PGIM QUANTITATIVE SOLUTIONS

TIME-VARYING DURATION AND THE VALUE FACTOR CORRELATION WITH INTEREST RATES

October 2023

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EXECUTIVE SUMMARY

The inconsistent relationship between the value factor returns and changes in interest rates, strong in recent years but mixed historically, can be explained by the time-varying duration of a portfolio that is long cheap stocks and short expensive stocks. In a simple model, holding all else equal, low government bond yields cause the duration of expensive stocks to increase by more than that of cheaper stocks, increasing the sensitivity of the portfolio to changes in interest rates. A period of higher interest rates may see a moderation in the recent heightened sensitivity of the value factor to movements in interest rates.

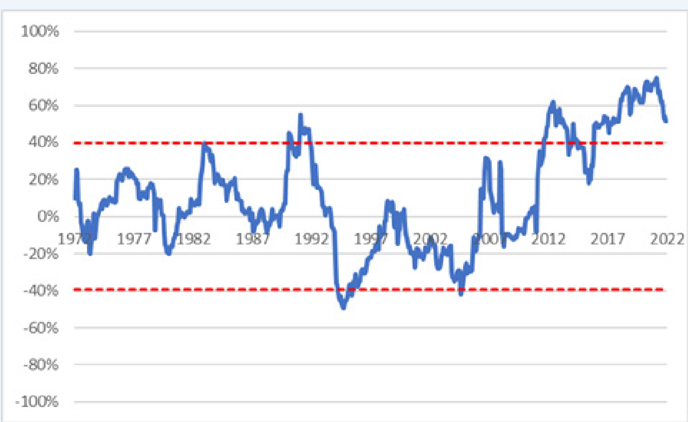
INTRODUCTION

Investment strategies that buy cheap stocks and sell expensive stocks have struggled in recent years.

The well-known Fama-French HML factor, calculated as a portfolio that is long low price-to-book ratio stocks and short high price-to-book ratio stocks, is representative of the performance of value investment strategies,[1] which fell -58% from December 2006 to the recent low in September 2020. However, the factor has seen a resurgence in recent years, rising 22% in 2021 and 32% in 2022.

The strategy's outperformance has come during a period of rising interest rates, just as value's recent underperformance occurred during a period of very low and falling interest rates. The strong correlation between the value factor and interest rates (Figure 1) over the past 10 years versus a relatively benign historical relationship has puzzled many market commentators and participants.

Figure 1: Value's Performance Correlates with Interest Rate Moves



Note: Dashed red lines represent the 1% significance level for the 36-month rolling correlation coefficient. When correlations are greater than the upper line or less the lower line, they are statistically different from zero.

Source: FactSet, Ken French Data Library. https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Data: Dec. 1969 to Dec. 2022.

1. While adjustments can improve the performance of HML, correlations should be sufficiently high for an alternative strategy that the argument that follows should hold.

The author is thankful for invaluable comments from George Patterson, Lorne Johnson, Stephen Courtney, Manoj Rengarajan, Edward Tostanoski, Christopher Lipari, William Liang, Harshad Lalit, and Furkan Isik.

This paper will demonstrate that the impact of very low and falling interest rates on stock duration played a contributing role in the increasing correlation between the value factor and interest rates. By bidding up prices of expensive stocks relative to cheap ones, investors have implicitly put an even greater weight on the present value of the expensive stocks' future dividends (or cash flows) compared to those of cheaper stocks.

When discount rates decline, there is a disproportionate impact on the long and short legs of the value portfolio (all else equal). The present value of future dividends increases by more for the expensive stocks than it does for cheaper stocks. This subsequently flows through into prices resulting in underperformance for the value factor. Moreover, since future dividends make up a greater share of the present value, the result is an increased sensitivity to interest rates (higher duration) of the short leg versus the long leg. For the portfolio as a whole, the duration will become more negative, suggesting that a decline in interest rates will also lead to underperformance in the value factor.[2]

Together, these effects help explain the value factor's underperformance as well as the recent increase in the correlation between the value factor and changes in interest rates. Moreover, this effect is significantly stronger when interest rates are low and more limited when rates are high, which helps explain the more modest correlation historically and the difficulty in identifying the effect in regressions.

While US interest rates have been trending lower since the 1980s, the recession of 2007-2008 sent short-term rates to the zero lower bound with the US Federal Reserve (Fed) resorting to Quantitative Easing to bring down long-term interest rates. This exceptionally low interest rate regime concluded with the end of the COVID-19 recession. However, central banks reversed course and began raising rates in order to combat steeply rising inflation driven by post-COVID supply chain constraints, stimulative government policies, and surging energy prices. Longer-term interest rates climbed, pricing in a higher expected path of short-term interest rates.

Our research suggests that as markets respond to this new economic regime of higher inflation and rates, the strong correlation between the value factor and interest rates is likely to break down.

DURATION OF A STOCK

Before considering the broader relationship between the value factor and interest rates, it is helpful to first answer the question: what is the relationship between the price of a stock and interest rates?

Gordon (1959) offers a simple stock pricing model (referred to herein as the Gordon growth model) that can help provide a starting point. The model assumes that stocks are valued like a growing perpetuity, with dividends increasing perpetually at a fixed rate. The price of a stock in this model is given by

$$P = \frac{D(1+g)}{r-g}$$

where D is current dividends, g is the growth rate of dividends, and r is the discount rate. Without loss of generality, the discount rate, r, is composed of a risk-free rate, r_f, plus some risk premium r_{rp}, such that for a given discount rate and risk-free rate, the implied risk premium can be backed out by using $r \equiv r_f + r_{rp}$.

In this model, falling discount rates will increase the present value of future dividends as well as the stock price. With future dividends making up a greater proportion of the present value, the stock's price grows increasingly sensitive to changes in the discount rate. Moreover, as the discount rate declines relative to the growth rate of dividends, the price will increase significantly. This implies that the duration of a stock is inversely proportional to its discount rate.[3] Figure 2 summarizes this relationship.

Figure 2: As Interest Rates Rise, Stock Values Fall

	Direction		PV Future Dividends		Price	Duration
Discount Rate	↑ ↓	→	↓ ↑	→	↓ ↑	↓ ↑

As shown in the mathematical appendix, the duration of a Gordon growth model stock is given by

$$MDur(r) = \frac{1}{r-g}$$

which is consistent with the intuition above. Decreasing the discount rate will result in a higher modified duration. As the discount rate falls close to the growth rate of dividends, the duration will rise towards infinity.

Figure 3 helps make the above analysis more concrete. Assuming the stock's risk premium is unchanged, the modified duration becomes a function of the risk-free interest rate only. The figure shows the duration assuming a 6% risk premium with expected dividend growth of 3%.

As the risk-free rate falls, the stock becomes increasingly sensitive to changes in interest rates. However, since the risk premium is higher than the expected growth rate, even a 0% risk-free rate would not cause the modified duration to spike to infinity.

2. For a positive duration, an increase (decrease) in interest rates leads to a decrease (increase) in price of an asset. An asset with a negative duration has the opposite relationships.

3. Holding the growth rate of dividends constant.

When interest rates increase, the future value of dividends generally declines, and the stock price therefore becomes less sensitive to those interest rate increases.

If the risk premium is higher or lower,[4] then the duration curve looks different. Building on Figure 3, Figure 4 adds duration curves with a 2% larger or smaller risk premium (to 8% or 4%, respectively, from 6% originally).[5] A higher (lower) risk premium boosts the discount rate, making future dividends less (more) valuable and decreasing (increasing) the sensitivity of the stock to interest rates.

The summary in Figure 3 does not capture the asymmetry in Figure 4 whereby a decline in the risk premium boosts the duration by significantly more than an increase in the risk premium moderates it. This effect is driven by the difference between the discount rate (which is itself composed of the risk-free rate and the risk premium) and the expected growth rate of dividends. As that difference approaches zero, the duration spikes higher. Moving in the opposite direction, when interest rates are higher, then - in contrast - the durations generally converge.

DURATION OF A LONG / SHORT PORTFOLIO

Putting these basic facts together, what duration would we expect from a long/short portfolio?

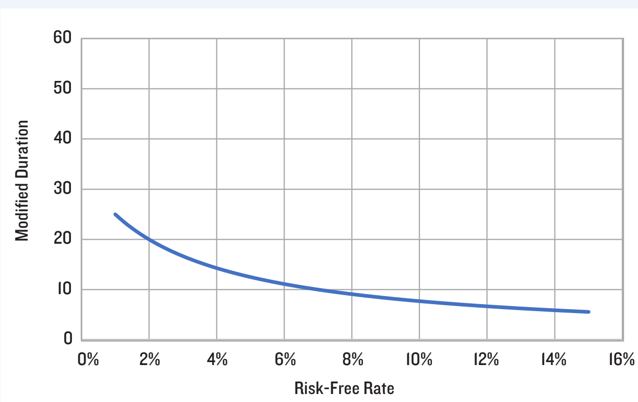
In this model, the duration of a long/short portfolio[6] depends on the differences in the risk premia and growth rates of each leg of the portfolio (as shown in the mathematical appendix). If the risk premium and growth rate of each leg is the same, then the duration is also equal and the combined portfolio therefore has zero duration.[7] However, if there are systemic differences in risk premia and growth rates between the long and short legs, then the long/short portfolio can have a material non-zero duration.

Holding expected growth rates equal, Figure 4 suggests that a portfolio that is long a stock with a higher risk premium (with more modest duration) and short a stock with a lower risk premium (with a higher duration) will tend to have a large, negative duration when interest rates are low. This means that rising (falling) interest rates will increase (decrease) the portfolio's value, but as interest rates rise, the duration will tend towards zero.

In other words, when risk-free rates decline, the relatively smaller risk premium of the short side means that the present value of future dividends will generally increase in value by more than the long side (hence the negative duration of the portfolio). Future dividends will also be increasingly more sensitive to changes in risk-free rates. However, as rates increase, the value of future dividends declines and so differences in risk premia are less significant.

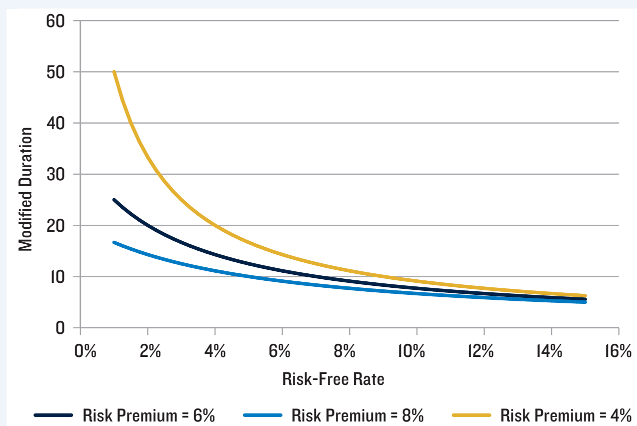
More concretely, assume that the risk premium and growth rate for the long side of the portfolio are 6% and 3%, respectively, and those for the short side are 4% and 3.5%.[8]

Figure 3: Modified Duration of a Hypothetical Stock



Source: PGIM Quantitative Solutions calculations.

Figure 4: Impact of Adjusting the Risk Premium



Source: PGIM Quantitative Solutions calculations.

4. In this model, the impact of an increase (decrease) in the risk premium on modified duration is equivalent to a decrease (increase) in the expected growth rate of dividends. There are identification issues in practice in determining what is driving the change.

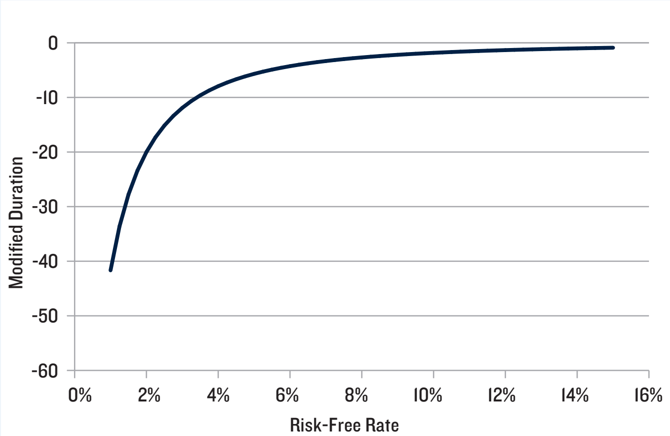
5. All else equal, an increase (decrease) in the risk premium will decrease (increase) the price-to-dividend ratio. The increase (decrease) in the risk premium can be thought of as the stock getting cheaper (more expensive) on a price-to dividend basis.

6. Assuming the investor is invested 100% long one asset and 100% short another.

7. For small differences in risk premia and growth rates, the durations would be small, particularly as the risk-free rate increases. This is consistent with the findings of Asness (2022). However, the existence of a long-term value premium (even if that premium is difficult to measure and perhaps smaller than in the past), suggests that differences in risk premia are not small.

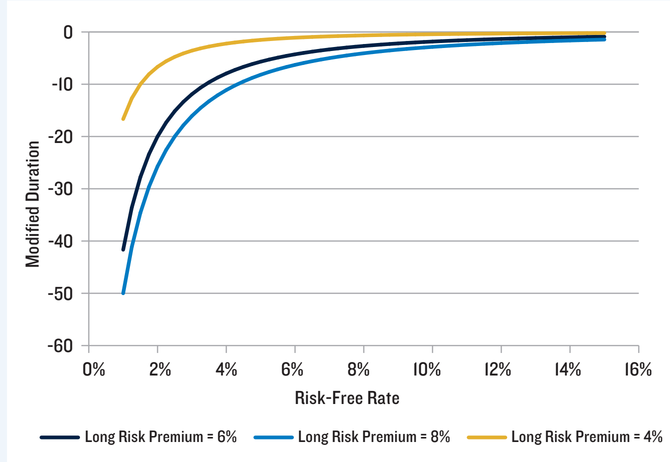
8. If the long and short sides were reversed, then the modified duration would be positive with the same shape.

Figure 5: Modified Duration of Hypothetical Long Value / Short Growth Portfolio



Source: PGIM Quantitative Solutions calculations.

Figure 6: Duration of Long/Short Portfolio When Changing Risk Premium Assumption of Long Leg



Source: PGIM Quantitative Solutions calculations.

While these values are somewhat arbitrary,[9] they are motivated by a long portfolio that invests in stocks with higher expected returns but slower dividend growth, consistent with a value strategy, while stocks in the short side of the portfolio are more expensive (based on the lower risk premium) but expected to grow more quickly.[10] Therefore, this is roughly consistent with what one would expect from a long/short value factor.

The duration of the long/short portfolio is then given by the chart in Figure 5.

While Figures 2 and 3 demonstrate that the duration is inversely proportional to the interest rate of an individual stock, Figure 5 suggests that the duration of the long/short portfolio is inversely proportional to the square of interest rates. The line is flatter as interest rates increase, but the duration of the portfolio becomes more extreme when interest rates decline.

Nevertheless, the results shown in Figure 5 are dependent upon the assumptions made. Figure 6 demonstrates the effect of increasing or decreasing the risk premium of the long leg of the portfolio in Figure 5 by 2% (to 8% or 4%, respectively, from 6% originally).[11]

Keeping in mind the results in Figure 4 that displayed the duration of an individual asset, rather than the duration of a portfolio, the higher (lower) risk premium of the long leg will increase (decrease) its discount rate, making future dividends less (more) valuable and decreasing (increasing) its duration. With the short side's more elevated duration unchanged and a declining (rising) duration on the long side, the combined portfolio will be more (less) sensitive to interest rates.

As in Figure 4, the impact is asymmetric between an increase or decrease in risk premia. Just a modestly smaller risk premium – 3.5% – is enough to set the durations of the long and short leg equal, zeroing out the duration of the combined portfolio.[12]

DIGRESSION: SHORT DURATION PREMIUM PUZZLE

Academics have studied the effect of stock duration on stock returns more closely in recent years. Weber (2017), Gonçalves (2022), Beckmeyer and Meyerhof (2022), and Gormsen and Lazarus (2022) document a short duration premium whereby stocks with shorter duration pay a higher premium than those with a longer duration. Some of these authors argue that this short duration effect subsumes the value factor as well as other factors.

However, from the perspective of a simple growing perpetuity model, this is less puzzling. In this model, duration and the price-to-forward-dividend ratio are equal. Stocks with shorter duration also have lower price-to-forward-dividend ratios, which will typically get picked up when constructing a value factor.

9. The levels are arbitrary in the sense that a reduction in each of the growth rates by a constant amount (that leaves them still above zero) will result in the same duration, provided the risk premia are also adjusted by the same amount. This is consistent with the results in the mathematical appendix. However, the resulting duration depends on the difference between the growth rates and risk premia.

10. For comparison, data from Robert Shiller's data library (available here: http://www.econ.yale.edu/~shiller/data.htm, accessed: 11/15/2022) suggests S&P 500 dividends increased 6.95% in nominal terms (4.54% real) over twenty years ending in 2021 and 5.95% (2.46% real) from 1947 to 2021. By contrast, Barberis and Huang (2001) find average aggregate dividend growth for NYSE stocks from 1925 to 1995 to be around 1.5%.

11. An increase (decrease) in the risk premium of the long leg is consistent with the long side getting cheaper (more expensive) on a price-to-dividend basis, all else equal.

12. The duration of the long/short portfolio depends on the difference between the risk premium and the expected growth rate of each asset. If that difference is the same in both assets, then they will cancel each other out.

In other words, the short duration premium is likely measuring the same underlying effect as the value factor.

WHAT DOES THIS MEAN FOR THE VALUE FACTOR?

The sections above provide a useful theoretical framework for analyzing the value factor and its sensitivity to interest rates.

Recall that the market environment from the 2007-2008 recession until the 2020 pandemic was generally a poor one for the value factor, with expensive stocks outperforming cheap stocks (and becoming even more expensive versus cheap stocks). The period also consisted of low and falling interest rates, resulting in a large correlation between changing interest rates and the value factor.

While large in recent years, the correlation historically was much more modest. Figure 5 helps explain this behavior. By buying stocks with a high risk premium and shorting stocks with a lower risk premium, the long/short portfolio in Figure 5 is essentially long cheap stocks and short expensive stocks, similar to the value factor. During periods of higher interest rates, the sensitivity of the value factor to interest rates will be low[13] and appear somewhat stable. Since rates were historically higher, it is not surprising that the historical correlation was more modest. However, falling interest rates can boost the sensitivity of expensive stocks to interest rates by more than they boost that of cheap stocks. As a result, portfolios long cheap stocks and short expensive ones will typically become more sensitive to interest rates, contributing to the higher correlation seen in recent years.

Nevertheless, by holding risk premia and expected growth rates constant, Figure 5 is not entirely representative of the real world. In the real world, risk premia and expected growth rates can change over time. Figure 6 helps provide insight into the impact of a changing risk premium. Holding interest rates unchanged, investors bidding up expensive stocks, either by reducing their estimate of the risk premia or by increasing their growth expectations,[14] will increase the sensitivity of a long/short value factor to interest rates. Moreover, the effect is more pronounced during periods of low interest rates.

In the period from 2009-2020, characterized by low and declining interest rates, investors bid up prices of expensive stocks beyond what would be expected solely from falling risk-free rates. As prices of expensive stocks rose, their sensitivity to interest rates likewise increased, contributing to the elevated correlation between rates and the value factor.

> **"Falling interest rates can boost the sensitivity of expensive stocks to interest rates by more than they boost that of cheap stocks."**

It is no coincidence that the period of low and falling interest rates, value factor underperformance, and rising correlation between the value factor and interest rates also occurred in tandem with a period when expensive stocks got more expensive.

In the Gordon growth model introduced on page 2, it turns out that a stock's modified duration is also equivalent to its price-to-forward-dividend ratio.[15, 16] A high price-to-dividend ratio, all else equal, is consistent with investors placing more weight on future dividends, which makes the stock price more sensitive to interest rate changes.

From this perspective, the widening valuation gap in recent years (as expensive stocks outperformed cheap stocks) was driven by both falling interest rates as well as changes in investors' perceptions of risk. The underlying factors driving the wider valuation gap also contributed to the value factor's greater sensitivity to interest rates than previously observed.

EMPIRICAL ANALYSIS OF THE VALUE FACTOR

While the prior section builds on the theoretical framework that helps explain trends driving the value factor, an empirical analysis can help quantify the size of the effect.

Prior research into the relationship between value and interest rates, such as in Maloney & Moskowitz (2022), generally focuses on the value factor's performance versus either the level or changes in interest rates. In addition, it is important to consider the impact of duration directly.

13. And given the volatility of stock returns, difficult to measure.

14. In practice, it can be difficult to identify whether movement in either individual stock prices or the long (or short) leg of the value factor is driven by a change in risk premia or expected dividend growth. It is a problem of identification (the Gordon growth model has four variables and two are unknown initially). Some assumptions must be made to determine the source of the change. Nevertheless, if one assumption is inaccurately measured and market prices are used to back out the other assumption, then the difference between the two will tend to be more precise. Similarly, the duration of the long/short portfolio depends on differences between risk premia and expected growth, both for individual assets as well as between them.

15. And proportional to the price-to-trailing dividend or price-to-earnings ratios.

16. Moreover, the relationship extends to the long/short portfolio in the section titled "Duration of a Long / Short Portfolio." The difference in the price-to-forward dividend ratios between the long and short legs is equal to the modified duration of the portfolio, essentially a valuation gap.

While Figure 1 introduced the time-varying relationship between the returns of the HML factor and changes in bond yields, the empirical analysis instead measures the value factor using a long/short portfolio that is long the MSCI USA Value Index and short the MSCI USA Growth Index. We refer to this as the MSCI USA Long/Short (LS) Value factor.

This MSCI USA LS Value factor has a roughly 70% correlation with the HML factor on a monthly basis from December 1974 to September 2022. Thus, the two factors are similar, but not precisely the same. Likewise, the performance of this simple strategy would differ from value strategies more sophisticated than HML. In contrast to the HML factor, which gives equal weight to large-cap and small-cap components, the MSCI indexes are dominated by large-cap and mid-cap stocks that, in aggregate, make up a larger share of the market. In addition, the construction of the HML factor entirely separates the cheap and expensive segments of the market, while there is overlap in the MSCI series. And although the MSCI indexes have a shorter history than the HML factor, the available MSCI data is easier to work with in this case. The HML factor requires the returns of four portfolios, while the MSCI factor requires only two,[17] resulting in half as many modified durations with half as many growth estimates.

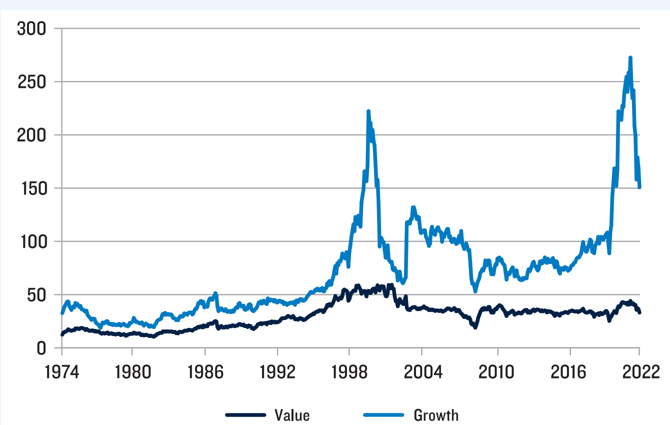
Preparation of a historical estimate of the modified duration of the value factor requires several assumptions. While what follows makes use of the simple Gordon growth model (as discussed above), the real world tends to be more complicated. Growth rates are unlikely to be constant over history, contributing to the popularity of multi-stage dividend discount models. Growth companies historically have been more sensitive to changes in expectations about net margins or growth (Henricksson et al., 2020). Hence, the durations that follow are at best an estimate.

Recall that in the Gordon growth model, the modified duration of a stock is equivalent to the forward price-to-dividend ratio. The forward price-to-dividend ratio is also equal to the trailing price-to-dividend ratio by dividing by one plus the expected growth rate. Since MSCI provides trailing dividend yields, we can invert the dividend yield to arrive at the trailing price-to-dividend ratio.

What remains is to estimate a growth rate for each of the value and growth indexes. Trailing dividends per share are backed out from the trailing dividend yields and prices. Growth in dividends per share for each index are assumed to equal the rolling three-year annualized growth of core PCE inflation plus the historical average of the real growth in dividends of each index (deflated using core PCE).[18]

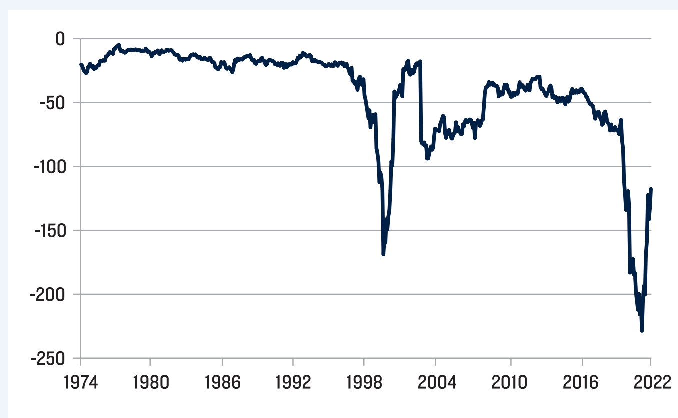
Figure 7 shows the modified duration of the MSCI USA Value and Growth indexes separately back to 1974. The data clearly demonstrate that the MSCI USA Growth Index had much more significant movements over the 45-year period. When the dividend yield falls close to zero in these assumptions, the duration spikes higher. The period around 1999-2000, when growth stocks were bid up to expensive valuations during the internet bubble, is quite exceptional.

Figure 7: Estimated Historical MSCI USA Value and Growth Modified Duration



Source: FactSet, PGIM Quantitative Solutions calculations.
Data: Dec. 1974 to Sept. 2022.

Figure 8: Estimated Historical MSCI USA LS Value Factor Modified Duration



Source: FactSet, PGIM Quantitative Solutions calculations.
Data: Dec. 1974 to Sept. 2022.

17. In addition, MSCI provides trailing 12-month dividend yields, which can be adjusted by prices to get dividends. By contrast, the Ken French data library has returns of the individual portfolios that make up HML with and without the effect of dividends. The dividend return needs to get backed out. Then, dividends would need to get backed out by incorporating provided market capitalization data, which has some difficulty since that isn't exactly the same thing as price.

18. A more sophisticated assumption for growth in dividends could be used for the more recent period where forward dividend yields are available. However, a big source of the variation is coming from dividend yields. Growth in dividends is generally assumed to be more stable.

Figure 8 provides the modified duration for this MSCI USA LS Value factor, calculated as the difference between the MSCI USA Value and Growth index durations. The duration tends to be negative over time, consistent with the higher dividend yield of growth stocks versus value stocks. Consistent with Figure 7, the duration trended lower in recent years as the growth duration increased. This corresponds with the period where the correlation between the value factor and changes in interest rates had increased. While this measure was generally low prior to the mid-1990s, it was also volatile during 2000, the period of the internet boom and bust. Extreme valuations (either from lower risk premia or higher expected growth rates) helped contribute to the volatility during this period,[19] which kept the correlation between the value factor and changes in interest rates more modest.

Figure 9 overlays the rolling 36-month correlation between monthly MSCI USA LS Value factor returns against changes in US 10-year yields. Similar to the correlation pattern shown in Figure 1, the rolling correlation is also higher in recent years as the duration has spiked, while historically hovering between -20% and +20%.

The relationship is a bit clearer when considering a regression of monthly returns of the MSCI USA LS Value factor against changes in 10-year US Treasury yields. Model 1 in Figure 10 represents this regression. While the coefficient is positive (suggesting rising yields are a positive for this value factor), the p-value of the slope is 10.3%, which suggests that the relationship is weak (and not statistically significant at the 10% level).

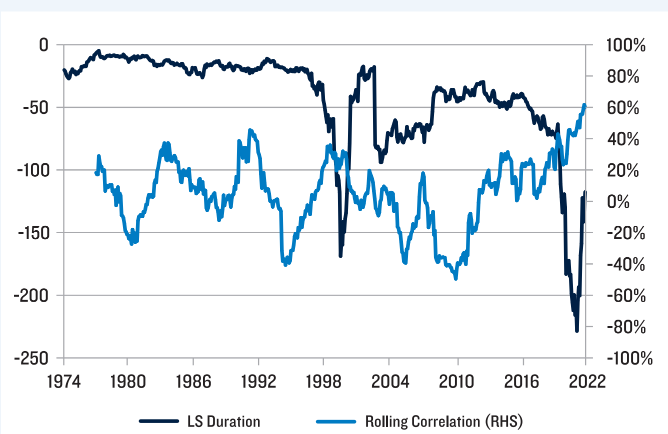
To incorporate the duration effect, Model 2 in Figure 10 adds a variable equal to the change in yields times the lagged value of the modified duration of the value factor. In this case, the change in yields variable is no longer significant, while the new variable has a p-value of 0.1%, suggesting a much stronger relationship. While the adjusted R^2 is low for both models, as is usually the case for factor time series, it is modestly higher for Model 2. Nevertheless, the low R^2 suggests that while a part of the movement in the value factor is driven by interest rates, it is a small part.

For Model 2, a 10bps increase (decrease) in 10-year yields – assuming a modified duration of -100 – would imply MSCI USA LS Value returns are 0.29% higher (lower) than average, which is modest but not extraordinarily large.

While such modest rate increases are more common over time, 2022 saw an increase in 10-year US yields, a multiple of the 10bps assumed above. Yields climbed 2.29% through September 30, 2022. While the duration of the value factor is generally not stable over time, Figure 8 suggests that duration was just beyond -200 at its most extreme before pulling back. It averaged roughly -160 in 2022. Under these assumptions, the model would predict an 11% return for the MSCI USA LS Value factor. In fact, the factor returned 15% in the nine months through September 2022.

Admittedly the outperformance of the value factor in 2022 (through September) has come during a bear market with both the MSCI USA Value and Growth indexes down significantly, -17.4% and -32.4%, respectively.

Figure 9: Long/Short Duration with Rolling Correlation Between Value Factor and Interest Rates Overlaid



Source: FactSet, PGIM Quantitative Solutions calculations.
Data: Dec. 1974 to Sept. 2022.

Figure 10: Regression of MSCI USA LS Value Factor Monthly Returns Against Changes in US Treasury 10-Year Yields

Models	Parameter	Intercept	Change in Yield	MDur. *Change in Yield	Adj. R^2
Model 1	Coefficient	0.00	0.52		0.29%
	T-Stat	-0.24	1.63		
	P-Value	81.1%	10.3%		
Model 2	Coefficient	0.00	-0.42	-0.033	2.03%
	T-Stat	-0.41	-0.98	-3.34	
	P-Value	68.5%	32.6%	0.1%	

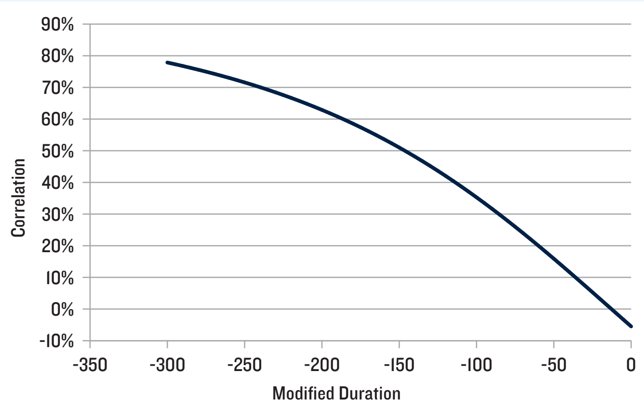
Source: FactSet, PGIM Quantitative Solutions calculations.
Data: Dec. 1974 to Sept. 2022

19. Since the modified duration calculated here assumes the growing perpetuity model, it is also strongly correlated with the difference in price-to-dividend ratios between the indexes.

The value index is one of stronger relative performers. Both indexes are sensitive to rising interest rates, but the growth index has a greater sensitivity.

Figure 11 expresses the regression results from Model 2 in Figure 10 in terms of the relationship between duration and the correlation of the value factor with interest rates. Model 2 would suggest a correlation of slightly above 60% if the duration is -200, which is roughly in the range shown in Figure 1 (with the qualification that this is a point-in-time correlation versus the rolling correlation in that figure). As

Figure 11: Relationship Between Duration and Value Correlation with Interest Rate Changes



Source: FactSet, PGIM Quantitative Solutions calculations.
Data: Dec. 1974 to Sept. 2022.

the duration approaches zero, the correlation also declines. A duration of 50, which is not at all uncommon in history, is consistent with a correlation closer to 15%.

While the relationship between the value factor and changes in bond yields may be tenuous, correcting the change in bond yields for the modified duration suggests a stronger underlying relationship. The secular downtrend in interest rates has contributed to a spike in the sensitivity of value returns to interest rates, but this relationship is conditional on other factors and is not stable over time.

OUTLOOK FOR VALUE

The low interest rate regime from the end of the 2007-2008 recession to the COVID-19 pandemic has come to an end. Supply chain constraints, monetary and fiscal stimulus, and the surge in energy costs associated with Russia's war in Ukraine had sent inflation in developed economies to its highest level in decades by the middle of 2022. Global central banks – initially behind the curve in responding to the threat of inflation – hiked rates swiftly to bring it under control. These trends accelerated in 2023 with the Fed and European Central Bank forward guidance now suggesting a higher-for-longer stance. Longer-term interest rates have climbed significantly, pricing in a higher expected path of short-term interest rates.

In spite of rising interest rates, 2023 has been a challenging year for the value factor as growth stocks rallied further. Investors bidding up growth stocks to more expensive valuations can actually contribute to the value factor being more sensitive to interest rates. The 2023 rally in growth stocks was concentrated earlier in the year during months where interest rates were either down or just rising modestly. In Q3, the 10-year yield rose 76bps, and MSCI USA LS Value rose a modest 0.7%. Based on monthly data for the first nine months of 2023, the MSCI USA LS Value factor has had a 62% correlation with changes in interest rates. The increase in interest rates has been a positive, all else equal, for the value factor.

> **"The secular downtrend in interest rates has contributed to a spike in the sensitivity of value returns to interest rates, but this relationship is conditional on other factors and is not stable over time."**

Further upward pressure on interest rates could lead to a breakdown in the correlation between the value factor and interest rates. But interest rates are just one component of the model. Model 2 from Figure 10 suggests that if duration remains extreme, then an increase in interest rates will contribute to better-than-average value factor returns in any given month. However, the R^2 in this regression is relatively weak, and the higher the level of interest rates, all else equal, the less sensitive the factor becomes to interest rate changes, making longer-term predictions difficult.

A period of elevated interest rates is not the only potential scenario. Central banks are attempting to thread the needle to deliver a soft landing. If central banks tighten policy by more than economies can sustain, then it could cause a global recession. Central banks would likely respond to such a scenario by cutting policy rates. Therefore, it may be that the potential for additional upward pressure on longer-term interest rates is limited.

CONCLUSION

Low and falling interest rates help explain the underperformance of the value factor during much of the last two decades as well as its increased correlation with interest rates. As investors bid up the prices of more expensive assets, their prices can theoretically become more sensitive to interest rates (though empirically, the relationship was more muted than theory predicts during the internet bubble).

Our research suggests that as markets respond to this new economic regime of higher inflation and rates, particularly long-term rates, the strong correlation between the value factor and interest rates is likely to break down.[20]

A rising rate environment could also result in a period of above-average returns for the value factor, all else equal. Nevertheless, all is not always held equal, and interest rates are just one driver – among many – of stock prices.

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20. As of this writing, it already has to some extent.

MATHEMATICAL APPENDIX

In the Gordon (1959) model, the stock price is equal to that of a growing perpetuity

$$P = \frac{D(1+g)}{r-g}$$

where P is the stock price, D is current dividends per share, g is the expected growth rate of dividends, and r is the discount rate.

The modified duration of a growing perpetuity is equal to:

$$\begin{aligned} MDur(r) &= -\frac{1}{P}\frac{dP}{dr} \\ &= -\left(\frac{r-g}{D(1+g)}\right)\left(-\frac{D(1+g)}{(r-g)^2}\right) \\ &= \frac{1}{r-g} \end{aligned}$$

assuming D and g do not depend on r.

Consistent with what is described in Section 2, the formula above implies that when the difference between the discount rate and the growth of dividends is small, then the asset is more sensitive to changes in the discount rate. The value of the stock is strongly influenced by future growth in dividends, so changes in the discount rate have a large impact on the price. By contrast, when the difference between the discount rate and the growth of dividends increases, then the stock's value will be less influenced by future growth of dividends and the sensitivity to changes in interest rates will be more modest.

Next, consider a portfolio that is long one growing perpetuity and short an equal amount of another. Without loss of generality, assume the discount rate of each includes a common component, akin to a risk-free rate, plus some unique risk premium $r_{p,i}$ to each, as in $r_i = r_f + r_{p,i}$.

The modified duration of the portfolio with respect to the risk-free rate equals the difference between the durations of the long and short sides:

$$\begin{aligned} MDur(r_f) &= MDur(r_f)_{long} - MDur(r_f)_{short} \\ &= \frac{1}{r_{long} - g_{long}} - \frac{1}{r_{short} - g_{short}} \\ &= \frac{(r_{short} - g_{short}) - (r_{long} - g_{long})}{(r_{long} - g_{long})(r_{short} - g_{short})} \\ &= \frac{(g_{long} - g_{short}) - (r_{long} - r_{short})}{(r_{long} - g_{long})(r_{short} - g_{short})} \\ &= \frac{(g_{long} - g_{short}) - (r_{p,long} - r_{p,short})}{(r_{long} - g_{long})(r_{short} - g_{short})} \end{aligned}$$

This formula takes a similar form as the modified duration for an individual stock, albeit including the "r minus g" of both stocks. Further, note that the sign of the modified duration depends on the magnitude of the equity risk premiums and expected growth rates of each of the assets. If the differences in the equity risk premiums and growth rates are assumed to be small (or equal), then the modified duration will be small in absolute value (or zero). However, if a factor exists with some positive risk premium (and is structured as a long/short portfolio), then it would be reasonable to assume that the term $(g_{long} - g_{short}) - (r_{p,long} - r_{p,short})$ is less than zero by some meaningful amount.

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