The Impact of Real Estate on the Terminal Wealth of the UK Mixed-Asset Portfolio

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Abstract

The argument for the inclusion of real estate in the mixed-asset portfolio has concentrated on examining its effect in reducing the portfolio risk - the time series standard deviation (TSSD), mainly using ex-post time series data. However, the past as such is not really relevant to the long-term institutional investors, such as the insurance companies and pension funds, who are more concerned the terminal wealth (TW) of their investments and the variability of this wealth, the terminal wealth standard deviation (TWSD), since it is from the TW of their investment portfolio that policyholders and pensioners will derive their benefits. These kinds of investors with particular holding period requirements will be less concerned about the within period volatility of their portfolios and more by the possibility that their portfolio returns will fail to finance their liabilities. This variability in TW will be closely linked to the risk of shortfall in the quantity of assets needed to match the institution's liabilities. The question remains therefore can real estate enhance the TW of the mixed-asset portfolio and/or reduce the variability of the TW.

This paper uses annual data from the United Kingdom (UK) for the period 1972-2001 to test whether real estate is an asset class that not only reduces ex-post portfolio risk but also enhances portfolio TW and/or reduces the variability of TW.

Key words: *Mixed-asset Portfolios, Terminal Wealth, Variance Drain.*

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1. Introduction

Typically, the combination of assets in the mixed-asset portfolios of institutional investors such as pension funds has been decided using mean-variance analysis (Markowitz, 1952). In this context, one asset that has received particular attention is real estate. Research in this area has concentrated on the reduction in the *standard deviation of returns* from the *ex post time series;* the time series standard deviation (TSSD) arising from the inclusion of real estate in the mixed-asset portfolio. However, the ex post time series standard deviation is not really relevant for long-term institutional investors - the insurance companies and pension funds. They are more concerned with the terminal wealth and the variability of this wealth, the terminal wealth standard deviation (TWSD) of their investments; it is from this that policyholders and pensioners will derive their benefits (Radcliffe, 1994). This kind of investor, with a rather specific holding period, is less concerned about the within period volatility of their portfolios but more by the possibility that their portfolio returns will fail to finance their liabilities. This variability in terminal wealth will be closely linked to the risk of shortfall in the assets needed to match the institution's liabilities. Lee and Byrne (2000) have shown for example that constructing a value-weighted real estate portfolio can improve the terminal wealth of a portfolio but there may be some significant counterbalancing risk effects.

The terminal wealth (TW) of a fund depends on two factors, the length of the holding period and the risk/return performance of the investments. It can be calculated as a function of its geometric mean (GM) as in equation 1:

$$TW = (1 + GM)^n \quad (1)$$

Thus, the greater the geometric mean for a given holding period the greater the TW. Alternatively, the longer the holding period, for a given geometric mean, the larger the TW. The geometric mean of the fund in turn can be approximated (see Messmore (1995) and Booth and Fama (1992) among others) by the arithmetic mean (AM), or expected returns, of the portfolio and the variance (V) of the portfolio returns, as shown in equation 2:

$$GM^2 \approx AM^2 - (V)/2 \quad (2)$$

Equation 2 shows that, for a given expected return, the greater the variability of returns (variance) the lower the geometric mean and so the smaller the TW of the fund. The difference between the arithmetic mean (AM) of an asset or portfolio and its geometric mean (GM) is approximately one-half the variance, a feature that Messmore (1995) calls "variance drain". It follows that including, in an existing portfolio, assets, which do not materially reduce expected returns but reduce portfolio risk should lead to greater TW. Of course, one asset that has been constantly claimed to reduce the risk of the mixed-asset portfolio is direct real estate. The argument for including real estate in the mixed-asset portfolio *may* therefore be made not only on its ability to reduce the ex-post risk of the mixed-asset portfolio, but also on its ability to increase the TW of the fund as a consequence of reductions in variance drain.

The remainder of the paper is organised as follows. The next section discusses the data and the de-smoothing approach adopted. Section three describes the research design employed. Results are presented and discussed in section four. Finally, section five concludes the paper and suggests directions for future research.

2. Data

There are a number of real estate indices in the United Kingdom (UK), the large majority of which are appraisal-based (Morrel,l 1991). The largest, in terms of value and number of properties covered, is the Investment Property Databank (IPD), with around 11900 properties in 236 funds, valued at approximately £99billion at the end of 2001. De facto, it is now considered to be the index against which the investment performance of UK institutional real estate is compared (SPR, 1994). In the present study the annual investment returns from this index series and its comparators are used over the period 1972 to 2001. The annual IPD Long Term Index is the longest possible time series that is available, and is in any case most appropriate since we are interested in the strategic allocation of assets. The comparable figures for equities and gilts (bonds) and cash (T-bills) are those used by IPD in their Annual Review. The summary statistics for these data series are shown in Figure 1.

Figure 1 indicates that the appraisal-based real estate data show a much lower level of return; 12.61% per annum than equities (17.75%), but at a significantly lower risk – 11.04%, (31.97%) with a coefficient of variation of 0.88 (1.80). Indeed, the risk of real estate is considerably less than UK government bonds, 15.33% per annum. The other important difference between the real estate returns and the other two major asset classes is in the serial correlation statistic. Figure 1 shows the returns of real estate display a significant first order serial correlation of 0.27.

The low value of the risk, compared with bonds, and the presence of significant first order serial correlation, is a common feature of commercial real estate data (see Fisher, *et al.,* 1994 and Corgel and deRoos, 1999, for comprehensive reviews). This downward bias in the second moment of appraisal-based real estate market indices is attributed usually to the behaviour of appraisers in conducting valuations and to the temporal and cross sectional aggregation of individual real estate valuations into the market index (Geltner, 1991 and Brown and Matysiak, 1998). To account for appraisal bias and to make the appraisal-based real estate data more comparable with the market based stock and bond returns, the real estate data were de-smoothed.

The de-smoothing model is that suggested by Geltner (1993). To some extent the amount of smoothing applied is arbitrary. The intention should be to correct for the degree to which a valuer weighs in past valuations when making the current valuation. The value of the de-smoothing parameter used here is 0.67, because this results in a de-smoothed return series that displays an insignificant first order correlation coefficient (0.01). It gives a mean value barely one percent different to the smooth value, but shows a standard deviation for the de-smoothed real estate data about 50% greater that of the appraisal based data, a value which is broadly similar to other studies where the data has been de-smoothed for this reason. All the remaining analysis uses the de-smoothed series.

3. Research Design

Initially, a mixed-asset portfolio was constructed without real estate, and its compound return (TW) was estimated using equation 2. The weights of the various assets were chosen to represent a typical institutional portfolio. In particular, the base mixed-asset portfolio has an effective 60/40 stock/bond structure, but with a small amount also in T-bills. A holding in real estate of 5% was then substituted into this mixed-asset portfolio increasing step-wise to 10%, 15% and 20%. The compound returns (TW) and variance drains were calculated. The re-allocation of the capital market assets was done in several ways to include real estate. First, the holding in real estate replaced the same percentage in Bonds. In the second approach the percentage allocated to real estate replaced the same proportion in Equities. Finally, the holding in real estate was equally split between the Equities and Bonds. In this way the impact of real estate on the mixed-asset portfolio could be evaluated under a number of scenarios. The statistics for these portfolio scenarios, including the GM and variance drain are presented in Figure 2.

Figure 2 shows that replacing bonds with real estate leads to an increase in mean return of only 10bp and a reduction in TSSD of 89bp. In contrast, replacing equities with real estate leads to a *reduction* in mean return of 106bp compensated for by a reduction in risk of 477bp. When real estate replaces an equal amount in equities and bonds the result lies between the two previous outcomes. The mean return falls by 48bp, while the TSSD reduces by 290bp. The inclusion of real estate, however, always leads to a reduction in variance drain. As a consequence, the geometric mean increased by 30bp when real estate replaced bonds. When real estate replaced equities it was reduced by 41bp and declined marginally by 9bp for equities/bonds. The impact of real estate on the mixed-asset portfolio therefore depends on both the allocation to real estate and the asset class replaced.

4. Bootstrapped results

The results in Figure 2 are only point estimates however, drawn from the sampled returns data. Consequently we cannot infer whether the results are representative of the likely outcome over different periods. This being so, how confident can we be that the results so far are representative of the benefits of including real estate in the mixed-asset portfolio in the long run? To overcome this, the return series were bootstrapped, generating a simulated ex ante return series to provide a confidence interval around the mean. The assumption here is that the ex ante returns of any asset are random variations of its ex post returns with the same contemporaneous structure as the original data. This flexibility permits a more detailed assessment of the effects of including real estate in the mixed-asset portfolio. Several studies have applied this kind of analysis to real estate, (see for example, Liang *et al*., 1996; Ziobrowski *et al*., 1997 and Hardin and Cheng, 2002).

The bootstrap provides a convenient method for estimating the sampling distribution of a random variable by repeated sampling, with replacement, from the original data set (Efron, 1979 and Efron and Tibshirani, 1986). However, while the method generally produces robust results, the technique is subject to two potential problems. First, as a purely statistical technique, the method ignores fundamental economic principles, such as the tendency for markets to converge to equilibrium. To avoid this particular problem the data series should be long enough to include at least one complete cycle (as here) so that such information will be present in the ex post data and be preserved in the simulated series. A second, and potentially more serious problem is that if the data are auto-correlated, re-sampling the original data directly will destroy its contemporaneous structure. So that any autocorrelation structure in the data series was preserved, a vector autoregression (VAR) procedure was applied such that:

$$V_t = C'V_{t-1} + \varepsilon_t \quad (3)$$

Where V are the time series data of the asset classes at time t and t-1, C is the coefficient matrix and ε_t is the error term matrix (Hardin and Cheng, 2002).

Equation 3 is limited to a first order autoregression model because most of the serial dependence in the series can be captured by the first lag. The error term matrix represents the random components of the sampled data and it is this random component that is bootstrapped in the simulation process. This re-sampled return series was then used to generate the portfolio mean, standard deviation, geometric mean, and variance drain. The process was repeated 10,000 times. This bootstrap distribution is taken to represent the sampling distribution of the data. The median of the bootstrap distribution was then computed. The results are presented in Figure 3.

Figure 3 shows that including real estate in the mixed asset portfolio generally leads, on average, to a reduction in portfolio returns, especially if real estate replaces equities. However, the inclusion of real estate also leads to a reduction in portfolio risk (TSSD) that is proportionally greater than the loss in return. Real estate therefore improves the ex post risk-adjusted performance of the mixed-asset portfolio. Real estate also reduces the variance drain on the mixed-asset portfolio. Finally including real estate leads to a minor reduction in the geometric mean and hence TW. However, the inclusion of real estate may lead to reductions in TWSD.

5. Terminal Wealth Simulations

Using the data in Figure 3 the TW of the various investment strategies represented there can be estimated for a number of holding periods. The holding periods taken here are from one to 30 years. Although these assets are held for the long term, naturally it is very unlikely that any one investment class will be held unchanged for a period as long as 30 years. This is true even for real estate and the limited amount of work that has been done on this shows that for real estate the average holding period for individual assets is actually likely to be much less (Collett, *et al*., 2003; Fisher and Young, 2000). Looked at in its entirety however, the mixed-asset portfolio maintains its general existence as a long-running entity and this justifies testing long holding periods for the portfolios as a whole, especially as one consequence is that in some cases very large TW amounts may accrue, though some of these will have large TWSDs. Even so, the fund manager will seek to maintain a certain amount of stability in the portfolio, and this is simulated here by the return and risk measures that represent the portfolios with particular asset mixes.

The method is to assume that the portfolio returns are Normally distributed, with the Mean and SD taken from scenarios in Figure 3. The portfolios chosen in each case replace 5% and 20% (low and high) of bonds, equities, and bonds and equities with an equal proportion in real estate. For each holding period from 1 to 30, a value was sampled from the distribution. The returns for each period were successively compounded to generate a TW value for the portfolio in each period up to period 30.

This process was repeated 5000 times for each scenario. The results are shown graphically in Figures 4-7[1].

In Figure 4, the mean TW for each holding period in each scenario is shown relative to the base portfolio. The expectation is that all portfolios would tend to perform less well in terms of their mean TW than the base portfolio, and this is what is generally seen, but with substantial overlap in most cases. However, replacing bonds with real estate does show improve return performance in most holding periods, a function of real estate's better average performance over the period than that of bonds. Replacing equities or equities and bonds shows a weaker return performance to the portfolios over most holding periods, reflecting a relatively much stronger equity performance in most periods of the analysis.

The TWSD performance is seen in Figure 5. Here the replacement of the low risk bond asset shows in the increase in TWSD across the holding periods for the bond-replacing scenarios – bond low and bond high. In contrast, replacing the high-risk equities gives a strong reduction in TWSD across the holding periods, more than 40% below the base portfolio equivalent at period 30.

Figure 6 examines the return/risk characteristics of the simulated portfolios using, in this case, a Sharpe-type measure, again relative to the base portfolio. In the case of a 20% holding in equities or equities/bonds, the fall in TWSD is greater than the fall in TW. The risk adjusted performance in these cases increases. In all other cases the degree of reduction in TWSD is not great enough to compensate for the loss in return, especially after approximately 20 years.

Figure 7 attempts to depict the worst case. Here the graphs show the lower value confidence value for a 10% confidence band around the mean. As can be seen the addition of real estate into the portfolio generally leads to increases in TW at this lower level of confidence, especially beyond holding periods of approximately 15 years. Fund managers with long investment horizons can feel more confident that, even in poor cases, they will achieve higher TWs from holding real estate compared with the base portfolio defined here.

6. Conclusions

This study has investigated the effect on the terminal wealth when real estate is included in a UK mixed-asset portfolio. Using data from the period 1972-2001, the results show that the inclusion of real estate has a variety of impacts depending upon the asset class replaced and the percentage of that asset which is replaced. Replacing bonds leads to an increase in TW. In contrast, replacing equities gives significant falls in TW. The replacement of both bonds and equities gives an intermediate result, which is influenced chiefly by the performance of equities.

In terms of TWSD however, the replacement of bonds ultimately leads to an increase in risk, whereas TWSD falls consistently for the other scenarios. As a consequence the replacement of equities and bonds/ equities results in risk adjusted performance.

Overall, including real estate in the mixed-asset portfolio appears to offer an improvement in terminal wealth and a reduction in TWSD compared with the base portfolio (without real estate). Issues that have not been incorporated here but which

[1] Full tabulated results are available from the authors.

may have fund management significance are the illiquidity and management costs within the direct real estate portfolio, which are assumed to be much higher than for equity and bond portfolios and which may reduce the net returns to the mixed-asset portfolio. One current outcome of this has been an increased desire on the part of fund managers in the UK to seek out indirect investment vehicles that have high liquidity and lower costs, but still offer returns equivalent to direct investment, thus maintaining the outcomes observed above.

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Figure 1: Summary Statistics: IPD Series - 1972-2001

Statistic	RE	Desmoothed RE	Equities	Bonds	T-bills
Arithmetic Mean	12.61	12.46	17.75	11.95	9.81
Standard Deviation	11.04	15.87	31.97	15.33	3.3
1st order serial correl.	0.27	0.01	-0.3	-0.17	0.73
Geometric Mean	12.07	12.38	14.01	10.97	9.76
Terminal Wealth	30.50	33.19	51.08	22.71	16.35
Variance Drain	0.006	0.013	0.051	0.012	0.001
% Mean	4.83	10.11	28.8	9.83	0.55

Figure 2: Replacement Scenarios: Portfolio Statistics

Replacing Bonds								
RE	Equities	Bonds	T-bills	Mean	SD	Geo. Mean	V Drain	% Mean
-	0.55	0.40	0.05	15.03	21.99	13.15	0.024	16.08
0.05	0.55	0.35	0.05	15.06	21.71	13.21	0.024	15.64
0.10	0.55	0.30	0.05	15.08	21.46	13.26	0.023	15.27
0.15	0.55	0.25	0.05	15.11	21.26	13.31	0.023	14.96
0.20	0.55	0.20	0.05	15.13	21.10	13.35	0.022	14.71
Replacing Equities								
RE	Equities	Bonds	T-bills	Mean	SD	Geo. Mean	V Drain	% Mean
-	0.55	0.40	0.05	15.03	21.99	13.15	0.024	16.08
0.05	0.50	0.40	0.05	14.77	20.74	13.06	0.022	14.56
0.10	0.45	0.40	0.05	14.50	19.53	12.97	0.019	13.14
0.15	0.40	0.40	0.05	14.24	18.35	12.86	0.017	11.82
0.20	0.35	0.40	0.05	13.97	17.22	12.74	0.015	10.61
Replacing Equities and Bonds								
RE	Equities	Bonds	T-bills	Mean	SD	Geo. Mean	V Drain	% Mean
-	0.55	0.40	0.05	15.03	21.99	13.15	0.024	16.08
0.05	0.525	0.375	0.05	14.91	21.22	13.14	0.023	15.10
0.10	0.50	0.35	0.05	14.79	20.48	13.12	0.021	14.17
0.15	0.475	0.325	0.05	14.67	19.77	13.10	0.020	13.31
0.20	0.45	0.30	0.05	14.55	19.09	13.06	0.018	12.52

Figure 3: Bootstrapped Results
Median: Portfolio Mean, SD, Geometric Mean, and Variance Drain
10,000 Iterations

RE Percentage	%	Portfolio Mean	SD	Geo. Mean	V Drain
Base-line	0	15.3	21.9	13.2	0.024
Replacing Bonds	5	15.3	21.7	13.2	0.024
	10	15.3	21.5	13.3	0.023
	15	15.2	21.2	13.3	0.023
	20	15.2	21.0	13.2	0.022
Replacing Equity	5	15.0	20.7	13.2	0.021
	10	14.7	19.5	13.1	0.019
	15	14.4	18.4	12.9	0.017
	20	14.1	17.2	12.8	0.015
Replacing E&B	5	15.2	21.2	13.2	0.022
	10	15.0	20.4	13.2	0.021
	15	14.8	19.7	13.1	0.019
	20	14.6	19.1	13.0	0.018

Gain/loss	%	%	%	%	%
Replacing Bonds	5	-0.1	-1.2	-0.2	-2.4
	10	-0.1	-2.2	0.2	-4.4
	15	-0.5	-3.2	0.2	-6.4
	20	-0.9	-4.3	-0.2	-8.4
Replacing Equity	5	-1.9	-5.6	-0.6	-10.8
	10	-3.7	-11.1	-1.3	-21.0
	15	-5.8	-16.2	-2.4	-29.9
	20	-7.9	-21.7	-3.4	-38.6
Replacing E&B	5	-0.8	-3.4	-0.1	-6.8
	10	-2.1	-6.9	-0.6	-13.4
	15	-3.2	-10.1	-1.1	-19.2
	20	-4.4	-13.2	-1.6	-24.6

Figure 4: Relative Mean Terminal Wealth - Base Portfolio = 100
Holding Periods 1 - 30

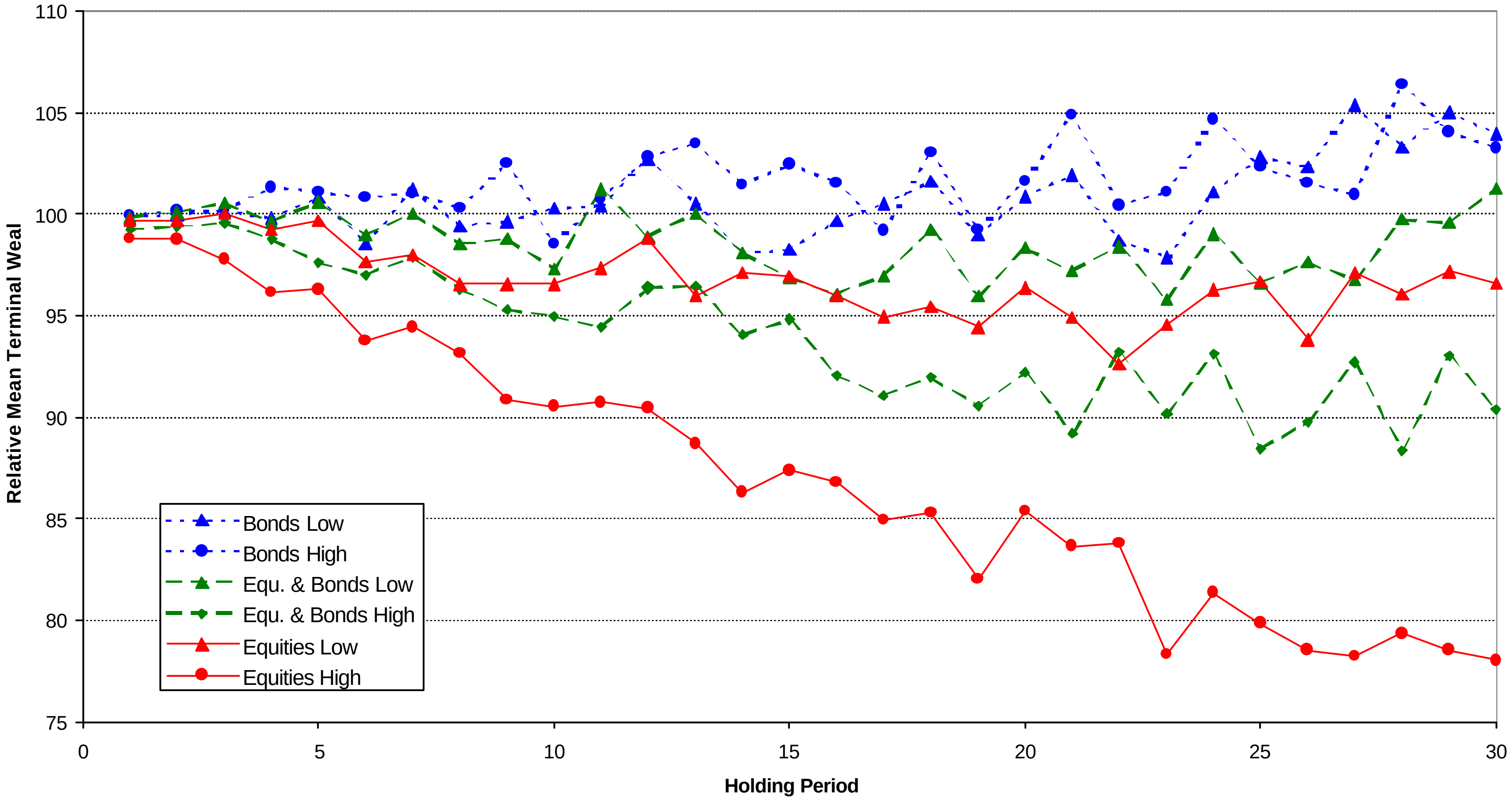

Figure 5: Relative TWSD - Base Portfolio = 100
Holding Periods 1 - 30

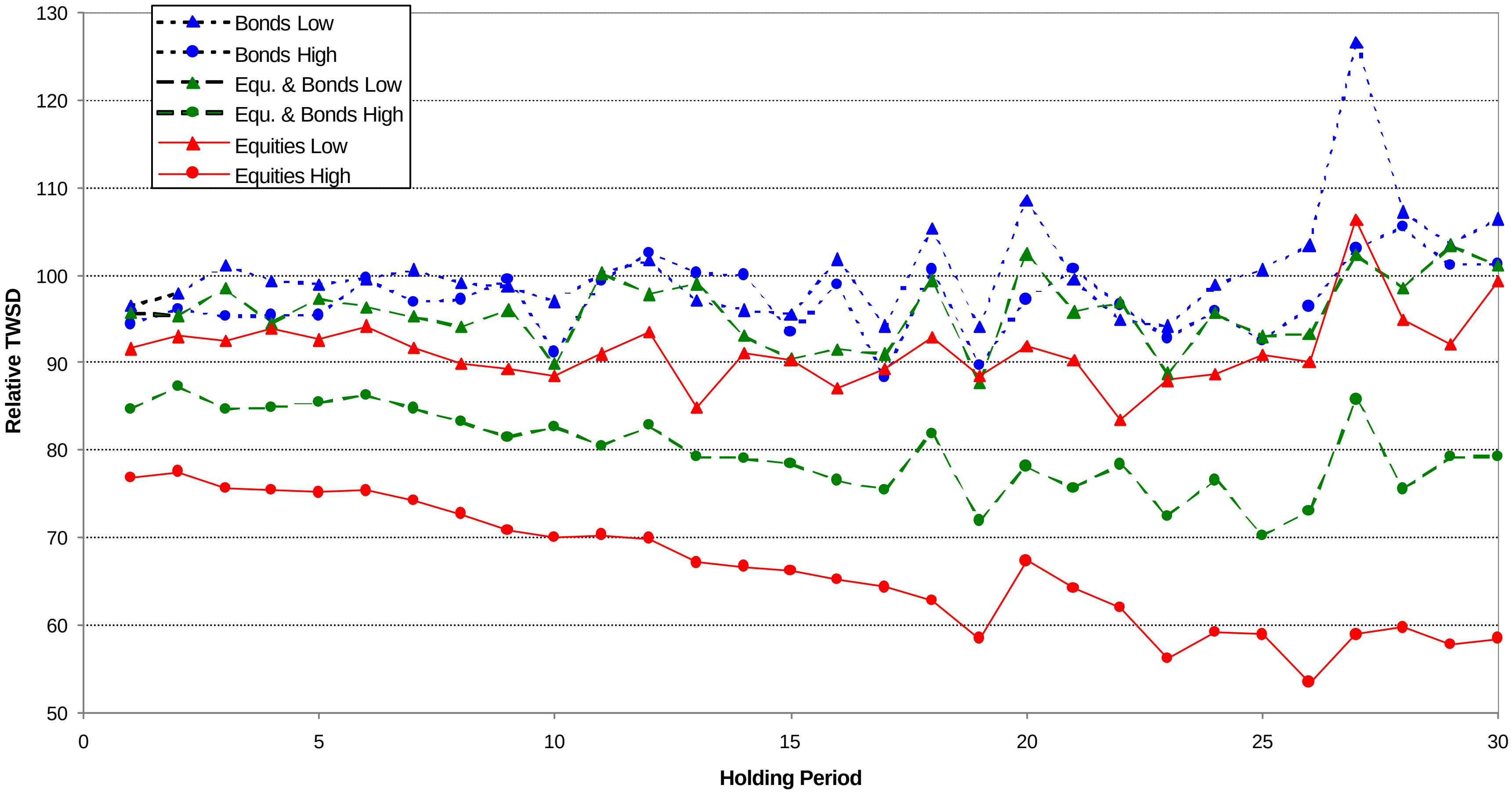

Figure 6: Relative Sharpe Ratios - Base Portfolio Ratio = 100
Holding Periods 1 - 30

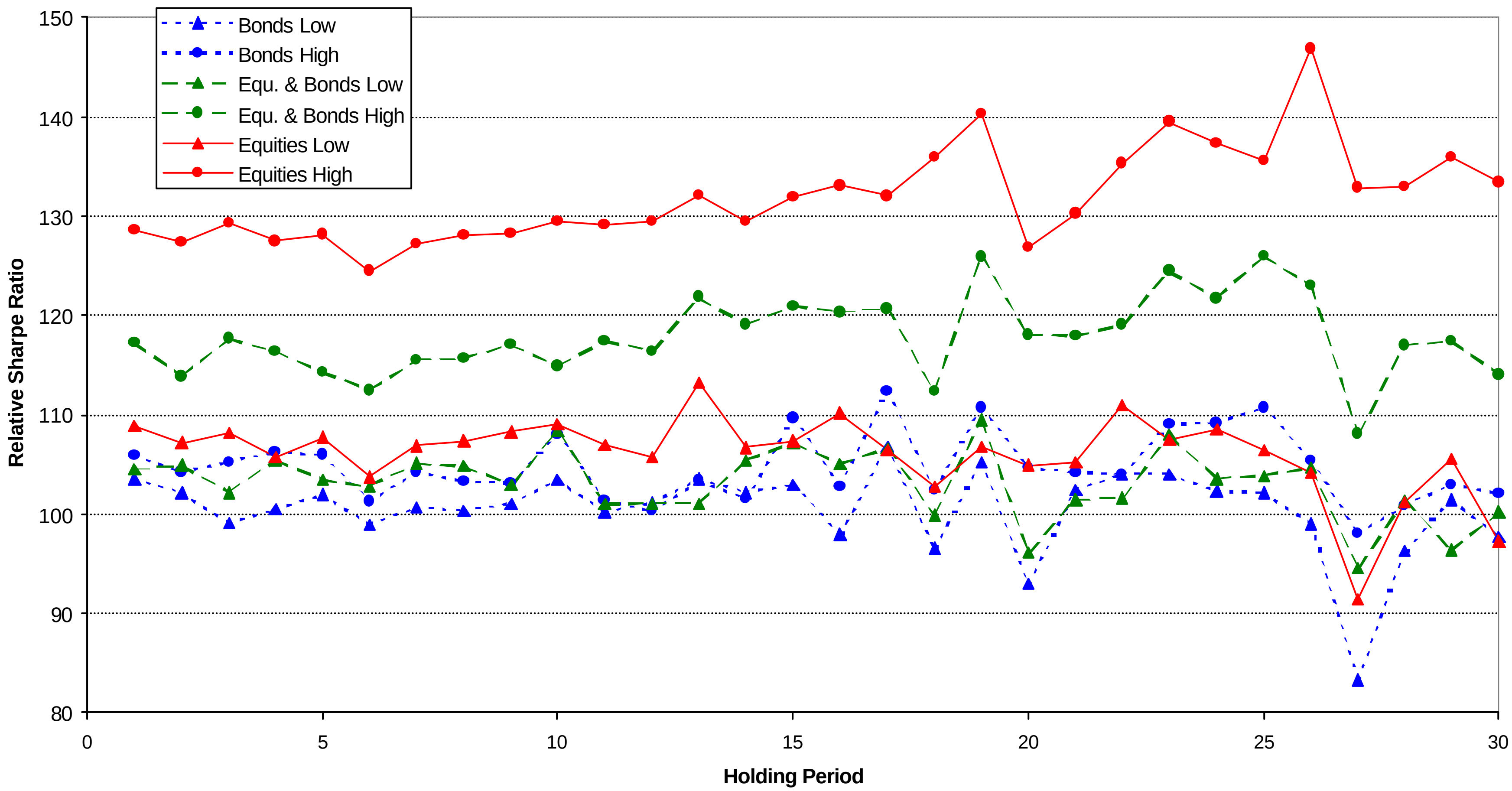

Figure 7: Relative Lower 5% Confidence Limit - Base Portfolio = 100
Holding Periods 1 - 30