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Theme This Issue  
**Risk And Return In Canada's Capital Markets**

# Is Equity Duration A Useful Concept?

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## Equity Duration: Long Or Short?

Equity duration has, until recently, kept a low profile relative to its famous bond related counterpart. But now a controversy about equity duration has erupted. While both logic and analysis suggest that equity durations are relatively long....in the 20-year range, there have been recent suggestions that equity durations are short....in the 2 - 6 year range [2]. What is this controversy about? How can equity durations be simultaneously long and short? This article offers a resolution. It shows there really is no contradiction between the old view and the new. It is all a matter of definition and application.

We commence with a brief review of the concept of duration in its more familiar bond context. Then we turn our attention to the stock context and solve the 'long or short?' mystery. The article next presents research on the relationship between stock returns and interest rates in Canada. Other factors impacting stock returns are added, leading to a fascinating look at some of the key economic variables that impact Canadian stock returns in a measurable way.

## Duration As 'Time' And 'Elasticity' Measures

The two most popular roles of duration are (1) a summary time measure of cashflows and (2) an elasticity concept or price risk index [3]. The concept of duration as a time measure was developed in 1938 by Frederick Macaulay in his groundbreaking work concerning interest rates and bond prices. Macaulay was dissatisfied with the use of term to maturity as a measurement of a bond's life.

Term to maturity simply reflects the number of years before the final payment is due and fails to take into account the amount and timing of interim cash flows. Instead, Macaulay proposed a weighted average number of years for all future cashflows where the weights are the relative present values of each cashflow to the total present value or price of the bond.

The use of duration as a price elasticity tool was subsequently proposed by the economist J.R. Hicks. He derived the same duration formula as Macaulay in his search for a measure of elasticity of bond prices with respect to interest rates. In this role, duration becomes an index of bond price risk in relation to a change in the bond's yield to maturity. Thus it also becomes a tool in the implementation of immunization strategies.

**There is a controversy about whether equity durations are long or short. The author shows it is all a matter of definition. Stock prices are very sensitive to changes in the equity risk premium and earnings growth expectations.... but not to changes in interest rates. While interest rate changes do affect Canadian stock prices, so do changes in the inflation rate, in the yield curve slope, and in the default risk premium.**

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## An Example

Both the 'time' and 'elasticity' contexts of bond duration are demonstrated in TABLE I by looking at what happens to the price and duration of a bond when its yield to maturity drops from 11% to 7%. Its price rises by 29%, close to the 26% estimate provided by multiplying the 4% drop by the bond's duration of 6.4 years. Note that as the bond's yield falls to 7%, its duration rises to 6.9 years.

## Duration As An Equity Time Measure For Short Holding Periods

Until quite recently, equity duration had gained little notoriety compared to its bond counterpart. However, equity duration can also be a time or a price sensitivity measure. The key time measurement question is the investor's holding period. The calculation depends on the length of the holding period, dividends to be paid, current stock price, final stock price, and the required rate of return [4]. The top panel of TABLE II shows an example of the calculation of equity duration as a time measure for short holding periods.

## Duration As An Equity 'Time' Measure For Long Holding Periods

Long holding periods are a different matter. When the holding period is indefinitely long, as may well be the case with pension funds or insurance surplus portfolios, the stock duration calculation is greatly simplified. The formula used above simply collapses to the inverse ratio of the difference between the required rate of return (R) and the expected dividend growth rate (G) of the stock or portfolio. Examples are shown in the bottom panel of TABLE II.

## Duration As An Equity 'Price Elasticity' Measure

Equity duration can also be derived as a price elasticity concept from the standard 'price equals current dividend over R minus G' dividend discount stock price model. The actual 'elasticity' duration formula reduces to the same formula used to calculate time duration for very long holding periods in TABLE II. It is the inverse ratio of R minus G.

Thus, in both its 'time' or 'elasticity' contexts, the duration calculation involves estimating the required return on the stock or stock portfolio (R) and its annual dividend growth rate (G). But of course, estimating the true values of R and G is easier said than done! And if R and G cannot be accurately estimated for a stock, neither can its actual duration.

Now it becomes apparent why duration, has found more immediate application with bonds rather than stocks. With bonds, R is known: it is a bond's yield to maturity. For that matter, so is G: it is zero. With both R and G known, and with a finite investment life, a bond's actual duration can be precisely calculated.

## Stock Prices And Interest Rates

Martin Leibowitz has argued equity durations are short, not long [5]. His context was the immunization of nominal dollar payment obligations. Thus Leibowitz was interested in the price sensitivity of stocks, not to the R or the G we discussed above, but to nominal interest rate movements.

By regressing S&P500 stock returns against changes in 10-year Treasury bond yields, he found an average stock return sensitivity coefficient of -2.3. That is, for every 100 basis points move in interest rates, stock returns averaged a 2.3% move in the opposite direction. Estimation based on 12-month sub-periods within the 1980-1986 time period produced coefficients ranging from +0.5 to -6.5.

From these results, Leibowitz correctly concluded that it is dangerous to try to immunize long term nominal dollar payment obligations with a stock portfolio. Not only is stock price sensitivity to interest rate changes too low on average, it is also highly uncertain!

TABLE I		
Bond Duration As Time And Elasticity Measures		
<b>Bond Description</b>		
Par Value: \$1000, Coupon: 10%, Term: 10 years		
<b>Bond Yields, Prices, And Durations</b>		
Case #1: Yield: 11%,	Price: \$ 940.25,	Duration: 6.4 years
Case #2: Yield: 7%,	Price: \$1213.19,	Duration: 6.9 years

## A Canadian Experiment

Using the TSE300 and the Scotia McLeod long bond index, we recreated the Leibowitz analysis in a Canadian setting. We found an average stock return sensitivity coefficient of -4.0. The range for rolling 12-month periods within the time frame was +0.5 to -9.5. FIGURE I traces the 12-month coefficients over the total time frame. We conclude that it is as dangerous to immunize a long term nominal payment stream with a stock portfolio in Canada as it is in the U.S.

Of course these findings are not very insightful with respect to equity duration as we earlier defined it. The regression coefficients in FIGURE I are only remotely related to the 'time' and 'price elasticity' measures for stocks in their original Macaulay and Hicks meanings. First, regressing stock returns against bond yield

changes has nothing to do with the 'longness' of equity investments. Second, if we want to understand which factors cause equity prices to change, then we must look beyond just interest rates.

## Looking Beyond Changes In Interest Rates To Explain Equity Price Changes

We noted above that mathematically, stock price changes are driven by R and G. We also noted that neither R nor G is directly observable. But there are observable factors which proxy for the true underlying R and G. Bond yields are one such factor.

Using the Arbitrage Pricing Theory (APT) framework, four factors have been shown to have a

**TABLE II**  
**Equity Duration As A Time Measure For Short Holding Periods**

Holding Period	3 years		
Annual Dividend	\$1		
Required Return	15%		
Current Price	\$20		
Final Price	\$27		
Term in years	1	2	3
Cashflow	\$1	\$1	\$28
Term* Cashflow	1	2	84
PV	0.9	1.5	55.2
Sum of PV	57.6		
PV-weighted Average	2.9 years = duration		

## Equity Duration As A Time Measure For Very Long Holding Periods

Required Return	Expected Dividend Growth	Duration
		$\frac{1}{R - G}$
.15	.13	50 years
.13	.09	25 years
.10	.05	20 years

"...We conclude that it is as dangerous to immunize a long-term nominal payment stream with a stock portfolio in Canada as it is in the U.S...."

significant impact on stock returns in the U.S. [6]:

1. the inflation rate
2. the slope of the yield curve
3. the growth rate of profits
4. default premiums

We found proxies for each of these four factors and regressed them, along with bond yield changes, against the TSE300. The results confirmed that, indeed, factors other than interest rate changes systematically affect stock returns.

## Explaining Canadian Stock Returns

TABLE III displays the test results. Each stock price sensitivity coefficient can be interpreted as the average monthly stock return impact of a one unit shift in a factor's value. For example, the 'CPI' value of -2.1 in TABLE III means that for every 1% of the inflation rate above its average experience, stock prices declined 2.1%, all other factors held at their average experience.

The factors used to explain monthly TSE300 returns were:

1. The monthly change in the Consumer Price Index (CPI);
2. The slope of the yield curve at the end of the month (SLOPE);
3. The monthly growth rate in TSE300 earnings (EARN);
4. The monthly spread between corporate and Canada bond yields in the ScotiaMcLeod indexes (DEF);
5. The monthly change in the ScotiaMcLeod long term corporate bond index (Y).

## Analyzing The Stock Return Elasticity Coefficients

All the estimated coefficients, except for one make good sense. They indicate that stock prices have been: (a) negatively related to the direction of inflation (CPI), (b) positively related to the slope of the yield curve (SLOPE), (c) negatively related to the degree of anticipated default risk in the bond market (DEF), and (d) negatively related to the direction of interest rates (Y). Note the -3.4 (Y) coefficient is close to the -4.0 average coefficient that came out of the simple stock return-interest rate change regressions discussed previously.

Only the coefficient related to the direction of TSE300 earnings (EARN) has the wrong sign. One would think that stock return and earnings growth patterns would be in the same rather than opposite directions. Maybe a lead-lag structure is required to properly model the stock return to earnings growth relationship. It is not so much actual earnings growth itself that matters, but actual earnings growth in relation to expected earnings growth.

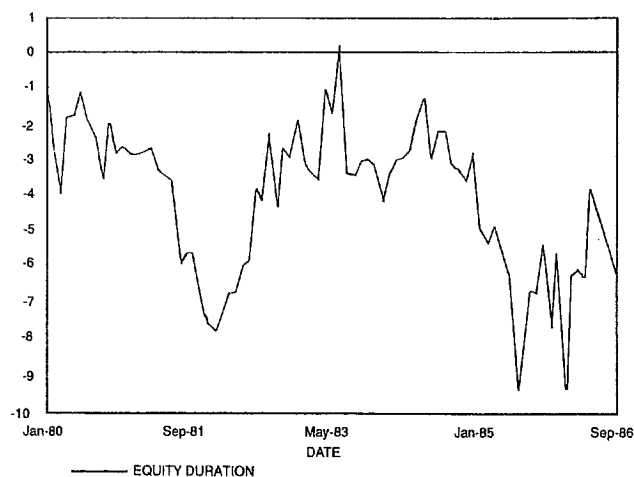
The multi-factor stock return model explained 36% of TSE300 return variability, more than double the 16% explained by interest rate changes alone.

## Is Equity Duration A Useful Concept?

Equity duration is not as directly useful as bond duration. Bonds have a finite life, a zero-growth income stream, and an observable yield to maturity. This makes bond duration useful both as a measure of length and of price sensitivity to changes in yield. Thus duration can be used in implementing immunization strategies.

Equities do not have a finite life, a known income stream, and a known required rate of return. Thus, equity duration cannot have the same direct practical relevance as its bond counterpart. But if equity duration becomes the final catalyst needed to get us thinking about what factors systematically impact stock prices, it might yet make its mark on the practice of equity analysis and portfolio management.

FIGURE I  
Monthly Rolling 1-Year Equity Durations  
January 1980 - September 1987



## Notes

- [1] This article is a condensed version of the author's unpublished January 1989 manuscript "Equity Duration Revisited". The author wishes to thank Frank Reilly and Paul Potvin for helpful comments and suggestions related to the manuscript, and Keith Ambachtsheer for his help in condensing the original paper into this article.
- [2] Martin Leibowitz of Salomon Brothers wrote a series of articles popularizing this viewpoint. Two appeared in the *Financial Analysts Journal*, September-October 1986 and March-April 1987 under the titles 'Total Portfolio Duration: A New Perspective On Asset Allocation' and 'Pension Asset Allocation Through Surplus Management'. Another appeared in the *Journal of Portfolio Management*, Winter 1987 titled 'Liability Returns: A New Look At Asset Allocation'.
- [3] For a more extensive discussion on duration, see Bierwag, Kaufman and Khang, 'Duration And Bond Portfolio Analysis: An Overview', *Journal of Financial and Quantitative Analysis*, November 1978, and Bierwag, Kaufman, and Toevs, 'Duration: Its Development And Use In Bond Portfolio Management', *Financial Analysts Journal*, July-August 1983.
- [4] For more extensive discussion of the formulas and applications of the duration concept to equities, see Casabona, Fabozzi and Francis, 'How To Apply Duration To Equity Analysis', *Journal of Portfolio Management*, Winter 1984, and Sorenson, 'Equity Duration in Equity Markets And Valuation Methods', *Institute of Chartered Financial Analysts*, Charlottesville Virginia, 1988.
- [5] See Note [2] above.
- [6] For more on Arbitrage Pricing Theory, see Chen, Roll and Ross, 'Economic Forces And The Stock Market', *Journal of Business*, July 1986, and Berry, Burmeister, and McElroy, 'Sorting Out Risks Using Known APT Factors', *Financial Analysts Journal*, March-April 1988 (Also, see the Muller and Booth-Rotenberg articles in this REVIEW issue).

**TABLE III**  
**Stock Return Elasticity Co-efficients**  
**(based on April 1980 - July 1987 data)**

CPI	SLOPE	EARN	DEF	Y
-2.1*	0.3	-0.4**	-6.0**	-3.4**

\* significant at the 95% confidence level

\*\* significant at the 99% confidence level

"....this model explained 36% of TSE300 return variability over the 1980-1987 period...."