QUANTITATIVE PORTFOLIO STRATEGY

Cost of the No-Leverage Constraint in Duration Timing

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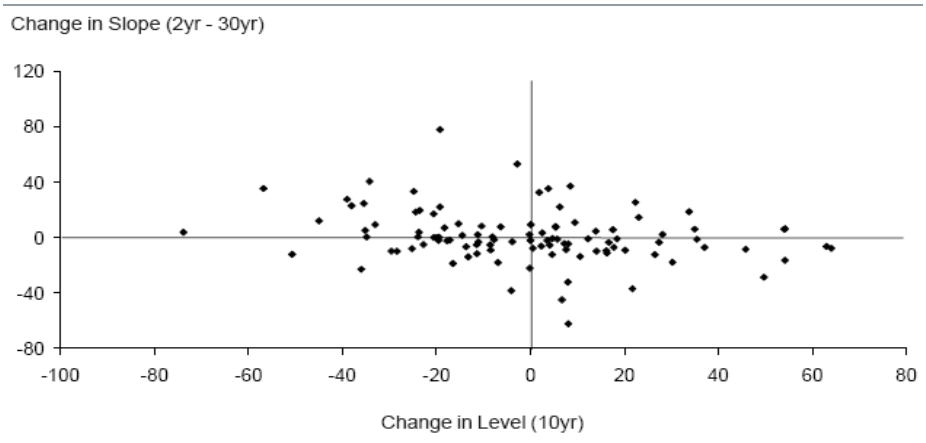
In many portfolio settings, investment policy forbids the use of leverage. This undoubtedly serves to prevent portfolio managers from engaging in certain extremely risky strategies. However, the no-leverage constraint can also have an unintended effect on portfolio performance by limiting the types of views that can be implemented.

In particular, a portfolio manager operating under a no-leverage constraint cannot easily implement a pure bullish view on interest rates. A typical method of adding duration to such a portfolio is to underweight the short-duration part of the market and overweight the long-duration part. However, such a position is clearly not a pure duration play, but carries with it an exposure to changes in the slope of the curve. The no-leverage constraint essentially forces the combination of a bullish view on duration with an unintended flattener. This combination has not been a very effective one historically. Figure 1 shows a scatter plot of changes in the level and slope of the curve (10-year par yield versus 2-30 slope). The graph shows a clear bias towards the top left quadrant (bullish steepening, 30 out of 104 observations) and the bottom right quadrant (bearish flattening, observed in 33 months). The bottom left quadrant shows only 23 months with bullish flattening, and even these tend to show only mild flattening. At the top right, we find 18 months with bearish steepening. The correlation between the level and slope over this time period is -25.6%. Decreases in the level of rates have historically been accompanied by steepening of the curve. Shifting portfolio exposure from the short end of the curve to the long end should therefore lead to performance reduction, compared with a pure duration strategy that increases exposure all along the curve by using leverage.

Figure 1: Historically Observed Yield Curve Changes, December 1993-July 2002



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To quantify the cost of the no-leverage constraint on portfolio performance, we investigate several different mechanisms for implementing a view on duration, and simulate their historical performance using "perfect foresight" at predicting the direction of interest rates. In each strategy, the portfolio duration is reset at the start of each month to be either one year longer than the benchmark or one year shorter than the benchmark, depending on the direction of the signal. Several different signals are explored. While the returns obtained using the perfect foresight assumption are unrealistically high, the comparison of the results of the different strategies should carry over to any setting in which a manager exhibits skill at duration timing.

A manager who wishes to extend his portfolio's duration can do so in any number of ways. Positioning a portfolio entails not only deciding what the duration exposure should be, but also where it should lie along the curve. Steepening or flattening exposures assumed in the process of extending duration may well be intentional, based on detailed analyses of curve dynamics and relative value. In this study, we investigate a simple, idealized version of the investment process. The duration view is assumed to be purely directional, and any steepening or flattening exposure is considered to be incidental. Further, the means of extending duration are limited to a small set of specific strategies. The no-leverage constraint may thus have a milder effect on performance in the more general portfolio context than in the simplified setting studied here.[1]

Strategies Considered

In this study, we consider the performance of six portfolios benchmarked against the Barclays Capital Treasury Index from December 1993 through July 2002. All six use duration timing strategies that go either long or short duration by one year versus the index according to a signal. Three are all-cash strategies, in which the duration view is implemented by overweighting and underweighting different parts of the index; the other three use overlays of Treasury futures.

The strategies are as follows:

1. Scaled Index—The portfolio either overweights or underweights the entire index to achieve the desired duration exposure. This is a purely directional view on the index, but may involve leverage. When the portfolio takes the bearish view, duration is shortened by selling bonds and leaving the proceeds in cash. To implement a bullish view, the portfolio lengthens duration by borrowing cash to buy more of each index security. In practice, strategies of this type could be implemented in the repo market.

2. Cash Neutral—The portfolio always remains fully invested in bonds, but shifts assets between the long-duration half of the index and the short-duration half to achieve the desired duration exposure. When bullish, there is an overweight to the long-duration half and an underweight to the short-duration half. This position is reversed to implement a bearish view. This strategy satisfies the no-leverage constraint, but always contains an unintended exposure to curve slope (most likely in the wrong direction) as it alternates between a bullish flattener and a bearish steepener.

3. Mixed—an asymmetric combination of the above two strategies. For a bullish view, where the Scaled Index strategy would violate the no-leverage rule, we use the Cash Neutral strategy to go long duration. When a bearish view is indicated, it is implemented using the Scaled Index strategy, spreading the underweight across the

[1] In a follow-up study, we plan to revisit this issue using a broader range of strategies, with skill applied simultaneously to setting the portfolio's duration view and curve shape exposures.

whole index to avoid the performance dilution that would occur if the curve flattened as rates rose (as is often the case). This strategy satisfies the no-leverage constraint, and alternates between a bullish flattener and a pure bearish position.

4. 10-Year Futures—In this strategy (as in the next two), we assume that the portfolio is constructed around a core bond position which is entirely passive to the index. The active position consists entirely of a futures position which is layered above the bond portfolio to implement the desired duration view. In this strategy the entire duration exposure is implemented using a long or short position in 10-Year Note Futures.

5. 30-Year Futures—Same as above, but using Bond Futures.

6. Futures Replication—The active duration bet of one year is implemented using a combination of four futures contracts (2-, 5-, and 10-Year Note Futures, and 30¬Year Bond Futures) selected to best match the duration profile of the index, using our methodology for index replication with futures contracts.[2] This strategy is very closely related to the Scaled Index strategy, except that the monthly changes in the position involve transactions on four futures contracts instead of all of the bonds in the index.

Figure 2 illustrates how the various strategies would have implemented a bullish duration exposure of one year longer than the index as of June 30, 2002. The Treasury index is divided into four duration cells, which correspond roughly to the four futures contracts used in the Replication strategy. The Cash Neutral strategy overweights the two longer-duration cells and underweights the two shorter-duration cells, matching the index distribution between the two cells in each half of the index. It can be seen that this strategy has a large allocation (and by far the largest duration contribution) in the longest index cell, duration over 7.5 years. The Scaled Index strategy overweights the four index cells proportionally to their index weights, and the Futures Replication strategy approximates this distribution using the four U.S. Treasury futures contracts. At the bottom of Figure 2, we show the effective cash position of each strategy, as a percentage of portfolio market value. The negative numbers shown for all but the Cash Neutral strategy indicate leveraged positions. For the futures strategy, the negative cash positions shown are those implied by treating the contracts as leveraged positions in Treasury Bonds and Notes.

Figure 2: Illustration of Strategies for Implementing Bullish 1-Year Duration View, as of June 30, 2002

			Active Positions to Achieve a Duration Overweight of +1 Year				
Asset	Duration	UST Index	Cash Neutral	Scaled Index	10-Year Futures	30-Year Futures	Futures Replication
Treas. Index, dur 0-3	1.76	35.8%	-8.9%	6.2%			
Treas. Index, dur 3-5	3.82	18.6%	-4.6%	3.2%			
Treas. Index, dur 5-7.5	6.07	12.3%	3.7%	2.1%			
Treas. Index, dur 7.5+	11.22	33.2%	9.9%	5.7%			
2-year futures	1.93						5.6%
5-yr futures	4.19						2.9%
10-year futures	6.55				15.3%		2.0%
30-year futures	12.29					8.1%	5.2%
Total Duration		5.82	1.00	1.00	1.00	1.00	1.00
Effective Cash Position (% of portfolio value)			0.0%	-17.2%	-15.3%	-8.1%	-15.7%

[2] For details see *"Replicating Index Returns with Treasury Futures,"* Lehman Brothers, November 1997.

Perfect Foresight Using Different Signals

To simulate the performance of each strategy historically, we just need to fill in the sequence of duration calls made each month—bullish or bearish. We will investigate the unrealizable upper limits of performance by utilizing a "perfect foresight" assumption—the duration decision at the start of each month is based on advance knowledge of what will happen as that month unfolds. In other words, the strategy always makes the "right" duration call. Interestingly enough, there is some ambiguity even in defining which is the right duration call after the fact. We have run the simulation using four different signals:

A. 10-Year Yield—The strategy is bullish during months in which the fitted 10-year par yield falls, and bearish when it rises.

B. Average Yield—The strategy is bullish during months in which there is a decline in the average of the fitted par yields at four points on the curve: 2, 5, 10 and 30 years.

C. Index vs. Cash—The strategy is bullish during months in which the Treasury Index earns a positive excess return over cash.

D. Index Slope—The strategy is bullish during months in which the long-duration half of the Treasury Index earns a greater total return than the short-duration half of the index.

This menu of signals corresponds to different ways of looking at interest rates. The 10-Year Yield is quite commonly used as a very simple barometer of the level of interest rates. The Average Yield, which spreads out the exposure along the curve, is somewhat more indicative of the yield change experienced by the index. The two strategies based on index returns are designed to produce the "right" duration call for specific implementations of the duration view. The Index versus Cash indicator should always give the best result for the Scaled Index strategy, and the Index Slope indicator should always give the best result for the Cash Neutral strategy.

These four signals are usually in synch with one another. A downward parallel shift in rates should result in a bullish signal by all four indicators; an upward parallel shift should give four bearish signals. The different indicators are most likely to give different signals in months where there is no noticeable parallel shift, but the curve changes shape. Non-parallel yield curve changes could make the 10-Year Yield move in the opposite direction from the Average Yield. When the dominant change in the yield curve is a change in slope, the Index Slope indicator is likely to give a different result than the others. In a steep yield curve environment, when any duration extension earns a pickup in yield, the bullish view may be a winning one even when rates back up slightly. This could cause the Index vs. Cash indicator signal to be different from the yield change signals.

Results

We simulated each of our six strategies using each of the four indicator signals from December 1993 through July 2002. For each of the 24 combinations, we calculated the mean monthly outperformance, the tracking error volatility, and the annualized information ratio. The results are shown in Figure 3.

In our view, Average Yield is the fairest indicator to use for duration timing in an index context, as it most closely corresponds to a parallel shift in the yield curve. Using this signal, we see that the highest information ratio (4.32) is obtained using the Scaled Index strategy. As expected, the Futures Replication strategy turns in very similar performance, with an

information ratio of 4.30.[3] Comparing the Cash Neutral strategy to the Scaled Index strategy, we see that the average monthly outperformance is 16% lower (15.6 bp versus 18.5 bp) while the tracking error volatility is 9% higher (16.2 bp versus 14.9 bp), making the annualized information ratio 23% lower (3.33 versus 4.32). The Mixed strategy, as a blend of the Scaled Index and Cash Neutral Strategies, falls between the other two: its average outperformance of 16.6 bp is 11% less than that of the Scaled Index strategy, and its information ratio (3.74) is 13% lower.

If the duration timing signal is based on the 10-Year Yield indicator, the results are largely unchanged for the Scaled Index and Futures Replication strategies, but the Cash Neutral and Mixed strategies fare much better. This is because the implementation of the duration view in the cash-neutral strategy places the exposure mostly on the 10-to-30-year part of the curve. In this case, the Scaled Index strategy achieves an information ratio of 4.31, the Cash Neutral is 9% lower at 3.91, and the Mixed strategy is 6% lower at 4.06.

The improved performance of the Cash Neutral strategy using the 10-year signal raises an interesting point. Within the framework of this study, duration extension was conceived as a view on the direction of a parallel shift in rates. We included the 10-year signal as a simple, commonly cited measure of the level of interest rates—but did not expect it to be a good measure of parallel shift. The improved performance of the Cash Neutral strategy using this signal is due to the fact that the 10-year yield change just happens to coincide with the part of the curve to which this strategy is most sensitive. The general message for investors who use a variant of this Cash Neutral strategy is that a duration extension of this type should not be considered as a view on a parallel shift in rates, but rather as a view on a single point on the yield curve where the strategy has the greatest duration exposure.

Figure 3: Summary of Perfect Foresight Results for Duration Timing Using Different Strategies and Indicator Signals
December 1993-July 2002

	Scaled Index	Cash Neutral	Mixed	10-Year Futures	30-Year Futures	Futures Replication
Indicator: 10-Year Yield (Change in 10-year Par Yield)						
Mean Outperformance (bp/month)	18.5	16.8	17.2	21.4	17.8	19.4
Tracking Error Volatility (bp/month)	14.9	14.9	14.7	18.3	14.7	15.7
Information Ratio (annualized)	4.31	3.91	4.06	4.04	4.19	4.29
Indicator: Average Yield (Average of Changes in 2-, 5-, 10-, and 30-year Par Yield)						
Mean Outperformance (bp/month)	18.5	15.6	16.6	21.6	17.1	19.5
Tracking Error Volatility (bp/month)	14.9	16.2	15.3	18.1	15.5	15.7
Information Ratio (annualized)	4.32	3.33	3.74	4.12	3.81	4.3
Indicator: Index vs. Cash (Excess return of Treasury Index over cash earning GC rate)						
Mean Outperformance (bp/month)	18.8	16.9	17.3	21.8	17.9	19.8
Tracking Error Volatility (bp/month)	14.5	14.9	14.5	17.8	14.6	15.3
Information Ratio (annualized)	4.50	3.92	4.14	4.24	4.27	4.48
Indicator: Index Slope (Difference in Returns of Long-duration and Short-duration halves of Treasury Index)						
Mean Outperformance (bp/month)	17.5	18.3	17.4	19.7	18.5	18.6
Tracking Error Volatility (bp/month)	16.1	13	14.6	20.1	13.9	16.7
Information Ratio (annualized)	3.78	4.87	4.14	3.40	4.62	3.87

[3] The Futures Replication strategy achieves slightly higher mean outperformance than the Scaled Index strategy regardless of which indicator is used. This can be attributed to changes in the futures basis over the period studied. It does not directly pertain to the phenomenon we are studying and cannot necessarily be expected to persist in the future. For this reason, when comparing the mean outperformance of different strategies, we will compare the Cash Neutral strategy to the Scaled Index strategy, and not to the Futures Replication results.

One surprise in the results concerns the use of the 10-year futures contract alone to implement the duration view. One might have expected that this would be the most effective strategy, especially when the indicator signal was the change in 10-year yields. In fact, regardless of which indicator signal was used, the 10-Year Futures strategy achieved the highest mean outperformance, but also the highest tracking error volatility. As a result, its information ratio is lower than that of the more balanced Futures Replication strategy in every case. The replication strategy, by diversifying the basis risk across four different contracts, reduces the tracking error volatility. The 10-Year strategy exhibits particularly high volatility because high demand by convexity hedgers and the hedging of new corporate issues in the 10-Year part of the curve cause many issues in that part of the curve to achieve above-average returns.

The two additional index-based indicators are not the best representations of a pure duration view. Rather, each is designed to take the "perfect foresight" approach to the limit, and give the best possible results for one particular strategy. The Index vs. Cash indicator should always signal the winning direction for the Scaled Index strategy. Indeed, the performance of that strategy using perfect foresight on this indicator gives the highest outperformance, the lowest volatility, and the highest information ratio across the four signals. Similarly, the Index Slope indicator should always signal whether it is better to go long or short duration using the Cash Neutral strategy—and it achieves its best performance using this signal. The information ratio of 4.87 achieved in this case shows that the Cash Neutral strategy is certainly capable of generating good risk-adjusted performance. The caveat is that skill at using this strategy involves more than a directional view on interest rates. The perfect foresight simulated in this case is more complex, and involves a simultaneous prediction of the changes in level and shape of the curve.

The information ratios obtained here are all unrealistically high due to the use of the perfect foresight assumption for generating the duration timing signal. (Generally speaking, an information ratio of 1.0 or better is considered to indicate excellent risk-adjusted performance.) However, we believe that the effect shown here can be applied proportionally to an actual portfolio management context. Figure 4 summarizes the proportional reduction in performance achieved by the Cash Neutral and Mixed strategies relative to the Scaled Index strategy, both in terms of mean outperformance and information ratio. We show the results using both the Average Yield signal, which corresponds to a view on parallel shift, and the 10-Year Yield signal, which matches more closely the true yield exposure of this strategy. To the extent that a skilled manager can generate outperformance by pure duration timing calls, the no-leverage constraint may be expected to reduce the risk-adjusted outperformance by anywhere from 6% to 23%.

To ensure that these results are robust, we calculated the information ratios over rolling 3-year time windows in addition to the single calculation over the entire time period. Figure 5 compares the information ratios of the Cash Neutral strategy with those of the Futures Replication strategy, using the Average Yield indicator signal. We see that the Futures Replication strategy achieves a higher information ratio over every 3-year window in our data sample.

Conclusion

The no-leverage constraint can impair a portfolio manager's ability to implement a pure directional view on interest rates in a risk-efficient manner. When a pure view on rates is implemented using the Cash Neutral strategy, it entails an exposure to the slope of the curve as well, and thus additional risk. Moreover, historical correlations between changes in curve level and slope show that this slope exposure is usually in the wrong direction. A manager who expects rates to rally is forced into a flattening trade, even though the curve tends to steepen as rates drop. In our observations, this reduced the achieved information ratio by 6% to 23%.

One clear conclusion of this study is that plan sponsors should consider this cost of the no-leverage constraint before imposing it on their portfolios. If possible, managers should be allowed to employ futures, swaps, or financed bond purchases on at least a limited basis to enable the risk-efficient implementation of yield curve views.[4] Additional risk constraints, for example on the maximum duration deviation from the Index, could be put into place to prevent the misuse of these instruments. Utilization of derivatives for curve trades might also entail advantages with respect to the ease and cost of trade execution.

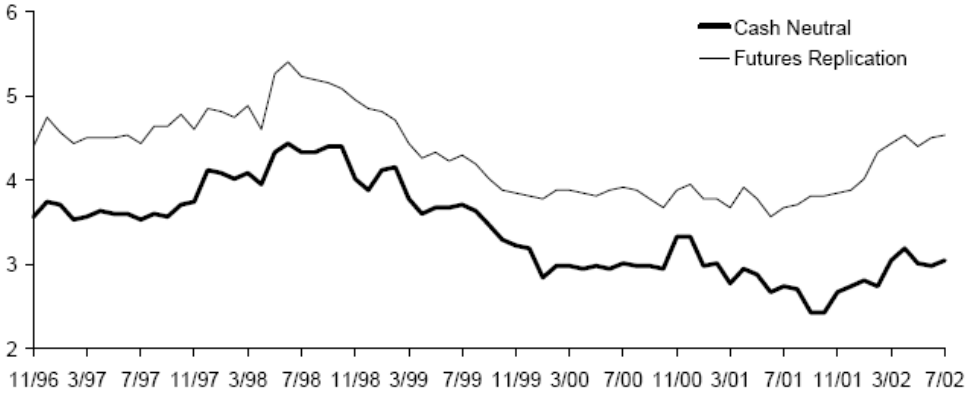
Figure 4: Summary of Underperformance of Cash Neutral and Mixed Strategies Relative to Scaled Index Strategy

Signal	Strategy	Mean	IR
Average Yield	Cash Neutral	-16%	-23%
	Mixed	-11%	-13%
10-Year Yield	Cash Neutral	-9%	-9%
	Mixed	-7%	-6%

For managers who must continue to operate under the no-leverage constraint, this study suggests several mechanisms for mitigating the adverse effects of this constraint. First, we observe that the Mixed strategy holds a clear performance advantage over the Cash Neutral strategy. Even though the no-leverage constraint may force all bullish trades to be flatteners, there is no reason to also require all bearish trades to be steepeners. Rather than overweighting the short half of the index to reflect a bearish view, one can reduce exposure across the curve. Second, we note that the problem is not so much with the inclusion of a slope exposure *per se*, but the inclusion of an *unintended* slope exposure. If the duration positioning decision can be made to include skilled consideration of the slope exposure implications as well, the problem can be avoided. Third, in the case of a pure view on directionality of rates, a manager using the Cash Neutral strategy should focus specifically on predicting changes in the 10-year rate rather than on predicting the direction of parallel shift across the curve.

[4] Similar effects can be accomplished with structured notes that are designed to reward specific types of yield curve movements. The use of structured notes allows managers to express any view on the curve they desire. The cost of the constraint in this case may be simply the increased cost of customized structured notes rather than standard derivatives like futures.

Figure 5: Annualized Information Ratios for Cash Neutral and Futures Replication Strategies over Rolling 3-Year Windows, Using Average Yield Indicator



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