Will Private Equity and Hedge Funds Replace Real Estate in Mixed-Asset Portfolios?

Not likely.

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It is conventional wisdom that hedge funds, private equity, and commodities all offer the benefit of portfolio diversification due to their low correlation with equities. Diversification potential is also often used to argue for the inclusion of real estate in a portfolio. If these benefits can be obtained in another way, however, with the added benefit of liquidity and lower transaction costs, does this imply that real estate allocations will fall?

We investigate in detail the risk and return characteristics of real estate and a selection of alternative assets, along with the benefits that arise from diversification and the role of these assets in an institutional investor's portfolio.

We consider that *core* asset *classes* are the traditional investment sectors favored by large institutional investors: equities (domestic and foreign); corporate bonds; gilts (including index-linked); commercial real estate; and Treasury bills. The *alternative asset classes* we consider have attracted the attention of some institutional investors for some time, but they are not traditionally considered an essential component of the asset mix: private equity, hedge funds, infrastructure, and commodity funds.

We do not consider investment in art, wine, or forestry as we do not believe such assets are under serious consideration by large segments of the institutional investment community, and there are not readily available plausible time series returns that we can use for analysis. This is not to say that some institutional investors do not hold these assets or that they necessarily lack investment merit.

One difficulty with the analysis of asset classes is obtaining a data set of sufficient integrity and historical coverage that describes the performance of each asset segment accurately. This is particularly the case for the

alternative assets. To some extent we have had to use data series that not all agree are appropriate to representing the performance of a specific asset segment. This is the limitation of any applied research project.

A second difficulty faced is to what extent one can identify an optimal portfolio. Institutional investors will have very different investment objectives; compare, for example, the investment objectives of a large life fund and a small occupational pension fund with immature liabilities. Many investors seek to develop an optimal portfolio for a specific set of future liabilities rather than optimize against some measure of risk in a single-period setting. Alternatively, investors may define risk broadly to include consideration of higher moments (such as skewness or kurtosis) or downside risk measures.

As it would be hard to consider all possible investment objectives, we choose a mean-variance approach to identify a global minimum portfolio. This has the attractive property that it is free from any assumptions about asset class returns. While it is the natural metric to consider in assessing the relative merits of different asset classes as potential diversifiers, this will not represent the portfolio held by the industry. They will differ because of differing beliefs about expected returns.

The mean-variance model provides a benchmark that is widely applied both in industry and in academic research. It is generally well understood, and its limitations are widely known.

We also do not focus on the issue of illiquidity. Although this may be an important factor in investment decision-making (and is particularly relevant to asset classes such as commercial real estate), it is beyond the scope of our research.[1]

LITERATURE REVIEW

Given the extensive work on optimal portfolio allocation, it is surprising that very little of this research considers optimal allocations for the full range of asset classes available to institutional investors.

Brennan, Schwartz, and Lagnado [1997]; Campbell, Chan, and Viceira [2003]; and Campbell and Viceira [1999, 2002, 2005] examine multiperiod allocation between equities and bonds. Researchers tend to look at only a few assets in multiperiod asset allocation because of the numerical complexity that arises in considering many asset classes. Solutions to such models are also highly dependent on the degree of predictability of asset returns and the level of investor risk aversion assumed.

The work of Hoevenaars et al. [2005] is of particular relevance to our analysis as it seeks to follow Campbell and Viceira [2002, 2005] extended to a wider range of asset classes (including hedge funds, commodities, and real estate). Hoevenaars et al. also consider an asset-liability matching strategy in addition to an asset-only portfolio. Interestingly, optimal asset allocations do not change significantly between the asset-liability portfolio and the asset-only portfolio; alternative assets (such as commodities and hedge funds) have an important role in the optimal portfolio for investors over both short and long horizons. Real estate seems less important in these optimal models.

Terhaar, Staub, and Singer [2003] consider a full range of asset classes from an institutional investor's perspective. The assets are similar to ours, but the methodology is based on simulations of asset returns after identifying common factors in the data. Terhaar, Staub, and Singer recommend a weighting of around 10% in alternative assets (private equity, hedge funds, and commodities), 10% in real estate, and the remainder in global equities and global bonds (52% and 28%, respectively).

There has been a great deal of interest in the role of commercial real estate in a mixed-asset portfolio in the academic literature. The case for including real estate in portfolios of institutional investors has been well made by Hudson-Wilson, Fabozzi, and Gordon [2003]. Excellent summaries of this research are available in Sirmans and Worzala [2003] and Worzala and Sirmans [2003], who cover both direct and indirect real estate investment in an international context.

The findings of these studies tend to be different, depending on whether investment is direct or indirect. Even within these subareas, the evidence is not clear-cut. For instance, Bond and Glascock [2006] find that European real estate securities do offer some diversification potential in a portfolio of equities, bonds, and cash, especially when equity market performance is poor. Similar findings have also been reported by Knight, Lizieri, and Satchell [2005] using a different methodology.

The work of Peyton and Lotito [2007] is the closest to our analysis. They investigate the risk and return characteristics of real estate and alternative asset classes for a U.S.-based investor and optimal portfolio allocations using bootstrap techniques. Peyton and Lotito find that private equity investment is not included in the optimal portfolio when real estate is also included in the choice set.

Other researchers include Hoesli et al. [2002], who find good diversification potential for low- and medium-risk investors by including real estate in the asset mix; in

this case, the greatest benefits were for direct property investment. Giliberto et al. [1999] provide an interesting example of using regime models to estimate means and variances for portfolio allocation (including real estate). While their results for the U.K. are less convincing than for the U.S. market, they argue that in the case of estimating means and variances, regime models may have some benefits for investors.

DATA ANALYSIS

We analyze historical data on the returns of the major core and alternative asset classes to assess the statistical characteristics and the risk-return profile of asset classes considered by institutional investors in the U.K. We ask a number of important questions. For instance, how have the asset classes performed in the past? What would an "optimal" portfolio look like? And, could alternative assets match or perhaps replicate the performance of real estate in a mixed-asset portfolio?

The analysis is based on a sample of data covering a number of asset classes from August 1990 through July 2006. This 16-year history covers the late 1990s bull market period as well as the bear market period after 2000. As quantitative analysis can be sensitive to particular market conditions, we check for robustness by dividing the entire sample into two subperiods; the bull period from August 1990 through December 1999, and the bear period from January 2000 through July 2006.[3]

We analyze in detail 12 different asset classes divided into two groups, a set of core assets and a set of alternative assets. For each asset class there are many potential time series available to us.

For the eight core assets, we use:

- The FTSE All Shares Index.
- MSCI World Index excluding the U.K.
- 10-15 year maturity U.K. government gilts.
- Index-linked gilts.
- Corporate bonds.[4]
- Overseas government bonds.
- IPD All Property Index.
- U.K. one-month Treasury bonds.

For the four alternatives, we use:

- The Credit Suisse/Tremont Hedge Fund Index.
- Macquarie Global Infrastructure Index.[5]
- Datastream U.K. Investment Trusts Private Equity.[6]
- Goldman Sachs Commodity Index.

For the real estate asset class, we must decide how to deal with the problem of valuation smoothing. It is widely accepted that the historical volatility of appraisal-based real estate returns (such as the IPD index or NCREIF index) is downward biased, and that real estate returns are more volatile in reality. If only the unadjusted IPD index returns were used, this might lead us to overstate the desirability of real estate in a mixed-asset portfolio. To allow for smoothing, we report two sets of data for the real estate asset class, the original IPD index returns, and an unsmoothed IPD index series that has been modified using the methods proposed by Bond and Hwang [2007].[7]

Bond, Hwang, and Marcato [2006] show that the smoothness of the IPD index return may not be entirely due to valuation smoothing, but could rather reflect the slowly changing nature of a number of fundamental economic influences on real estate prices including long-term interest rates, inflationary expectations, or demographic trends. Yet when this method is applied to the monthly data, the resulting standard deviation of the unsmoothed IPD index is lower than that suggested by many practitioners and in some of the academic literature. Our response was to increase the standard deviation of the unsmoothed IPD index returns, so that the standard deviation of the annual unsmoothed IPD index returns equaled 13% (suggested by Key and Marcato [2006]).[8]

We use monthly rather than annual data. Considering the investment horizon and the intervals for measuring performance, annual data would be more appropriate. Indeed, in some cases the annual data sets are more comprehensive than the monthly series (e.g., the IPD annual versus monthly index). Annual data reduce the number of observations available for some of the asset series to a level not useful for meaningful analysis, i.e., fewer than 16. This would limit the statistical precision of the results. Also, in many cases asset allocation decisions are carried out using monthly observations, so our focus on monthly data is consistent with industry practice.

In a check for robustness, we compare the results of using monthly and annual returns, and find they are not qualitatively different. We report the results using monthly returns to save space.[9]

Properties of Data

The key statistical properties of the monthly returns series for the 12 asset classes are reported in Exhibit 1. Private equity was the best-performing asset class over the entire time period, followed by infrastructure and

Exhibit 1
Properties of Monthly Returns

A. Entire Sample Period: August 1990 - July 2006	UK Equities	OS Equities	UK Gilts	UK Index-linked Gilts	UK Corp Bonds	OS Govt Bonds	IPD All Property Index	Unsmoothed IPD	UK Tbills	Hedge Funds	Infrastructure*	Private Equity	Commodities
Mean	0.008	0.006	0.008	0.006	0.008	0.006	0.83%	0.008	0.005	0.007	0.009	0.010	0.007
Std. Dev.	0.041	0.050	0.019	0.018	0.036	0.023	0.68%	0.023	0.002	0.032	0.083	0.066	0.061
Skewness	-0.661	-0.590	-0.182	0.333	-0.480	1.367	0.450	1.497	1.681	0.405	-0.151	-0.230	0.229
Kurtosis	3.762	3.943	3.395	5.404	5.017	8.157	4.955	8.132	5.612	4.565	3.319	4.655	3.568
Jarque-Bera	18.629	18.237	2.312	49.790	39.923	272.531	37.056	281.829	144.978	19.526	0.926	23.613	4.255
Sharpe Ratio	0.196	0.119	0.420	0.360	0.233	0.259	1.222	0.361	2.714	0.220	0.114	0.144	0.108
First Order Autocorrelation	0.079	0.064	0.075	0.060	-0.069	0.101	0.830	0.329	0.957	-0.084	-0.014	0.110	0.047
B. Bull Market: August 1990 - December 1999													
Mean	0.012	0.012	0.010	0.008	0.011	0.008	0.007	0.007	0.006	0.010	0.002	0.015	0.004
Std. Dev.	0.040	0.050	0.021	0.019	0.029	0.025	0.008	0.025	0.002	0.038	0.090	0.056	0.057
Skewness	-0.467	-0.612	-0.349	0.468	-0.640	1.518	0.750	1.696	1.399	0.229	-0.019	0.468	0.453
Kurtosis	3.480	4.601	3.237	5.738	7.098	8.030	4.970	8.543	4.021	3.902	3.455	5.567	4.247
Jarque-Bera	5.193	19.123	2.559	39.421	86.791	162.519	28.871	198.836	41.775	3.071	0.312	35.162	11.192
Sharpe Ratio	0.313	0.229	0.478	0.403	0.389	0.312	0.886	0.285	3.050	0.258	0.027	0.270	0.074
C. Bear Market: January 2000 - July 2006													
Mean	0.002	-0.002	0.005	0.004	0.004	0.003	0.011	0.010	0.004	0.004	0.013	0.001	0.010
Std. Dev.	0.041	0.049	0.014	0.015	0.044	0.019	0.005	0.020	0.001	0.025	0.079	0.077	0.067
Skewness	-0.925	-0.615	-0.178	-0.268	-0.219	0.364	1.148	0.789	0.373	0.469	-0.204	-0.466	-0.016
Kurtosis	3.859	3.023	2.794	2.790	3.548	3.928	4.138	4.764	2.076	3.800	3.178	3.451	2.963
Jarque-Bera	13.704	4.986	0.559	1.092	1.617	4.580	21.629	18.438	4.638	5.001	0.655	3.533	0.008
Sharpe Ratio	0.037	-0.039	0.328	0.291	0.093	0.166	2.294	0.502	6.132	0.179	0.159	0.017	0.150

D. Correlation Matrix (Entire Sample Period)	UK Equities	OS Equities	UK Gilts	UK Index-linked Gilts	UK Corp Bonds	OS Govt Bonds	Unsmoothed IPD	UK Tbills	Hedge Funds	Infrastructure	Private Equity	Commodities
UK Equities	1.000											
OS Equities	0.795	1.000										
UK Gilts	0.242	0.128	1.000									
UK Index-linked Gilts	0.282	0.182	0.679	1.000								
UK Corp Bonds	0.181	0.080	0.771	0.604	1.000							
OS Govt Bonds	0.255	0.399	0.374	0.453	0.319	1.000						
Unsmoothed IPD	0.075	0.059	0.035	0.071	0.123	-0.027	1.000					
UK Tbills	0.009	-0.005	0.215	0.077	0.124	0.182	-0.187	1.000				
Hedge Funds	0.515	0.727	0.165	0.179	0.129	0.394	0.019	0.116	1.000			
Infrastructure	0.305	0.321	0.086	0.032	0.186	0.332	-0.111	0.029	0.186	1.000		
Private Equity	0.743	0.645	0.132	0.194	0.135	0.146	0.108	-0.105	0.400	0.155	1.000	
Commodities	0.101	0.185	-0.023	0.097	0.036	0.334	-0.113	0.018	0.321	0.168	0.105	1.000

**Note: Infrastructure index is available only from January 1997.*

corporate bonds. The asset groups with the poorest performance were Treasury bills, overseas government bonds, and overseas equities.

Exhibit 2 displays a plot of the return of each asset class against its standard deviation (a measure of total risk). Looking at the assets in the upper left-hand quadrant, which have the desirable characteristics of higher returns and lower risk than the other asset classes, we see that commercial real estate and gilts have appealing risk-return trade-offs. The best-performing asset classes (private equity and infrastructure) have slightly higher average returns than real estate but also very high levels of volatility. The simple Sharpe ratios suggest that real estate has outperformed the others because of its low volatility.

As is well known in financial economics, most asset return series are not normally distributed, and this is consistent with the results shown in Exhibit 1. Many of the assets show right or left skewness and leptokurtosis, which means that more positive or negative returns are likely to occur, and also more extreme returns, than if the underlying return distributions had been normally distributed. The non-normality is also confirmed by the Jacque-Bera statistics.

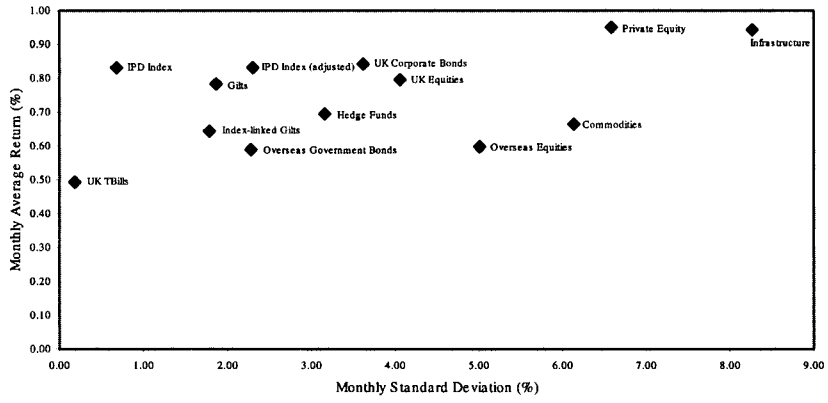
The second and third panels in Exhibit 1 show the sample characteristics over two subperiods (August 1990 - December 1999 and January 2000 - July 2006). In the first subperiod, private equity and U.K. equities show the highest returns, reflecting the strong bull market in equities that occurred in the 1990s. Infrastructure, commodities, and real estate all showed poor performance during the bull market period.

The situation was reversed in the bear market period; most core assets showed poor performance, except for the IPD index. Among the alternative assets, infrastructure and commodities show much better performance in the second subperiod than in the first subperiod, explaining recent interest in these alternative assets.

Generally the asset returns are not serially correlated, with the noticeable exception of the IPD index (and cash). Even after applying unsmoothing procedures to the IPD index returns, the adjusted data still show positive significant autocorrelations. Bond, Hwang, and Mercato [2006] explain that this autocorrelation (persistence) can be interpreted as the smoothness of the fundamental economic information driving valuation-based real estate returns rather than the problem of appraisal smoothing.

EXHIBIT 2

Asset Class Historical Performance and Risk Mean and Standard Deviation of Monthly Total Returns August 1990 - July 2006



Note: Infrastructure series is available only from January 1997.

finding, as it points to the beneficial role real estate might play in mitigating portfolio risk in a mixed-asset portfolio that includes alternative assets. The positive correlations among hedge funds, private equity, and equities suggest less beneficial risk reduction from including these alternative assets along with core asset holdings.

REAL ESTATE AND ALTERNATIVE ASSETS IN A PORTFOLIO CONTEXT

We can demonstrate the positive risk reduction benefits obtained when real estate is included in a mixed-asset portfolio. It will be shown that these benefits are greater than when alternative asset classes replace real estate in a portfolio.

In general, the core assets have shown better risk-adjusted results over the full sample period than the four alternatives; that is, core assets show higher returns relative to volatility. If fund managers are limited in the number of asset classes they can invest in (because of either mandates or resource costs) or for some other reason are required to minimize the number of the asset classes invested in, our results suggest that the eight core assets are the right choice. If there is no restriction on the number of asset classes included in a portfolio, it is possible to reduce portfolio risk further by adding the alternative assets.

A simple way to evaluate the possible reduction in risk to be achieved by combining assets in a portfolio is to examine the correlation matrix of asset returns. As real estate is not significantly positively correlated with other core assets, this suggests that including real estate could reduce the risk of a portfolio appreciably. Hedge funds and private equity are highly correlated with the core assets, which is not surprising, as hedge funds consist of the other assets, and private equities are also highly sensitive to equity market movements.

Our analysis now uses seven core assets excluding cash. Portfolio optimization procedures often allocate a high investment proportion to cash simply because of its low volatility. In fact, holding cash is generally not for investment purposes, except in periods of expected adversity; it is more likely to prepare for other investment opportunities or to pay back cash to investors.

Comovements in Asset Returns

Many investors are concerned not just with the risk and return characteristics of each asset class, but also the extent to which returns on the assets move together. Asset classes that tend to move in similar ways, at similar times, may add little value in a portfolio context, as the benefits of risk diversification will not be as great.

To consider the question of interrelations among the data, and hence an asset's desirability in a mixed-asset portfolio, we present the correlation matrix of asset returns for the complete sample period in Panel D of Exhibit 1.[10]

A number of interesting results are clear from the data. U.K. equities are highly correlated with overseas equity markets (0.80). U.K. equities are also highly correlated with hedge funds (0.52) and private equity (0.74). Correlation among fixed-income sorts of assets is also high. For example, the correlation coefficient between U.K. gilts and index-linked gilts is 0.68. Between gilts and corporate bonds, the correlation coefficient is even higher at 0.77. Gilts, index-linked gilts, and overseas government bonds also display high correlation.

Real estate, Treasury bills, and commodities tend to have lower correlation with the other asset classes in the sample. Real estate in particular is generally characterized by low levels of correlation, and even negative correlation, with the other asset classes. Compared to the alternative asset classes, real estate has a negative correlation with commodities and infrastructure. This is an interesting

Real Estate in a Mixed-Asset Portfolio

The investment proportion allocated to real estate has been increasing gradually for the last five years in the U.K. To what extent does including real estate in a portfolio result in reduced portfolio risk? To examine this question, from the asset return series we construct the global minimum-variance portfolio; that is, the portfolio with the lowest level of risk among all efficient portfolios. We then examine how its variance is reduced by the addition or deletion of additional assets. This method allows us to assess the hedging impact of an asset class independently of its alpha contribution.

The results of the analysis are shown in Exhibit 3, which compares the standard deviations of the global minimum-variance (GMV) portfolios with and without real estate. It shows the composition of the minimum-variance (lowest-risk) portfolio under several different assumptions. In each case, the table reports the results for a portfolio that constrains asset weights to be non-negative.

The portfolio is constructed using the full sample of monthly returns. The first column shows the asset weights for the minimum-variance portfolio without including real estate in the asset mix. These portfolios include primarily fixed-income investments, with a small allocation to equities. The annualized standard deviation of this portfolio is 5.50%.

The second and third columns of Exhibit 3 show the composition of the minimum-variance portfolio if real estate is now included in the selection process. Two sets of data are used for real estate. The first is the original (unadjusted) IPD series, labeled "smoothed IPD". The second is the portfolio weights using the unsmoothed IPD index returns.

Clearly the standard deviation of the portfolio can be reduced substantially by including real estate in the asset mix (4.61% compared to 5.50%). Using smoothed IPD index returns could reduce the standard deviation even more, but the further reduction is probably obtained by a downward bias in the volatility of real estate returns resulting from the appraisal smoothing. As this is likely to be a superficial improvement, henceforth we use only the unsmoothed IPD index returns.

An interesting result is that when real estate is not included, bonds dominate the other assets. When real estate is included, it dominates the other assets. These results are to be expected, as both bonds and real estate are less volatile than the other assets (and real estate has the higher return-risk trade-off of the two).

The investment proportions of the global minimum portfolio are different from what is typically suggested by asset consulting firms, of proportions in equities and bonds of around 60% and 30%, respectively. This is not surprising, as there is no reason to believe that institutional investors choose the GMV as their preferred portfolio.

The reason we consider the global minimum portfolio is that it has the attractive property that it is free from any assumptions about asset class returns. It is thus the natural metric to consider when assessing the relative merits of different asset classes as potential diversifiers.

Can Alternative Assets Replicate the Role of Real Estate?

Could any of the alternative asset classes provide a similar or a greater level of risk reduction to that provided by real estate? Exhibit 4 shows the results of a similar analysis, but this time each of the alternative assets is considered individually alongside the core asset group. Note that here the results are calculated for January 1997 - July 2006 because the infrastructure series is not available over the full period (which is why the numbers in the first part of the table do not match those in Exhibit 3).

Panel A of Exhibit 4 shows the composition of the minimum-variance portfolio when either hedge funds, infrastructure, private equity, or commodities are added to the core asset mix (excluding real estate) (e.g., the allocation to hedge funds equals 7.4%). In no case does adding one of the alternative assets to the core asset mix achieve a significant level of risk reduction.

EXHIBIT 3

Global Minimum-Variance Portfolio with and without Real Estate (192 monthly returns August 1990 - July 2006)

		Without Real Estate	Smoothed IPD	Unsmoothed IPD
Annual Global Minimum Standard Deviation		5.50	2.00	4.61
Investment Proportions	UK_EQ	3.3	0.0	1.0
	OVER_EQ	0.0	0.0	0.0
	UK_GILTS	35.0	9.6	25.2
	UK_IDX_GILTS	39.2	0.4	23.4
	UKCB	0.0	0.0	0.0
	OVER_GB	22.6	8.6	18.5
	Real Estate		81.5	31.8

EXHIBIT 4

Global Minimum-Variance Portfolio with six Core Assets and one Alternative Asset (115 monthly returns January 1997 - July 2006)

A. Global Minimum Variance Portfolios with Alternative Assets without Real Estate

		No Alternative Assets	Hedge Funds	Infrastructure	Private Equities	Commodities
Annual Global Minimum Standard Deviation		4.43%	4.38%	4.43%	4.43%	4.41%
Investment Proportions	UK_EQ	8.0%	5.1%	8.0%	8.0%	7.8%
	OVER_EQ	0.0%	0.0%	0.0%	0.0%	0.0%
	UK_GILTS	30.8%	30.1%	30.8%	30.8%	31.7%
	UK_IDX_GILTS	38.9%	39.0%	38.9%	38.8%	38.7%
	UKCB	0.0%	0.0%	0.0%	0.0%	0.0%
	OVER_GB	22.4%	18.4%	22.4%	22.4%	19.9%
Alternative Asset			7.4%	0.0%	0.0%	1.9%

B. Global Minimum Variance Portfolios with Alternative Assets and Real Estate

		No Alternative Assets	Hedge Funds	Infrastructure	Private Equities	Commodities
Annual Global Minimum Standard Deviation		3.76%	3.73%	3.76%	3.76%	3.73%
Investment Proportions	UK_EQ	4.4%	2.2%	4.3%	4.4%	4.0%
	OVER_EQ	0.0%	0.0%	0.0%	0.0%	0.0%
	UK_GILTS	27.1%	26.5%	27.0%	27.1%	28.2%
	UK_IDX_GILTS	20.9%	21.4%	21.0%	20.9%	20.7%
	UKCB	0.0%	0.0%	0.0%	0.0%	0.0%
	OVER_GB	15.9%	13.0%	15.7%	15.9%	12.6%
	Unsmoothed IPD	31.7%	31.3%	31.8%	31.7%	32.1%
Alternative Asset			5.6%	0.1%	0.0%	2.4%

For example, in the portfolio for the core asset group, excluding real estate and any alternative assets, the (annual) standard deviation of returns for the minimum-variance portfolio is 4.43%. The greatest risk reduction occurs when hedge funds are included in the portfolio. Including infrastructure or private equity in the core asset group results in no risk reduction.

Panel B of Exhibit 4, on the other hand, shows again that adding real estate to the asset mix results in a reduction in overall portfolio risk, although adding the alternative assets to the portfolios with real estate does not contribute to reduction in risk. This finding is consistent with the results of Peyton and Lotito [2007].

We now consider all possible asset classes for the minimum-variance portfolio (both core and alternative assets) to see the maximum possible level of risk reduction. Exhibit 5 shows that the extent of the risk reduction depends on whether or not real estate is included in the portfolio. When real estate is not included, the reduction in volatility is marginal. When real estate is included, the volatility of the portfolio can be reduced by 15%. Including the four alternative assets does not contribute to a reduction in volatility, and the extent of the risk reduction is close to zero.

This analysis clearly shows the importance of real estate as the principal hedging instrument in portfolio formation, and justifies the recent increase in this asset class.

Application to Pension Fund Asset Allocation Decisions

To make our approach to portfolio allocation constraints more realistic, we analyze how much volatility reduction is possible by adding alternative assets to portfolios that might be commonly held by institutional investors (such as for-profit life funds or pension funds). We take the relative weights of the core asset as fixed, and include real estate as a core asset. It is assumed that these managers allocate their funds to core assets as follows.

	For-profit life funds	Pension funds
U.K. gilts	10.00%	6.25%
Corporates and other non-govt	15.00%	6.25%
U.K. index-linked	0.00%	10.00%
Overseas bonds	5.00%	2.50%
U.K. equities	37.50%	32.50%
Overseas equities	12.50%	30.00%
Property	15.00%	7.50%

The percentages do not add to 100%, reflecting the holdings of cash and the potential to invest in other assets, such as the alternative asset classes under consideration in this study. We take these relative weights as given, and calculate the optimal investment allocation to the alternative assets. A two-stage decision process is assumed. Asset managers must decide on how to allocate their assets between the core asset group (as a whole—in the proportions shown above) and the alternative assets. The allocations to the core assets are then split by the proportions above.

To begin, one alternative asset at a time is added to the portfolio (assumed to represent a U.K. for-profit life fund and a pension fund). The sample periods (sample sizes) of the four cases are not the same. To compare various cases, we use a sample period when all asset return series are available: 115 monthly observations from January 1997 to July 2006. We calculate the core asset

EXHIBIT 5

Global Minimum-Variance Portfolio Using Core Assets and All Four Alternatives (115 monthly returns January 1997 - July 2006)

		Without Real Estate	With Real Estate
Annual Global Minimum Standard Deviation		4.38%	3.71%
Investment Proportions	UK_EQ	5.3%	2.3%
	OVER_EQ	0.0%	0.0%
	UK_GILTS	30.8%	27.6%
	UK_IDX_GILTS	39.0%	21.0%
	UKCB	0.0%	0.0%
	OVER_GB	17.0%	10.7%
	Unsmoothed IPD		31.7%
Alternative Assets	Hedge Funds	6.7%	4.5%
	Infrastructure	0.0%	0.1%
	Private Equities	0.0%	0.0%
	Commodities	1.4%	2.0%

portfolio's volatility and the volatility we can achieve by adding an alternative asset.

Panel A of Exhibit 6 shows little difference in the standard deviation of portfolio returns across the alternative assets. Except for adding hedge funds, the other three cases show that we need to invest more than 80% in the core assets to obtain the minimum variance. Adding infrastructure and private equity does not reduce the variance. In the case of hedge funds, the investment proportion in the core asset portfolio is 53.4% (pension funds), reflecting the high correlation between the core assets and hedge funds.

Even if we add all four alternative assets to the core asset portfolio, Panel B shows that volatility is reduced very little more (compare the standard deviation of 8.08% to the standard deviation of the portfolio that does not include any alternative asset, 8.41%)

Assuming that investment managers are unconstrained in their allocation to alternative assets is unrealistic, however. It would be more realistic to assume that the maximum investment proportion in the alternative assets category is 10%. Panel C shows the results with the restriction that the investment proportion in the core asset portfolio must be at least 90% (that is, no more than a 10% allocation to alternative assets). As expected, the restricted portfolios are slightly more volatile than those in Panel B, but the alternative assets still do not contribute to any significant reduction in risk.

Finally, as a check on the robustness of the results to the sample period chosen, we repeat the same procedure during the bull and bear market periods. Panels D and E suggest that there is little difference in our conclusion; the four alternative assets do not reduce risk significantly. One noticeable difference between the bear and bull markets is that during the bull market of the late 1990s commodities were the preferred alternative asset included in the optimal portfolio, while hedge funds were chosen during the recent bear market period.

Efficient Frontier with Real Estate and Alternative Assets

So far we have focused on the reduction of the volatility (portfolio risk) of the global minimum-variance portfolio (GMV). When the variance of the GMV declines with additional assets, the whole efficient frontier expands outward. Hence, a greater range of risk-return possibilities opens up.

Exhibit 7 shows four curves that represent the efficient frontier under different assumptions about the assets available for inclusion in an investment portfolio. The efficient frontier obtained without real estate or any of the alternative assets is in the far right bottom corner of the figure (the line marked by Xs). This suggests considerable scope to expand the efficient frontier by adding assets.

For example, when the four alternative assets are added to the portfolio mix (not including real estate), the efficient frontier is shown to expand toward the upper left quadrant (the curve represented by diamonds in the chart). In this case, the expansion is limited compared with the results obtained by adding real estate to the core asset mix (shown by the triangles). When real estate is added to the portfolio, a large outward shift occurs in the efficient frontier.

This suggests that investors can now achieve a higher return for the same level of risk they assumed before real estate was added to the portfolio. Alternatively, investors may be able to lower portfolio risk for a given level of return.

Finally, using all possible assets expands the frontier even further (the curve represented by squares). Here the expansion beyond the previous curve is marginal; the diversification gain is not as great as that obtained by adding real estate to the portfolio.

EXHIBIT 6

Global Minimum-Variance Portfolio Using Core Assets and All Four Alternative Assets

A. Adding One Alternative Asset (115 monthly returns from January 1997 1 July 2006)

	Profit Life Funds	Pension Funds
Annual Standard Deviation of Core Asset Portfolio	8.410%	10.400%
Hedge Funds		
Annual Global Minimum Standard Deviation	8.21%	9.62%
Core Assets	78.5%	53.4%
Hedge Funds	21.5%	46.6%
Infrastructure		
Annual Global Minimum Standard Deviation	8.41%	10.40%
Core Assets	100.0%	99.0%
Infrastructure	0.0%	1.0%
Private Equity		
Annual Global Minimum Standard Deviation	8.41%	10.40%
Core Assets	100.0%	100.0%
Private Equity	0.0%	0.0%
Commodities		
Annual Global Minimum Standard Deviation	8.19%	9.92%
Core Assets	91.6%	86.6%
Commodities	8.4%	13.4%

B. Adding All Four Alternative Assets (115 monthly returns January 1997 1 July 2006)

	Profit Life Funds	Pension Funds
Annual Standard Deviation of Core Asset Portfolio	8.410%	10.400%
Annual Global Minimum Standard Deviation	8.08%	9.44%
Core Assets	77.3%	52.5%
Hedge Funds	16.2%	38.5%
Infrastructure	0.0%	0.7%
Private Equity	0.0%	0.0%
Commodities	6.5%	8.3%

C. Adding All Four Alternative Assets Alternative Assets Restricted to 10% (115 monthly returns January 1997 1 July 2006)

	Profit Life Funds	Pension Funds
Annual Standard Deviation of Core Asset Portfolio	8.410%	10.400%
Annual Global Minimum Standard Deviation	8.16%	9.95%
Core Assets	90.0%	90.0%
Hedge Funds	4.1%	1.3%
Infrastructure	0.0%	0.2%
Private Equity	0.0%	0.0%
Commodities	5.9%	8.5%

D. Bull Period (January 1997 - December 1999): Adding All Four Alternative Assets Alternative Assets Restricted to 10%

	Monthly Returns (36 Observations)	
	Profit Life Funds	Pension Funds
Annual Standard Deviation of Core Asset Portfolio	8.23%	10.64%
Annual Global Minimum Standard Deviation	7.99%	10.12%
Core Assets	90.7%	90.0%
Hedge Funds	0.0%	0.2%
Infrastructure	0.0%	0.0%
Private Equity	0.0%	0.0%
Commodities	9.3%	9.8%

E. Bear Period (January 2000 - July 2006): Adding All Four Alternative Assets Alternative Assets Restricted to 10%

	Monthly Returns (79 Observations)	
	Profit Life Funds	Pension Funds
Annual Standard Deviation of Core Asset Portfolio	8.300%	10.030%
Annual Global Minimum Standard Deviation	7.95%	9.57%
Core Assets	90.0%	90.0%
Hedge Funds	9.2%	7.3%
Infrastructure	0.1%	0.3%
Private Equity	0.0%	0.0%
Commodities	0.8%	2.3%

These results are consistent with our analysis of the minimum-variance portfolio. Portfolio risk is reduced dramatically by including real estate in a mixed-asset portfolio, and the four alternative assets play a somewhat limited role.

SUMMARY

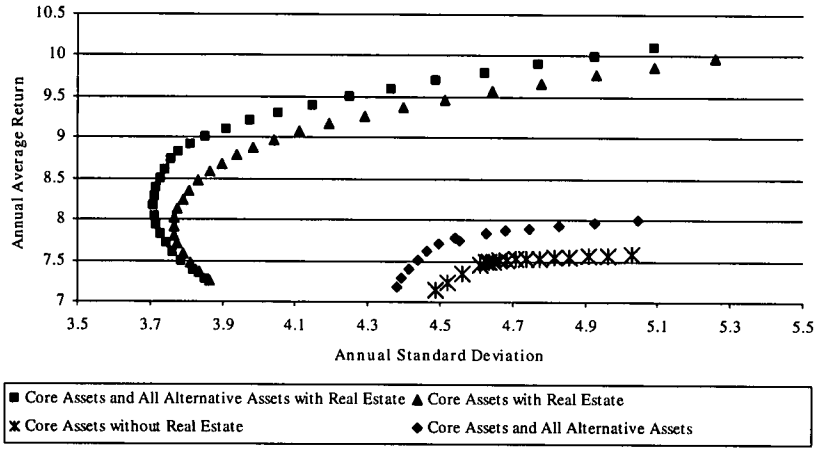
We have investigated the empirical attributes of a set of core assets and a list of alternative asset classes typically considered by portfolio managers (hedge funds, commodities, private equity, and infrastructure). The historical risk-adjusted performance of these asset classes has differed dramatically over the sample period. Private equity and infrastructure had high returns but also high levels of risk. Real estate was shown to have attractive risk and return characteristics for a U.K. institutional investor.

The volatility of our benchmark portfolio (the global minimum-variance portfolio) can be reduced substantially by including real estate in the asset mix (4.61% compared to 5.50%). Could a similar reduction in risk be achieved by using alternative assets? In no case does adding one of the alternative assets to the core asset mix achieve a significant level of risk reduction.

If real estate is not already included in the portfolio, the greatest risk reduction occurs by adding hedge funds to the portfolio (although the advantage is slight compared to that obtained from including real estate). Including infrastructure or private equity in the core asset group results in no risk reduction. When core asset holdings are held in a fixed proportion to reflect the portfolio structure of either a U.K. pension fund or a for-profit life fund, the role of alternative assets in providing portfolio diversification is small. Preference for which alternative asset to hold was found to depend on the state of the market. Commodities provided some diversification benefit during the bull market period, and hedge funds were the preferred diversifier during the bear market.

EXHIBIT 7

Efficient Frontier (115 monthly returns January 1997 - July 2006)



The analysis clearly shows the importance of real estate as the principal hedging instrument in portfolio formation, and justifies the recent increase in this asset class.

Encouragingly for investors, the historical evidence provides strong support for the current trend toward high and increasing allocations to real estate. On a risk-adjusted basis, real estate has been one of the best-performing asset classes over the sample period studied, and real estate has a significantly better risk hedging characteristic than any of the other asset classes.

As to whether these benefits could be derived by substituting other alternative assets for real estate, the emphatic answer is that no other asset class can deliver the same level of portfolio hedging benefits as real estate.

NOTES

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[1]See Bond et al. [2007] for a more detailed discussion of liquidity risk in commercial real estate markets.

[2]All the returns are calculated in nominal terms. Taking inflation into consideration has identical effects on the returns, and is not expected to change our conclusions markedly.

[3]We collect monthly data from Bloomberg from April 2000. From August 1990 through March 2000, we use the quarterly USB Warburg AA over ten-year bond total return index to generate monthly returns. Within each quarter the dynamics of the created monthly returns follow those of the U.K. gilts.

[4]This series is based on the performance of publicly listed investment vehicles, not on the performance of private infrastructure funds. It is available only from January 1997.

[5]We also collect BVCA (annual data) and LPX50 Private Equity (monthly data from November 2003 through July 2006) for private equities, and find that the DataStream U.K. Investment Trusts Private Equity series is not much different.

[6]When the method proposed by Bond and Hwang [2007] is applied, the smoothing level of the IPD index returns is only around 0.4, which is in sharp contrast to indications elsewhere that suggest more than 0.9. Summaries of the smoothing literature can be found in Geltner et al. [2007] and Geltner, MacGregor, and Schwann [2003].

[7]If the reported standard deviation from the summary statistics is multiplied by the square root of 12, a number different from 13 will be found. The multiplication approach to annualizing a monthly value is not applicable when the series are heavily autocorrelated.

[8]We use three different methods to convert the monthly data into the annual returns: multiplying the monthly returns by 12; rolling windows of past 12 months (overlapping); and annual returns (non-overlapping). The results are not qualitatively different from each other.

[9]In a second set of results, not shown, we investigate common factors in the returns series using principal components analysis and find that six common factors explain 99% of the variation in the eight core asset return series. For the alternative assets, hedge funds were found to be a redundant asset class.

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