Liability-Driven Investing and Equity Duration

In this article, the Brandes Institute profiles the interest in liability-driven investing ("LDI"),[i] summarizes our findings on methods for calculating equity duration,[ii] and raises questions about asset-liability matching.[iii]

The concept of asset-liability matching is not a new one. Over 50 years ago, U.K. actuary Frank Redington introduced the concept of immunizing assets and liabilities from changes in interest rates through duration matching.[iv] In recent years, a number of factors have combined to refocus attention of the pension community on asset-liability matching through the newly-christened LDI. The "post-bubble" bear market, the subsequent underfunded status of many retirement plans, and recent legislative changes in pension regulations have resulted in LDI attracting increased attention among plan sponsors in both North America and Europe. While only a minority of plans actually has implemented LDI, more could be adopting the approach. The SEI Pension Management Research Panel reported:[1]

- Only 20% of pension plans currently use a liability-driven investing approach.
- One-third of plans are not considering LDI.
- However, another 12% of plans will use an LDI approach by the end of 2007.
- Another 35% will consider an LDI strategy in 2008 or later.

The SEI Panel surveyed executives at 226 pension plans in Canada, the Netherlands, the United States, and the United Kingdom in April and May 2007. Each of the plans had assets between US$30 million and US$5 billion. Among these respondents, SEI also reported:

- Half of the pension plans use short-duration[v] securities and cash strategies to fund current liabilities.
- 76% use, or are considering, using long-duration bonds.

Using long-duration bonds can help plans replicate cash flows needed to pay benefits, but the *Financial Times* reported a potential problem: a limited supply of bonds and increasing demand from pension plans has "greatly reduced yields, particularly on the longest dated bonds."[2]

Still, for plan sponsors seeking to extend the duration of fixed income assets as a first step in LDI, implementing a similar approach for their *equity* assets might be the next step. But *extending* equity duration assumes one can first measure it. Calculating duration for bonds

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1 Excerpted from *Pensions & Investments* online. "Pension funds' use of LDI to rise, says SEI." Posted June 5, 2007.

2 Padraig Floyd. "FT Fund Management: Wise to Think Outside the Swaps Box." from *Financial Times* online. May 21, 2007.

tends to be relatively precise, given their fixed payment schedules and maturities. Equities, however, lack the "fixed" payments and maturities of bonds, raising the question of how to accurately measure equity duration.

The problem goes beyond the additional uncertainty of estimating timing and amount of equity dividends and terminal value,[vi] as the concept behind bond duration doesn't translate well into equities. For bonds, duration can be defined in terms of the sensitivity of a security price to changes in interest rates. This relationship follows from the mathematical formula used to calculate bond duration. However, equities don't have such a direct relationship with interest rate changes, so using this "empirical" definition can lead to results that don't fit with the concept of equities as a "long duration" asset class. This was first demonstrated over 20 years ago by Martin L. Leibowitz.[3]

EMPIRICAL DEFINITION: EQUITIES APPEAR TO BE SHORT-DURATION ASSETS

Using only this empirical definition (sensitivity of price change to interest rate changes), the Brandes Institute calculated equity duration by conducting a linear regression analysis[vii] of monthly changes in the 10-year U.S. Treasury bond and monthly changes in the S&P 500 Index.

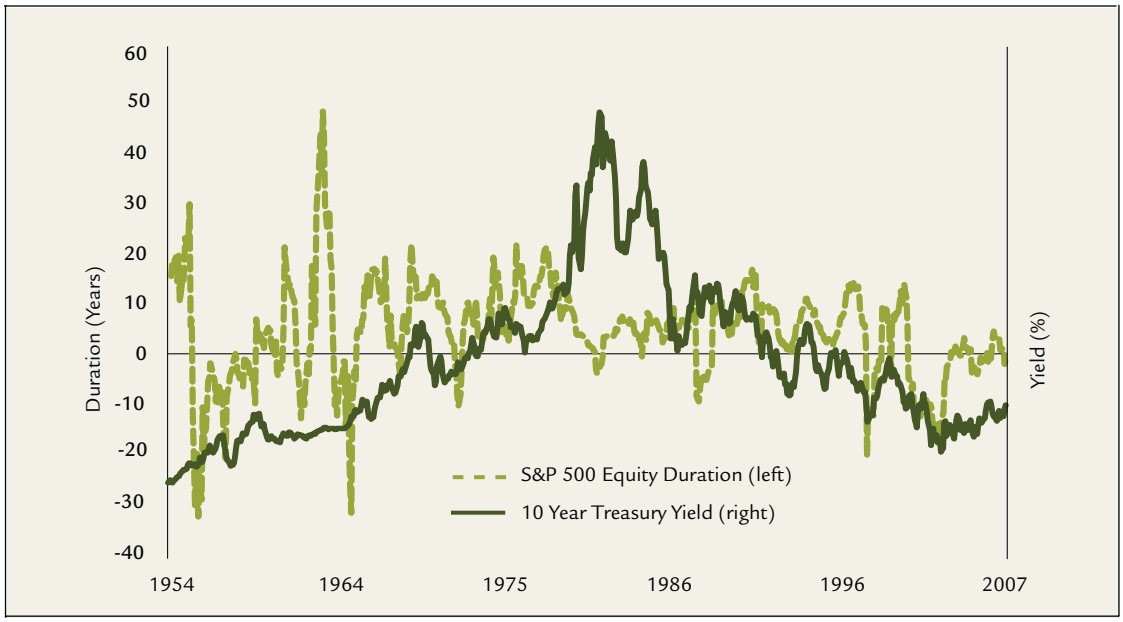
Over the 54-year period since April 1953 (the earliest date for which data is available for 10-year U.S. Treasury bonds), the average rolling[4] 1-year empirical duration for the S&P 500 Index was 3.3 years (see Exhibit 1). In its characterization of equity duration as much shorter than typical bond portfolios, Leibowitz's empirical approach has found supporters in the investment community who advocate re-allocation from equities to bonds in seeking to lengthen overall portfolio duration.

[3] Martin L. Leibowitz. "Total Portfolio Duration: A New Perspective On Asset Allocation." *Financial Analysts Journal,* September/October 1986, Vol. 42, No. 5: 18-29.

[4] Rolling periods represent a series of overlapping, smaller time periods within a single, longer-term time period. A hypothetical example is the 20-year time period from 12/31/82 through 12/31/02. This long-term period consists of 16 smaller five-year "rolling" segments. The first segment is the five-year period from 12/31/82 to 12/31/87. The next rolling segment is the five-year period from 12/31/83 to 12/31/88, and so on.

Liability-Driven Investing and Equity Duration

EXHIBIT 1: AVERAGE ROLLING, 1-YEAR EMPIRICAL DURATION FOR THE S&P 500 INDEX (APRIL 1953 TO JUNE 2007)



Source: FactSet, Standard & Poor's, The Brandes Institute, as of 6/30/07

We also applied this approach to the Russell 3000 style indices to test for differences in empirical equity duration between *value* and *growth* stocks. Between January 1979 (the inception date for the Russell indices) and June 2007, the average rolling, 1-year empirical duration for the Russell 3000 Value Index was 1.9 years vs. 1.6 years for the Russell 3000 Growth Index.

Additional analysis revealed:

- Over rolling, 3-year periods, the average empirical duration was 1.8 years for the Russell 3000 Value Index and 1.4 years for the Russell 3000 Growth Index.
- Among larger-cap stocks (as measured by the Russell 1000 style indices), we found rolling, 3-year average empirical duration was 1.9 years for value stocks and 1.6 years for growth stocks.
- The rolling, 3-year average empirical duration for bonds, as measured by the Lehman Brothers U.S. Aggregate Index, was 3.8 years.

To see whether these results were statistically meaningful, we tested the strength of the relationship between these variables (changes in interest rates and changes in index values) using R-squared.[viii] The results are summarized in Exhibit 2.

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EXHIBIT 2: AVERAGE ROLLING, 1-YEAR R-SQUARED FOR VARIOUS INDICES VS. THE 10-YEAR U.S. TREASURY BOND, AS OF JUNE 30, 2007

Index	1-Year R-Squared
S&P 500 Index	0.20*
Russell 1000 Index	0.23**
Russell 3000 Value Index	0.24**
Russell 3000 Growth Index	0.21**
Russell 1000 Value Index	0.25**
Russell 1000 Growth Index	0.21**

* since 4/1/53; **since 1/1/79

Source: Standard & Poor's, FactSet, The Brandes Institute, as of 6/30/07

The low R-squared for each equity index suggests a weak relationship between these variables. Comparatively, the average rolling 1-year R-squared between January 1, 1979 and June 30, 2007 for the Lehman U.S. Aggregate Bond Index was much higher at 0.83.

In summary, the empirical evidence suggested very short durations for equities, no material difference in duration between growth and value stocks, notable volatility over time, and a weak relationship between the variables measured. In addition, it is important to keep in mind the limits of the R-squared calculation – it does not suggest causality – only the strength (or weakness) of a relationship.

"MACAULAY" AND "MODIFIED" DURATION

In our opinion, the short duration of equities, as demonstrated in the empirical definition (Exhibit 1), relies on a questionable assumption. Broad acceptance of the definition of duration as "price sensitivity to interest rate moves" is incorrect when applied to equities, in our view. For bonds (with a fixed payment stream), the mathematical definition of duration results in the consequence that a bond's duration is indeed effectively its price sensitivity to interest-rate moves. However, by including the uncertainty of equity payment streams instead, and the related low correlations shown in Exhibit 2, this cause/effect sequence breaks down. Despite the fact that measuring equity duration will require certain assumptions about dividend growth, we believe we must use the modified Macaulay "bond duration" approach for equity requirements.

Liability-Driven Investing and Equity Duration

To start, it may be helpful to review Macaulay duration, derived in 1938 by Frederick Macaulay. Macaulay duration is a measure of the time flow of cash from a bond. Its calculation is based upon three factors:[5]

- the time period in which a bond's coupon or principal payment occurs
- the interest or principal payment that occurs in that period
- the bond's yield to maturity

Macaulay duration illustrates an inverse relationship between coupon and duration and an inverse relationship between yield to maturity and duration. A bond with a larger coupon will have a shorter duration than a smaller-coupon bond because more of the total cash flows (interest payments) occur earlier. A subsequent change made to the Macaulay duration formula led to the version in use today being known as modified duration.[ix]

Our objective in applying the modified duration approach[6] was to investigate two aspects of equity duration:

- duration measurements vs. the empirical definition
- differences between growth and value stocks

We applied a method of quantifying equity duration through the use of a Gordon dividend discount model ("DDM") first introduced by Martin L. Leibowitz and Roy D. Henriksson in 1989.[7] This simplified form of calculating equity duration effectively requires two inputs: an equity discount rate[x] (k) and a constant dividend growth rate (g), as illustrated in the formula below:

DURATION = 1/(k-g) * (1-dk/dg)

k = equity discount rate
g = dividend growth rate
dk/dg = sensitivity factor

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5 Frank K. Reilly and Keith C. Brown. *Investment Analysis and Portfolio Management, 8th Edition.* (Mason, OH: Thomson South-Western, 2006) 719 – 720.

6 A modified equity duration approach is assumption-based. Among the more important assumptions are: the Gordon dividend discount model which assumes a constant dividend growth rate, a forecasted dividend growth rate, equity risk premium, beta, and a risk-free rate.

7 Marin L. Leibowitz and Roy D. Henriksson. "Portfolio Optimization With Shortfall Constraints: A Confidence-Limit Approach To Managing Downside Risk." *Financial Analysts Journal.* 45.2. March/April 1989: 34-41.

Liability-Driven Investing and Equity Duration

This approach is similar to that used by Standard & Poor's in their publications on this topic, starting in 2004, and authored by David Blitzer and Srikant Dash.[8] They measured the duration of the U.S. equity market since 1973, noting that it has varied from almost 40 years in duration (1982), to under 20 years more recently. These modified durations are longer than those of most bond benchmarks, contrasting with the empirical approach in Exhibit 1, which produces shorter equity durations.

When applied to fundamental data (beta, dividend growth rate, etc.) for S&P indices as of June 30, 2007, modified duration calculations yield the following:

EXHIBIT 3: MODIFIED DURATION FOR S&P INDICES, AS OF JUNE 30, 2007

	Duration (years)
S&P 500 Index	28.6
S&P 500 Value Index	21.3
S&P 500 Growth Index	46.4

Source: The Brandes Institute, as of 6/30/07

Applying this duration model to individual equities requires an additional assumption, that the current or historical dividend growth rate be converted to a constant, future dividend growth rate. Adjustments were made using a weighted-average growth rate from a 3-stage dividend discount model ("DDM")[xi] approach. Two sample stocks, one large-cap, S&P Value and one large-cap, S&P Growth stock, chosen as representative examples of value and growth stocks in our opinion, yielded the results shown in Exhibit 4.

EXHIBIT 4: MODIFIED DURATION FOR VALUE AND GROWTH STOCKS, AS OF JUNE 30, 2007

	Beta	Discount Rate	Dividend Growth Rate	Duration (years)
Value Stock	0.85	10.0%	5.5%	21.9
Growth Stock	1.82	16.3%	13.1%	31.3

Source: The Brandes Institute via FactSet, as of 6/30/07

Using a modified duration measure, the duration between value equities and growth equities can be materially different. This observation is consistent with 2004 work by Seliman, Sloan, and Dechow ("SSD") on measuring equity duration using a cash flow-based model.

8 David M. Blitzer and Srikant Dash. "Using Equity Duration In Pension Fund Asset Allocation." Standard & Poor's. January 27, 2004.

SSD noted, "Long-duration equities tend to be 'growth' stocks. . . ." They added, ". . . long-duration equities have historically generated lower average returns, suggesting that equity investors have long investment horizons and require a premium to hold short-duration equities."[9]

From a practical perspective, we note that value stocks have been shown to outperform "glamour" stocks consistently (see the Brandes Institute study *"Value vs. Glamour: Updated and Expanded, 2006"*). Investors considering allocations between value and growth may need to consider the trade-off between potentially higher returns from value stocks against potential benefits of the typically longer durations of growth stocks. Note that the longer durations shown for growth stocks are partially based on assumptions that future dividend growth will be higher for these stocks than for their value counterparts. If this assumption does not hold, then the duration difference may narrow.

LOOKING AHEAD

A May 2007 article, "Dead Plan Walking," appearing in *Institutional Investor* reported that pension plans may continue to face a challenging landscape ahead. In August 2006, the United States passed the Pension Protection Act of 2006, which requires plan sponsors to value their pension assets and liabilities more frequently starting in 2008.[10] In addition, new Financial Accounting Standards Board ("FASB") rules currently in place addressing *how* assets and liabilities are valued may put additional pressure on companies. Until last year, FASB allowed plan sponsors to report the net funded status of their pension plans in balance-sheet footnotes and temper, or 'smooth,' swings in the value of their pension assets and liabilities by amortizing gains and losses over a variable period, typically 10 to 15 years.[11]

Now, as a result of FASB rules, companies must use the current market value of assets and liabilities to measure a plan's funded status and this calculation will then impact the balance sheet, potentially reducing the company's net worth.[12] *Institutional Investor* reported, "In the next three to four years, many expect FASB to extend mark-to-market pension accounting to the income statement, a move that could make corporate earnings more volatile."[13]

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[9] Patricia M. Dechow, Richard G. Sloan, and Mark T. Soliman. "Implied Equity Duration: A New Measure of Equity Risk." *Review of Accounting Studies.* 9.2-3. June/Sept. 2004: 197-228.

[10] Virginia Munger Kahn and Michael Shari. "Dead Plan Walking." *Institutional Investor.* May 2007: 184-196.which assumes a constant dividend growth rate, a forecasted dividend growth rate, equity risk premium, beta, and a risk-free rate.

[11] Ibid.

[12] Ibid.

[13] Ibid.

[14] Ruth Sullivan. "Pensions Slow to Employ LDI." *Financial Times.* June 11, 2007.

Liability-Driven Investing and Equity Duration

Still, Patrick Disney, head of SEI's European institutional business, notes ". . . there is a lot of talking about LDI but not necessarily a lot of doing as pension funds try to gain a full understanding of how LDI can be used to manage the pension's impact on the balance sheet."[14]

LDI may stand for "Liability-Driven Investing," but in practice, many plan sponsors may see the approach as moving them toward "Long Duration Investments," given that their liabilities generally have a longer duration than their assets. This clearly can be done through lengthening the duration of bond portfolios, although given the historical duration profile of the major bond indices, there appear to be limits to how far this can go. As equity (or equity-type) investments are generally more heavily weighted in plan sponsors' total portfolios, we believe a realistic LDI approach should take into account the impact of equity duration.

In this article, we have attempted to shed light on this topic and on the difficulties inherent in making such measurements. For example, for plans that need to lengthen the duration of their liability structure, increasing the exposure to longer-duration bonds moves them in the right direction. Moves from equities into bonds may fail to do that, given that both value and growth equities are long-duration assets as measured by modified duration (but short-duration if measured by the empirical approach).

In the same context, these observations on duration may be relevant to plans that are closing or terminating, which has been a more frequent occurrence in recent years. Over time, the term of the liabilities of these plans will gradually reduce. For those plans that continue to invest in a mix of equities and bonds, the plan sponsors' estimates of the duration of their equity portfolios are central to their understanding and management of overall portfolio duration. The question posed in this article is whether a reduction in equity allocation will reduce their overall duration, or increase it.

There is clearly growing interest in LDI, combined with some wariness to adopt it. Given the uncertainties in methodology and assumptions that we have highlighted in this article, this wariness may be justified. As with any major decision, plan sponsors should give careful thought to understanding what is fact and what is assumption before making their final assessments.

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Unlike Treasury bonds and bills, stocks are not backed by the full faith and credit of the United States government. Stock and bond prices will experience market fluctuations. Please note that the prices of government securities and bonds in general have an inverse relationship to interest rates. Bonds carry the risk of default, or the risk that an issuer will be unable to make income or principal payment. There is no assurance that private guarantors or insurers will meet their obligations. The credit quality of the investments in the portfolio is no guarantee of the safety or stability of the portfolio.

The Lehman Brothers U.S. Aggregate Index is an unmanaged index consisting of U.S. dollar-denominated, fixed-rate, taxable bonds. The Index includes bonds from the Treasury, Government-Related, Corporate, Mortgage-Backed Securities (agency fixed-rate and hybrid adjustable-rate mortgage passthroughs), Asset-Backed Securities and Commercial Mortgage-Backed Securities sectors. Securities must be rated investment grade (Baa3/BBB-/BBB- or above) by Moody's, S&P, and Fitch, respectively. When all three agencies rate an issue, a median or "two out of three" rating is used to determine Index eligibility by dropping the highest and lowest rating. When a rating from only two agencies is available, the lower ("most conservative") of the two is used. When a rating from only one agency is available, that rating is used to determine Index eligibility.

The Russell 3000 Index is an unmanaged index that measures the performance of the 3000 largest U.S. companies based on total market capitalization. It represents approximately 98% of the U.S. market. It includes the reinvestment of dividends and income, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing.

The Russell 3000 Value Index is an unmanaged index that measures the performance of those Russell 3000 Index companies with lower price-to-book ratios and lower forecasted growth rates. It includes the reinvestment of dividends and income, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing.

The Russell 3000 Growth Index is an unmanaged index that measures the performance of those Russell 3000 Index companies with higher price-to-book ratios and higher forecasted growth rates. It includes the reinvestment of dividends and income, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing.

The Russell 1000 Index is an unmanaged index that measures the performance of the 1000 largest securities of the Russell 3000 Index based on total market capitalization. It includes the reinvestment of dividends and income, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing.

The Russell 1000 Value Index is an unmanaged index that measures the performance of those Russell 1000 Index companies with lower price-to-book ratios and lower forecasted growth rates. It includes the reinvestment of dividends and income, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing.

The Russell 1000 Growth Index is an unmanaged index that measures the performance of those Russell 1000 Index companies with higher price-to-book ratios and higher forecasted growth rates. It includes the reinvestment of dividends and income, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing.

The S&P 500 Index is an unmanaged index that consists of 500 stocks and is designed to form a representative sample of the United States stock market. This index is often used as a benchmark for U.S. equity portfolios and includes dividends and distributions, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing.

The S&P 500 Growth Index is an unmanaged index that measures the performance of those S&P 500 Index companies with higher price-to-book ratios. It includes the reinvestment of dividends and income, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing.

The S&P 500 Value Index is an unmanaged index that measures the performance of those S&P 500 Index companies with lower price-to-book ratios. It includes the reinvestment of dividends and income, but does not reflect fees, brokerage commissions, withholding taxes, or other expenses of investing

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Liability-Driven Investing and Equity Duration

NOTES:

[i]Liability-driven investing is a form of investing often used by institutional plan sponsors which targets a return on assets sufficient to meet all current and long-term liabilities.

[ii]Duration is a measure of a security's or portfolio's price sensitivity to a given change in interest rates. Because equities do not share the fixed payment schedules and maturities of bonds, measuring equity duration is less precise.

[iii]Asset-liability matching aligns asset values to future liabilities. This matching is intended to ensure a specified rate of return over a given period regardless of interest rate moves.

[iv]Duration matching is an investment strategy that is intended to protect against the potentially negative effects of interest rate movements. With this approach, the duration of assets (not the maturity) is matched with liabilities.

[v]Short-duration securities are typically considered to be less than two years in duration.

[vi]Terminal value is the future value of the expected final cash flow. In the case of equity, it is the cash flow projected to grow at a constant rate in perpetuity.

[vii]Linear regression analysis is a mathematical technique that tests the causal relationship between a dependent variable, independent variables, and a random term using estimates of hypothesized parameters.

[viii]R-squared measures the proportion of return variability in a security or portfolio explained by movements in the benchmark index. It is commonly referred to as the model's "goodness of fit" or the coefficient of determination. Computationally, r-squared is equal to one minus the sum of the squared errors divided by the total sum of squares. Its values range from 0 to 1; the closer to 1, the better the "goodness of fit."

[ix]Modified duration equals Macaulay duration divided by one, plus the current yield to maturity divided by the number of payments in a year.

[x]Equity discount rate is the return equity investors require to hold a company's stock.

[xi]In its simplest form, the Dividend Discount Model ("DDM") is a method used to value a company's stock based on the present value of the expected future dividends. The DDM-based equity duration model is a method of calculating an individual equity or group of equities' duration. This method doesn't account for effects that nominal interest rate changes (changes in interest rate before accounting for inflation) have on dividend growth rates or the equity risk premium. A 3-stage dividend discount model was used to derive a "constant" dividend growth rate. This requires an assumed length of time for each stage of the model (depending on whether the stock is a value or a growth stock), and to make assumptions about what the growth rate will be in each of those stages.

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