or very near the current full-market value of the asset. "Informational efficiency" refers to the propensity of the market prices of the assets to rapidly incorporate and reflect all publicly available news and information relevant to the value of the assets. The combination of liquidity and informational efficiency means that investors in publicly traded assets can generally expect to be able to quickly "cash out" any investment at a "fair" price, given the currently available information.

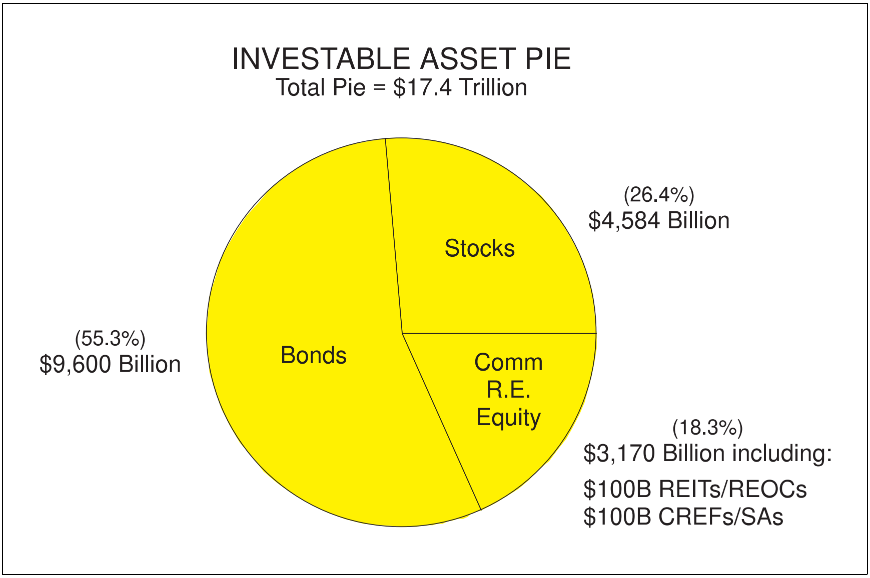
Although stocks and bonds represent over $14 trillion worth of assets by market value, they do not include all of the tradable capital assets in the Unites States. For the past two decades (particularly since the passage of the Federal ERISA legislation in 1974), a third major asset class, commercial real estate equity, has been seriously considered by many pension funds as a candidate for a significant share of their total portfolio investment. As can be seen in Figure 15–1, commercial real estate equity represents over $3 trillion in market value, or almost one-fifth of the investable, U.S. domestic "asset pie" (that is, excluding owner-occupied housing equity and other privately held assets in which it is often difficult for outsiders to invest).

Most, but not all, commercial real estate is traded *privately*. That is, most commercial properties are not traded on the public stock exchanges but, rather, trade directly in the private property markets in "deals" negotiated privately between individual buyers and sellers. In this chapter, we will refer to such real estate as "private" real estate. Only the publicly traded real estate investment trusts (REITs) and real estate operating companies (REOCs), whose market value totals around $100 billion, will be considered "public" real estate assets. In general, in comparison to the public capital markets, private asset markets tend to exhibit high transactions costs and a relative lack of liquidity and informational efficiency in asset pricing.

While the vast majority of commercial properties are held directly by owner-users and individual real estate investor/entrepreneurs who actively manage the properties they hold, it is also possible for investors who do not have the expertise or time to devote to active property management, such as most pension funds, to invest in commercial real estate equity. Broadly speaking, two approaches are available to such investors. They can invest in *public* real estate by means of the REITs or REOCs, or they can invest in *private* real estate by way of property "pools" and "syndications," such as commingled funds (CREFs) or separate accounts (SAs) managed by

FIGURE 15–1

U.S. Domestic Investable Assets by Market Value as of Mid-1990s



Source: Miles et al, *Real Estate Finance* 11(1), Spring 1994.
Excludes owner-occupied housing equity and non-real estate private assets.

specialized real estate investment advisers. By the mid-1990s, there were roughly $100 billion of pension fund assets invested in private real estate equity by these means, a value approximately equal to the total market value of the public real estate assets traded indirectly in the stocks of REITs and REOCs.

1.2 Why Should Pension Funds Care About Private and Public Real Estate?

From the beginning of pension fund interest in real estate as an investment asset class back in the 1970s, a major motivation was the belief that real estate presents risk-and-return characteristics that are different from those of the stock and bond markets. This would make real estate attractive as a *diversifier* of the stock-and-bond-dominated pension fund portfolios. At least since the development of modern portfolio theory (MPT) in the 1950s and 1960s, investors have understood how the overall risk in a portfolio can be reduced and the expected returns measured on a risk-adjusted basis can be enhanced by diversifying the assets held in the portfolio. Assets, or classes of assets, are particularly valuable as diversifiers if they provide returns that tend *not* to be highly correlated with those of the other asset classes in the portfolio. Such assets tend to dampen out the "ups" and "downs" of the portfolio, reducing the overall portfolio's volatility.

While the investments pension funds made in private real estate during the 1970s and 1980s generally worked pretty well as a diversifier, many investors became disenchanted with private real estate when commercial property market prices fell in the late 1980s and early 1990s. Lack of liquidity in the private markets made it difficult for investors to "bail out" of their real estate holdings during the crash. Lack of informational efficiency in the private markets as well as a narrowly defined concept of "institutional-grade" real estate may have contributed to prices of commercial properties "bubbling" up too high in the mid-1980s (when much investment was made) and then subsequently crashing to levels below what seemed reasonable in the long run.[1]

As a result of this experience with private real estate investment, especially CREFs, many institutional investors began asking whether public real estate investment vehicles, such as REITs, were not a better way to make their real estate investment. This question became all the more appropriate by the mid-1990s as a result of developments in the REIT industry. The Tax Reform Act of 1986 had removed the major tax advantages of private real estate for taxable investors while giving REITs greater flexibility and allowing them to be self-administered. This change allowed for the removal of a major source of agency problems associated with advised REITs and promoted better management of REITs. The Tax Act of 1993 then facilitated REIT investment by tax-exempt institutions as a result of the "look-through" provisions in the law (that is, relaxation of the 5/50 Rule for pension funds). The development of the UPREIT structure in late 1992 also contributed to a veritable explosion of REIT capitalization. This increase in capitalization brought REIT assets up to a critical mass, which for the first time enabled large institutional investors to seriously consider investing in real estate equity by way of publicly traded REITs.

A key question about the appropriateness of REITs as a vehicle for pension fund real estate investment has to do with the original motivation for such investment, namely, the concern for *diversification* of the overall portfolio. As REITs are stocks, and trade in the public exchanges, does the REIT investor not sacrifice much of the unique real estate characteristics of the investment? Would not public real estate investment (in the form of REITs) tend to be much more positively correlated with the stock and bond markets (which are also public) than is the case for private real estate investment? How much of the diversification benefit of real estate in the typical stock-and-bond-dominated pension fund portfolio derives from the fact that the assets are traded in private as opposed to public markets? Furthermore, while REIT share prices no doubt reflect greater informational efficiency than private property market prices, the stock market is often criticized for overreaction and excess volatility, at least in the short run. To what extent do these problems in the stock market reduce the desirability of REITs as a vehicle for real estate investment in institutional portfolios?

1.3 Main Objectives

This chapter sheds light on the answers to the preceding portfolio strategy questions, based on an analysis of the historical performance record of commercial property in both the private and public asset markets. This objective requires a careful treatment of the empirical data available on the investment risk-and-return performance of private and public real estate so as not to misleadingly compare apples and oranges. Consistently defined risk-and-return data (in particular, across public and private asset markets) is vital for accurate analysis of mixed-asset portfolios. Thus, we have made a major effort in compiling this chapter to develop historical risk/return performance data for private and public real estate that is appropriate for mixed-asset portfolio analysis for institutional investors.

Two main data problems need to be attended to in any careful analysis of the questions we seek to address. Because of thin trading in the property markets, return data for private real estate has been based on appraised values. This causes “smoothing” of the returns over time in such widely used indexes of private real estate returns as the Russell-NCREIF Index. On the other hand, indexes of REIT historical returns (such as the NAREIT Index), while based on liquid market transaction prices and therefore not smoothed, reflect the effect of *leverage,* which may distort the returns provided by the underlying property assets held by the REITs. Thus, in this chapter we attempt to adjust and correct the historical returns data to remove the effects of smoothing in the appraisal-based private real estate returns and of leverage in the REIT-based public real estate returns. In addition, as pension funds typically make their real estate investments with the expectation of a medium- to long-term holding horizon, we attempt to define returns in a manner more relevant to investors with such horizons. In particular, we shall define risk-and-return statistics based on a five-year holding period rather than the quarterly or annual holding period that has generally been considered in past studies.

The remainder of this chapter is divided into three major parts. Part 2 will describe the historical return data we are using, including a description of the methods we employ to "unsmooth" private real estate returns and to "unlever" public returns. We believe we can substantially correct these problems in the empirical data, to allow a more accurate examination of optimal mean-variance portfolios for medium-term investors. Such a portfolio analysis will be presented in Part 3, including a description of our method of modeling the five-year holding returns that are more relevant for many pension funds. Finally, Part 4 will summarize and conclude the analysis, with a particular focus on the strategic and tactical investment policy implications for pension funds.

2. HISTORICAL RISKS AND RETURNS OF PRIVATE AND PUBLIC REAL ESTATE

2.1 The Record of Private Real Estate

We will base our analysis of the historical investment risk-and-return performance of private real estate on the Russell-NCREIF Index (hereafter, RNI) and the Evaluation Associates Index (EAI).[2] Both of these indexes are based on appraised values and represent institutional-grade commercial properties typical of those held by pension funds. They depict period-by-period total returns (including income and capital appreciation) on a before-tax, "free-and-clear" unlevered basis, gross of asset management fees. In this section, we present a brief description of the indexes and discuss our treatment of appraisal smoothing.

The RNI is the most widely cited benchmark of commercial property investment performance in the private markets in the United States. This index currently contains over 1,500 individual properties, with an aggregate market value in excess of $23 billion. A shortcoming in the RNI is that it begins only in 1978. The EAI goes back to 1969, reporting the total return to the major commingled property funds held in institutional portfolios in the United States. There is much duplication and similarity in the properties included in the EAI and Russell-NCREIF indexes.[3] In order to obtain a longer time series, we have spliced these two return series. Our private real estate is thus based on the EAI returns from 1969 to 1978 and on the Russell-NCREIF from 1978 through 1993.[4]

Both the RNI and EAI are reported quarterly, but most of the properties are effectively reappraised only annually, at different times staggered throughout the year. As a result, these indexes are not really quarterly indexes so much as they are annual indexes partially updated each quarter. For this reason, it makes more sense to work with the annual frequency return data.

As noted, appraisal-based indexes are inevitably subject to lagging and smoothing across time. That is to say, the returns on the index itself present a smoothed and lagged picture of what was actually happening at each point in historical time in the underlying commercial property market. This problem is caused by two phenomena: (1) The appraisal process at the level of individual property valuation is essentially “backward looking,” as it relies on transaction prices of past sales of comparable properties, and (2) the index construction process requires temporal aggregation of appraised values, as the index is constructed each period by averaging across the most recent appraised values of all the individual properties (even those that were not reappraised during the current quarter). This data problem causes the returns of appraisal-based indexes *to appear to have less volatility than is really the case and to have less correlation with other returns series that are not similarly smoothed and lagged.* This distorts any direct comparison of the risk-adjusted investment performance of private and public real estate (or of private real estate and liquid securities such as stocks and bonds) and biases the results of any mixed-asset portfolio optimization analysis based on the index returns data.

In this chapter, we address this data problem by using the unsmoothing procedure described by Geltner (1993).[5] While no unsmoothing procedure is perfect, this approach has the advantage of avoiding the assumption that the private property markets are informationally efficient.[6] Mathematically, the unsmoothing procedure works by applying a “reverse filter” to recover the true underlying private property market returns from the appraisal-based index:

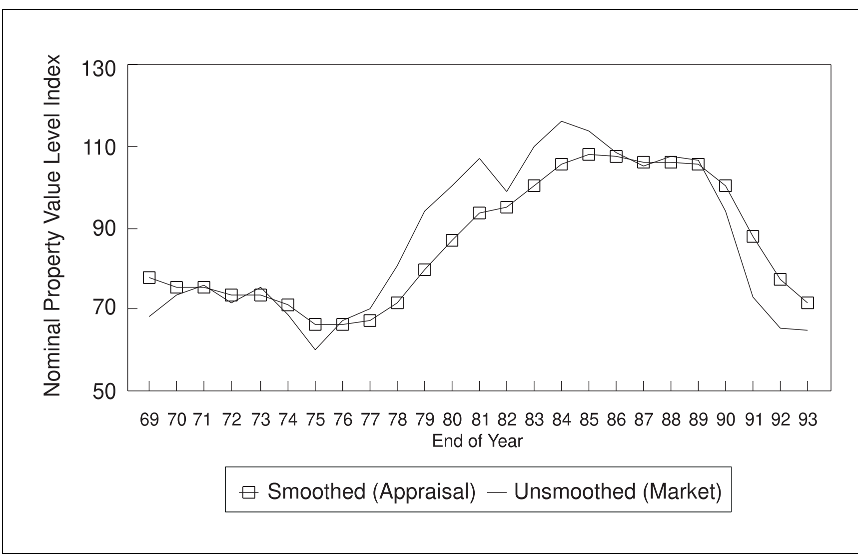
$$g_t = (g_t^* - (0.6)g_{t-1}^*)/(0.4) \quad (1)$$

where: g_t is the unobservable underlying market appreciation return (growth, or capital gain) in the private property market in calendar year t, and g_t^* is the observable appraisal-based index appreciation return in calendar year t. This equation is based on a structural analysis of the sources and nature of smoothing in the appraisal-based index. It is argued in Geltner (1993) that this procedure can largely correct for both the disaggregate-level smoothing induced by the appraisal process as well as the aggregate-level smoothing caused by index construction.

Figure 15–2 displays the historical profile of private real estate nominal value levels (accumulated capital returns) implied by both the appraisal-based index and the unsmoothed index based on Equation (1). The graph provides a "reality check" for the path of commercial property prices over the past two decades. The historical value profile in Figure 15–2 appears plausible for institutional commercial property holdings. In comparison to

FIGURE 15–2

Smoothed and Unsmoothed Private Market Commercial Real Estate Nominal Value Levels (set to 1982–1992 avg = 100), Based on Appreciation Returns



the unadjusted appraisal-based index, the graph shows the unsmoothed index peaking one year earlier (in 1984), and falling more sharply in 1987 and 1990. By 1993, the unsmoothed index suggests that the commercial property markets had largely “found bottom,” even though the appraisal-based index was still falling rapidly that year.[7]

Equation (1) corrects the appreciation return in the appraisal-based index, which is the source of almost all of the volatility (and therefore of the risk and correlation statistics) in the historical returns data. However, it is still necessary to correct the total return, which consists of the appreciation component plus the current income component. While the income component of the appraisal-based index is presumably based on accurate and timely observation of the actual net operating incomes (NOI) of the properties included in the index, the income return is nevertheless distorted by the smoothing in the asset-value level across time (which is the denominator in the income return component). This distortion is easily corrected, however, once the unsmoothed asset value level series depicted in Figure 15–2 has been constructed.

The procedure for constructing the corrected, or unsmoothed, total return series is as follows. First, an index of the implied NOI value-level series is constructed from the appraisal-based appreciation and income-return components.[8] This series gives an accurate depiction of the profile of NOI over time, up to a constant multiple. This NOI level index is then divided by the preceding end of year *unsmoothed* value-level index (as depicted in Figure 15–2, computed from the unsmoothed accumulated appreciation returns). This unsmoothed value-level index is also an accurate depiction of the historical profile of property values, up to a constant multiple. Thus, the ratio we have just constructed of the NOI level index divided by the unsmoothed asset value-level index gives an accurate representation of the unsmoothed income-return component, up to a constant multiple.[9]

This constant multiple is now determined based on the criterion that the mean total return of the appraisal-based index is theoretically unbiased, taken over a complete real estate “cycle.” That is, although the time-series second moments of the returns of the appraisal-based index (for example, volatility, correlations) are biased by the smoothing and lagging phenomena, the first moment (mean return across time) is not biased by these phenomena, provided we incorporate exactly one (or more *whole)* complete real estate cycles in the time series sample period. Examination of Figure

15–2 suggests that the period 1975–1993 included exactly one complete cycle. Thus, in theory, the appraisal-based mean total return over the 1975–1993 period should equal the true (unsmoothed) total return over that period. The unsmoothed income return component is thus multiplied by a constant multiple so that the unsmoothed total return and the appraisal-based total return will equal during the 1975–1993 sample period. The total return in any period, of course, equals the income return component plus the appreciation return component: $r_t=y_t+g_t$. We will label this constructed unsmoothed index of private real estate total returns, NCREIF(UNS), or unsmoothed RNI.

2.2 The Record of Public Real Estate

We will base our analysis of the historical investment risk-and-return performance of public real estate on the NAREIT All-REIT Index (hereafter, NAREIT).[10] We will incorporate the 1975–1993 period so as to coincide with the full cycle in the private real estate market, noted previously.[11] Based on the actual market transaction share prices in the relatively liquid stock market, the NAREIT Index does not suffer from the smoothing or lagging problems described previously for the private real estate index. However, it is necessary to address another data problem associated with using the NAREIT Index for the purpose of comparing the public market versus private market investment performance of real commercial property assets. This is the fact that REITs are typically levered (especially in the early years of the industry and, to a much lesser extent, currently) and we must remove the effect of this gearing on the REIT returns in order to obtain a return history for public real estate that is directly comparable to that for private real estate represented by the unsmoothed RNI Index described in the previous section, which is an index of unlevered, free-and-clear property values. This is in line with our objective in this chapter of considering REITs as essentially a vehicle for pension funds to invest in real estate, only through the public capital markets rather than through the private property markets. REIT investments could be effectively “unleveraged” by simultaneously investing in bonds.

In fact, REITs in general contain debt on both the asset and liability sides of their balance sheets. On the asset side, some 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 used as capital sources by REITs. In the aggregate across all REITs, the debt on the asset side typically 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 NAREIT returns by using a simple weighted-average cost of capital (WACC) model that 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

$$P_t + M_t = D_t + E_t \tag{2a}$$

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 debt-like 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:

$$r_{E,t} = (P/E)_t r_{P,t} + (M/E)_t r_{M,t} - (D/E)_t r_{D,t} \tag{2b}$$

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

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

(2b) becomes

$$\begin{aligned} r_{E,t} &\approx (P/E)_t r_{P,t} + [(M/E)_t - (D/E)_t] r_{D,t} \\ &= (P/E)_t r_{P,t} + [1 - (P/E)_t] r_{D,t} \end{aligned} \tag{2c}$$

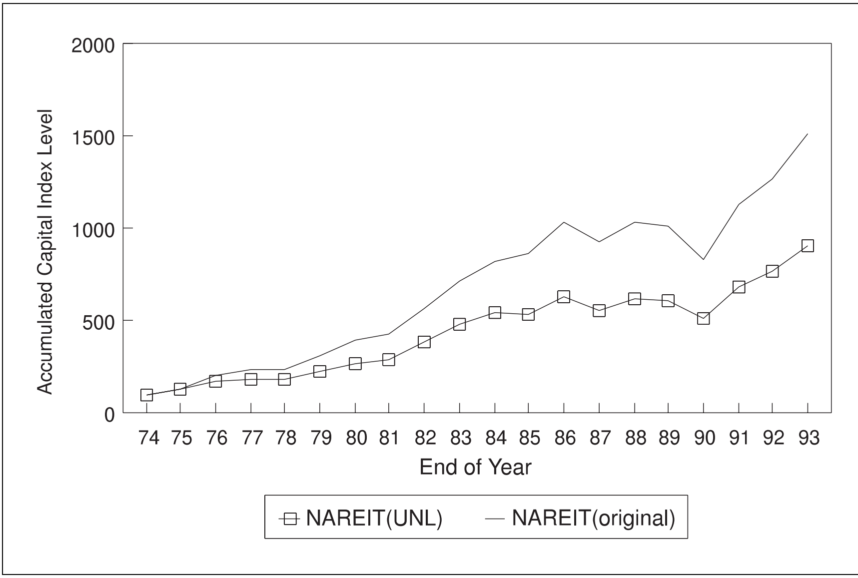
Thus, at least as a usable approximation, we can derive the property (unlevered) returns implied by REIT share market values as

$$r_{P,t} = \{r_{E,t} - [1 - (P/E)_t] r_{D,t}\}/(P/E)_t \tag{2d}$$

To quantify (2d) 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 return.

FIGURE 15–3

NAREIT Levered and Unlevered Accumulated Total Capital Index with Reinvestment (1974 = 100), Based on Total Returns



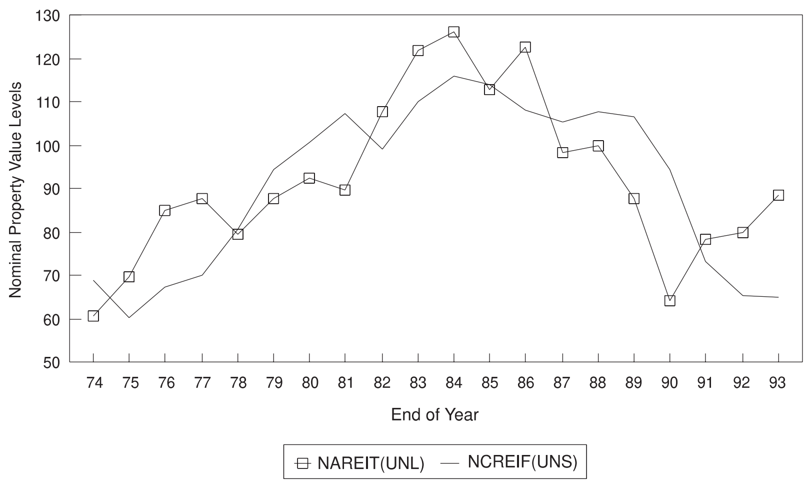
The original (levered) and unlevered NAREIT total returns have been compounded (or "chain-linked") and are presented for comparison purposes as accumulated total capital indexes (including reinvestment of cash flow), in Figure 15–3. As there has generally been more debt on the liability side than the asset side of most REITs (positive gearing), it is not surprising that the unlevered index shows a lower overall growth trend and less volatility, though with the timing of upticks, downticks, and turning points it is generally unaffected by the unlevering.

2.3 Comparing the Historical Performance of Public and Private Real Estate

The unleveraging procedure described above has been applied both to the total return and to the capital appreciation component separately. This allows us to perform the same kind of reality check we did before for the unsmoothed RNI Index, by examining the implied historical free-and-clear

F I G U R E 15–4

Public (Unlevered) and Private (Unsmoothed) Real Estate Nominal Value Levels (Set to 1982–1992 avg = 100), Based on Appreciation Returns



property values traced out over time by the corrected NAREIT capital gains returns. The unlevered appreciation returns have been accumulated to produce the unlevered NAREIT nominal property value index displayed in Figure 15–4, labeled NAREIT(UNL). Figure 15–4 also shows the corresponding unsmoothed RNI values, labeled NCREIF(UNS).

Again, as with any index, the absolute level is arbitrary; it is the relative change in value across time within each index that is meaningful. In Figure 15–4, we have scaled both indexes so that they have average 1982–1992 values equal to 100.[12] This facilitates comparison of what the two indexes are saying was happening at each point in time to commercial real estate values and reveals graphically the differences and similarities between private and public real estate over the historical period in question.

Examination of Figure 15–4 calls attention to some important similarities and differences between public and private real estate during the 1975–1993 period. The most striking feature in Figure 15–4 is the broad overall similarity in the two indexes. This is seen in the generally parallel pattern traced out by the two indexes. Both public and private real estate exhibited a notable “rise-and-fall” pattern during the 1975–1993 period, with peaks and troughs at similar (though not identical) points in time and relative magnitudes of rise and fall also similar across the two indexes. Viewed as a cycle, the broad-brush indication from Figure 15–4 is that both the period and amplitude of the public and private real estate cycles are very similar, but the two cycles are slightly out of phase with one another. In particular, it appears that public real estate *leads* private real estate, typically by about *one or two years.* That is, public real estate, as represented by the NAREIT(UNL) Index, experiences the major turning points in the cycle one or two years before private real estate, as represented by the NCREIF(UNS) Index. This pattern is broadly consistent with the hypothesis that public and private real estate are essentially the same thing (in that they both represent the same type of underlying assets) but with public real estate reflecting the greater informational efficiency of the public securities markets, while price changes in private real estate reflect the inertia and sluggishness of the less efficient private markets.

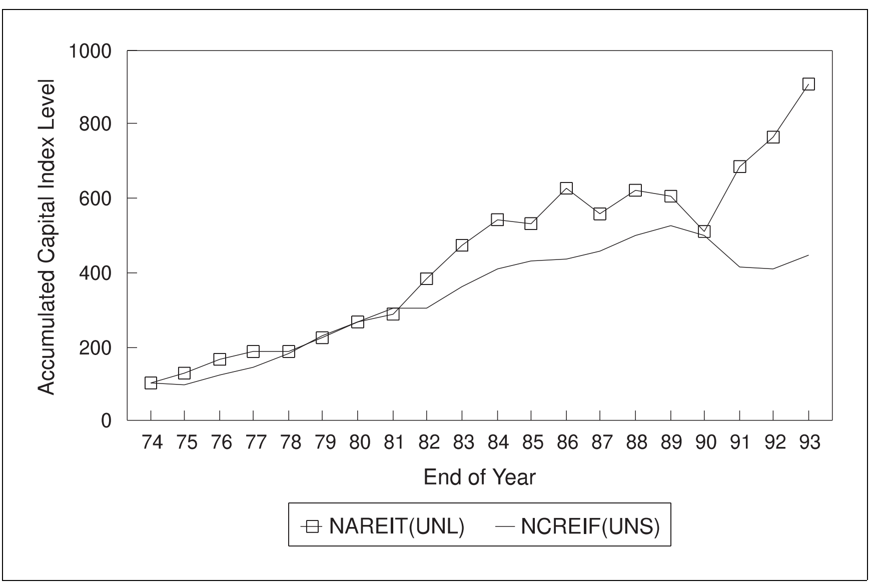
More careful analysis of Figure 15–4 reveals additional information about the differences between private and public real estate and the relation between these two ways of investing in real estate. Although public real estate generally leads private real estate, the length of the lead is variable. Both series peaked in the same year, 1984, while public real estate bottomed out three years ahead of private real estate (1990 versus 1993). Major downturns in public real estate in 1981, 1985, and 1989 were echoed one year later by major downturns in private real estate in 1982, 1986, and 1990. Major upturns in public real estate in 1975–1976 and 1982–1983 were followed one to two years later by major upturns in private real estate in 1976–1978 and 1983–1984.

Also intriguing is the evidence presented in Figure 15–4 regarding volatility. Even though we are working with an unsmoothed private index and an unlevered public index, public real estate seems to display greater short-run volatility than private real estate. However, it is important to note that most, if not all, of the “extra” volatility in public real estate prices appears to be transient in nature. That is, the public real estate prices bounce around a bit more in the short run, but *show a strong tendency to revert back toward the same long-run underlying trend and cycle.* The fact that long-run volatility is similar is revealed in the fact that the relative magnitude of the rise and fall (or amplitude of the overall cycle) appears to be *about the same* between the public and private value indexes. The relatively high short-run volatility in the public index may reflect stock market noise or overreaction of the type noted in Section 1. Highly liquid markets such as the public stock exchanges appear to be subject to transient bearish and bullish sentiments, which may cause excess volatility. There is some evidence in the academic literature that this phenomenon is particularly strong among small-capitalization stocks whose trading is heavily influenced by small individual investors. REITs have been in this category throughout much of the historical period covered in this analysis. One might anticipate that as institutional involvement in REITs becomes more pronounced, the volatility of REITs associated with market noise may decline over time.

Another important difference between the historical performance pattern of public versus private real estate is revealed in Figure 15–5, which displays the accumulated total returns of the unsmoothed RNI and unlevered NAREIT index (as opposed to the accumulated appreciation returns depicted in Figure 15–4). In Figure 15–5, it is apparent that over the

FIGURE 15–5

Public (Unlevered) and Private (Unsmoothed) Real Estate Accumulated Total Capital Index with Reinvestment (1974 = 100), Based on Total Returns



1975–1993 period public real estate has outperformed private real estate as far as the overall average total return is concerned. Although the two types of real estate investment tracked generally parallel to one another for much of the historical period covered in Figure 15–5, public real estate tended to outperform private real estate in the early 1980s and again in the early 1990s, to give public real estate the overall performance edge. Comparison of Figures 15–4 and 15–5 suggests, somewhat surprisingly, that the superior public real estate performance is due to generally higher income, rather than greater capital growth. As the NAREIT Index is composed of all publicly traded REITs at each point in time (including those that subsequently failed), this performance difference cannot be attributed to "survivor bias" in the public real estate index.

The historical investment performance of public and private real estate during the 1975–1993 period is summarized statistically in Table 15–1. The performance of stocks (represented by the S&P 500), long-term bonds (represented by the Ibbotson Long-Term Government Bond Index), Treasury bills, and inflation are also reported for comparison purposes in the table. The superior performance of public real estate over private real estate during this period is also apparent in the statistics of Table 15–1. The mean return was nearly 400 basis points higher. The performance of private real estate was barely above that of Treasury bills during this period. Examining the Sharpe ratio (the risk premium per unit of risk, as measured by the excess return over T-bills divided by the volatility), we see that public real estate had the second best risk-adjusted return performance, after the S&P 500, while private real estate had the worst performance. The 1975–1993 period was a particularly good one for the stock market, as reflected in the very high Sharpe ratio for the S&P 500.

One possible explanation for the superior total return performance of public real estate is that the greater liquidity and informational efficiency of the public capital markets puts greater pressure for performance onto the managers of public real estate (the REIT managers), which leads to a more effective weeding out of poor managers. The result would be that properties managed by publicly traded entities would tend on average over the long run to perform better than the average property held in the private real estate market. However, in the long run in equilibrium in the capital markets, such superior management should result in investors bidding up the price of REIT shares, providing the successful REITs with a lower cost of capital and a ready source of capital for expansion, but should not result in higher-than-normal risk-adjusted returns for the investors, on average. It is

TABLE 15–1

Historical Total Return Performance Statistics 1975–1993
(Annual Nominal Return Statistics)

	Private* Real Est.	Public** Real Est.	Stocks: S&P 500	Bonds: LTGovt	T-Bills	Inflation
Mean	7.88%	11.62%	16.09%	11.03%	7.40%	5.64%
Std.dev.	10.98%	13.54%	13.59%	12.34%	2.93%	3.25%
Sharpe***	0.04	0.31	0.64	0.29	NA	NA

* Unsmoothed RNI
** Unlevered NAREIT
*** Sharpe ratio, a measure of risk-adjusted return, equals mean total return in excess of T-bills divided by standard deviation.

possible that the historical period studied here does not represent the long-run equilibrium return relationships. Within the context of long-term equilibrium, it is probably more logical to expect a higher return for equivalent assets that are held privately to generate higher expected returns due to their lack of liquidity and greater management burden for investors. Over the subject period measured, this was not the case.

Apart from the superior management theory, there are other possible explanations for the superior performance of public real estate during the 1975–1993 period. For one thing, the types of properties held by REITs has historically not been exactly the same as what has been represented in the NCREIF Index. In particular, REITs have traditionally tended to hold smaller properties in smaller cities and to hold a greater variety of different types of properties (such as hotels and health care facilities). It may be that these types of properties tend to be more risky than the property types more strongly represented in the NCREIF Index. This greater risk would, in equilibrium, be expected to generally command a higher return premium, which would be reflected in higher long-term historical average total returns. Also, public real estate would be expected to have relatively more "systematic risk," or covariance with stocks and bonds, the main components of most investment portfolios. This could cause public real estate to command a greater risk premium in equilibrium, which could explain the greater Sharpe ratio noted in Table 15–1. Risk-and-return considerations such as these are often most effectively viewed from the perspective of modern portfolio theory, a perspective to which we now turn our attention.

3. PORTFOLIO CONSIDERATIONS

Since its development in the 1950s and 1960s by Harry Markowitz, William Sharpe, and others, so-called "modern portfolio theory" (MPT) has provided the basis for rational, quantitative investment analysis and planning. The basic idea in MPT is to minimize the overall portfolio risk, or volatility in the portfolio, associated with a given target total return objective for an investor's portfolio. As noted in Section 1 of this chapter, MPT has provided much of the underlying motivation for including real estate in the pension fund portfolio, as real estate has been seen as a potential diversifier of the stocks and bonds that dominate most pension funds' portfolios. Indeed, the ERISA law, which stimulated much pension fund investment in real estate beginning in the mid-1970s, was inspired by MPT when it urged prudent portfolio diversification to reduce overall risk.

Portfolio considerations are particularly important to the central question we are examining in this chapter, the role of public versus private real estate for pension investors. Viewed in isolation from portfolio considerations, the superior investment performance of public real estate, noted in the preceding section, would appear to make public real estate a "slam dunk." Why would anyone want to invest in private real estate when one can apparently do at least as well if not better in public real estate and with much more liquidity and lower management and transactions costs? But the point of MPT is that investment decision makers should not view each asset class in isolation but examine them from the perspective of how they affect the risk-and-return performance of the overall portfolio. As noted in Section 1, it is possible that public real estate, because it is traded in the liquid public capital markets where stocks and bonds trade, may have much greater covariance with these other dominant asset classes and therefore not provide as much diversification benefit as private real estate within the typical pension fund overall portfolio. This is therefore the question to which we now turn our attention.

3.1 MPT, Long-Horizon Investors, and Private Real Estate

In applying MPT, the main focus is to identify optimally diversified portfolios, that is, mixtures of asset classes that lie on the so-called "efficient frontier" of portfolios that minimize the overall portfolio volatility (return standard deviation over time) for any given total return target. Higher return targets will, of course, have higher portfolio volatility, so in choosing a return target the investors are, in effect, deciding or expressing how risk-averse or risk-tolerant (that is, how conservative or aggressive) they wish to be. But in any case, they should never, in theory, want to invest in a mixture of assets that is more risky than necessary to provide the given expected return target. (In other words, investors should never invest in a portfolio that is not "on the frontier.") Portfolios on the efficient frontier are known as "mean-variance efficient" portfolios because they minimize the variance in the return for any given mean return or, equivalently, maximize the mean return for any given variance.

To determine the frontier of efficient portfolios is a simple mathematical exercise with modern computers, given the risk-and-return expectations regarding each of the classes of assets that may comprise the portfolio. The necessary inputs include, for each asset class, the mean return, the standard deviation of that return (or square root of the variance), and the correlation coefficient between the returns to each pair of asset classes (a "correlation matrix").

Traditionally, MPT has been applied using quarterly or annual historical return performance statistics as the required inputs. By using such relatively short-interval returns, one obtains more data points from a given historical period. This enables one to obtain statistically more accurate and reliable estimates of the risk/return performance of the various asset classes. This is particularly useful for real estate, which does not have a very long history of good data availability. For example, the 1975–1993 period considered in the previous section provides us with 76 quarterly or 19 annual return data points, but it would not even provide us with four half-decade return periods.

The use of quarterly or annual return statistics should not imply that investors have such short horizons when they make portfolio policy and investment decisions. Indeed, most pension funds have a medium- to long-term investment horizon that would probably be better represented by a five-year period than a quarterly or annual period. But the use of short-period return statistics to apply MPT to longer-horizon investors does not matter *when asset markets are informationally efficient*. It is a mathematical fact that when returns are uncorrelated across time and unpredictable (that is, there are no lagged linkages between the returns to different asset classes), the return statistical inputs required by MPT will be effectively identical no matter what the length of the return time interval. This is because, with efficient markets, the mean, variance, and all covariances of the returns among all the asset classes will all be exactly proportional to the return time interval (for example, the variance in the five-year return will be exactly five times the variance in the annual return, and the covariance between any two assets in the five-year return will be exactly five times the covariance in the annual return). The result is that one will obtain the same optimal portfolio no matter what return frequency is used for the input statistics. So why not use the shorter-horizon return frequencies that provide more historical data points?

The problem is that *private real estate is not informationally efficient.* Therefore, to properly conduct portfolio analysis for medium- to long-horizon investors, *if such investors wish to include consideration of private real estate as a potential asset class in the portfolio, one cannot simply use the short-interval return statistics as the inputs to the portfolio analysis*. To examine optimal portfolios for investors with five-year horizons, for example, one needs to use five-year return expectations regarding the mean, standard deviation, and correlations among the asset classes.

This distinction matters a lot when considering the role of private and public real estate in pension portfolios. Recall from our historical comparison of private and public real estate in Section 2.3 that, over the *long-run* (in the "big picture" of Figure 15–4, for example), public and private real estate seemed to perform rather similarly, at least as far as the "second moments" of the returns were concerned. (That is, the *deviation* over time of asset values around their long-run trends seemed to be similar between private and public real estate, as evidenced by the parallel patterns and similar magnitude of rise and fall apparent in Figure 15–4). Thus, in long-run returns such as five-year returns, we would expect to see relatively high positive correlation between public and private real estate. On the other hand, the lag of a year or more between public and private real estate returns means that short-run returns, such as annual returns, will show little or no correlation between public and private real estate. Thus, from a portfolio perspective, using annual return statistics will make public and private real estate appear much more different than they would appear using, say, five-year returns. This difference (which is not realistic for a long-horizon investor) will distort the roles that the two forms of real estate would play in optimally diversified portfolios.

Thus, to be more accurate and relevant to long-horizon investors such as pension funds, MPT should be applied using five-year return statistics rather than annual return statistics as the inputs for the optimization analysis. The five-year statistics will be, in effect, the same as the annual statistics for the efficient asset classes (public real estate, stocks, bonds).[13]

The five-year statistics will be different from the annual statistics for the inefficient asset class, private real estate.

It is important to understand the nature of the differences in moving from short-interval to long-interval return statistics for private real estate. In general, the volatility and correlation statistics will increase for private real estate relative to those for public real estate and the other efficient asset classes. The sluggishness and inertia in private real estate imparts positive serial correlation into its returns, which causes the return variance to increase more than proportionately with the return time interval. In other words, the five-year return volatility for private real estate will be more than $\sqrt{5}$ times the annual volatility. Intuitively, this can be understood as follows. With private real estate, the rise up the cycle is relatively smooth, and the fall down the other side of the cycle is relatively smooth. However, the amplitude of the cycle, the magnitude of the rise and fall, is quite large. With longer-interval returns, it is this amplitude of the cycle that dominates the standard deviation of the return. *With short-interval returns, it is the smoothness of the rise up and fall down that dominates the standard deviation. Similarly, in the longer-interval returns, the correlation should be greater between private real estate and other asset classes that are linked to private real estate by economic fundamentals, such as public real estate and the stock market.* This is because, in the longer run, the fundamental economic linkages come through, reflecting the “big picture” of the return histories.

As a result of these differences between short- and long-interval return statistics for private real estate, portfolio analysis using short-interval return statistics will be biased toward showing a larger role for private real estate than is actually appropriate for a long-horizon investor. We avoid this bias in the present analysis by applying MPT using five-year return statistics rather than annual or quarterly statistics. Our method of determining the five-year return statistics for private real estate is described in the Technical Appendix to this report, the results of which are summarized in the following section.

3.2 Five-Year Return Statistics for Private Real Estate

As described in great detail in the Technical Appendix, five-year-interval return statistics can be derived for private real estate using the 19-year history of annual returns for the unsmoothed NCREIF Index developed in Section 2. This is done by building statistical models of the annual returns, which include the lagged effects.[14]

For example, based on regression analysis, we can model the annual private real estate return as a function of (1) a "stock market factor," (2) a "bond market factor," and (3) a pure "real estate factor." In order to allow for the lack of informational efficiency in the private real estate market, a regression model can be developed, which allows for lagged relationships and serial correlation, based on the annual returns to private real estate and stocks and bonds. Such a model [Technical Appendix (3e)] has been calibrated as follows:

$$r_t = 0.005 + (0.11)m_t + (0.265)m_{t-1} - (0.123)b_t - (0.093)b_{t-1} + (0.527)R_{t-1} + \upsilon_t$$

where: r_t is the true (that is, unsmoothed) real annual total return to private real estate in year t; m_t is the similarly defined return to the stock market (S&P 500); and b_t is the bond market (long-term treasuries). The R_{t-1} term is the lagged residual from the regression of private real estate on to contemporaneous and lagged stock and bond returns and represents the lagged component of the pure "real estate factor." The "real estate innovation," or new component of the pure real estate factor, is represented by the υ_t term, which is uncorrelated over time or with either stocks or bonds.

As can be seen from the coefficients on the stock market, this model suggests that, based on the 1975–1993 historical performance, private real estate has a "total beta" with respect to the S&P 500 of around +0.375. This is considerably higher than is typically reported in studies of historical private real estate returns because most previous studies have failed to correct for smoothing in the private real estate indexes and have failed to consider the lagged relationships and serial correlation implied by private real estate's lack of informational efficiency. These considerations are important for correctly applying MPT to include consideration of private real estate for medium- to long-term investors.

A similar regression-based model can be developed for the relationship between private and public real estate. As shown in the Technical Appendix (4d), the calibrated model is

$$r_t = 0.009 + (0.098)n_t + (0.257)n_{t-1} + (0.457)V_{t-1} + \varepsilon_t$$

where n_t is the public real estate return (unlevered NAREIT) in year t, and V_{t-1} is the lagged private-market effect. This model reflects the fact that public real estate leads private real estate, with most of the link between the two occurring after one year.

Using the above-described, historically based empirical models of private real estate returns, we can construct the implied five-year-interval risk-and-return statistics for private real estate. Along with the assumption that the public markets are essentially efficient, this results in the five-year-interval return statistics presented in Table 15–2. These statistics are the appropriate inputs for a five-year horizon portfolio optimization analysis based on MPT. The statistics in Table 15–2 represent the mean, standard deviation, and correlation coefficients in the five-year-interval, inflation-adjusted total returns to stocks (S&P 500), bonds (long-term U.S. government bonds), public real estate (unlevered NAREIT), and private real estate (unsmoothed NCREIF).

The five-year returns were calculated simply by multiplying the historical annual returns by five. The five-year standard deviations were calculated as the annual standard deviations multiplied by the square root of five (under the assumption that these asset classes, traded in efficient markets, have nearly zero autocorrelation), and by the same reasoning, the five-year correlations among the efficient assets were assumed to be the same as the annual correlations.

The correlation coefficients in Table 15–2 are not lagged, but contemporaneous within the five-year-interval return frequency and thus are the appropriate inputs for mean-variance portfolio optimization with a five-year investment horizon. In the case of the publicly traded asset classes, these correlations are the same as the historical annual frequency correlations, consistent with the assumption of informational efficiency in the public markets. The private real estate coefficients, however, are different, incorporating the lagged relationship at the annual frequency between private real estate and the other asset classes. For example, at the annual frequency, the contemporaneous correlation between the real total returns of private real estate and stocks during the 1975–1993 period was –23.9 percent, instead of the +25.2 percent obtained at the five-year frequency based on the market model described above. Similarly, the standard deviation indicated for private real estate in Table 15–4 is more than $\sqrt{5}$ times the annual standard deviation, due to the inertia in the private market annual returns.

3.3 Optimal Portfolios for Five-Year Horizon Investors

Based on the inputs in Table 15–2, the mean-variance efficient frontier of mixed-asset portfolios can be determined for five-year-horizon investors. This frontier and the efficient portfolios that compose it are shown in Table

TABLE 15–2

Risk-and-Return Expectations for Five-Year Horizon Optimal Portfolio Analysis

	S&P 500	LTG Bonds	NAREIT(UNL)	NCREIF(UNS)
Mean	52.28%	26.97%	29.90%	11.23%
Std. dev.	31.52%	32.64%	31.48%	28.30%
		Correlations:		
S&P 500	100.0%	49.6%	49.5%	25.2%
LTG bonds	49.6%	100.0%	42.3%	–6.1%
NAREIT(UNL)	49.5%	42.3%	100.0%	33.8%
NCREIF(UNS)	25.2%	–6.1%	33.8%	100.0%

Statistics are for five-year-interval real (inflation-adjusted) total returns based on 1975–1993 annual historical returns.

TABLE 15–3

Mean-Variance Efficient Frontier, Five-Year Horizon Investor

Portfolio:		***Shares (% of Portfolio Value):***			
Mean**	**Std. Dev.****	**Stocks**	**Bonds**	**Public Real Estate**	**Private Real Estate**
22.50%	20.40 %	11.26	33.31	7.53	47.90
25.00	20.54	18.33	30.25	7.94	43.48
27.50	20.86	25.41	27.18	8.36	39.05
30.00	21.36	32.49	24.12	8.77	34.63
32.50	22.02	39.57	21.05	9.18	30.20
35.00	22.83	46.65	17.98	9.60	25.78
37.50	23.77	53.72	14.92	10.01	21.35
40.00	24.84	60.80	11.85	10.42	16.93
42.50	26.01	67.88	8.78	10.83	12.50
45.00	27.27	74.96	5.72	11.25	8.08
47.50	28.61	82.04	2.65	11.66	3.65
50.00	30.03	89.81	0.00	10.19	0.00

* Based on input statistics from Table 15–2.

** Inflation-adjusted five-year-interval total return statistics.

15–3 and Figures 15–6 and 15–7 for real five-year, mean-return targets ranging from 22.5 percent to 50 percent (equivalent to annual real-return targets of 4.5 percent to 10 percent).[15] The mixes of asset classes indicated in the table and figures represent the minimum variance portfolios for each of the mean-return targets, assuming no short sales are permitted.

As can be seen in the table and figures, both public and private real estate appear in the optimal portfolios in most of the target return range. As the return target becomes more aggressive, the optimal share of stocks and public real estate increases, while that of bonds and private real estate decreases. This is because the risk-adjusted performance of stock and public real estate is superior to that of bonds and private real estate. The large role of bonds and private real estate in the conservative portfolios is due to the very low correlation between private real estate and bonds, which enables the combination of these two asset classes to provide a low-risk element in the portfolio. In general, private real estate has as large a role as it does in the optimal portfolios despite its very poor risk-adjusted return performance because of its relatively low correlation with the other asset classes. Even so, private real estate drops completely out of the optimal portfolio at the most aggressive return target, while public real estate remains in the optimal portfolio at all target levels. In the midrange of target returns shown in the figures, which is typical of most pension funds, both private and public real estate have significant positions in the optimal portfolios.

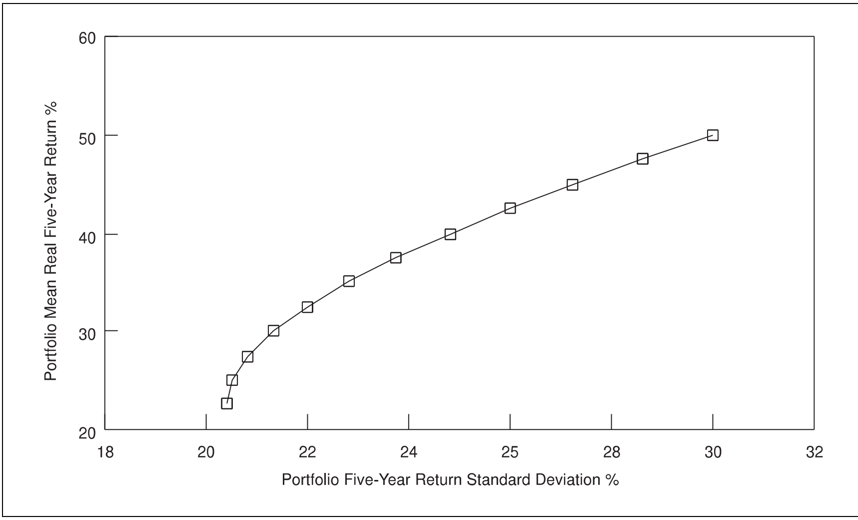
4. CONCLUSIONS FOR INVESTMENT STRATEGY

Let us now return to the primary question that motivated this chapter, the role of public and private real estate in the typical pension fund portfolio. What light does the above-described, historically based portfolio analysis shed on this question? More broadly, what do our general findings in sections 2 and 3 about the nature of public and private real estate in a portfolio context tell us about the role these two ways of investing in real estate can play for pension funds?

Perhaps the single most important message to emerge from the foregoing analysis is that, after being as careful as possible to correct for statistical and data problems such as smoothing in private real estate returns, leverage in public real estate returns, and the implications of market inefficiency for long-horizon investors, *we find strong evidence that both public and private real estate should have significant positions*

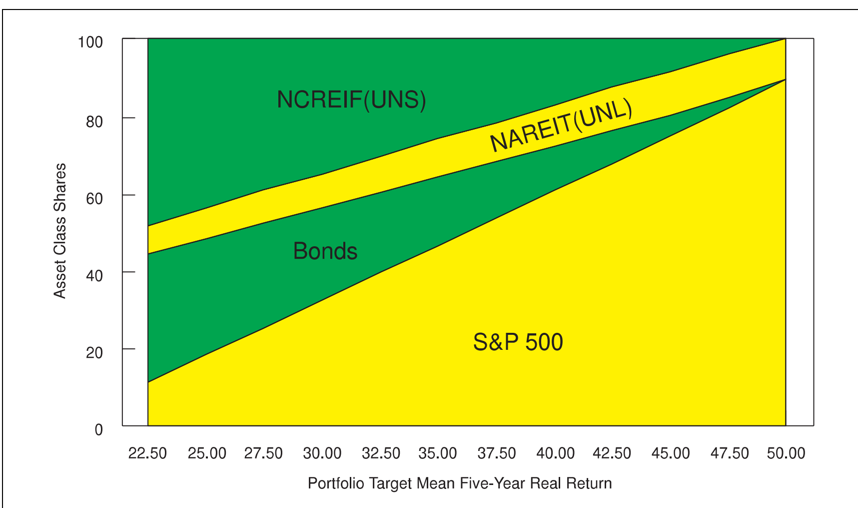
F I G U R E 15–6

Efficient Frontier of Portfolios of Stocks, Bonds, Public Real Estate, and Private Real Estate, Based on Five-Year Real Estate Return Statistics in Table 15–3



F I G U R E 15–7

Asset-Class Shares of Optimal Portfolios, as a Function of Return Target



in the optimal overall portfolio of the typical pension fund. While the role of private real estate is more dependent on the particular portfolio return target the investor selects, the position of public real estate is more robust to the return target. More conservative investors would put relatively more into private real estate and bonds, while more aggressive investors would put more into public real estate and stocks. *Even the most conservative investors, however, would put some portion of their portfolio into public real estate,* according to the portfolio analysis described in the previous section.[16]

While we have not extended the analysis to more recent data than that for 1993 and prior years, we note that stocks, REITs, and direct real estate have all performed well since 1993. The turnaround in the direct market would likely appear stronger after correcting for appraisal smoothing than it appears in the published NCREIF returns, while both stocks and REITs have had strong performance in recent years. Furthermore, there is evidence that correlations between REITs and the S&P 500 have been lower since 1993 than prior to that time. Consequently, the usefulness of REITs in the mixed-asset portfolio may have increased, relative to what was the case in our analysis within this chapter.

In the broader picture, it should be noted that formal portfolio analysis based on MPT and the use of historically based return statistics as the inputs to such analysis should be taken with a grain of salt when making strategic investment decisions. Such analysis provides powerful and important insights, based on a more objective and quantitative approach than has hitherto been possible. But it cannot replace the common sense and broader perspective that is necessary in decision making.

With this in mind, it is often useful to think of two major considerations in strategic investment decision making, *diversification* and *timing*. Diversification responds to the common-sense argument against putting all your eggs in one basket. MPT has given diversification a more formal and quantitative framework to help direct investment decision making. The roots of MPT go back to the "classical" school of financial economics that flowered in the 1960s and 1970s, based heavily on the assumption that capital markets were essentially informationally efficient. Under this assumption, it is fruitless in the long run to attempt to "beat the market," and the efficiency of the market will tend to protect well-diversified investors from making serious "mistakes." This perspective tended to discredit or play down the importance of timing considerations in making investment strategy.

More recently, many financial economists have become convinced that even public capital markets are not *perfectly* efficient, although the efficient market assumption is probably close enough to the truth for most investors' purposes in the case of public market investments. Private real estate markets, however, are more indisputably and more seriously inefficient. While this does not mean that it is easy to "beat the market" in private real estate, it does mean that timing is a relatively more important consideration. Lack of informational efficiency brings both danger and opportunity. Particularly for long-horizon investors with relatively low need for liquidity, such as many pension funds, lack of informational efficiency in private real estate markets can provide opportunities to improve long-run investment performance. To take advantage of real estate investment timing opportunities, it is likely that a mixture of public and private real estate will be useful. Because of its greater informational efficiency and lower transaction costs, it may make sense to use public real estate as a "swing" element in the portfolio, *providing flexibility to the overall real estate position.* For example, during times when the private market appears overheated, additional real estate investments should be made using public real estate, and a rigorous "sell discipline" should be enforced for the private market holdings. For investors who do not wish to expose themselves to the dangers of market inefficiency (for example, buying "overvalued" assets), real estate investment should probably be confined to public real estate. One of the major points of the analysis in Section 2 is that, in the long run, public and private real estate are, to a considerable extent, the same thing.

TECHNICAL APPENDIX: DEVELOPING THE FIVE-YEAR RETURN STATISTICS FOR PRIVATE REAL ESTATE

With only 19 years of good return statistics, or less than four independent (nonoverlapping) five-year return intervals, how can we develop reliable five-year-interval return statistics for private real estate?[a] The answer is that we will use annual frequency data to develop a statistical model of private real estate returns, including the autocorrelation in those returns and the lagged relation between private real estate and public real estate and stocks and bonds. This statistical model can then be used to derive the implied five-year return statistics for private real estate.

Our statistical model of private real estate returns has two components: a "market model," relating private real estate returns to stock and bond returns, and a "real estate model," relating private and public real estate returns. Consider the market model first. We postulate that the private market real estate returns, as represented by the unsmoothed RNI described in Section 2, can be unbundled into a "stock market component," a "bond market component," and a "pure real estate component." The stock market factor exists because real estate is embedded in the overall economy, whose general health and direction is reflected in the stock market. The bond market factor exists because real estate has high-yield, low-growth characteristics, as well as in many cases a fixed-income component (based on preexisting leases) similar to bonds. The pure real estate factor then represents aspects that are unique to private real estate, not shared by either the stock or bond markets. This model can be represented as follows:

$$r_t = \alpha + S_t + B_t + R_t \tag{3}$$

where: r_t is the true private market total return to real estate in year t (that is, corrected for index smoothing); S_t is the stock component in year t; B_t is the bond component in year t; R_t is the year t pure real estate component from the private property market; and α is a constant reflecting a possible differential trend or "drift" rate for real estate as compared to stocks and bonds.

While the stock and bond markets are informationally efficient, the private real estate market is not, and so we would expect the stock and bond components within the private real estate return to possibly be lagged. Thus, we have

$$S_t = \beta_0 m_t + \beta_1 m_{t-1} \tag{3a}$$

and

$$B_t = \gamma_0 b_t + \gamma_1 b_{t-1} \qquad (3b)$$

where m_t and b_t are the total return to, respectively, the stock and bond markets during year t. The pure real estate component is characteristic of the private real estate markets and thus also reflects the sluggishness or inertia of that market in responding to new information. Thus, we would expect the real estate factor to exhibit positive first-order serial correlation, well modeled in annual returns by a first-order autoregressive process:

$$R_t = \upsilon_t + \rho R_{t-1} \qquad (3c)$$

where υ_t is the pure real estate "innovation" in year t, a serially uncorrelated ("white noise") element. This real estate innovation represents the "news," or *new* information that arrives in year t relevant uniquely to private real estate.

By definition, υ, and therefore R, are uncorrelated with either S or B (although S and B may be correlated with each other). Also, due to informational efficiency in the stock and bond markets, m and b are uncorrelated across time (white noise with drift) and unpredictable (no lagged cross-correlation). The lack of informational efficiency in the private real estate market is reflected in the lagged terms: the $\beta_1 m_{t-1}$ term in (3a), the $\gamma_1 b_{t-1}$ term in (3b), and the ρR_{t-1} term in (3c). It is possible that almost *all* of the relationship between real estate returns and stock and bond returns is lagged, that is, β_0 and γ_0 may be very small or nonexistent. In that case, the serial correlation in private real estate returns would derive entirely from the autoregressive pure real estate factor modeled in (3c).

Combining (3a), (3b), and (3c), we see that we can model the private real estate return for year t as a function of the stock and bond market returns in years t and t-1, and the autoregressive pure real estate residual:

$$r_t = \alpha + \beta_0 m_t + \beta_1 m_{t-1} + \gamma_0 b_t + \gamma_1 b_{t-1} + R_t \qquad (3d)$$

While no model is perfect, this would seem to be a reasonable model for capturing the essence of what is going on in the annual-frequency private real estate market return. This model incorporates both the fundamental economic linkages between real estate markets and the economy and capital markets, as represented by the stock and bond markets. The model also reflects the possibility that there may be a unique real estate factor, and it allows for the lack of informational efficiency in the private real estate market.

In Section 2, we quantified the private real estate return series, $\{r_t\}$, by unsmoothing the RNI. As $\{m_t\}$ and $\{b_t\}$ are also empirically observable, it is clear that (3d) can be quantified empirically by regressing the unsmoothed private real estate returns onto contemporaneous and lagged stock and bond market returns. In so doing, we need to be sensitive to the fact that the residuals from such a regression, the pure real estate component $\{R_t\}$, would be expected to have positive first-order serial correlation. Thus, we need to account for this serial correlation in our regression estimation procedure. This can be done by using a generalized differencing procedure and an estimation procedure for the autoregressive coefficient r from (3c). We have used the Cochrane-Orcutt procedure for this purpose to obtain the following quantification of (3c) and (3d):[b]

$$r_t = 0.005 + (0.11)m_t + (0.265)m_{t-1} - (0.123)b_t - (0.093)b_{t-1} + (0.527)R_{t-1} + \upsilon_t \quad (3e)$$

Table 15A–1 presents more details of the regression estimation results for the private real estate annual return market model. While the fit of the regression is low by classical econometric standards, this is not surprising

TABLE 15–A1

Regression Results for the Market Model

Variable	Coefficient	Std. Error	T-Statistic	Prob.
α (constant)	0.005	0.051	0.101	0.921
m_t (stock yr t)	0.110	0.147	0.747	0.468
m_{t-1} (stock yr t-1)	0.265	0.141	1.876	0.083
b_t (bond yr t)	–0.123	0.172	–0.717	0.486
b_{t-1} (bond yr t-1)	–0.093	0.176	–0.528	0.607
R_{t-1} (pure RE yr t-1)	0.527	0.251	2.098	0.056

R-squared: 0.358	Adjusted R-squared: 0.111
Durbin-Watson statistic: 1.555	

Regression based on annual real (inflation-adjusted) total returns during 1975–1993 (19 observations). Dependent variable is unsmoothed RNI. Stock and bond returns from Ibbotson Assoc., Inc., SBBI Yearbook. Stock returns represented by S&P 500. Bond returns represented by long-term U.S. government securities. Cochrane-Orcutt procedure used to estimate autoregressive coefficient.

given the scarcity of data points for estimating the regression (19 annual return observations). Furthermore, a good fit is not a particularly important criterion for a market model of this nature. More important is that the signs and magnitudes of the parameter coefficients should make economic and intuitive sense, which in this case they do. In particular, we note that the relationship between real estate and the stock market is modestly positive, as we would expect given the real economic links between real estate and the rest of the economy. The two estimated b coefficients suggest a total (contemporaneous and lagged) "beta" of just under +0.4. Most of the relationship is lagged one year, which is not surprising given the greater informational efficiency in the stock market. The relationship with bonds is negative, which makes sense based on real estate's inflation—hedging abilities—versus bonds' exposure to inflation. The weakness in the bond relationship also makes sense, as most of the value of real estate does not derive from the preexisting leases. Finally, the autoregressive coefficient on the pure real estate factor (the residuals from the regression) is a moderately positive 0.53, which is in agreement with conventional perceptions that the private real estate market is sluggish in its incorporation of new information relevant to property values.[c]

The other aspect of the annual private real estate returns that must be modeled in order to develop the five-year-interval return statistics that we need for our portfolio analysis is what may be called the "real estate model," relating private real estate returns to public real estate returns. In this case, we model the annual private real estate market returns as a bundle of two components: a "public real estate factor" and a "pure private market factor." The public real estate factor is represented by our unlevered REIT returns and consists theoretically of stock market, bond market, and unique real estate factors all together but with the informational efficiency characteristics of the liquid securities markets. Then the pure private market factor reflects elements that arise uniquely from the private market structure in which private real estate assets trade. As before, the lack of informational efficiency in the private real estate market is reflected both in a lag in the relationship with the public real estate factor and in an autoregressive structure in the pure private market factor.

The real estate model can be expressed algebraically as follows:

$$r_t = a + P_t + V_t \tag{4}$$

where: r_t is the true private market total return to real estate in year t (as before, corrected for index smoothing); P_t is the public real estate factor in year t; V_t is the pure private market factor in year t; and a is a constant. Expanding the two factors as before, we have

$$P_t = \delta_0 n_t + \delta_1 n_{t-1} \tag{4a}$$

$$V_t = \varepsilon_t + \varphi V_{t-1} \tag{4b}$$

where n_t is the unlevered REIT total return in year t (which has no serial correlation or predictability, due to the informational efficiency of the public capital market) and e_t is the pure private market innovation (white noise). Equation (4a) captures the contemporaneous and lagged relationship between private and public real estate, while (4b) reflects the residual pure private market element in the private real estate returns.

As with the market model, the real estate model can be estimated using observable empirical data by regressing the unsmoothed RNI returns onto the unlevered NAREIT returns and explicitly incorporating the serial correlation in the residuals from this regression (which represent the pure private market factor). The regression is[d]

$$r_t = a + \delta_0 n_t + \delta_1 n_{t-1} + V_t \tag{4c}$$

The estimated relation, based on the 1975–1993 historical real total returns (and using the Cochrane-Orcutt procedure to estimate the autoregressive relation in the residuals), is indicated below:[e]

$$r_t = 0.009 + (0.098)n_t + (0.257)n_{t-1} + (0.457)V_{t-1} + \varepsilon_t \tag{4d}$$

The details of the regression results are presented in Table 15–A2. Again, the signs and magnitudes of the estimated parameter values make economic and intuitive sense and appear consistent broadly with the findings in the market model, equation (3d), which is simply an alternative model of the same private real estate returns.

The models of private real estate annual frequency total returns contained in equations (3e) and (4d) can be used to estimate the five-year internal return statistics of private real estate necessary to apply modern portfolio theory for long-horizon investors, as discussed in Section 3.1. In particular, market model (3d) implies that the five-year private real estate returns are related to the annual stock and bond returns and to the pure real estate innovations by the following equation:[f]

$$r_t^5 = 5\alpha + \beta_0 \sum_{j=0}^{4} m_{t-j} + \beta_1 \sum_{j=1}^{5} m_{t-j} + \gamma_0 \sum_{j=0}^{4} b_{t-j} + \gamma_1 \sum_{j=1}^{5} b_{t-j} + \sum_{j=0}^{\infty} \left(\upsilon_{t-j} \sum_{k=X}^{j} \rho^k \right) \tag{5}$$

TABLE 15–A2

Regression Results for the Real Estate Model

Variable	Coefficient	Std. Error	T-Statistic	Prob.
a (constant)	0.009	0.038	0.234	0.818
n_t (NAREIT UNL yr t)	0.098	0.115	0.856	0.405
n_{t-1} (NAREIT UNL t-1)	0.257	0.098	2.619	0.019
V_{t-1} (pure priv. yr t-1)	0.457	0.218	2.100	0.053

R-squared: 0.411	Adjusted R-squared: 0.293237
Durbin-Watson stat 2.035	

Regression based on annual real (inflation-adjusted) total returns during 1975–1993 (19 observations). Dependent variable is unsmoothed RNI. Unlevered NAREIT Index is RHS variable. Cochrane-Orcutt procedure used to estimate autoregressive coefficient.

where r_t^5 represents the five-year-interval return to private real estate for the five-year interval ending at the end of year t; m_s, b_s, and υ_s are the annual innovations (for year s) as defined previously in equation (3); and X is the maximum of either zero or j-4. Similarly, the real estate model (4c) gives the following relation to annual public real estate returns and the pure private market innovations:

$$r_t^5 = 5a + \delta_0 \sum_{j=0}^{4} n_{t-j} + \delta_1 \sum_{j=1}^{5} n_{t-j} + \sum_{j=0}^{\infty} \left(\varepsilon_{t-j} \sum_{k=X}^{j} \varphi^k \right) \quad (6)$$

Given informational efficiency in the public markets (that is, assuming that m_t, b_t, and n_t are not serially correlated and are unpredictable), the five-year-interval return second moments for private real estate returns we need for portfolio analysis are obtained as follows from equations (5) and (6). We can calculate the five-year return variance for private real estate from either equation (5) or (6) (very similar results obtain). For example, from equation (6) we obtain the following:[g]

$$VAR[r_t^5] = \left((\delta_0)^2 + (\delta_1)^2 + 4\,(\delta_0 + \delta_1)^2 \right) VAR[n_t] + \left(\sum_{j=0}^{\infty} \left(\sum_{k=0}^{j} \varphi^k \right)^2 \right) VAR[\varepsilon_t] \quad (7)$$

From equation (5) and the efficient market assumption for stocks we obtain the covariance between the five-year-interval private real estate return and the five-year-interval stock market return as

$$COV\,[r_t^5, m_t^5] = (5\beta_0 + 4\beta_1)VAR\,[m_t] + (5\gamma_0 + 4\gamma_1)COV\,[b_t, m_t] \qquad (8)$$

where m_t^5 refers to the five-year-interval return to the stock market. The five-year covariance with the bond market is similarly derived from equation (5):

$$COV\,[r_t^5, b_t^5] = (5\beta_0 + 4\beta_1)COV\,[m_t, b_t] + (5\gamma_0 + 4\gamma_1)VAR[b_t] \qquad (9)$$

While the five-year-return-interval covariance between private and public real estate is derived from equation (6) as

$$COV\,[r_t^5, n_t^5] = (5\delta_0 + 4\delta_1)VAR\,[n_t] \qquad (10)$$

Finally, the correlation coefficients are obtained using the standard definition. For example, the correlation coefficient between private real estate and the stock market is

$$CORR[r_t^5, m_t^5] = \frac{COV\,[r_t^5, m_t^5]}{\sqrt{VAR\,[r_t^5]}\sqrt{VAR\,[m_t^5]}} \qquad (11)$$

where $VAR[m_t^5]=5VAR[m_t]$ under our assumption of efficient public markets.

Using the above definitions and the empirical relationships established in (3e) and (4d), we obtain the inputs for a five-year horizon portfolio optimization analysis indicated in Table 15–2 of Section 3.3 of the report.

ENDNOTES

1. The twin problems of illiquidity and informational inefficiency led some observers to compare the private commercial real estate market of the early 1990s to "Chinese water torture." The "crash" lasted several years, during which time it was possible for investors to foresee that prices would continue to slide, yet because of the lack of liquidity they could not get out of their real estate positions.
2. The RNI is produced by the National Council of Real Estate Fiduciaries (NCREIF) in Chicago. The EAI is produced by Evaluation Associates, Inc., in Norwalk, Connecticut.

3. During the period of overlap, the two indexes have a correlation coefficient of 93 percent in their returns.
4. As the EAI does not separate the total return into income and appreciation components, we have used the "cap rates" (defined as net operating income as a fraction of property value) reported for commercial properties by the American Council of Life Insurance (ACLI) to approximate the income return component prior to 1978.
5. See D. Geltner, "Estimating Market Values from Appraised Values Without Assuming an Efficient Market," *Journal of Real Estate Research* 8, no. 3 (Summer 1993), pp. 325–346.
6. Some prior studies, particularly in the academic literature, have relied on the efficient market assumption (i.e., assumed unpredictability, or a presumed lack of correlation across time in the real estate market returns) in order to unsmooth the appraisal-based returns. This may lead to inaccurate unsmoothing if, as is widely believed by practitioners, the private commercial property markets are in fact not informationally efficient (and therefore have returns that are somewhat predictable over time). This issue, and a comparison of a number of unsmoothing methods, is discussed more fully in J. Fisher, D. Geltner, and R.B. Webb, "Value Indexes of Commercial Real Estate: A Comparison of Index Construction Methods," in the *Journal of Real Estate Finance & Economics* 9, no. 2 (September 1994), pp. 137–164.
7. Note that the absolute value levels of the smoothed and unsmoothed indexes are not rigorously comparable. (Both indexes are set arbitrarily to have an average value of 100 during the 1982–1992 decade.) However, this relative calibration of the two indexes agrees with the conventional wisdom that market values were well below appraised values by the early 1990s and with the observation that the commercial property market suffered a severe lack of liquidity at that time. Periods of illiquidity are characterized by market values below appraised values. As most property owners try to avoid selling at less than appraised value, and lenders hesitate to finance property purchases when they do not have confidence in appraised values, the situation is akin to "bid price" falling below "ask price" in a double-auction market, resulting in no trades. Such a circumstance tends to be a regular cyclical occurrence in an informationally inefficient market where price changes have "inertia." Falling market values tend to be followed by more falling values, which given the "backward-looking" perspective of appraisal, tends to cause appraised values to exceed market values on the downswing of the cycle. This then adds to the illiquidity in the private market, which thereby exacerbates the cycle. Once the market "bottoms out" and turns up again, the same dynamics tend to propel the market too high.

8. Letting NOI_t be the NOI level in period t, an index of NOI level over time can be obtained from: $NOI_t = y_t^* V_{t-1}^*$, where: V_{t-1}^* is the appraisal-based property value level (accumulated compounded capital returns up through t-1), and y_t^* is the current income return component from the appraisal-based index for period t. Of course, like any index, this NOI level index will have an arbitrary starting value but will accurately show the relative changes over time in the NOI level. While the return formula definitions in the Russell-NCREIF Index do not permit this index construction method to be formally exact, tests using the (proprietary) actual NOI data in the Russell-NCREIF database have shown that this method produces an index that is virtually identical to an exact index of the actual NOI level (see J. Fisher, "Alternative Measures of Real Estate Performance," *Real Estate Financ*e 11, no. 3 (Fall 1994), pp.79–87.

9. Letting y_t represent the true (unsmoothed) income return for calendar year t and V_{t-1} represent the true (unsmoothed) asset value level as of the end of calendar year t-1, we thus have: $y_t = NOI_t / V_{t-1}$. Of course, our constructed indexes actually give the true levels up to a constant multiple, say a NOI_t for the NOI index and bV_t for the asset value index. Thus, we are actually obtaining the series $(a/b)y_t$. We need to determine the constant multiple, (a/b), so we can recover the true y_t series.

10. The NAREIT Index is produced by the National Association of Real Estate Investment Trusts (NAREIT), in Washington, DC. The All-REIT Index is used rather than the Equity REIT Index for two reasons. First, 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. Second, as we will be 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 the unlevering formula discussed below, there is no reason not to include the mortgage REITs in our sample.

11. The NAREIT Index actually begins in 1972, but its first three years appear anomalous. During the 1972–1974 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 1972–1973 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 underlying property values that are the focus of the present study.

12. This scaling, accomplished by multiplying each index by a constant, does not affect the implied returns or relative changes in index values across time.
13. Under the efficient market assumption, the annual mean would simply be multiplied by 5, the annual standard deviation would be multiplied by $\sqrt{5}$, and the correlations (with other efficient assets) would remain the same.
14. Note that using rolling five-year moving averages of returns is an invalid way of developing the return statistics required for five-year-horizon investors. *Independent* (i.e., nonoverlapping) five-year interval return statistics are required.
15. Assuming inflation of 4 percent per year, this would be equivalent to nominal annual return targets in the range of 8.5 to 14 percent.
16. Although one hesitates to take the precise numbers from an MPT-based portfolio optimization too literally, the findings reported in Table 15–5 suggest that even investors with overall portfolio real total return targets as low as 4.5 percent per annum would place 7.5 percent of their portfolios in public real estate. This would actually imply a REIT investment slightly smaller, as the asset class we are defining as "public real estate" is "unleveraged REITs," and so in practice would consist of a combination of REIT equity plus bonds. Currently no pension funds have even anywhere near 5 percent of their overall portfolios in REIT shares, and practical considerations would caution against moving too rapidly to increase REIT holdings.

TECHNICAL ENDNOTES

a. Note that we need a historical period with good return statistics not only for private real estate but also for all the other asset classes that will potentially be included in the portfolio because we require the correlation statistics between private real estate and these other asset classes. Thus, we are limited by the 19 years of good available data on public real estate returns, beginning in 1975.

b. A good introductory discussion of serial correlation in regression models, and the procedure employed here, is found in Chapter 6 of R. Pindyck and D. Rubinfeld, *Econometric Models and Economic Forecasts*, 3rd ed. (New York: McGraw-Hill, 1991), pp. 137–147. The market model has been estimated using real (inflation-adjusted) total returns, as these are the types of returns for which our informational efficiency statistical assumptions are most relevant. It should also be noted that the authors tested several alternative specifications of the real estate market model, including the possibility of lags of more than one year. The model described here performed best, and there was no indication of significant further lags in the relationships.

c. The low t-statistics on some of the parameters is also not surprising given the few data points and likely small magnitudes of the true relationships. While the standard errors provided in Table 15–A1 could allow sensitivity analysis to be conducted in the subsequent portfolio analysis, it should be emphasized that the point estimates represented by the estimated parameter values are unbiased and are theoretically the best numbers upon which to base investment decisions.

d. The reader may ask why we do not combine the market model and the real estate model and estimate a single regression, the combination of (3d) and (4c). There are two reasons. First, at a conceptual level these really are two separate and complete models, representing two different perspectives of the same phenomenon (namely, private real estate market returns). The real estate model and regression (4c) is not an "omitted component" from the market model and regression (3d) but represents a different way of "slicing the pie." Second, at a practical level (and related to this conceptual point), if we did combine the two regressions we would expect to have our estimation results severely clouded by the collinearity between the stock market (S&P 500) returns and the public real estate (unleveraged NAREIT) returns, both of which would then be right-hand-side variables in the single regression. This would make it empirically difficult to obtain the information necessary to apply portfolio theory to the five-year return statistics.

e. Again, tests of alternative specifications revealed no additional lags beyond those incorporated in (4c).

f. This follows directly from the definition of return. Working with continuously compounded returns (arithmetic differences of log value levels), five-year-interval returns are just the sum of the five annual returns included in the five-year interval.

g. In practice, we have used the variance implied by equation (6) and the real estate model (4d), as this model produced a better fit to the historical return data, as seen by comparing the R^2s in Tables 15–A1 and 15–A2. However, the variance implied by equation (5) and the market model (3e) is virtually the same, and our portfolio conclusions are robust to this difference.