S&P Dow Jones Indices

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RESEARCH
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Applying Equity Duration to Pension Fund Asset Allocation:
A Review of S&P 500® Duration

INTRODUCTION

In fixed income analytics, duration is seen as a standard and ubiquitous measure of a bond's price sensitivity to interest rate changes. Similarly, equity duration measures the sensitivity of equity prices to interest rate changes.[1] The extension of the duration concept to equities is relatively recent, with the earliest literature on the subject dating back just over 28 years. Its use in investment management is far from widespread and there are two primary reasons for this.

1. Unlike bonds, the terminal value of equities is not fixed.
2. Interest payments for bonds are predetermined, while dividend payments of equities are uncertain.

The difficulties associated with estimating equity duration do not detract from its importance in portfolio immunization, tactical asset allocation, and risk management.

As suggested in our original 2004 paper and subsequent updates,[2] the difficulties associated with estimating equity duration do not detract from its importance in portfolio immunization, tactical asset allocation, and risk management.

Immunization: Immunization refers to a form of investing that allows an investor to match assets and liabilities regardless of changes in interest rates. It refers not only to matching the present value of assets with the present value of liabilities, but also to matching the interest rate sensitivities of assets with those of liabilities. Since the duration of any instrument varies with time and changes in rates, complete immunization can be costly and impractical. For this reason, immunization in practice is often a tradeoff between cost and efficiency. A pension plan can benefit from immunization, as not only must it align its present value of assets with its projected obligations, but it also must ensure that the durations of its assets match those of its obligations. Since equities often account for significant portion of assets in most pension plans, an estimate of equity duration is equally important.

[1] It is important to note that, unlike in bonds, interest rates do not have significant explanatory power for equity returns. Rather, the rate effect is transmitted to equity prices through other variables that have significant explanatory power.

[2] See Blitzer, David. Dash, Srikant (2010) Equity Duration: Updated Duration of the S&P 500.

Risk Management: Equities tend to compose a significant portion of plans' portfolios, and empirical evidence suggests that equities do react to changes in rates. Therefore, any risk management plan should factor in the sensitivity of the equity portfolio to rate changes.

Tactical Asset Allocation: Tactical asset allocation makes opportunistic estimates about changes in the external economic environment by shifting allocations among different asset classes. Since interest rate changes are an indicator of the external economic environment, knowledge of equities' rate sensitivity would be important for plan managers who are considering shifts in asset allocations in order to take advantage of projected changes in interest rates.

EVALUATING EQUITY DURATION

There are three distinct approaches to evaluating equity duration.[3] The dividend discount model approach is the original and simplest of these; however, it tends to be upwardly biased and produces high estimates of equity duration. More importantly, the approach fails to account for the "flow-through" effects of interest rates; that is, it does not consider the fact that growth might be sensitive to rates. The empirical approach, on the other hand, derives equity duration from historical changes in equity prices and interest rates. While statistically appealing and direct, the empirical approach suffers from biases that result in lower-than-expected estimates of duration. Flow-through duration models emerged from the dividend discount model, but they also factor in the sensitivity of growth to rates. In our calculations, we use a flow-through duration model to derive our estimate of equity duration.

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The model can be described as follows:

$$1/P * \left(\frac{dP}{dk}\right) = -\frac{1}{k-g} * \left(1 - \frac{dg}{dk}\right) \quad (1)$$

where P is the price of the stock, *k* is the equity discount rate, and *g* is the dividend growth rate. This is a simple flow-through model, where d*g*/d*k* measures the sensitivity of dividend growth to changes in the equity discount rate. Several properties of duration can be drawn from this approach.

1. Higher growth implies higher duration. That is, higher-growth portfolios will have a higher duration and, therefore, greater sensitivity to interest rates.

[3] See our original paper for a more complete description of these approaches and historical estimates derived from them: "Using Equity Duration In Pension Fund Asset Allocation - Introducing a New Data Series: The 30-Year History of Duration for the S&P 500," Jan. 27, 2004. For a subsequent update of the paper, see Equity Duration: Updated Duration of the S&P 500.

2. If the dividend growth rate is steady, a higher equity discount rate implies a lower duration and, therefore, a lower sensitivity to changes in interest rates.
3. Low sensitivity of growth opportunities to the discount rate increases the duration of a portfolio and, therefore, increases the sensitivity of a portfolio's value to changes in interest rates.

In our calculations for evaluating the duration of the S&P 500, *g* was defined as the quarterly dividend growth of the S&P 500. For *k*, we used Moody's Seasoned Baa Corporate Bond Yield series.[4] Traditionally, the equity discount yield in this context has been defined as the yield of a long-term Treasury bond with a constant equity risk premium added to it. However, because the equity risk premium varies across time periods, an average might not be appropriate. The corporate bond series provides a market-determined, risk-adjusted measure of the discount rate.

Since 2010, the equity duration of S&P 500 has been steadily climbing, reaching its all-time high of 63 in 2016.

The sensitivity of *g* to *k* is more difficult to estimate. Following some prior literature, we took this factor ($\delta g/\delta k$) as the correlation of change in *g* to change in *k*. We used averages for 40 quarters (10 years) from 1973 through 2005 and averages for 80 quarters (20 years) from 2006 through 2016. For the $\delta g/\delta k$ term, we used the correlation of change in *g* to change in *k* for the 40 quarters from 1973 through 2005 and the 80 quarters from 2006 through 2016. We lengthened our smoothing function for 2006 through 2016 to 20 years in order to correct for the anomalous past 10 years.

UPDATED DURATION ESTIMATES

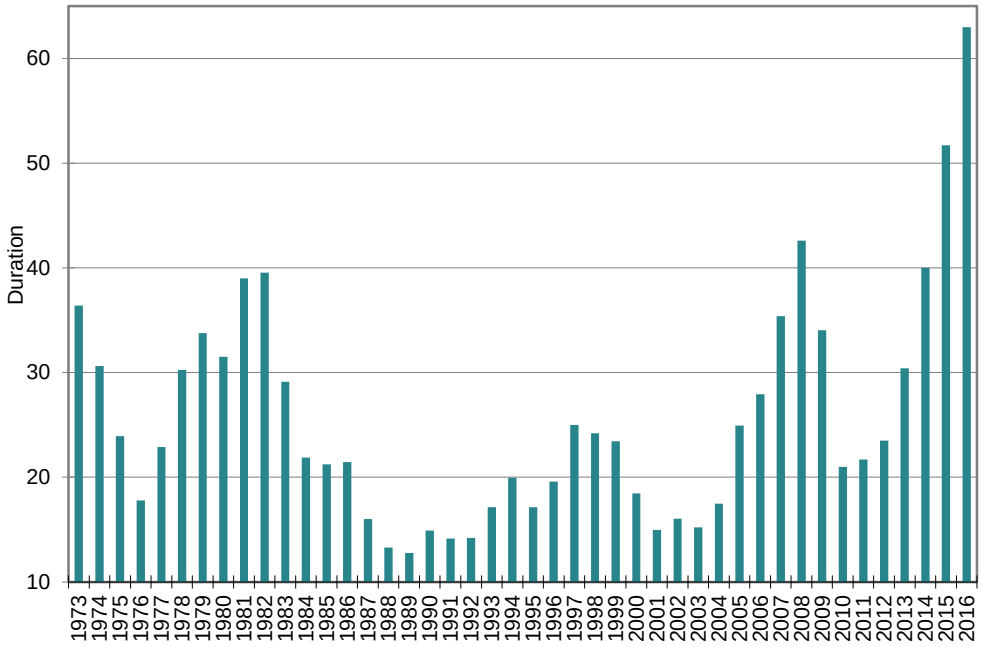
The duration of the S&P 500 from 1973 to 2016 is shown in Appendix 1 and plotted in Exhibit 1. We can observe that since 2010, the equity duration of S&P 500 has been steadily climbing, reaching its all-time high of 63 in 2016. We witnessed a similar peak of 42.6 leading up to the financial crisis in 2008.

As we noted in our previous papers, the first quarter of 2004 through the first quarter of 2008 saw one of the longest sustained periods of double-digit dividend growth. After exhibiting a growth rate of 11% in June 2008, dividend growth contracted to its all-time low of -21% in December 2009, as corporations across the index slashed dividends. Since then, dividend growth has rebounded quickly and dramatically as corporations have repaired their balance sheets. From 2011 to 2015, dividend growth was in the double digits, with an average growth rate of 14% per year. At the end of 2012, the growth rate reached a 40-year high of 18.2%.

[4] The choice of a corporate bond yield series departs from the literature, but we believed it to be more practical than the use of a long-term (10- or 20-year) U.S. Treasury bond.

Given that we measure our growth parameter, *g*, as the growth rate in dividends, the increase in dividend growth rate is reflected directly in the increase of the equity duration estimation.

Exhibit 1: Duration of the U.S Equity Market



Source: S&P Dow Jones Indices LLC. Data from March 31, 1973, to Sept. 30, 2016. Estimates are for the middle of each calendar year. Past performance is no guarantee of future results. Chart is provided for illustrative purposes.

Owing greatly to the aggressive policy actions undertaken by the U.S. Federal Reserve and other central banks, overall credit market conditions started to improve slowly in the first quarter of 2009, and bond yields began to decline gradually.

The discount rate is also an important part of our model. Following the second quarter of 2007, rising volatility in the equity market, as evidenced by the CBOE Volatility Index's (VIX) historic high of 59.8 in October 2008 and the subsequent tightening of credit markets, led to higher corporate bond yields[5]. Owing greatly to the aggressive policy actions undertaken by the U.S. Federal Reserve and other central banks, overall credit market conditions started to improve slowly in the first quarter of 2009, and bond yields began to decline gradually. The discount rate measured at the end of 2016 stood at a historical low. This is expected to change, as the Federal Reserve embarks on a tightening phase[6].

Since our model is highly sensitive to the difference between growth (*g*) and the equity discount rate (*k*), it is useful to see how they have varied over time. Exhibit 2 charts the values of *k* and *g* through time. One notable observation is that *g* was greater in magnitude than *k* from the first quarter of 2004 through the third quarter of 2008, and again from the third quarter of 2011 through 2016.

[5] Moody's Seasoned Baa Corporate Bond yield rose to 9.21% at the end of October 2008 from 6.4% 12 months prior.

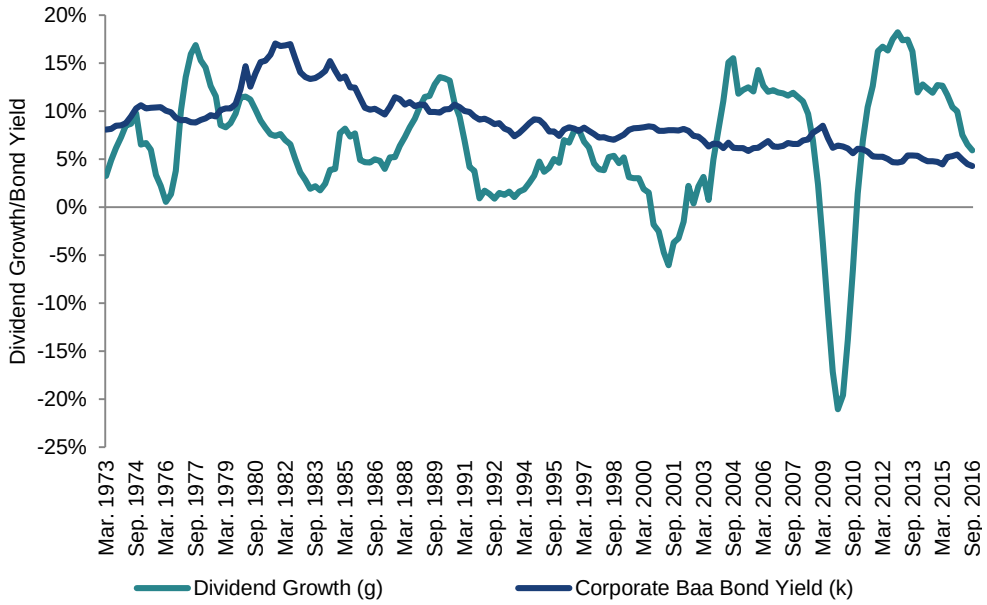
[6] The Federal Reserve raised its benchmark rate for the second time in three months on March 15, 2017. The Fed indicated in December 2016 that three hikes would be likely in 2017.

Theoretically, such a situation would lead to absurd results: stock values would be bid continually higher if dividends could continue to grow faster than the required rate of return on equity. From an empirical perspective, however, dividends cannot continue to grow at double-digit rates. In fact, the records since the first quarter of 2016 show that dividend growth rates have been declining gradually.

Exhibit 3 tracks the value of the difference between the 10-year averages of *k* and *g* through time, showing that it has been residing in negative territory for the last four years of the study period. This negative dip in (*average k* – *average g*) since 2012 contributes to the rebound of our duration estimate.

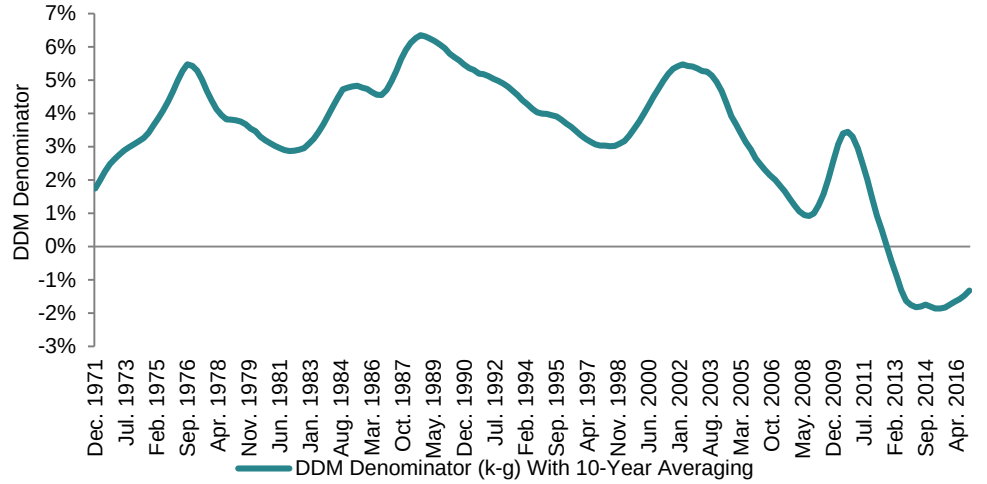
The records since the first quarter of 2016 show that dividend growth rates have been declining gradually.

Exhibit 2: Dividend Growth Rates and Corporate Bond Yield Through Time



Source: S&P Dow Jones Indices LLC, Moody's. Data from March 31, 1973, to Sept. 30, 2016.

Exhibit 3: DDM Denominator (k-g) With 10-Year Averaging



Source: S&P Dow Jones Indices LLC, Moody's. Data from March 31, 1973, to Sept. 30, 2016.

CONCLUSION

Our flow-through duration estimate involves long-term parameters and is inappropriate for shorter-term market timing. It is intended to provide context for long-term asset allocation involving rebalancing every three years or more, which is consistent with the asset allocation review cycles of most pension plans. Further, the trend should be considered as important as the point estimate.

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Therefore, in Appendix 1, we have added a 12-quarter moving average column. In light of this, it would be inaccurate to interpret the June 2016 duration estimate as an indication that the S&P 500 would fall 47.4% for every 1% rise in interest rates. Rather, a more appropriate way of interpreting the estimate is that the duration of the S&P 500 would be 47.4 years if it were a fixed income instrument discounted at its appropriate risk-adjusted rate.

APPENDIX I: ANNUAL DURATION OF THE S&P 500

Exhibit 4: S&P 500 Duration

YEAR	DURATION OF THE S&P 500	12-QUARTER MOVING AVERAGE OF DURATION
1973	36.4	-
1974	30.6	-
1975	23.9	-
1976	17.8	26.0
1977	22.9	22.2
1978	30.2	22.7
1979	33.8	27.1
1980	31.5	30.8
1981	39.0	33.8
1982	39.5	36.2
1983	29.1	36.4
1984	21.9	32.4
1985	21.2	26.2
1986	21.4	22.5
1987	16.0	20.4
1988	13.3	17.9
1989	12.8	15.1
1990	14.9	13.7
1991	14.2	13.8
1992	14.2	14.2
1993	17.2	14.9
1994	19.9	16.3
1995	17.1	17.3
1996	19.6	18.2
1997	25.0	19.7
1998	24.2	21.9
1999	23.4	23.3
2000	18.5	22.5
2001	15.0	19.7
2002	16.0	16.9
2003	15.2	15.4
2004	17.5	15.8
2005	24.9	18.1
2006	27.9	22.2
2007	35.4	27.5
2008	42.6	33.3
2009	34.0	38.2
2010	21.0	35.4
2011	21.7	29.1
2012	23.5	22.7
2013	30.4	24.0
2014	40.0	29.1
2015	51.7	37.0
2016	63.0	47.4

Source: S&P Dow Jones Indices LLC. Data from March 31, 1973, to Sept. 30, 2016. Past performance is no guarantee of future results. Table is provided for illustrative purposes.

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