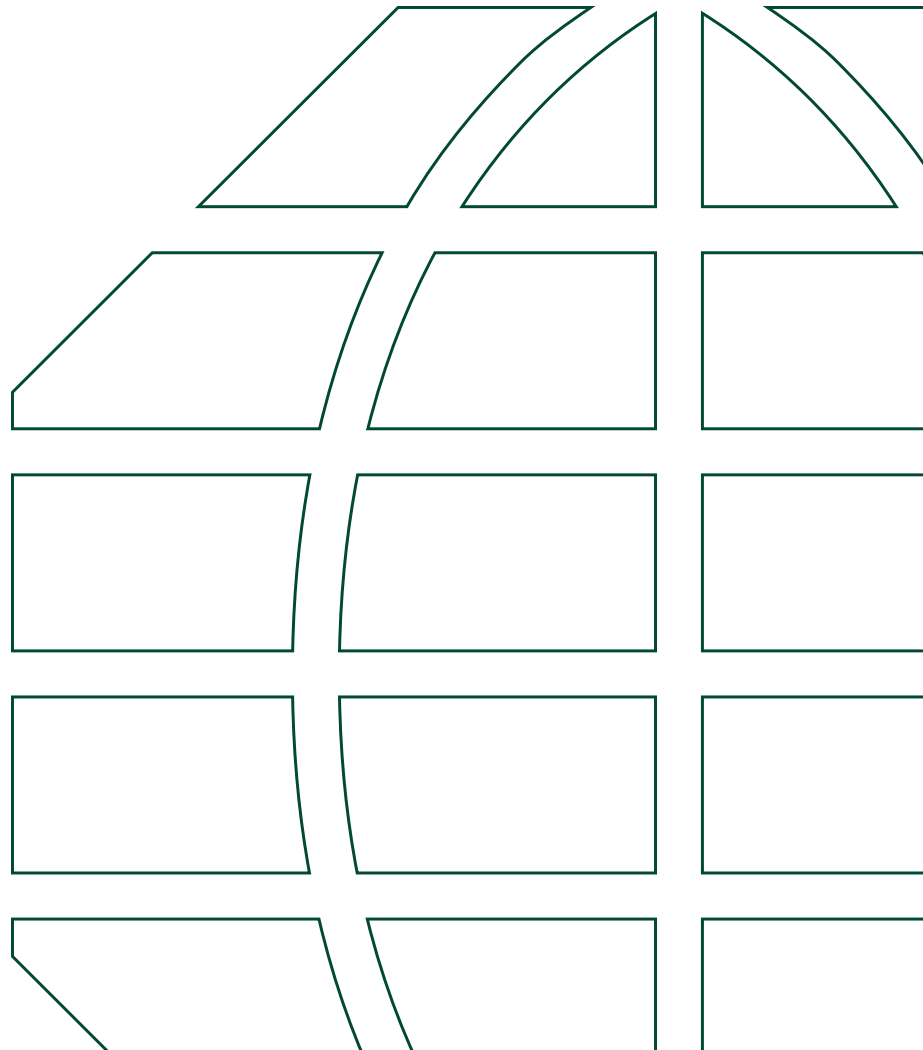


RESEARCH AND PRODUCT DEVELOPMENT

A Simple Treasury Futures Duration Adjustment

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When volatile interest rates challenge even the most skilled fixed-income portfolio managers, CME Group U.S. Treasury futures provide easy, efficient, and flexible means to adjust portfolio interest rate sensitivity.

Fluctuating interest rates can cause nightmarish losses, high transaction costs, and lost opportunities for the fixed income portfolio manager who wants to maintain an appropriate portfolio duration target. When volatile interest rates challenge even the most skilled fixed-income portfolio managers, CME Group U.S. Treasury futures provide easy, efficient, and flexible means to adjust portfolio interest rate sensitivity.

This paper discusses how to manage portfolio duration with Treasury futures while anticipating changes in yields. This is illustrated by two scenarios: Scenario A examines yield-curve flattening during a period of falling interest rates, and Scenario B examines yield-curve steepening during a period of rising interest rates.

Alternative Approaches

In theory, the simplest way to adjust portfolio duration is to shift the portfolio's allocation between long-dated and short-dated assets by buying and selling securities in the cash market. In practice, however, this may involve hard trade-offs between generic duration management and specific portfolio allocation decisions.

A portfolio manager frequently expends much effort in determining whether a particular bond is likely to outperform comparable assets, before deciding whether to add it to the portfolio. By changing positions in such bonds simply to adjust generic portfolio duration, the portfolio manager risks sacrificing the hard-won upside potential that is unique to

these holdings. Moreover, given the wide bid/offer spreads that frequently apply to individual bond issues, the portfolio manager is apt to find that this is a relatively expensive way to tweak portfolio duration target.

By contrast, Treasury futures are ideal for this purpose. The CME Group Treasury suite comprises all key maturity points: 2-year, 5-year, and 10-year Treasury notes and long-term Treasury bonds. Among their many advantages are low transaction costs and tremendous flexibility. In particular, the portfolio manager can establish and unwind a futures position quickly, should the need arise. The same is seldom true for positions in cash securities.

The simplest way to shorten or lengthen duration with Treasury futures is to buy or sell the required number of contracts in one contract – for example, by buying or selling 10-Year T-Note futures. However, a more effective approach may be to apportion the futures position across several maturity sectors. This enables the portfolio manager to maintain the duration target even if the yield curve changes shape. Scenarios A and B on the following pages examine both alternatives.

The Impact of Yield Curve Shifts on Portfolio Valuation

Suppose you hold a \$100 million par portfolio of Treasury securities. For simplicity, assume it is composed of the four Treasury securities shown in Exhibit 1.

Exhibit 1:
Initial Portfolio Composition and Market Conditions
December 12, 2008

Treasury Security	Yield	Modified Duration (years)	Full Price with Accrued Interest (per \$1 million face value)	DV01 (per \$1 million face value)	
2-year	1 1/4% of Nov 2010	0.791%	1.933	\$1,009,421.36	\$195.10
5-year	2% of Nov 2013	1.585%	4.707	\$1,020,511.68	\$480.40
10-year	3 3/4% of Nov 2018	2.628%	8.325	\$1,100,451.48	\$916.10
30-year	4 1/2% of May 2038	3.066%	17.789	\$1,280,291.78	\$2,277.50

In face value terms, the portfolio contains \$26 million 2-year notes, \$47 million 5-year notes, \$19 million 10-year notes, and \$8 million 30-year bonds. Its weighted average duration is approximately six years. Exhibit 2 lays out the details of the portfolio's interest rate sensitivity.

Exhibit 2:
Portfolio Weighted Average Duration = Six Years

Treasury Security	Modified Duration	Position (units of \$1 million face value)	Market Value (Full Price X Position)	Aggregate DV01	Weight (Duration X Market Value)
2-Year 11/4% of Nov 2010	1.933	26	\$26.24M	\$5,072.60	\$50.73M
5-Year 2% of Nov 2013	4.707	47	\$47.96M	\$22,578.80	\$225.77M
10-Year 3 3/4% of Nov 2018	8.325	19	\$20.91M	\$17,405.90	\$174.06M
30-Year 4 1/2% of May 2038	17.789	8	\$10.24M	\$18,220.00	\$182.20M
Portfolio	6.006	100	\$105.36M	\$63,277.30	\$632.76M

For each portfolio component, the values in the 'Weight' column equal duration times the full price. The weighted average duration at the bottom of the 'Modified Duration' column is the sum of the weights divided by the sum of market values ($\$632,760,000 / \$105,360,000 = 6.006$).

Testing Futures Strategies

Scenario A: Falling Interest Rates and Flattening Yield Curve

Suppose you anticipate a decline in the general level of yields along with a flattening of the yield curve. Exhibit 3 illustrates the impact of a drop in yields combined with flattening of the yield curve on the unhedged portfolio.

Exhibit 3:
Portfolio Impact of Falling Yields and Flattening Yield Curve

Treasury Security	Aggregate DV01	Yield Change (basis points)	Result
2-Year 11/4% of Nov 2010	\$5,072.60	-5 bps	\$25,363.00
5-Year 2% of Nov 2013	\$22,578.80	-10 bps	\$225,788.00
10-Year 3 3/4% of Nov 2018	\$17,405.90	-20 bps	\$348,118.00
30-Year 4 1/2% of May 2038	\$18,220.00	-30 bps	\$546,600.00
Portfolio	\$63,277.30		\$1,145,869.00

To enable the portfolio to benefit from this course of events, you might wish to extend your portfolio duration target from six years to, say, eight years. Suppose you elect to do so by augmenting the portfolio with a futures overlay consisting of a long position in either 10-Year T-Note futures or T-Bond futures.

To construct the overlay for 10-Year T-Note futures, first calculate the number of contracts that would be required to replicate the DV01 for the entire portfolio. That is, divide the portfolio DV01 – \$63,277.30 per basis point – by the 10-Year T-Note futures DV01 – \$80.81 per basis point.¹

$$\$63,277.30 / \$80.81 = 783 \text{ 10-Year T-Note futures}$$

Given that your objective is to increase the portfolio DV01 by one-third (i.e., to boost portfolio duration from six years to eight years), you would then simply scale the futures overlay so that it equals one-third of 783 contracts:

$$0.333 \times 783 \text{ 10-Year T-Note futures} \approx 260 \text{ 10-Year T-Note futures}$$

In the same way, to obtain appropriate scale for a Treasury Bond futures overlay, first find the number of Treasury Bond futures that would replicate the portfolio DV01. With the T-Bond futures DV01 at \$153.44 per basis point¹, the result is:

$$\$63,277.30 / \$153.44 = 412 \text{ T-Bond futures}$$

Accordingly, to increase portfolio DV01 by one third, the T-Bond futures overlay should be:

$$0.333 \times 412 \text{ T-Bond futures} \approx 137 \text{ T-Bond futures}$$

Single-Maturity Futures Overlays

If Treasury yields were to decline uniformly by, say, 20 bps along the entire yield curve, then the choice of futures contract for the overlay structure would be moot. The 10-Year T-Note version and the Treasury Bond version would perform almost identically, with each producing an incremental portfolio gain around \$420,000. Note that this would boost the total portfolio return to nearly \$1,566,000, or 37 percent more than the \$1,145,869 portfolio return without the futures overlay.

Parallel Shifts vs. Slope Changes

If the yield curve changes shape, however, then your choice of futures overlay makes a potentially big difference. Exhibit 4 summarizes the performance of each futures overlay – 10-Year T-Note futures versus Treasury Bond futures – for Scenario A in which a flattening of the curve accompanies the drop in yields.

Exhibit 4:
Duration Extension with Either 10-Year T-Note Futures or 30-Year T-Bond Futures

Futures Maturity	Futures DV01	Yield Change (basis points)	Futures Position	Result
10-Year T-Note	\$80.81	-20 bps	Long 260 contracts	+\$420,229.69
30-Year T-Bond	\$153.44	-30 bps	Long 137 contracts	+\$630,656.00

As before, given a 20 bp decrease in yields at the 10-year point on the curve, the overlay that holds a long position of 260 10-Year T-Note futures would boost portfolio returns by 37 percent. With a 30 bp drop in yields at the 30-year point on the curve, however, the overlay employing a long position of 137 T-Bond futures would generate incremental revenue of \$630,656, raising total portfolio returns by 55 percent.

The important lesson in this is that by constructing the futures overlay with one futures contract, referencing only one segment of the Treasury curve, you may introduce an unwelcome source of incremental risk into your portfolio management program. Insofar as the single-maturity overlay fails to respond to appropriately to shifts in yield curve slope or shape, it is unlikely to be the right tool for achieving duration extension.

A Multiple-Maturity Futures Overlay

Using a combination of Treasury futures to extend duration at each of the portfolio's key maturity points should enable you to extend duration while maintaining a tighter control over portfolio risk exposure.

Assuming that your aim is still to boost portfolio duration by 33.3 percent, you would construct the futures overlay as follows. First, for each key maturity bracket within the portfolio, calculate the number of futures contracts at the corresponding term to maturity that would be required to replicate that maturity bracket's DV01. Then, in each case, use one-third of that number of contracts, as illustrated in Exhibit 5. Exhibit 6 indicates how this multi-contract overlay would perform against Scenario A's combined drop in yields and flattening of the yield curve.

Exhibit 5:
Duration Extension with the Full Treasury Futures Curve: Construction

Treasury Security	Aggregate DV01	Futures DV01	Futures Equivalent (Contracts)	Futures Overlay (0.333 x Futures Equivalent)	
2-Year	1 1/4% of Nov 2010	\$5,072.60	\$3771 (\$18,857 x 2) ²	135	45
5-Year	2% of Nov 2013	\$22,578.80	\$50.00	452	150
10-Year	3 3/4% of Nov 2018	\$17,405.90	\$80.81	215	72
30-Year	4 1/2% of May 2038	\$18,220.00	\$153.44	119	39

Exhibit 6:
Duration Extension with the Full Treasury Futures Curve: Results

Futures Maturity	Futures DV01	Yield Change (basis points)	Futures Overlay	Result
2-Year T-Note	\$3771	-5 bps	Long 45	+\$8,485.66
5-Year T-Note	\$50.00	-10 bps	Long 150	+\$75,000.00
10-Year T-Note	\$80.81	-20 bps	Long 72	+\$116,371.30
30-Year T-Bond	\$153.44	-30 bps	Long 39	+\$179,529.81
Portfolio				+\$379,386.77

Using a combination of Treasury futures to extend duration at each of the portfolio's key maturity points should enable you to extend duration while maintaining a tighter control over portfolio risk exposure.

For the fiduciary portfolio manager concerned with management of market risk exposures, the notable feature of the results in Exhibit 6 is their precision. The futures overlay generates an incremental portfolio gain of \$379,386.77, signifying 33.1 percent increase beyond the \$1,145,869 portfolio return without the futures overlay. Given that the objective in extending duration is to boost portfolio returns by one third, the outcome is reassuringly close to target.

Scenario B: Rising Interest Rates and Yield-Curve Steepening

Rising interest rates vex even the most skilled fixed-income managers. Fortunately, the Treasury futures toolkit is as equally effective for adjusting a bond portfolio to cope with bear market conditions as it is for modifying the portfolio to accommodate a bull market.

To see this, suppose once again that your portfolio is as shown in Exhibits 1 and 2. Suppose, moreover, that you anticipate a general rise in yields combined with a steepening of the curve. Exhibit 7 illustrates the impact of an increase in yields and a steepening of the yield curve on the unhedged portfolio.

Exhibit 7:
Portfolio Impact of Rising Yields and Steepening Yield Curve

Treasury Security	DV01 (Position)	Yield Change (basis points)	Result	
2-Year	1 1/4% of Nov 2010	\$5,072.60	20 bps	(-\$101,452.00)
5-Year	2% of Nov 2013	\$22,578.80	35 bps	(-\$790,258.00)
10-Year	3 3/4% of Nov 2018	\$17,405.90	50 bps	(-\$870,295.00)
30-Year	4 1/2% of May 2038	\$18,220.00	75 bps	(-\$1,366,500.00)
Portfolio		\$63,277.30		(-\$3,128,505.00)

Rising interest rates vex even the most skilled fixed-income managers. Fortunately, the Treasury futures toolkit is as equally effective for adjusting a bond portfolio to cope with bear market conditions as it is for modifying the portfolio to accommodate a bull market.

Single-Maturity Futures Overlays

Faced with this prospect, you decide to shrink portfolio duration by one-third, i.e., to four years from its current six years. Exhibit 8 presents calculations similar to those in Exhibit 4 to illustrate the performance of duration adjustment overlays that use single futures contracts – either 10-Year T-Note futures or 30-Year T-Bond futures.

Exhibit 8:
Duration Shrinkage with Either 10-Year T-Note or 30-Year T-Bond Futures

Futures Maturity	Futures DV01	Yield Change (bps)	Futures Position	Result
10-Year T-Note	\$80.81	+50 bps	Short 261 contracts	+\$1,054,614.90
30-Year T-Bond	\$153.44	+75 bps	Short 138 contracts	+\$1,588,148.32

Given a 50 bps yield increase at the 10-year point of the curve, a futures overlay consisting of a short position of 261 10-Year T-Note futures would produce incremental revenue of \$1,054,615. This would suffice to scale back the portfolio's overall loss to \$2,073,890, 34 percent smaller than the \$3,128,505 loss on the cash Treasury portfolio without the futures overlay. In the same way, for a 75 bp increase in yield at the 30-year point of the curve, a futures overlay consisting of 138 short T-Bond futures would produce incremental gains of \$1,588,148, enough to trim the overall portfolio loss by a half.

A Multiple-Maturity Futures Overlay

Gratifying though these results might be, they stray disturbingly far from your basic objective of achieving a 33 percent reduction in portfolio interest rate sensitivity. As in the bull market environment featured in Scenario A, the prudent investment manager is likely to achieve a finer degree of control over the portfolio's risk exposure under Scenario B's bear market move by using a combination of Treasury futures that reference several points along the yield curve.

Procedures for structuring a multi-contract duration reduction overlay are exactly as for the duration extension overlay. For each of the portfolio's key maturity brackets, calculate the number of futures contracts at the corresponding term to maturity needed to replicate the maturity bracket's DV01.

Then, in each case, find 33.3 percent of that number of contracts. Exhibit 9 sketches the computational details, and Exhibit 10 shows how the multiple-maturity futures overlay performs when it confronts Scenario B's combination of a general interest rate rise and a steepening of the yield curve.

Exhibit 9:
Duration Shrinkage with the Full Treasury Futures Curve: Construction

Treasury Security		Aggregate DV01	Futures DV01	Futures Equivalent (Contracts)	Futures Overlay (0.333 x Futures Equivalent)
2-Year	1 1/4% of Nov 2010	\$5,072.60	\$37.71 (\$18.857 X 2) ²	-135	-45
5-Year	2% of Nov 2013	\$22,578.80	\$50.00	-452	-151
10-Year	3 3/4% of Nov 2018	\$17,405.90	\$80.81	-215	-72
30-Year	4 1/2% of May 2038	\$18,220.00	\$153.44	-119	-40

Exhibit 10:
Duration Shrinkage with the Full Treasury Futures Curve: Results

Futures Maturity	Futures DV01	Yield Change (bps)	Futures Overlay	Result
2-Year T-Note	\$37.71	+20 bps	Short 45	\$33,942.64
5-Year T-Note	\$50.00	+35 bps	Short 151	\$264,250.00
10-Year T-Note	\$80.81	+50 bps	Short 72	\$290,928.25
30-Year T-Bond	\$153.44	+75 bps	Short 40	\$460,332.85
Portfolio				\$1,049,453.73

The multi-contract futures overlay produces an incremental gain of nearly \$1,049,454, enough to trim the overall loss on the portfolio by 33.5 percent. Given that your basic objective in deploying the futures overlay is to reduce portfolio exposure to rising interest rates by one-third, this outcome is pleasingly close to target.

Conclusion

Regardless of the general direction of market interest rates, if you anticipate any material change in the slope of the yield curve, then the most effective approach to duration targeting with futures overlays will be to construct the futures position with a mix of U.S. Treasury futures contracts that reference all key maturities to which your portfolio is exposed.

By contrast, if you expect any changes in market interest rates to take the form of a parallel or near-parallel shift in the yield curve, then you are likely to find that constructing the futures overlay with a single contract, referencing a single maturity sector, is simpler and more direct, and therefore potentially more desirable. Regardless of the approach you choose, CME Group U.S. Treasury futures permit quick and cost-effective adjustment to your portfolio duration target.

With the futures overlay in place, you can afford to move gradually, waiting for propitious conditions in the cash market to adjust your portfolio's securities holdings. As you do so, you can easily disassemble your futures overlay at a comparably gradual pace, until your portfolio make-over is complete. If instead you anticipate that the move in interest rates that motivated you to add the futures overlay in the first place will be temporary, prone to near-term reversal, then the ease and flexibility of market entry and exit that are characteristic of Treasury futures will prove all the more important. In either case, your futures overlay position can be unwound as easily as it was initiated.

With the futures overlay in place, you can afford to move gradually, waiting for propitious conditions in the cash market to adjust your portfolio's securities holdings

For more information, visit www.cmegroup.com/interestrates.

- 1 Technically speaking, a Treasury futures contract does not inherently have a DV01 since it is not a coupon-bearing instrument. Instead, the contract derives its interest rate sensitivity from the cash-market instrument that it tracks most closely – usually the cheapest-to-deliver (CTD) Treasury security within the contract's deliverable grade. To move from the cash DV01 to a rough estimate of the future's DV01, simply find the DV01 of the CTD Treasury security and then divide it by the Treasury futures conversion factor that corresponds to it. For more on calculating a Treasury futures DV01, please visit the [CME Group Interest Rate Resource Center at www.cmegroup.com/ircenter](http://www.cmegroup.com/ircenter) and read "Calculating the Dollar Value of a Basis Point."
- 2 The CME Group 2-Year Treasury Note futures contract has a notional value of \$200,000, twice the amount of the other Treasury futures contracts. Therefore, its DV01 is doubled.



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