

# Optimal Allocation to Real Estate in Canada

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## The Optimal Allocation to Real Estate in Canada

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The last two decades have seen an increasing awareness amongst institutional investors of real estate as a viable asset class. As of 2005, Canadian pension funds had on average 5.5% of their assets allocated to real estate, a substantial increase from previous years.<sup>1</sup> Proponents note that real estate's relatively low volatility and low correlation with other asset classes make it an excellent source of diversification in a portfolio, reducing overall risk without sacrificing returns. Despite the increased awareness amongst institutions about real estate and its perceived benefits, many commentators believe that institutional investors continue to make lower than optimal allocations to it within their portfolios (see, for example, Chun, Sa-Aadu and Shilling (2004)). This points to the possibility that institutional investors are missing out on potential improvements in portfolio performance by under-allocating to real estate.

The question of whether institutional investors under-allocate to real estate is contingent on the answer to a more basic question: What *is* the optimal allocation to real estate? The

**'What is the optimal allocation to real estate?'**

optimal portfolio allocation to real estate has been studied by several researchers in the U.S. (see, for example, Firstenberg et al. (1988), Ziering and McIntosh (1997), Geltner and Rodriguez (1998) and Craft (2001) among others). In Canada, however, the optimal allocation to real estate remains an important but understudied topic. The research here is meant as a first step towards rectifying this situation.

In what follows, I use historical data on Canadian commercial real estate to examine a number of specific questions regarding real estate within a strategic asset allocation:

- (1) How has real estate performed as an investment, and how has it compared to the more traditional capital markets based asset classes?
- (2) Does including commercial real estate as an asset class improve the investment opportunities available to investors?
- (3) What is the optimal allocation to commercial real estate within a diversified portfolio?
- (4) How does investment performance and optimal allocation vary by property type?
- (5) What role does commercial real estate play for pension funds interested in managing their assets in relation to their liabilities?
- (6) Can Real Estate Investment Trusts (REITs) be used effectively as a proxy for direct investments in commercial real estate?

I address each of the questions above within a Canadian context, due to the lack of prior research on the investment characteristics of the real estate sector in Canada. The questions asked are designed to help institutional investors make allocation decisions regarding Canadian commercial real estate. Thus, the results may be of interest to Canadian institutional investors as well as to international investors considering an expansion into the Canadian real estate space. At this point, readers uninterested in the methodology employed to construct returns for Canadian commercial real estate can skip, without loss of continuity, to the results starting on page 8.

### **Preliminaries: Part 1 – The Problem with Real Estate Returns**

Any study of the investment characteristics of real estate is always faced with the same problem – the data. While historical returns on asset classes such as equities or bonds are readily available and widely accepted, the same is not true of real estate. Because commercial real estate does not have the same frequency of transactions as do, for instance, equities, most indices of real estate performance are appraisal based. The

available measures of real estate performance are therefore not based on actual market values, but rather on estimates of market values.

It is widely known that appraisal based indices suffer from “smoothing”. The nature of the appraisal process and the manner in which the indices are constructed results in volatility and correlations with other asset classes both being underestimated. Using an appraisal based index will therefore result in overestimating the benefits of real estate and overestimating the optimal allocation. While, recently, some non-appraisal based indices have become available for U.S. commercial real estate (for example the TBI Index from the MIT Centre for Real Estate), these are not (at least as of yet) widely followed or accepted by the investment community. As well, in Canada, as in most countries, no such alternative indices exist.

**‘Using an appraisal based index will therefore result in overestimating the benefits of real estate...’**

The essential nature of the appraisal smoothing problem is this; when an appraiser estimates the value of a property, one of the first places he or she will look is the last appraisal of the property. This last appraisal will then be updated based on signals from the market such as comparable sales. However, this signal is noisy. The comps may not be exactly comparable in terms of location or attributes, or may be too far back in time to be fully relied on. Therefore, any change in the property’s value implied by the signal will, to a certain extent, be discounted by the appraiser. Essentially, today’s appraisal of a property’s value will tend to be anchored by the last appraised value because appraisers can never be sure as to the true applicability of the current information they are receiving. Quan and Quigley (1991) develop a formal model that shows that anchoring appraisals on previous appraisals is a logical and rational response of appraisers to the uncertain market information with which they are faced.

This result is problematic for those of us interested in the historical returns to real estate. Because appraisals are anchored on past values, changes in an appraisal based index will tend to lag behind changes to actual market values. This implies that any changes to actual market values will tend to be reflected slowly in an appraisal based index. Thus,

appraisal based indices will tend to underestimate real estate returns in up markets, and underestimate losses in down markets. Appraised values will therefore tend to be less volatile over time than actual property market values and will only gradually incorporate changes to actual market values. Hence the term “smoothed”; over time appraisal based indices will look less volatile (smoother) than true market values. Appraisal based indices will also tend to lag actual market values, and will tend to exhibit significant momentum over time (increase following increases and vice versa) as any changes to actual values are gradually reflected in the index.

### **Preliminaries: Part 2 – So How Do We Measure the “True” Returns to Real Estate?**

For this study, real estate returns are initially represented by the ICREIM/IPD Canadian Property Index.<sup>2</sup> This index provides returns to Canadian commercial real estate, with returns broken down into the income component and the appreciation component. The index is available both in aggregate and by property type (retail, office, residential, industrial and mixed use). For this study I use all of the available data, resulting in a 21

**‘...21 year history of annual returns to Canadian real estate, from 1985 to 2005.’**

year history of annual returns to Canadian real estate, from 1985 to 2005.<sup>3</sup> Note that annual returns are used as not all properties in the index are reappraised each quarter, potentially biasing the quarterly returns.<sup>4</sup> Appendix A provides details on my calculation of annual returns from the quarterly index.

The IPD Index is an appraisal based index and therefore suffers from the smoothing problems outlined above. Before proceeding, a methodology must be employed to “unsmooth” the returns. We want, as much as possible, to undo the effects of appraisal smoothing in the index and reveal the true returns to real estate over the period. The research literature on the effects of appraisal smoothing and methods to unsmooth returns is large, and there are numerous economic methodologies available. The most commonly used models, however, are based on the same basic unsmoothing equation, as described below.

Let  $R_{app,t}$  be the appreciation return (i.e. percentage increase in property values) for period  $t$  based on an appraisal index. Let  $R_t$  be the actual appreciation return to real estate for period  $t$  based on current market signals. Appraisal smoothing results in the following:

$$R_{app,t} = \alpha R_t + (1 - \alpha)R_{app,t-1}$$

Because the appraisal process is anchored on the past, the appraisal based return this year is a blend of the true return based on current market conditions ( $R_t$ ) and last year's appraisal based return. The parameter  $\alpha$  is largely related to the confidence that appraisers have in the current market information which they observe. If appraisers have high confidence in the signals they are receiving from the market (e.g. the comps they see and other market signals) then  $\alpha$  will be high and appraisal based returns will be almost identical to market based returns. Conversely, if confidence is low in observed market signals (e.g. very few comps, market signals seem mixed and hard to interpret) then appraisers will be worried about making large appraisal errors based on current information and will tend to put more weight on past appraised values ( $\alpha$  will be low).

Note that appraisal errors on individual properties will tend to cancel out in an aggregated index, so for our purposes  $R_t$  can be thought to represent the true appreciation return to real estate. It is therefore a matter of simple algebra to rearrange the equation above to solve for the true return:

$$R_t = \frac{R_{app,t} - (1 - \alpha)R_{app,t-1}}{\alpha}$$

Hence, two consecutive returns on an appraisal based index can be used to back-out the true return to real estate for the period. Two of the most common approaches to unsmoothing appraisal based returns, see Geltner (1993) and Firstenberg, Ross and Zisler (1988), are based on this construct although each comes to it via a different method. The question is, at what level should  $\alpha$  be set?

Firstenberg, Ross and Zisler (1988) use a regression framework to estimate the serial relationship between  $R_{app,t}$  and  $R_{app,t-1}$  and then set  $\alpha$  such that all serial correlation is removed from the true return series.<sup>5</sup> The intuition behind this approach is that

momentum in appraisal based returns must be due to appraisal smoothing, and therefore taking out the effects of momentum will reveal the true returns to real estate. However, momentum in the appraisal based returns may come from two sources: (1) real estate, by its nature, is truly driven by a certain degree of momentum over time with good years being followed by good years and vice versa, and (2) the appraisal smoothing problem may make appraisal based indices exhibit momentum that is not actually present in the market. The Firstenberg, Ross and Zisler (1988) approach removes all momentum from the returns, including the part that is a true characteristic of the real estate market.<sup>6</sup> In that sense, the approach goes too far in unsmoothing the returns.

An alternative approach is due to Geltner (1993). He develops a model that estimates an  $\alpha$  to correct for the lagging and smoothing problems associated with an appraisal based index, while allowing for any true momentum in the return series to remain. Geltner's approach has been widely adopted by academics and practitioners for unsmoothing real estate returns. While the Geltner approach is an excellent way to estimate the true returns to real estate over time, for our purposes of looking at the investment characteristics of real estate there is a problem. As part of the process of unsmoothing the returns, an assumption is required about the volatility of real estate returns. In his original paper, to estimate the  $\alpha$  parameter Geltner made an assumption that real estate returns have volatility one-half as big as the stock market (others who have used the methodology have made assumptions such as real estate volatility being halfway between stocks and bonds). Because in this study I am interested in comparing the investment characteristics of real estate and capital market asset classes, and their relative roles in a portfolio, making an assumption about the volatility of real estate is a case of putting the cart before the horse. Any assumption that is made will, in part, drive the results that would come out of the analysis.

It seems that that the two most common approaches to unsmoothing are inadequate for the purposes of this study. All is not lost, however, as previous research on Canadian real estate markets gives an idea of an appropriate level at which to set  $\alpha$ . Clayton, Geltner and Hamilton (2001) use actual historical appraisal reports from Canadian real estate

portfolio managers over a 10 year period to examine the manner in which appraisers make their assessments. In particular, they calibrate the extent to which appraisers of Canadian commercial properties use current market information versus past appraisals to estimate property values. In their results, Clayton, Geltner and Hamilton (2001) estimate  $\alpha$  to be 0.815 (indicating that appraisers on average put an 81.5% weight on current market information and  $1-0.815 = 18.5\%$  weight on past appraisals). Given this result, and especially the fact that it is based on Canadian data, I adopt the following equation to unsmooth real estate returns:

$$R_t = \frac{R_{app,t} - (1 - 0.815)R_{app,t-1}}{0.815}$$

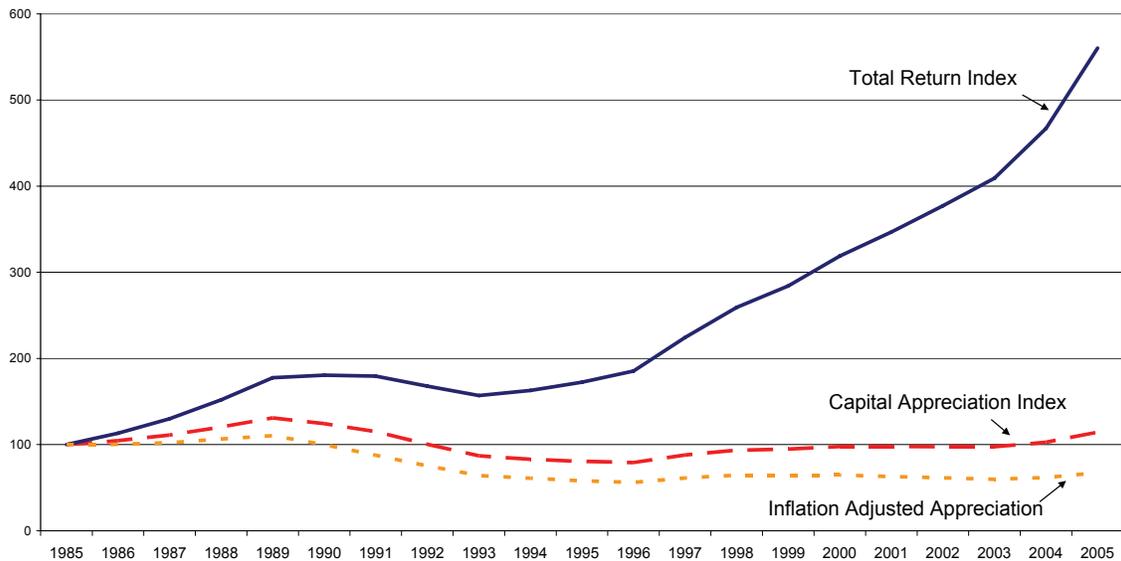
The  $R_{app,t}$  are the capital appreciation returns from the ICREIM/IPD Canadian Property Index. The equation is then used to unsmooth these appraisal based returns. Note that the unsmoothing procedure results in the loss of the first year's return, so that the results that follow are based on a 20 year period from 1986-2005. Based on the unsmoothed (true) appreciation index, the income return for each year is then adjusted to correct for smoothing as well. The appreciation and income returns for each year are then totaled to provide the total return, corrected for the biases in the appraisal based index, for Canadian commercial real estate. Appendix B provides technical details on the process employed.

Now that the reported real estate returns have been corrected to better reveal the true returns to Canadian real estate over the last 20 years, we can now turn to the question of how real estate has performed as an investment and how it has stacked up against the capital markets.

## Canadian Real Estate Over the Last Twenty Years – How Has it Performed?

Figure 1 below shows a total return (income plus appreciation) index for Canadian commercial real estate from 1985 to 2005, as well as an index based on capital appreciation alone (the indices have been unsmoothed as discussed above). Real estate was on an upward trend through the mid to late 1980's before peaking in 1990. The problems of the early 1990's are evident on the graph. Property values declined from 1990 through to 1996, although ongoing income meant that the total return index hit a low in 1993, and has been on an upward trend ever since.

**Figure 1**  
**Real Estate Performance 1985-2005**



The graph reveals an important fact about real estate investment (although one, perhaps, not likely to startle real estate professionals); real estate is very clearly an income investment. While the overall (total returns) have been healthy, this has been due to ongoing income and not from increasing property values. The appreciation index shows that commercial property values have still not regained the highs they reached in 1989, and it was only in 2004 that values surpassed those at the start of the series in 1985. Also shown on the graph is the appreciation index adjusted for inflation (based on the Consumer Price Index). Property values on average did not even keep up with inflation

over the period, with inflation adjusted values in 2005 being significantly below their level 20 years prior.

**‘...real estate should be viewed as an income oriented asset class. Capital appreciation accounts for very little of the long run return.’**

All of this points to one conclusion; for an investor with a long horizon, real estate should be viewed as an income oriented asset class. Capital appreciation accounts for very little of the long run return. Of course, this result is for Canadian commercial property on average and over a long horizon. Appropriate decisions on market timing and property selection by individual real estate portfolio managers could lead to higher capital appreciation returns, although I do not investigate the viability of this in this study.

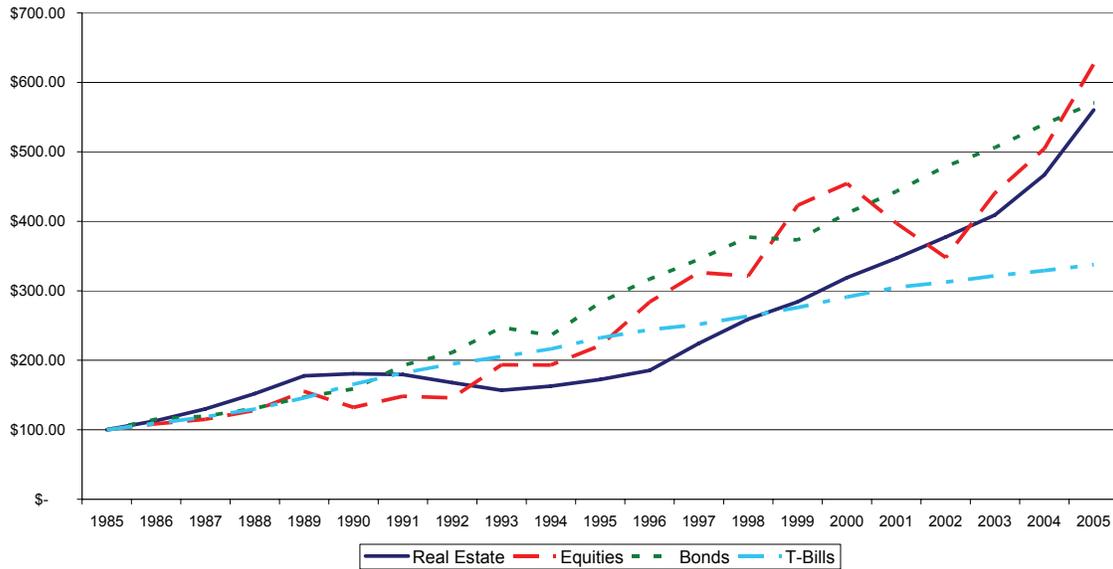
The average total return to real estate is 9.28% per year, while the average return from capital appreciation is a meager 0.93% with the remainder due to income. This indicates that only 10% of the average total return to real estate is due to capital appreciation. On the other hand, the variance of annual total returns is 0.0059, while the variance of annual appreciation returns is 0.0049. Thus, capital appreciation accounts for 82% of the

**‘...capital appreciation accounts for 82% of the risk in real estate investment, but only 10% of the average returns.’**

variability of total return to real estate.<sup>7</sup> Put another way, capital appreciation accounts for 82% of the risk in real estate investment, but only 10% of the average returns. Obviously, the value of real estate as an investment asset class depends on the income stream it produces.

While appreciation returns to Canadian property values have been somewhat dismal over the last two decades, this is not to say that real estate has not performed well overall. The majority of real estate returns come from ongoing property income, and this has been quite healthy. Figure 2 shows the value (including re-invested income and capital gains) of a hypothetical \$100 investment made at the end of 1985 in four asset classes: commercial real estate, Canadian equities, Canadian bonds, and T-Bills.<sup>8</sup>

**Figure 2**  
**\$100 Invested in Real Estate, Equities, Bonds, T-Bills**



An investor in real estate would have ended the 20 year period with almost the same wealth as an investor with their money exclusively in bonds, but less than a purely equity investor. On the other hand, the returns to real estate each year would appear to be somewhat more volatile than those for bonds, but substantially less volatile than equities.

Table 1 below shows the returns to real estate and the other asset classes over the last five, ten, fifteen and twenty years.<sup>9</sup> Real estate had, by far, the highest returns of the asset classes over the most recent five year period. Even over ten years, real estate had the highest return, outperforming equities by 48 basis points per year. Over longer time

| <u>Asset Class</u>       | <u>Five Year</u><br><u>Average</u><br><u>Return</u> | <u>Ten Year</u><br><u>Average</u><br><u>Return</u> | <u>Fifteen Year</u><br><u>Average</u><br><u>Return</u> | <u>Twenty Year</u><br><u>Average</u><br><u>Return</u> |
|--------------------------|---|--|--|---|
| Commercial Real Estate   | 12.02%  | 12.60%   | 8.14%  | 9.28%   |
| Equities                 | 8.06%   | 12.12%   | 11.91%   | 10.55%  |
| Bonds                    | 6.75%   | 7.30%  | 9.11%  | 9.27%   |
| 91 Day T-Bills           | 3.01%   | 3.81%  | 4.89%  | 6.32%   |
| Real Estate Income       | 8.72%   | 8.94%  | 8.43%  | 8.35%   |
| Real Estate Appreciation | 3.30%   | 3.66%  | -0.29%   | 0.93%   |

periods the average returns to real estate are lower, but certainly competitive with those provided by other asset classes, especially given real estate’s low volatility.

The excellent performance of real estate in recent years has been driven largely by above average appreciation returns. In the last year of the sample, 2005, the annual appreciation return was over 11%, compared to the twenty year average of less than 1%. Table 1 also shows that income returns have remained fairly stable over time, even decreasing somewhat in the last five years compared to the five years before that. The lack of growth in income returns would indicate that the recent gains in property values have been largely due to cap rate compression.

For purposes of strategic asset allocation, investors should concentrate on the long run characteristics of asset classes, including their risk. Table 2 shows the average annual returns for each asset class over the entire 1986-2005 period along with its volatility (measured by standard deviation of returns) as a measure of risk. Real estate returned almost exactly the same as bonds but less than Canadian equities.<sup>10</sup> On the risk side, real estate has a little over half the risk of equities, but more risk than bonds. Also shown is the Sharpe measure for each asset class. The Sharpe measure incorporates both the average return and the volatility into a single measure of risk-adjusted performance.<sup>11</sup> Despite higher returns, Canadian equities were the worst performing asset class on a risk-adjusted basis due to their volatility. Bonds performed best, with real estate falling almost exactly in the middle.

| <u>Asset Class</u>     | <u>Average Return</u> | <u>Volatility</u> | <u>Sharpe Measure</u> |
|------------------------|-----------------------|-------------------|-----------------------|
| Commercial Real Estate | 9.28%                 | 7.91%             | 0.374                 |
| Equities               | 10.55%                | 14.53%            | 0.291                 |
| Bonds                  | 9.27%                 | 6.26%             | 0.471                 |
| 91 Day T-Bills         | 6.32%                 | 3.27%             | n/a                   |

As a stand alone investment, the performance of Canadian commercial real estate has been in between that of bonds and stocks over the last 20 years. Few investors, however, would consider any asset class on a stand alone basis. More realistically, each asset class

would form part of the asset allocation in a diversified portfolio. It is to the role of real estate within such a portfolio that I now turn.

**How Does Canadian Commercial Real Estate Fit in a Diversified Portfolio?**

Of more interest to institutional investors than the stand alone performance of real estate is its role within an optimal strategic asset allocation. While this depends, in part, on the average return and risk, real estate’s role in providing risk reduction via diversification is also very important. Table 3 shows the correlations between the four Canadian asset classes being considered. Despite the income nature of real estate as an investment it is

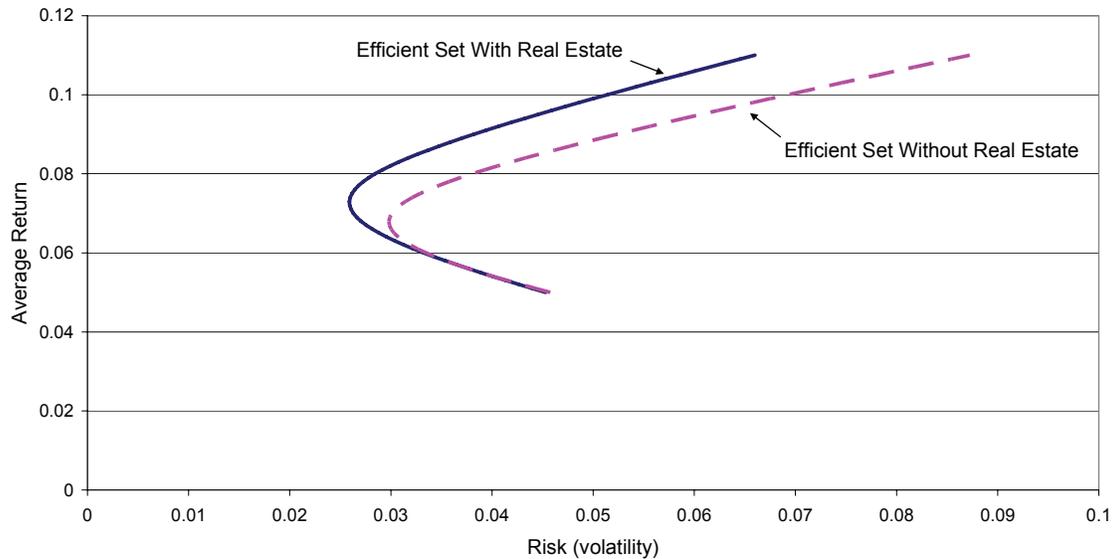
negatively correlated with both bonds and Treasury Bills. While real estate has a positive correlation with equities, the correlation is small and is, in fact,

|                | Real Estate | Equities | Bonds |
|----------------|-------------|----------|-------|
| Real Estate    | 1           |          |       |
| Equities       | 0.108       | 1        |       |
| Bonds          | -0.253      | 0.133    | 1     |
| 91 day T-Bills | -0.193      | -0.205   | 0.347 |

smaller than that between bonds and equities. The low correlations between real estate and the other asset classes indicate that real estate may serve as an excellent source of diversification in a portfolio.

To see the role of real estate in improving portfolio performance more clearly, I construct the efficient set of portfolios using equities, bonds and T-Bills, and again using these three asset classes plus real estate. The efficient set shows the lowest risk portfolio for each average return and therefore can be interpreted as the optimal strategic asset allocations amongst the asset classes over a range of target returns. The results are shown in Figure 3.<sup>12</sup>

**Figure 3**  
**Efficient Set With and Without Real Estate**



It is apparent from the graph that including real estate in an asset allocation improves portfolio performance. Investors are able to obtain the same target return with lower risk if real estate is included. To determine whether the improvement in the efficient set is statistically significant, I employ the Jobson and Korkie (1989) version of the Huberman and Kandel (1987) test statistic. The result indicates that there is a statistically significant (p-value = 5.4%) improvement in the investment opportunities available when real estate is included as an asset class. Given that statistical significance is obtained despite the relatively low number of observations in the sample (only 20 years of annual returns), this is strong evidence of the ability of real estate to improve performance.

**‘It is apparent...that including real estate in an asset allocation improves portfolio performance.’**

The efficient sets shown in Figure 3 are unconstrained; that is, they allow for the possibility of short positions in any asset class. For the majority of investors, a short position within a long term strategic asset allocation is not reasonable. To account for this, I calculate optimal (least risky) portfolios for a range of portfolio target returns, including a constraint that all asset classes can have no less than a 0 weighting in the portfolios. These portfolios therefore represent the best allocations for each target return assuming that short positions are not

allowed. As a base case, Table 4 shows the results when only equities, bonds and T-Bills are included in the portfolio.

| Target Portfolio Return | Portfolio Standard Deviation | Weights in Optimal Portfolio |       |         |
|-------------------------|------------------------------|------------------------------|-------|---------|
|                         |                              | Equities                     | Bonds | T-Bills |
| 6.5%                    | 3.06%                        | 4.3%                         | 0.0%  | 95.7%   |
| 7.0%                    | 3.01%                        | 8.8%                         | 10.5% | 80.7%   |
| 7.5%                    | 3.29%                        | 10.6%                        | 24.9% | 64.5%   |
| 8.0%                    | 3.80%                        | 12.4%                        | 39.3% | 48.4%   |
| 8.5%                    | 4.47%                        | 14.2%                        | 53.7% | 32.2%   |
| 9.0%                    | 5.24%                        | 16.0%                        | 68.0% | 16.0%   |
| 9.5%                    | 6.06%                        | 18.2%                        | 81.8% | 0.0%    |
| 10.0%                   | 9.08%                        | 57.3%                        | 42.7% | 0.0%    |
| 10.5%                   | 14.05%                       | 96.5%                        | 3.5%  | 0.0%    |

The optimal allocations not including real estate are as one might expect; large allocations to Treasury Bills for very conservative portfolios, large allocations to equities for aggressive portfolios, with bonds having significant allocations for all but the extreme portfolios.

The optimal allocations (with no short positions allowed) with no real estate can be compared to the allocations when real estate is included in the mix. These are shown in Table 5. The first point of interest is that all optimal portfolios include some allocation to

real estate, even the most aggressive or most conservative. For all but the most extreme portfolios, the optimal allocation to real estate is quite significant, peaking at an almost

**‘...almost all Canadian institutional investors would be better served by including real estate in their asset allocation, and at levels higher than currently typical.’**

35% weight when the target return is 9%. This indicates that almost all Canadian institutional investors would be better served by including real estate in their asset allocation, and at levels higher than currently typical.

| Target Portfolio Return | Portfolio Volatility | Weights in Optimal Portfolio |          |       |         |
|-------------------------|----------------------|------------------------------|----------|-------|---------|
|                         |                      | Real Estate                  | Equities | Bonds | T-Bills |
| 6.5%                    | 3.01%                | 4.6%                         | 1.1%     | 0.0%  | 94.3%   |
| 7.0%                    | 2.64%                | 14.0%                        | 4.8%     | 2.2%  | 79.0%   |
| 7.5%                    | 2.62%                | 19.2%                        | 5.1%     | 13.5% | 62.2%   |
| 8.0%                    | 2.85%                | 24.3%                        | 5.4%     | 24.8% | 45.4%   |
| 8.5%                    | 3.27%                | 29.5%                        | 5.8%     | 36.1% | 28.6%   |
| 9.0%                    | 3.82%                | 34.6%                        | 6.1%     | 47.4% | 11.9%   |
| 9.5%                    | 4.74%                | 33.7%                        | 17.9%    | 48.4% | 0.0%    |
| 10.0%                   | 8.84%                | 18.3%                        | 57.2%    | 24.6% | 0.0%    |
| 10.5%                   | 14.05%               | 2.8%                         | 96.5%    | 0.7%  | 0.0%    |

If the asset class universe is expanded to include commercial real estate (and if real estate has a positive weight in the portfolio) then the other asset classes will need to have reduced weights to accommodate the real estate allocation. Comparing the portfolios in Tables 4 and 5 shows that, while equities, bonds and T-Bills all have reduced weights when real estate is introduced, for the most part it is bonds that are displaced from the portfolio. For instance at the 9.5% and 10% target returns, the allocations to equities and T-Bills are essentially unchanged and the full allocation to real estate comes about via a reduction in the allocation to bonds.

At this point a caveat is in order. The optimal portfolios derived above are based on historical data. That is, they represent what the optimal allocations to real estate would

have been over the 1986-2005 period. This could (and will likely) be different than optimal allocations going forward. It is well known that risk-return optimizations based on historical data often result in extreme allocations to well performing asset classes. This is because of the tendency to trend chase when basing optimizations on past history; the process assumes that the best performing assets in the past will continue to outperform in the future. Nevertheless, while the exact allocations shown in the preceding tables should be taken with a grain of salt, it is the general conclusions that are more important. Specifically, real estate can improve portfolio performance and a significant allocation to it would likely improve the risk adjusted performance of most portfolios.

### **Real Estate in an Asset-Liability Framework for Pension Funds**

For many pension funds (e.g. defined benefit pension plans) it is not only the performance of their asset portfolio that matters but also how their portfolio relates to their liabilities. In the end, it is the ability to cover pension liabilities that is of prime concern and because of this an increasing number of pension funds incorporate asset-liability management (ALM) techniques in their asset allocation decisions. In an ALM paradigm, the correlation between the pension fund's asset portfolio and liabilities becomes important as the fund wishes to protect any surplus. Hence, portfolios which are highly correlated with liability values are, all else being equal, preferred to portfolios with low correlation as they will tend to rise and fall with liabilities, leaving surplus (relatively) unchanged.

I explore the role of Canadian commercial real estate within an ALM framework by adapting the approach of Sharpe and Tint (1990). Details of the methodology are shown in Appendix C. The key insight is that in ALM a pension fund wants a portfolio that not only produces high returns with low risk, but also wants the portfolio to be highly correlated with its liabilities. To implement an ALM optimization, I require a series of "liability returns"; i.e. the percentage changes in pension fund liabilities over time. To represent pension fund liabilities I use returns to the Citigroup Pension Liability Index, an index constructed to represent the market value of liabilities for a "typical pension plan" in the U.S.<sup>13</sup> This is a U.S. index, but unfortunately no equivalent exists for Canadian

pension liabilities. The assumption I am using is that changes through time in U.S. pension liabilities are similar to those for Canadian pension funds. The Pension Liability Index is only available from 1995, so my results on ALM with real estate are based on a shorter time period of only 10 years.

**Table 6**  
**Optimal Real Estate Allocations in Asset-Liability Management**  
**(1995-2005)**

| Target Asset Portfolio | Portfolio Return | Portfolio Volatility | Asset Portfolio Weights |          |       |         |
|------------------------|------------------|----------------------|-------------------------|----------|-------|---------|
|                        |                  |                      | Real Estate             | Equities | Bonds | T-Bills |
| 8%                     | 4.7%             |                      | 0.0%                    | 0.0%     | 89.1% | 10.9%   |
| 9%                     | 4.2%             |                      | 15.1%                   | 0.0%     | 84.9% | 0.0%    |
| 10%                    | 3.1%             |                      | 43.5%                   | 0.0%     | 56.5% | 0.0%    |
| 11%                    | 3.6%             |                      | 71.9%                   | 0.0%     | 28.1% | 0.0%    |
| 12%                    | 5.0%             |                      | 97.1%                   | 2.9%     | 0.0%  | 0.0%    |

Table 6 shows the optimal allocations to the four asset classes (including real estate) in an ALM framework estimated over the 1995-2005 period.<sup>14</sup> The high allocations to bonds, and low to equities, are an outcome of the ALM process as bonds typically have a much higher correlation with pension liabilities because of the fixed income like nature of pensions. Of particular interest for our purposes here is the allocation to real estate which is substantial for most portfolios. While the most conservative pension funds (target return of 8%) would have no allocation to real estate, the most aggressive would be

**‘...commercial real estate may have a significant role to play...for Canadian pension funds wishing to match assets and liabilities.’**

almost entirely in real estate. The mid-range portfolios have less extreme allocations to real estate, but very substantial ones.

I must repeat my caveat about using historical data. The ten year period used for the ALM analysis was very good time for real estate with annual returns averaging over 12%. Obviously, one would be remiss to actually implement an asset allocation that was 97% or even 43% invested in real estate. It is simply too extreme to be in line with prudent investment decision making, and is an outcome of the characteristics of the period used for the analysis. Still, the process is informative in that it shows that commercial real estate may have a significant role to

play (although most likely at levels reduced from Table 6) for Canadian pension funds wishing to match assets and liabilities.

**What is the Role of Property Type?**

Up to now, I have treated Canadian commercial real estate as a single asset class, without regard for the many differences across types of property. While there are obviously differences in the physical characteristics and uses of the various property types (retail, office, industrial, residential and mixed use), the question is whether there are also differences in their investment characteristics.

I use the ICREIM/IPD Index returns by property type, corrected for smoothing as

| <u>Property Type</u> | <u>Average Return</u> | <u>Volatility</u> | <u>Sharpe</u> |
|----------------------|-----------------------|-------------------|---------------|
| Retail               | 11.13%                | 6.12%             | 0.786         |
| Industrial           | 10.96%                | 6.75%             | 0.688         |
| Residential          | 11.03%                | 6.16%             | 0.764         |
| Office               | 8.49%                 | 9.68%             | 0.224         |
| Mixed Use            | 6.41%                 | 9.81%             | 0.010         |

described previously, to calculate their risk return characteristics over the 1986-2005 period, as shown in Table 7.<sup>15</sup>

The performance varies considerably by property type. Retail and residential have provided the highest returns with the lowest volatility. This results, of course, in the Sharpe measures of retail and residential being the best amongst the property types. Industrial property is characterized by slightly lower average returns and somewhat higher risk than retail/residential, and therefore lagged these two property types on a risk adjusted basis according to the Sharpe measure. Office property shows substantially lower returns and much higher risk, with a Sharpe measure far below the other property types (other than Mixed Use, which is a distant fifth place in terms of risk-adjusted performance).

**‘...institutional investors ...may better off with a heavier allocation to the better performing property types, especially retail and residential.’**

The results are particularly interesting in light of the fact that institutional investor real estate portfolios are typically most heavily weighted on office properties, which is one of the worst performing categories. Given the results, institutional investors may be concentrating their portfolios in precisely the wrong spot, and may better off with a heavier allocation to the better performing property types, especially retail and residential.<sup>16</sup>

**Table 8**  
**Optimal Allocations by Property Type**  
Weights in Optimal Portfolio

| Target Portfolio Return | Portfolio Volatility | Retail | Industrial | Residential | Office | Mixed Use | Equities | Bonds | T-Bills |
|-------------------------|----------------------|--------|------------|-------------|--------|-----------|----------|-------|---------|
| 6.5%                    | 2.84%                | 0.0%   | 0.0%       | 0.0%        | 1.0%   | 10.1%     | 3.6%     | 0.0%  | 85.3%   |
| 7.0%                    | 2.61%                | 9.2%   | 0.0%       | 0.0%        | 1.7%   | 5.0%      | 4.7%     | 0.0%  | 79.4%   |
| 7.5%                    | 2.47%                | 16.4%  | 0.0%       | 2.1%        | 0.0%   | 2.5%      | 3.7%     | 4.6%  | 70.7%   |
| 8.0%                    | 2.41%                | 21.2%  | 0.4%       | 5.0%        | 0.0%   | 0.0%      | 2.8%     | 9.8%  | 60.8%   |
| 8.5%                    | 2.44%                | 24.2%  | 0.0%       | 9.9%        | 0.0%   | 0.0%      | 2.0%     | 15.8% | 48.1%   |
| 9.0%                    | 2.58%                | 26.9%  | 0.0%       | 14.8%       | 0.0%   | 0.0%      | 1.2%     | 21.8% | 35.4%   |
| 9.5%                    | 2.81%                | 29.6%  | 0.0%       | 19.6%       | 0.0%   | 0.0%      | 0.4%     | 27.8% | 22.6%   |
| 10.0%                   | 3.11%                | 32.1%  | 0.0%       | 24.4%       | 0.0%   | 0.0%      | 0.0%     | 33.5% | 10.0%   |
| 10.5%                   | 3.50%                | 37.2%  | 0.0%       | 30.7%       | 0.0%   | 0.0%      | 0.0%     | 32.1% | 0.0%    |

I again derive optimal portfolios, assuming no short positions allowed, this time considering each of the property types as a separate asset class. The results, shown in Table 8, are not unexpected given the stand alone performances of property types. For all but the most conservative portfolios, the majority of the optimal real estate allocation is

**‘...consideration of the different investment characteristics across property types allows investors to more finely tune their portfolios, resulting in much larger overall allocations to real estate.’**

invested in retail and residential properties. In fact, for allocations with a target return of 8.5% or greater the entire real estate allocation is constructed of residential and retail.

If one compares the real estate allocations from Table 5, where commercial real estate was treated as a single class, to the total allocation to real estate

from all five property types in Table 8 an interesting conclusion can be reached. The total allocation to real estate when property types are considered separately is substantially higher than when real estate is treated as a single class. This is especially true for the more aggressive portfolios; for instance, for a target return of 10.5% the optimal allocation to real estate is only 2.8% when commercial property is treated as a single class, but when property types are considered separately the total allocation to real estate is almost 68% of the portfolio. Explicit consideration of the different investment characteristics across property types allows investors to more finely tune their portfolios, resulting in much larger overall allocations to real estate.

### **What is the Role of REITs?**

Real Estate Investment Trusts (REITs) provide an interesting alternative to direct real estate investment. REITs provide a number of benefits to investors: the professional management of REITs allows investors to allocate to real estate without the need to develop an in-house real estate management team, they allow investment in pools of quality real estate assets when direct investment opportunities may be lacking, REIT investment may be taken on any scale (a problem with direct real estate investment for individuals and smaller institutions), and REITs provide a substantially more liquid avenue for real estate investment.

The lack of liquidity in the direct real estate market presents a constraint for investors. Direct real estate entails an extra level of liquidity risk when compared to capital markets because of the difficulty in decreasing real estate exposure when markets turn down. This has given rise to considerable interest in securitized forms of real estate amongst institutional investors, and REITs in particular. As REITs trade on the stock market, they avoid the liquidity problems associated with direct real estate investment. The question is whether securitized real estate in the form of REITs serves as an adequate proxy for direct real estate in investors' portfolios. Whereas the assets underlying REITs are real estate, the fact that they are traded on the more volatile stock market may change the nature of the investment. Considerable research has been done on this question in the

U.S. REIT market. Clayton and MacKinnon (2003), for instance, show that U.S. REITs can be viewed as a hybrid of real estate, stocks and bonds.

To examine this question within a Canadian framework, I use the S&P/TSX Capped REIT Index to proxy for a diversified investment in Canadian REITs. I then use the ICREIM/IPD Index to proxy for a diversified direct investment in Canadian commercial property. Based on these indices I look to see if REITs can serve as a replacement for direct real estate in a policy portfolio.

Unfortunately, the REIT Index is only available from Q1 1998 onwards. This is due to the relatively short history of REITs in Canada, which began only in 1994.<sup>17</sup> This means that using the REIT Index from 1998 on leaves only 8 years of annual returns with which to work, hardly a satisfying number of observations for any analysis. Because of this, I adopt quarterly returns for this section of the study. Hence, I look at quarterly returns to REITs and direct real estate from Q1 1998 to Q4 2005. The problem is that quarterly returns are notoriously difficult to work with for direct real estate.

Not all of the properties in the ICREIM/IPD Index (or any appraisal based index) are re-appraised each quarter. Any quarter in which the property is not re-appraised will show a zero change in value, no matter what actually happened that quarter. This makes interpretation of the quarterly returns suspect. Assume, for example, that a specific property is only appraised in the fourth quarter of each year. Let's say that the actual value of the property rises 0.5% each quarter, or 2% for the year (ignoring compounding). An appraisal index of that property's value will show 0 return for the first three quarters, and a 2% return for Q4. Essentially, the quarterly returns look artificially volatile in the appraisal based index because value changes are observed in a "lumpy" fashion, rather than spread out over a time period.

This means that the preference with appraisal based real estate data is generally to use annual returns, as was done above. In this case, however, where the time period is simply too short to make the use of annual returns viable, I use quarterly returns, with an ad hoc

procedure applied to mitigate the problems with the quarterly data. In essence the ad hoc procedure I employ is designed to first smooth the returns out on a quarterly basis to account for the fact that most properties are appraised in the fourth quarter, and then to unsmooth the returns on an annual basis to correct for the appraisal smoothing issue as before. Details on the methodology employed are given in Appendix D.

The period examined (1998-2005) was a good one for real estate (again, please remember my caveat concerning use of historical data in developing optimal portfolios). As can be seen in Table 9, the return to REITs was more than double the return to equities in general, and even direct real estate outperformed equities in terms of return.

**‘...on a risk adjusted basis direct real estate far outshone REITs.’**

On the risk side, direct real estate had volatility only a fraction of the volatility of equities over this time. REITs, perhaps intuitively given their nature as a hybrid security, had a risk level in between that of equities and direct real estate. Looking at the Sharpe measure, it is apparent that REITs outperformed both bonds and general equities on a risk adjusted basis. However, due to direct real estate’s relatively large returns and very low

risk it was, by far, the best performer on a risk adjusted basis. During this period, on a risk adjusted basis direct real estate far outshone REITs.

| Asset Class        | Average Return (per quarter) | Volatility (quarterly) | Sharpe |
|--------------------|------------------------------|------------------------|--------|
| Direct Real Estate | 2.90%                        | 1.00%                  | 1.98   |
| REITs              | 5.33%                        | 7.00%                  | 0.63   |
| Equities           | 2.55%                        | 9.96%                  | 0.16   |
| Bonds              | 1.60%                        | 1.81%                  | 0.37   |
| T-Bills            | 0.92%                        | 0.32%                  |        |

I now construct the

efficient set of optimal portfolios under two conditions: (1) the investor allocates among equities, bonds, T-Bills and REITs, and (2) the investor allocates among those four asset classes plus direct real estate. The question is whether adding direct real estate, on top of REITs, improves portfolio performance. The results are shown in Figure 4.<sup>18</sup>

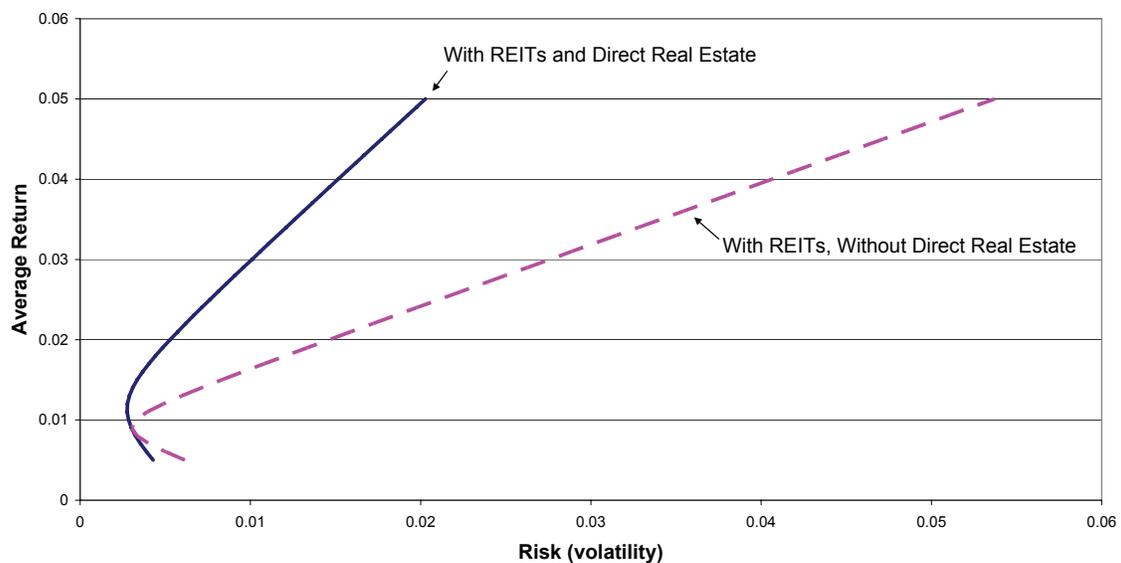
It is apparent from the graphs that including direct real estate substantially improves

**‘...investors cannot obtain all of the benefits of real estate investment from REITs alone; direct investment in commercial property brings significant further improvements.’**

performance beyond what can be accomplished using only REITs to proxy for real estate. The Jobson and Korkie (1989)/Huberman and Kandel (1987) test shows that direct

real estate statistically significantly (p-value = 0.000) improves the available investment opportunities. The conclusion is that, despite the excellent recent performance of REITs, investors cannot obtain all of the benefits of real estate investment from REITs alone; direct investment in commercial property brings significant further improvements.

**Figure 4**  
**Efficient Set – REITs versus Direct Real Estate**



## Conclusions

As always when using historical data to guide investment decisions, one must be careful in assigning too much weight to the exact numbers that come out of an analysis; there is no guarantee that the future will resemble the past. However, there are several general conclusions that come out of my analysis. First, over the last twenty years commercial real estate in Canada has generated very respectable performance as an investment, falling between bonds and equities on a risk-adjusted basis. Second, optimal portfolios typically have a substantial allocation to commercial real estate at levels far above what

most institutional investors currently allocate. Commercial real estate generally serves as a replacement for the fixed income allocation in portfolios, and as such, the benefits of real estate investment also hold for pension funds involved in asset-liability management. Third, institutional investors would be better off considering real estate by property type, rather than as a single asset class. There are considerable differences in performance by property type, with office properties (where institutions tend to concentrate holdings) one of the worst performers. Finally, Canadian REITs have exhibited excellent performance over the last decade. Despite this, they do not seem to serve as an adequate proxy for direct real estate investments. Perhaps, as the REIT sector in Canada continues to expand and mature, this will change although the current uncertainty surrounding the Federal government's approach to income trust taxation may delay this.

Overall, the benefits of commercial real estate investment in Canada seem clear. Direct real estate investment does present issues in information costs, transaction costs and liquidity that are not encountered to the same extent in more traditional asset classes and these factors pose obstacles to real estate investment. However, it would appear that those institutions willing to hurdle these obstacles have the opportunity to achieve significantly better long term performance.

## Endnotes

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<sup>1</sup> See "Perspective on Real Estate 2007", Bentall Capital

<sup>2</sup> I would like to thank Clayton Research, and especially Patricia Arsenault, for providing me with the IPD data used for this study.

<sup>3</sup> Prior to 2000, the data is actually based on the Russell Canadian Property Index (RCPI). The RCPI was discontinued and replaced by the ICREIM/IPD Index.

<sup>4</sup> Later in the study, when examining the role of REITs in a portfolio, I use quarterly returns because of a lack of a sufficient number of years of data. The issues with using quarterly real estate returns and the ad hoc approach I use to mitigate the problems are discussed more fully at that time.

<sup>5</sup> Specifically, they estimate  $(1-\alpha)$  as the coefficient from a first order autoregressive model of the appraisal based returns.

<sup>6</sup> Formally, the Firstenberg, Ross and Zisler (1988) approach is based on an assumption of informational efficiency in the real estate market. It is widely accepted, however, that the real estate market is not efficient.

<sup>7</sup> The remainder of the total return variance is due to the variance of income returns and to the covariance of income and appreciation returns.

<sup>8</sup> Canadian equity returns are represented by the total return to the S&P/TSX Composite Index. Bond returns are represented by the total return to the Scotia Capital Canadian Bond Universe Index. T-Bills are represented by the total return to the Scotia Capital 91 day T-Bill Index.

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<sup>9</sup> As the IPD data is only available up to 2005, the returns omit the returns from 2006 which have reportedly been extremely good for real estate. Also note that all of these time periods end in 2005 and so the reported returns are subject to end date bias.

<sup>10</sup> Figure 1 shows bonds slightly outperforming real estate while Table 2 shows real estate slightly outperforming on average. The difference is due to the use of compounded (geometric average) returns in Figure 1 and arithmetic average returns in Table 2.

<sup>11</sup> The Sharpe measure is calculated as (average return to the asset class minus average T-Bill return) divided by the asset class standard deviation. It represents the average return provided by the asset class in excess of the risk-free return, per unit of risk.

<sup>12</sup> The portfolio optimization process used throughout the report should be viewed with some caution as it does not account for any issues surrounding the illiquid nature of direct real estate investment and the problems with portfolio rebalancing that this may cause.

<sup>13</sup> The index was formerly known as the Salomon Brothers Pension Liability Index. Details of its construction can be seen in Bader and Ma (1995).

<sup>14</sup> Table 5 is estimated assuming a pension fund that is currently 20% over funded. However, in this case the optimal allocations do not change even if the fund were 20% under funded.

<sup>15</sup> I use the same estimate for  $\alpha$  for each property type as I used for real estate on average ( $\alpha = 0.815$ ). The implicit assumption is that all property types suffer from appraisal smoothing to the same degree.

<sup>16</sup> Institutional allocations to residential do seem to have been increasing over the years at least in the U.S. See Pagliari, Scherer and Monopoli (2005).

<sup>17</sup> A longer history of REIT returns could be constructed by averaging the returns to individual REITs (i.e. constructing a custom index going back farther than 1998). However the length of the time period would not increase that much (less than four years) and the early years would be based on only a very small number of REITs.

<sup>18</sup> REITs were added to the S&P/TSX Composite Index beginning in December 2005. Thus, there is some overlap in that REITs are counted in both the REIT Index and the S&P/TSX Composite which I use as the general equity index. However, given that it is only one month of overlap, and that REITs were included at one-half their market capitalization during this month, the effect is likely to be extremely small.

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## Appendix A Calculating Annual Returns from the Quarterly Index

It is advantageous for calculation purposes to have the income component of return ( $I_t$ ) in period  $t$  plus the capital appreciation component ( $C_t$ ) add to the total return ( $TR_t$ ). Normally, this is the situation for most reported real estate returns (although that is no longer true for the IPD data as it is now calculated on a monthly basis and then compounded to produce quarterly returns. See below for the reason that this results in the additive property no longer holding). However, the IPD data is in the form of quarterly returns whereas I wish to use annual returns. I therefore need a method to go from quarterly to annual returns while preserving the additivity of income and appreciation returns.

Normally, one would simply compound returns together to calculate the return over a longer time interval. Consider, as an example, two periods:

$$TR_{2\text{period}} = (1 + TR_1)(1 + TR_2) - 1$$

$$I_{2\text{period}} = (1 + I_1)(1 + I_2) - 1$$

$$C_{2\text{period}} = (1 + C_1)(1 + C_2) - 1$$

The problem is that even if for each sub-period (quarter) it is true  $I+C = TR$ , when you compound out to two periods the two types of return do not add up to total return. To see this, first note:

$$\begin{aligned} TR_{2\text{period}} &= (1 + TR_1)(1 + TR_2) - 1 \\ &= TR_1 + TR_2 + TR_1 TR_2 \end{aligned}$$

And looking at the different income forms split up:

$$\begin{aligned} TR_{2\text{period}} &= (1 + TR_1)(1 + TR_2) - 1 \\ &= (1 + I_1 + C_1)(1 + I_2 + C_2) - 1 \\ &= (I_1 + I_2 + I_1 I_2) + (C_1 + C_2 + C_1 C_2) + C_1 I_2 + I_1 C_2 \\ &= I_{2\text{period}} + C_{2\text{period}} + C_1 I_2 + I_1 C_2 \end{aligned}$$

Thus, the compounded total return assumes reinvestment so that there are interaction terms between income and capital gains (e.g. income is reinvested to earn capital gains next period, and capital gains earn income next period). These interaction terms are why the income and capital components do not add to the total return.

To account for this problem, I retain the assumption that reinvestment occurs (to be consistent with IPD and with other asset classes). Therefore the annual total return is taken to be the quarterly  $TR$ 's compounded out. The annual Appreciation return is taken to be the compounded quarterly appreciation returns. Then, the annual income return is calculated as  $I=T-C$ . In this fashion the components will add up (which facilitates the smoothing process). Note that this assumption is not entirely correct as the interaction terms could be partially  $C$  or partially  $I$  since they are a combination of both. I assign all of them to  $I$ . However, the cross-product terms should be small.

## Appendix B Unsmoothing Appraisal Based Returns

The ICREIM/IPD Canadian Property Index provides the income, appreciation and total returns to Canadian commercial properties. As appraisal smoothing applies to the value of properties, rather than total returns, the equation:

$$R_t = \frac{R_{app,t} - (1 - 0.815)R_{app,t-1}}{0.815}$$

is used to unsmooth the appreciation returns from the series (as discussed in the body of this report). This results in a series of unsmoothed appreciation returns from 1986 to 2005. However, as the income component of return is expressed as a percentage of value, this will also be affected by smoothing. To account for this effect, the following procedure is employed:

- 1) A smoothed price index is constructed. The index is given an arbitrary starting value of 100 at the beginning of 1986 and the smoothed appreciation return from the IPD index is applied to this starting value to generate a time series representing smoothed property values.
- 2) In each year, a variable representing the dollar value of income based on the smoothed property index is calculated. The representation of income in dollar form is calculated by multiplying the smoothed property value index from above by that year's (smoothed) income return from the IPD index.
- 3) An unsmoothed index of property values is constructed. The index is given an arbitrary starting value of 100 at the beginning of 1986 and the unsmoothed appreciation return from the equation above is applied to this starting value to generate a time series representing unsmoothed property values.
- 4) Each year the dollar representation of income is divided by the unsmoothed value index to create a series of unsmoothed income returns.

To complete the unsmoothing process, each year the (unsmoothed) appreciation return is added to the (unsmoothed) income return to yield an unsmoothed total return series.

## Appendix C Methodology for Asset-Liability Management Optimization

Sharpe and Tint (1990) show that rather than concentrating on asset returns, in a surplus optimization framework the investor can concentrate on:

$$Z = R_A - \frac{L}{A} R_L$$

where  $R_A$  is the return to the asset portfolio,  $R_L$  is the return to the liabilities (e.g. percentage increase in liabilities for the period), and  $L$  and  $A$  are the current values of the fund's liabilities and assets, respectively.<sup>1</sup> Essentially, Sharpe and Tint (1990) show that whereas an asset-only investor makes allocation decisions based on  $R_A$  alone, an asset-liability based investor should consider  $Z$  in its place. With Sharpe and Tint as a starting point, an asset-liability management optimization that is directly comparable to the previous asset-only optimizations can be constructed via the following objective function:

$$\text{Minimize } \{\text{Var}[Z]\}$$

Subject to:

$$E[Z] = \text{target}$$

and

Positive weights on all asset classes

The problem is therefore to choose an asset allocation, with no short positions, that minimizes surplus risk while meeting a target return. Sharpe and Tint (1990) point out two key aspects of their formulation of  $Z$ . First:

$$E[Z] = E[R_A] - \frac{L}{A} E[R_L]$$

, the second term of which is unaffected by asset allocation decisions. Hence, in making decisions the term  $E[Z]$  can be replaced by  $E[R_A]$ . Second:

$$\text{Var}[Z] = \text{Var}[R_A] + \frac{L^2}{A^2} \text{Var}[R_L] - 2 \frac{L}{A} \text{Cov}[R_A, R_L]$$

, the middle term of which is unaffected by asset allocation decisions. This means that the optimization problem can be re-written as:

$$\text{Minimize } \left\{ \text{Var}[R_A] - 2 \frac{L}{A} \text{Cov}[R_A, R_L] \right\}$$

Subject to:

$$E[R_A] = \text{target return}$$

and

Positive weights on all asset classes

I utilize the framework above to solve for optimal asset allocations for a range of target returns in an asset-liability framework.

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<sup>1</sup> The Sharpe and Tint (1990) approach allows for a varying weight to be put on surplus optimization versus the more traditional asset-only optimization. In the form presented here I am assuming full weight is placed on surplus optimization (i.e. it is a full asset-liability management framework).

## Appendix D

### Ad Hoc Procedure for the Use of Quarterly Real Estate Returns

Note that in the raw IPD data for quarterly returns the sum of income and capital appreciation (I+C) does not equal Total return (TR) in all cases. This is especially prevalent in the latter quarters when IPD changed the way they calculated the index returns (IPD moved to time weighted returns based on monthly observations of the index). See Appendix A for an explanation of this effect. To be consistent with what I have done previously, I assign all cross-product re-investment income to the income component. This means that I recalculate Income return in each quarter to equal  $TR - C = I$  (note that the biggest difference between (income plus appreciation) and the reported total return is 9 basis points, so this recalculation of income return is not a factor driving the results). In this way, in each quarter the income plus capital appreciation equals total return.

The next step is to smooth returns over the quarters of each year as an ad hoc correction for the fact that most properties are appraised in Q4 of each year. The process uses the following steps:

1. Convert appreciation returns to continuously compounded ( $\ln(1+C)$ ) so that the four quarterly returns add to annual return (this is done for convenience of calculations and will be undone at the end of the process).
2. Take the absolute value of each quarter's return.
3. The average abs(return) in Q4 is 0.030457. The average abs(return) in Q123 is 0.007892. The ratio is  $0.030457/0.007892 = 3.86$ . So, the abs(return) in Q4 is 3.86 times as big as in the other quarters on average. This is a reflection of the fact that most properties are re-appraised in Q4. (Note: absolute values are used since Q4 returns will tend to be higher in up years and lower in down years).

Note that averages are calculated using the entire time period of returns available (start =1985) even though I will not use entire period when comparing to REITs. This was done to insure that a longer series covering an entire cycle was used.

4. Divide Q4 return by 3.86.
5. Now, the reduction in Q4 return must be allocated to the quarters. The assumption I use is that, ex ante, there should be no seasonality in returns other than that caused by the bulk of the appraisals being in Q4. So, for each year, take  $(R_{Q4} - R_{Q4}/3.86)/4$  as the amount that should be added to each quarter's return (this is the divided Q4's return divided evenly over the four quarters). This is added to each of the four quarters (including Q4) returns in each year: that is:

$$\text{Smoothed } R_{Qi} = R_{Qi} + \frac{\left( R_{Q4} - \frac{R_{Q4}}{3.86} \right)}{4}$$

for Q123.

And

$$\text{Smoothed } R_{Q4} = \frac{R_{Q4}}{3.86} + \frac{\left( R_{Q4} - \frac{R_{Q4}}{3.86} \right)}{4}$$

For Q4

where  $R_{Q_i}$  is the raw appreciation return for quarter  $i$  in each year ( $R_{Q4}$  is the Q4 return for that year's Q4).

6. Convert each quarterly return back to an effective rate by taking  $\exp(\text{return})-1$

The returns now have to be corrected for appraisal smoothing at an annual level. In the quarterly data this should be reflected at a 4 quarter lag since properties appraised in Q1 were probably appraised last in Q1 last year etc. I combine this fact with the Clayton, Geltner, Hamilton estimate of the confidence factor and use the following equation to calculate the unsmoothed quarterly appreciation return:

$$\text{unsmoothed } R_t = \frac{R_t - (1 - 0.815)R_{t-4}}{0.815}$$

Where the  $R_t$  is the quarterly return that has been corrected for annual frequency appraisals as above.

Next the income component is corrected for appraisal smoothing using the method described in Appendix B.

Finally, add the new income return and the new appreciation return together to get the new total return.



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