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US Rates

UST RV Primer: A hitchhikers guide to RV on the UST curve

A hitchhikers guide to RV on the Treasury curve

The purpose of this primer is to provide an overview of some of the ways one can measure relative value (RV) relationships on the Treasury curve. The Treasury curve is considered risk-free, and as such it is at the base of valuations across all asset classes. Understanding RV on the Treasury curve is important in order to understand RV across the spectrum of risk. RV can be particularly helpful in identifying trading opportunities under lower vol or range-bound markets, but also helps identify contexts where the market starts to trade ahead of fundamentals even in higher momentum regimes.

In RV strategies the aim is not to take a directional view but rather to take advantage of pricing anomalies in markets (sometimes also to look for the most efficient way to express a macro view). In the interest rate market, most investors focus on exploring dislocations on the yield curve.

There are different metrics for RV valuations: model-free metrics, model dependent metrics, carry + rolldown analysis, etc. We discuss some of these in this primer, and structure it in the following way:

- The first section discusses model independent metrics. These generally involve looking at current bond yields or spreads to other curves (generally the OIS discount curve or the libor curve) vs the recent history for these yields or spreads.
- In the second section we focus on model-dependent metrics. Here we gauge value in Treasuries either vs the broader dynamic of bond yields (e.g. through spline methods, PCA, DFM) or the dynamic of macroeconomic fundamentals (e.g. our macro model).
- Section three discusses cover rolldown + carry (R+C), which is an important measure to understand the staying power on a position. In positive R+C positions the investor has time to let his view unfold, while in negative R+C positions the investor needs to have a higher degree of conviction that his view will materialize sooner rather than later.
- In the fourth section we discuss how USTs supply can impact RV signals. Dealers generally create room on their balance sheets ahead of supply, which tends to drive some cheapening going into the event. An approach that is often used to gauge the recent UST dynamic around supply is to look at different curve and fly positions and their performance around recent auctions of a given maturity.
- Finally, in the final section we look at the Treasury market dynamic in the context of the broader economic cycle, the different modes for the yield curve dynamic at different stages of the cycle, and how one needs to consider the economic backdrop and cycle stage when looking at RV across the curve.

We like to think of this primer as a work in progress, with a greater level of detail likely to be added over time.

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Rates Strategy
United States

Anna (Caiyi) Zhang
Rates Strategist
BofAS
caiyi.zhang@bofa.com

Bruno Braizinha, CFA
Rates Strategist
BofAS
bruno.braizinha@bofa.com

Ralph Axel
Rates Strategist
BofAS
ralph.axel@bofa.com

US Rates Research
BofAS
+1 646 855 8846

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The following table of contents may help the reader navigate its way through the primer:

1. Model independent RV metrics

Most model independent metrics of RV involve looking at current bond yields or spreads of Treasury yields to other curves (generally the OIS discount curve or the libor curve) vs the recent history for these yields or spreads. A concept that is often used in this context is that of the Z-Score.

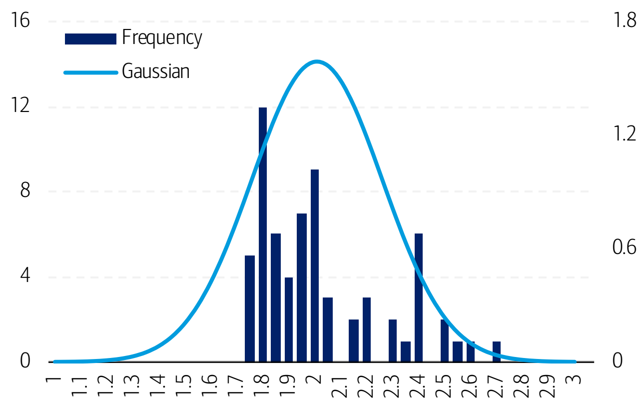
1.1 - Z-score on yield series

The Z-Score of a yield series measures how many standard deviations above or below the mean is the current yield of a bond. One generally uses a 3m history to calculate the mean and the standard deviation of a given bond yield series, and the Z-Score is simply the current yield level minus the mean of the bond yield over that history, divided by the standard deviation over the same history.

Z-Scores are a way to compare rich/cheapness of a bond against a normal curve: a Z-Score of +2 suggests a bond that is quite cheap, with only c.2.5% of recent observations found to be cheaper than the current level (2 standard deviations of a normal distribution corresponds to 95% of the mass of the distribution). Of course, this metric is calculated on the yield levels, and it is unlikely that the distribution of yield levels over the last 3m is normal, but this metric still provides some measure of value (richness or cheapness) versus the recent history.

By plotting Z-Scores of bonds across the yield curve one gets some indication of relative richness or cheapness of one bond vs. another, and also a broader view for what sectors look rich or cheap on the curve. The shortcoming is that yield levels are hardly Gaussian distributed (see Exhibit 1), so Z-Scores on yield levels are a rather statistically unprecise metric of fair value (Z-Scores on 5d changes for example are perhaps better - Exhibit 2).

Exhibit 1: 3m yield distribution of 10yT vs normal distribution
Frequency (y-axis) vs yield levels (x-axis): 2.6-2.7% levels are clearly >1sigma in the recent context, but distribution hardly normal



Source: BofA Global Research, Bloomberg; Levels used for illustration only
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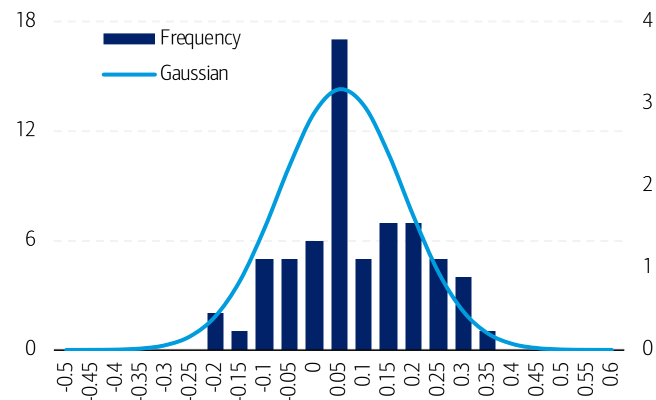
Exhibit 2: 3m distribution of 5d yield changes vs normal distribution
Frequency (y-axis) vs 5d yield moves (x-axis): 30-35bp 5 day changes for 10yT yields are clearly >1 sigma in the recent context



Source: BofA Global Research, Bloomberg; Levels used for illustration only
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1.2 - Curve spreads

Z-Scores for bonds across the curve offer some view on relative rich/cheapness not only for specific bonds but also across sectors. However, they offer little in the way of explanation for why some of those bonds or sectors look rich or cheap.

Looking at Z-Scores on the spreads of Treasury yields to other curves (OIS or Libor curve) adds some information on the potential drivers or the recent richening/cheapening and the broader dynamic of the Treasuries curve.

Swap spreads (MMSS - matched maturity)

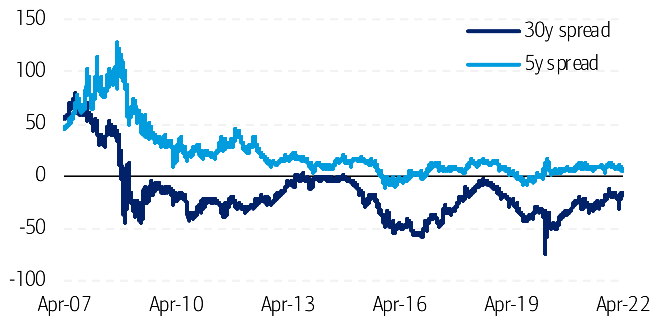
A match maturity swap spread (MMSS) is the spread between the Treasury bond yield (typically a benchmark bond) and a swap of equivalent maturity (Libor swaps historically, and more recently SOFR swaps).

The widening/tightening (richening/cheapening of USTs on the swap) of the MMSS is a measure of the relative demand for the Treasury leg vs. the swap leg (prior to clearing the MMSS also contained a counterparty credit risk component, but that has dissipated since). Classically, much of the dynamic of USTs vs Libor swaps was driven by corporate supply (tightening on corporate issuance as some corporates, financials in particular, swap fix for floating liabilities – receive fix to offset coupon payments on corporate issuance, and pay floating) and hedging by negatively convexity accounts (like mortgage servicers or VA portfolios – these accounts pay fixed on selloffs and receive fixed on rallies, implying a bear widening and bull tightening dynamic for MMSSs).

Significantly, Treasury spreads to LIBOR swaps and OIS swaps (fed funds overnight indexed swap rates) underwent a regime shift in late 2008, resulting in negative 30y spreads that persist today (see Exhibit 3 and Can swap spreads normalize?). There have been a series of factors behind this move, including: the removal of credit risk from the LIBOR swaps curve due to central clearing of swaps; increased volumes and stock of Treasury supply, and increased average maturity; increased credit risk within the Treasury market; reduced Treasury holdings in global reserve portfolios; increased volumes of fixed-rate corporate supply that is swapped to floating; the tight level of investment-grade corporate debt spreads; the tight level of cross currency basis swaps, in particular the JPY/USD basis; hedging of Power Reverse Dual Currency books; the decrease in available balance sheet to finance Treasuries due to Dodd-Frank; regulatory frictions preventing arbitrage of negative swap spreads (capital costs, balance sheet and trading restrictions); the decline in GSE mortgage portfolios which reduced the demand to pay fixed; and pension and insurance demand to receive swaps versus no natural payer of long-end swaps.

Also significant as a driver for the collapse in swap spreads, and the one factor that explains the broader pressure along the curve and the correlation of these moves across regions, was the sudden shift in the supply/demand balance within the unsecured interbank funding market, resulting from central bank creation of large quantities of excess reserves. This explains front-end as well as long-end spread dynamics and may explain spread movements observed in the UK, Canada, and Germany around that time.

Exhibit 3: 30y & 5y swap spreads
30y spread inverted after the 2008 GFC, 5y spread also moved to inverted



Source: BofA Global Research, Bloomberg

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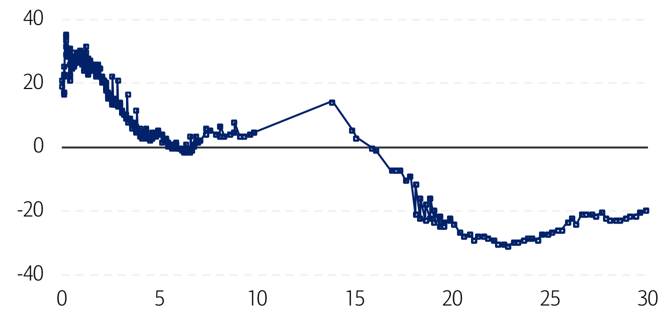
Exhibit 4: Matched maturity swaps
Profile for MMS levels across the UST curve



Source: BofA Global Research; Levels used for illustration only

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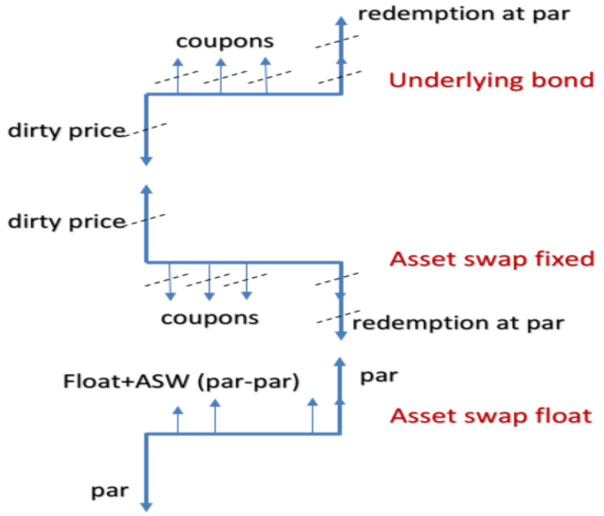
Asset swap spread (ASW – par/par vs proceeds)

An asset swap is a combination of a cash bond and an interest rate swap (generally defined with a stub to adjust to the bond cash flows). The asset swap buyer is long the cash bond, and exchanges the fixed coupons that it receives on the bond with floating rate coupons + a spread (the asset swap spread - ASW). The asset swap spread can be positive or negative and is calculated to PV the asset swap to zero at inception. The asset swap allows investors to hedge out interest rate risk by swapping fixed payments for floating. The spread measures the difference between the market price of the bond and the present value of the bond's cash-flows, discounted using the swap zero rates.

There are two conventions for asset swaps, par/par and proceeds. The main difference between the two conventions is that: (1) in a par/par asset swap the asset swap buyer receives the floating rate + ASW cash flows on a par notional (see Exhibit 5); whereas (2) on a proceeds asset swap the asset swap buyer receives floating rate + ASW cash flows on the dirty price of the bond (see Exhibit 6). In terms of RV signal, the information contained in either of these formats is very similar.

Exhibit 5: par/par asset swap cash flows
Floating + ASW paid on the par notional



Source: BofA Global Research

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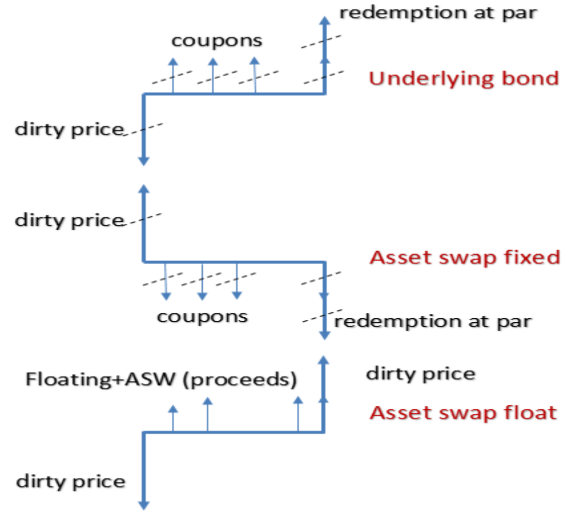
Exhibit 6: proceeds asset swap cash flows
Floating + ASW paid on the dirty price



Source: BofA Global Research

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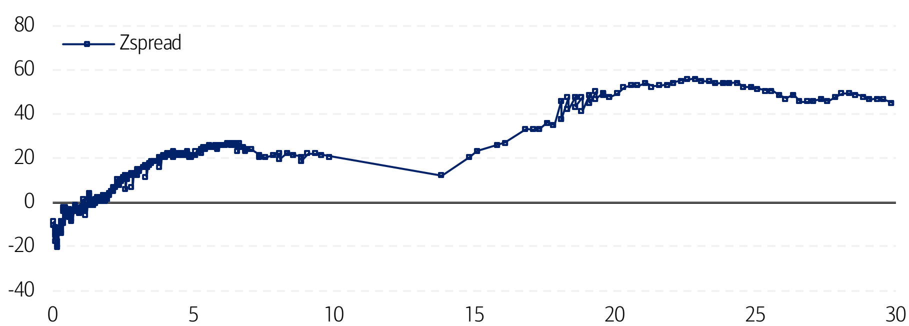
Zero-volatility spread (Z-Spread)

Z-spread is the constant spread over Treasury zero coupon rates that, when used to discount the bond cash flows, equals the sum of those to the price of the bond:

$$P = \frac{C_1}{\left(1+\frac{r_1+Z}{2}\right)^2} + \frac{C_2}{\left(1+\frac{r_2+Z}{2}\right)^4} + \cdots + \frac{C_n}{\left(1+\frac{r_n+Z}{2}\right)^{2n}}$$

Where *P* is the current dirty price of the bond (including accrued interest), C_i is the coupon payment at time t_i, r_i is the Treasury zero coupon at each maturity, and *n* is the number of cash flows. Compared to the ASW or the MMSS above, the Z-spread is a more granular measure of RV across the grid. The ASW and MMSS tend to indicate broad sectors of richness and cheapness on the yield curve, while the Z-Spread is more CUSIP specific.

Exhibit 7: Z-spread
Z-Spread levels across the UST curve



Source: BofA Global Research; Levels used for illustration only

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Options-adjusted spread (OAS)

The options-adjusted spread (OAS) is the spread between a bond with embedded option and the Treasury yield. It is often used for valuation of mortgage-backed securities (MBS) and callable bonds. The main use of OAS is for comparing bonds with different redemption structures. It allows investors to see how the embedded option impacts the value of a bond and to determine whether the investment is worthwhile when taking into account the additional risk from the embedded option. In the example of a callable bond, it will have a higher yield and lower price than a traditional bond as investors will expect to be compensated for the issuer's call option.

The calculations for OAS and Z-spread are similar, but OAS further adjusts the Z-spread to include the embedded option value. The relationship between the two spreads is: OAS = Z-spread – value of embedded options. However, while the Z-spread only considers one rate path, which is the current spot curve, OAS often involves simulating various paths of interest rates to account for the possible evolution of the yield curve over time. This means OAS is sensitive to interest rate volatility. The higher the volatility, the lower the value of the callable bond, since a higher volatility implies an increased likelihood of the call option being exercised. The rate volatility itself is modeled using a binomial interest rate tree. The calculation of OAS depends on a number of factors and modeling assumptions, and a different model and/or set of assumptions can meaningfully alter the value of the OAS.

Treasury futures basis

A futures contract delivers the cheapest to deliver (CTD) bond in a basket of bonds that is deliverable into the contract. The futures basis gauges the relative value of a bond versus futures. Gross basis is defined as the difference between the cash price of a bond and the converted futures price:

$$Gross\ basis = bond\ price - futures\ price \times conversion\ factor$$

The conversion factor standardizes the different bonds in the delivery basket, and it is defined as the price at which $1 par of a security would trade if it had a six percent yield-to-maturity.

Gross basis can be isolated into two components: carry + delivery option value. The first component is the carry between the T+1 settlement date and the contract delivery date. The second component, which is known as the net basis (also called the "basis net of carry"), exists because the seller of futures has the option to choose which bond to deliver. Because of this delivery option, the futures price needs to be lower in order to compensate the buyer. The net basis is expressed as:

$$Net\ basis = (bond\ price - carry) - futures\ price \times conversion\ factor$$

The higher the net basis, the richer the bond is versus futures. The futures seller will always deliver the bond with the smallest net basis. Changes in interest rates and steepening/flattening of the curve impact the bond that is likely to be delivered into the contract. As rates decrease bonds with lower duration are more likely to be delivered into the contract (see Exhibit 9). In periods where the Fed anchors rates around the bottom of the range the value of the delivery options decreases as the lowest duration bond in the delivery basket is anchored at the CTD.

Traders often roll forward a contract as it approaches the delivery window. This is done by closing front month contract vs the back contract (the next delivery). When the roll size is large it can potentially impact RV of the bond. The roll impact can be estimated either by calculating the bond equivalent notional of the open interest (OI) in the front contract, or by estimating the additional DV01 that might be needed if all of the OI longs are rolled.

Exhibit 8: FV Treasury futures gross & net basis

¾ of 5/36 was the CTD bond under the FV contract for delivery in March '22

Cash Security	Price	Source	Conven Yield	Conver Factor	Gro/B...↑ (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)
Adjust Value								
1) T 0 ¾ 05/31/26	92-31	BGN	2.5397	0.8089	-5.190	16.453	0.212	-5.383
2) T 0 ⅞ 06/30/26	93-11⅝	BGN	2.5323	0.8102	2.646	-7.023	0.212	2.407
3) T 0 ⅝ 07/31/26	92-08	BGN	2.5238	0.7975	13.811	-41.386	0.212	13.659
4) T 0 ¾ 08/31/26	92-20¾	BGN	2.5206	0.7989	21.403	-64.135	0.212	21.212
5) T 0 ⅞ 09/30/26	93-01+	BGN	2.5200	0.8005	28.258	-84.488	0.212	28.022
6) T 1 ⅛ 10/31/26	94-00+	BGN	2.5164	0.8071	34.942	-102.824	0.212	34.615
7) T 1 ¼ 11/30/26	94-17⅞	BGN	2.4927	0.8091	44.949	-131.802	0.212	44.581
8) T 1 ¼ 12/31/26	94-14	BGN	2.4994	0.8062	51.758	-152.321	0.212	51.387
9) T 1 ⅞ 02/28/27	97-09⅛	BGN	2.4649	0.8266	67.724	-193.580	0.212	67.146

Source: Bloomberg, BofA Global Research

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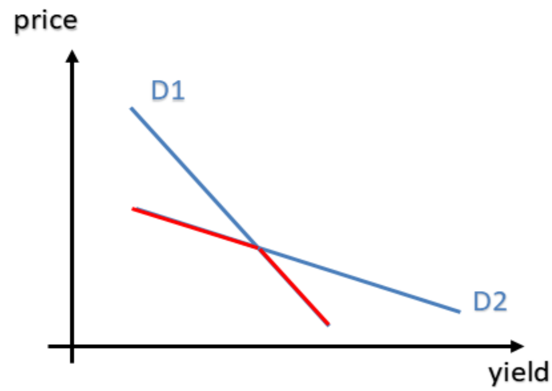
Exhibit 9: CTD switch between different duration bonds

D2 (lower DV01) to D1 (higher DV01) CTD switch in a selloff



Source: BofA Global Research

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1.3 – Micro switches

Micro switches is one way to explore some of the RV metrics discussed above. The micro switch is a long/short between bonds that are found to be cheap/rich on some of these metrics (preferably several of them). The idea is to explore mean reversion of one or both bonds to fair value, but be relatively uncorrelated to large moves on the curve. In a search for micro-switches across the curve one chooses the duration gap between the bonds to be relatively small, typically less than 6m, such that there is little duration impact in the RV.

1.4 - Specifics of the TIPS curve and seasonality

The complexity in RV and carry analysis increases as bonds take on new features like callability or have their payments linked to particular indices. A good example of that is the TIPS (Treasury Inflation Protected Securities) market.

The principal on TIPS is linked to an inflation index, which means that both the principal payment at maturity and the coupon payments on the bonds (the fixed coupons on TIPS bonds are relative to the accruing principal) are protected for inflation. TIPS bonds also contain a deflation floor that guarantees that investors will not receive less than the nominal value at maturity. This floor is obviously more valuable for bonds with principal values closer to par, usually the more recent issues. Significantly, TIPS bonds have a strong seasonal component in their dynamic driven by seasonality in the index to which there are linked, and the seasonal adjustments made to the index.

All these characteristics complicate the analysis of RV and carry across the TIPS curve, particularly the seasonal component of the TIPS dynamic. New issuance is concentrated in Jan/Feb, April and July, with different seasonal dynamics for each of these three types of bonds. To accommodate for this, instead of one spline in TIPS space, one would need to fit 3 splines, one for each type (it makes sense to trade a rich signal vs a cheap one only on the same spline which takes into account the common seasonality between bonds). This is not an optimal solution. The TIPS market is already much smaller than the UST one, and the number of issues on each spline become even smaller, which restricts the number of trading opportunities. In general one tries to adjust TIPS bonds for their seasonality component, and put all bonds on an equal footing through a metric like the Z-spread above that is less sensitive to the seasonality and allows for a comparison of RV across the curve.

2. Model dependent RV metrics

Model dependent metrics of RV generally try to understand the Treasury curve dynamic relative to either:

- The broader dynamic of bond yields, e.g. through spline methods or PCA and DFM frameworks;
- The dynamic of macroeconomic fundamentals, as in a macro model framework for the Treasury curve;
- Or the broader dynamic of assets, e.g. when one looks at the relative attractiveness of bonds vs other assets in a mean variance framework (see USTs and the 2022 allocation backdrop), or in an Equity risk premium framework (see On the negative feedback loop between bond yields and risky assets) where one measures the spread of the internal rate of return on equities vs risk free rates);

We discuss the first two and some of these different frameworks one may use for that effect in this section (the links on the third bullet provide some insights on how to look at broader relationships of Treasuries and other assets):

2.1 – Spline methods

Spline spreads are a common way to determine relative value. A spline is a smooth representations of the yield curve that is calibrated to minimize the error between the spline value at each given maturities and the observed yields at those maturities. The history of the residuals of bond yields to the spline can be used to gauge RV for each individual bond, generally through the Z-Score of those residuals.

There are two main approaches in estimating the yield curve: parametric and non-parametric methods. In a parametric approach, one makes assumptions about the shape of the yield curve, arrives at a parametric form to represent it, and estimates the set of parameters involved. A non-parametric approach, on the other hand, does not assume any prescribed distribution. The choice between the two depend mainly on how much flexibility one would like, particularly around the interpretability of the parameters and their own dynamic.

Nelson-Siegel parameterization

The Nelson-Siegel model is a prime example for a parametric model that specifies a functional form for the instantaneous forward rates n years ahead with only 4 parameters[1]:

$$f_t(n,0) = \beta_0 + \beta_1 \exp\left(-\frac{n}{\tau_1}\right) + \beta_2 \left(\frac{n}{\tau_1}\right) \exp(-\frac{n}{\tau_1})$$

Where n is time to maturity, and the parameters may be interpreted as having an instantaneous forward rate that starts at $\beta_0 + \beta_1$ and converges to the level β_0. The curve also has a hump where the magnitude and sign are determined by $\beta_2$and the location determined by τ_1.

The Nelson-Siegel model is widely used by central banks and policy makers to model the term structure of interest rates. An extension of the above is the Nelson-Siegel-Svensson model, which has more flexibility in the shape of the curve by including a second hump with 2 additional parameters:

$$f_t(n,0) = \beta_0 + \beta_1 \exp\left(-\frac{n}{\tau_1}\right) + \beta_2 \left(\frac{n}{\tau_1}\right) \exp\left(-\frac{n}{\tau_1}\right) + \beta_3 \left(\frac{n}{\tau_2}\right) \exp(-\frac{n}{\tau_2})$$

[1] Gurkaynak et al., "The U.S. Treasury Yield Curve: 1961 to the Present", www.federalreserve.gov/pubs/feds/2006/200628/200628pap.pdf

This specification captures the hump that usually occurs at longer maturities due to convexity. The parameters are typically estimated by minimizing the sum of squared errors (SSE) using an OLS regression.

LOESS spline

A LOESS spline is an example of a non-parametric spline as it does not involve the specification of a functional form for the final smooth curve (see Exhibit 10). The LOESS spline stands for "locally estimated scatterplot smoothing". The advantage of LOESS spline is that it is quite straightforward – the method involves fitting simple linear least squares to localized segments of the curve, which means it does not require any complex model specification to describe the whole curve. The downside is that it can be rather computationally intensive compared to models with a parametric form.

Par curve

Both zero coupon yields and par yields can be used to express the yield curve. While obtaining the zero coupon curve is mathematically simpler, the par curve is more practical as the market typically quotes the yields on coupon-bearing bonds. Par yield is the coupon rate of a security that trades at par (see Exhibit 10). It can be determined from the bond pricing equation where the bond price is set to $1:

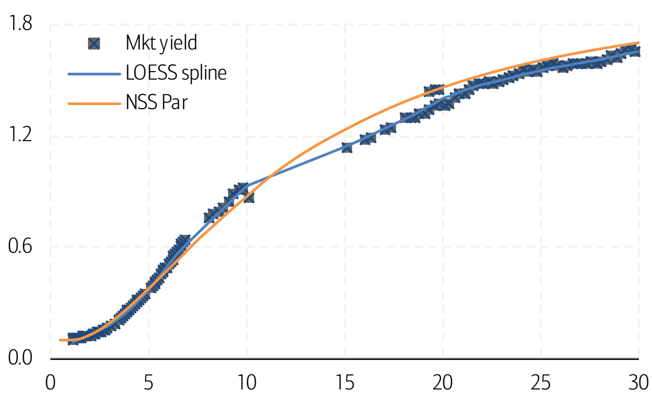
$$1 = \sum_{i=1}^{2n} \frac{y^{par}(n)}{2} d\left(\frac{i}{2}\right) + d(n)$$

Where $d(\cdot)$ is the discount function, n is the maturity of the coupon-bearing bond. Solving for y^{par},

$$y^{par}(n) = \frac{2(1 - d(n))}{\sum_{i=1}^{2n} d(\frac{i}{2})}$$

Exhibit 10: UST curve vs NSS par curve and LOESS spline

NSS is a parametric type curve, while LOESS is non-parametric



Source: BofA Global Research, Bloomberg

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Exhibit 11: PCA transformation (eigenvectors of the covariance matrix) for the US yield curve

The first three principal components explain more than 99% of the variance, and are relatively easy to interpret in terms of the curve rotation they imply

	PCA1	PCA2	PCA3	PCA4	PCA5	PCA6
2y	22%	47%	-60%	0.57	0.2	0.01
3y	31%	48%	-24%	-0.59	-0.51	-0.05
5y	43%	29%	35%	-0.29	0.69	0.21
7y	48%	4%	45%	0.33	-0.2	-0.65
10y	48%	-22%	15%	0.27	-0.38	0.69
30y	46%	-64%	-49%	-0.24	0.2	-0.21
Interpretation	**Level**	**Slope**	**Convexity**			
Eigenvalues	96.5	8.3	1.6	0.4	0.2	0.2
% Explained	90%	98%	99%	100%	100%	100%

Source: BofA Global Research; Levels used for illustration only

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2.2 - Principal Component Analysis (PCA)

Principal component analysis (PCA) is often used as a dimensional reduction technique. When we are faced with a large number of correlated factors (bond yields across the curve for example), principal component analysis (PCA) allows us to distill the broader dynamic down to a small number of factors that explain most of the variability in the dataset. These factors, the principal components, have the added advantage of being orthogonal. The PCA rotation transforms a *n x m* data set (*n* series and *m* observations) which may have significant collinearity between the *n* series, into an *n x m* data set of orthogonal principal components (defined by the eigenvectors of the covariance matrix). When sorted by their eigenvalues, often the first 2-3 principal components explain 90% or more of the variance of the data-set.

A classic example of the application of principal component analysis is on the yield curve because of how intuitive the interpretation of the principal components becomes in this case. In Exhibit 11 we show the PCA transformation (the eigenvectors of the covariance matrix) for the set of benchmark Treasury bonds (2y, 3y, 5y, 7y, 10y, and 30y Treasuries).

The first three principal components explain 99% of the variance of the data set. The first principal component (first column in Exhibit 11) corresponds to a quasi-parallel move across the yield curve (an on-hold Fed stance suppresses volatility at the frontend of the curve and explains the smaller weights in 2-5y rates for the first principal component). The second principal components correspond to a flattening/steepening move on the curve, and the third to an increase/decrease of its convexity.

It is not often, however, that principal components lend themselves to such intuitive interpretations. In more complex data sets it is likely that the first few principal components show a lot more structure. Consider for example a data-set with clear correlation structures, as say price data for the individual constituents of the S&P (which can be grouped by sectors) or implied rate volatility data (with clear clusters of correlation in gamma, upper-left corner or vega). In these cases, a PCA framework can be enhanced by folding the correlation structure in the estimation of the eigenvectors of the covariance matrix - this can be done in a hierarchical PCA framework (see Understanding Principal Components)

PCA flies

The fact that that the principal components are orthogonal adds to the significance of the third principal component in a 3-dimensional data set (*n*=3). By construction the third principal component is uncorrelated with the first and the second components, the level and slope of the curve, respectively. The weights of the third principal component in a 3-dimentional data set define a PCA-weighted fly that is therefore insensitive (in the historical period used to calculate the PCA rotation) to changes in the level of rates and slope of the curve. The idea is that the PCA weighted fly should mean revert in the absence of a structural shift in the curve dynamic, however it is important to note that the PCA-weighted fly is often not duration neutral. In Exhibit 12 we show an example of a recent run of stats for PCA and 50/50 flies.

Exhibit 12: Statistics for PCA and 50/50 flies

Z-Scores for the flies measure rich/cheapness of belly vs wings

			PCA Fly Stats (3M)				50/50 Fly Stats (3M)				R2 w/	Residual	
Flies	**Min**	**Max**	**Mean**	**SD**	**Last**	**Z-Score**	**Mean**	**SD**	**Last**	**Z-Score**	**belly**	**Model**	**Z-Score**
2y/3y/5y	-15.0	-0.1	-7.5	2.5	-15.3	-3.1	9.4	5.5	8.7	-0.1	80.8%	-8.0	-3.3
2y/3y/7y	-23.6	-1.8	-13.1	3.5	-23.8	-3.1	6.2	10.9	7.6	0.1	87.7%	-13.7	-3.6
2y/3y/10y	-31.4	-4.1	-18.7	4.5	-31.5	-2.8	2.3	15.2	5.1	0.2	89.1%	-18.4	-3.7
2y/3y/30y	-32.0	-2.4	-20.2	6.2	-30.8	-1.7	2.8	24.6	17.6	0.6	92.8%	-20.3	-3.1
2y/5y/7y	-27.3	-11.3	-19.7	2.4	-26.9	-3.0	18.0	12.0	8.7	-0.8	49.0%	4.9	0.6
2y/5y/10y	-60.8	-28.9	-45.7	4.9	-59.8	-2.9	14.1	9.4	6.1	-0.8	21.3%	-0.6	-0.1
2y/5y/30y	-110.6	-63.0	-93.3	9.2	-109.1	-1.7	14.7	10.4	18.7	0.4	23.4%	-4.6	-0.5
3y/5y/7y	-17.1	-8.2	-13.0	1.6	-16.6	-2.3	2.7	5.6	-0.6	-0.6	52.6%	3.6	0.9
3y/5y/10y	-35.2	-17.9	-27.3	3.2	-34.4	-2.2	-1.2	3.8	-3.1	-0.5	0.0%	-1.9	-0.5
3y/5y/30y	-55.0	-29.8	-43.7	5.7	-47.9	-0.7	-0.6	10.6	9.4	0.9	77.0%	-5.9	-1.1
2y/7y/10y	-41.7	-22.6	-32.6	2.9	-41.0	-2.9	20.6	18.7	8.4	-0.7	53.7%	13.7	1.1
2y/7y/30y	-117.9	-73.9	-101.6	8.6	-114.0	-1.5	21.2	12.9	20.9	0.0	11.9%	8.1	0.7
3y/7y/10y	-30.7	-17.4	-24.4	2.4	-30.1	-2.4	5.3	12.4	-0.8	-0.5	59.8%	12.1	1.5
3y/7y/30y	-76.8	-47.9	-64.1	6.3	-68.4	-0.7	5.9	7.3	11.7	0.8	0.3%	6.5	0.9
5y/7y/10y	-10.7	-6.1	-8.4	1.1	-10.3	-1.6	-0.6	1.7	-1.4	-0.4	27.5%	1.0	0.7
5y/7y/30y	-18.2	-8.8	-13.3	2.6	-11.6	0.7	-0.1	8.9	11.1	1.3	87.2%	-4.6	-1.4
2y/10y/30y	-86.3	-54.6	-73.2	6.3	-77.7	-0.7	29.0	18.4	25.9	-0.2	41.3%	21.8	1.5
3y/10y/30y	-63.4	-40.9	-52.6	5.0	-52.4	0.0	13.7	12.3	16.7	0.2	41.4%	19.6	2.1
5y/10y/30y	-25.2	-12.5	-19.2	2.9	-15.1	1.4	7.7	3.2	16.2	2.6	3.0%	7.3	2.3
7y/10y/30y	-6.8	-0.2	-4.2	1.5	-0.3	2.5	4.5	5.7	15.0	1.9	85.8%	-0.5	-0.2

Source: BofA Global Research; Levels used for illustration only

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2.3 – Macro driven models

Macro driven models try to explain the dynamic of Treasuries as a function of the dynamic of macro-economic variables. Indeed, Exhibit 13 shows the broad correlation between the 10yT yield and leading indicators for the US economy.

Macro model - adjusted and un-adjusted

In our macro framework for the dynamic of Treasuries (see A Rates Strategist Toolkit) we calculate the first two PCs of the rates curve (2s, 5s, 10s and 30s), and regress each of these on fed funds (to define cycle dynamic) and the principal components of:

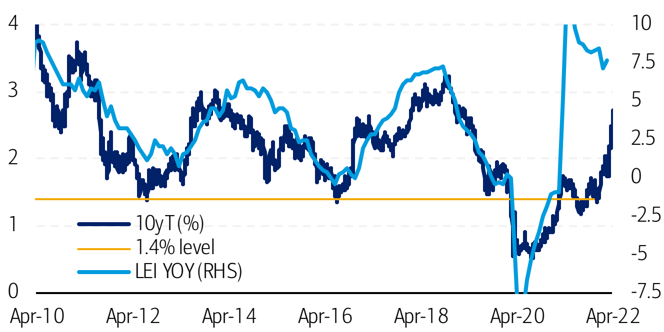
- Growth variables (e.g. GDP, Capacity utilization, IP, ISM and Retail sales)
- Inflation variables (e.g. CPI, PCE, ECI and Import price index)
- Employment variables (e.g. NFP, Initial jobless and UR)

Macro models are calibrated over long historical windows, generally longer than the average cycle length (somewhere between 7-15 years) to capture the broader dynamic of Treasuries throughout the cycle. Significantly, these models tend to break down in periods of significant non-economic buying of Treasuries. We have seen several of these periods over the last couple of cycles, for example:

- The Greenspan conundrum, where we saw the backend of the Treasury curve rallying even as the Fed hiked rates in the early stages of the '04-'06 tightening cycle, driven foreign central bank buying
- QE periods, where Fed acts as a non-economic buyer. Indeed, in general these periods drive a negative correlation between growth and yields, and it is a challenge to avoid solutions that converge to these sorts of non-economic betas in macro frameworks for the dynamic of yields
- Global yield demand in a context of very low global yields. Indeed global demand for USTs may be driven less by US fundamentals but more by yield differentials to other DM yields and the cost of hedging the FX exposure (see R+C section)

To account for the pressures on the Treasury curve from these non-economic distortions we include in our independent data set the dynamic of the Fed balance sheet and the first principal component of global DM rates. In our framework, therefore, we converge to two solutions, one where we express fair value consistent with US macro fundamentals alone, and an adjusted framework where we incorporate the impact of overseas demand on the Treasury curve. In Exhibit 14 we show the 10yT yield vs the adjusted fair value obtained from our macro framework for the Treasuries curve.

Exhibit 13: 10yT vs US economy leading indicators
10yT tracks the evolution of macroeconomic indicators



Source: BofA Global Research; Bloomberg; The Conference Board

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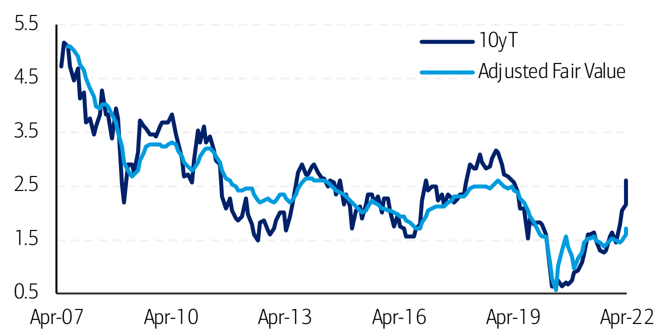
Exhibit 14: 10yT fair value framework
Adjusted fair value takes into account potential demand from overseas



Source: BofA Global Research; Bloomberg

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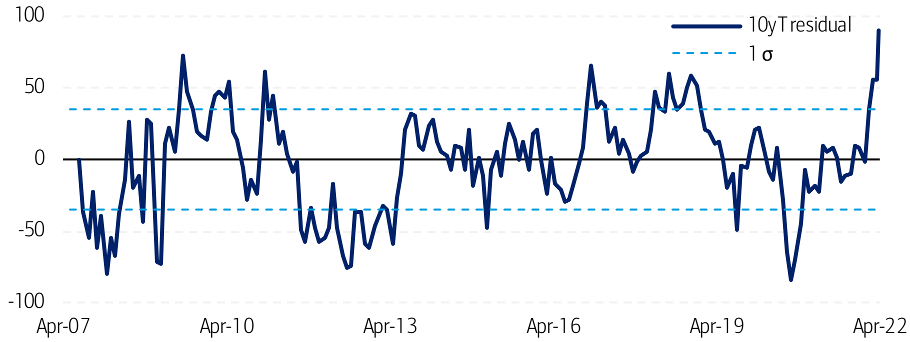
Exhibit 15: Residual of the 10yT fair value framework

Recent residual shows 10yT at the cheapest levels vs fundamentals over the entire calibration window



Source: BofA Global Research

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Decomposition of the 10yT dynamic

It is useful also to try to understand the macro drivers that are most significant in the recent dynamic of the Treasury curve. The macro model can be used in this context, by looking at the sensitivity matrix of Treasury yields to the independent variables (one needs to first convert the betas of the Treasury PCs regressions on the PCs of the different groups of variables into betas on the variables themselves, and then convert these Treasury PCs betas into betas of the Treasury yields – using the transposed of the corresponding PCA transformations). However, it is often more user friendly to use specific models for this decomposition, and we describe two approaches here.

Bayesian VAR approach

In statistics, the traditional frequentist approach assumes that each parameter has a "true" value and the goal is to find a close estimate to that (fixed) value. In contrast, the Bayesian approach views each parameter as a random variable, characterized by some underlying probabilistic distribution, along with constrains on the relative dynamic of the different parameters. The latter allows the analyst to avoid non-economic solutions, for example models where Treasury yields are negatively correlated with growth.

The vector auto-regressive framework is used to capture the relationship between multiple time series as they evolve over time, versus lagged levels. A *p*th-order VAR refers to a VAR model with a time lag for the last *p* time periods and is denoted VAR(*p*). This can be expressed as:

$$y_t = a_0 + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \epsilon_t, \text{ with } \epsilon_t \sim N(0, \Sigma)$$

Where y_t is the $M \times 1$ vector of endogenous variables, a_0 is the $M \times 1$ vector of constants, A_i is the $M \times M$ time-variant coefficient matrix, and ϵ_t is the $M \times 1$ exogenous factor or the error terms with a Gaussian distribution with mean zero and variance-covariance matrix Σ.

In our BVAR model we adapted an existing ECB framework[2] to decompose the dynamic of 10yT yields in terms of monetary policy, demand, risk and inflation shocks. The key in this models is to define the sign restriction priors that transform the dynamic of the underlying variables in the model (10yT yields, 5y5y inflation, real effective exchange rate for the dollar, and cyclical adjusted P/E ratios) into the shocks above (see Exhibit 16). In Exhibit 17 we show the results for the decomposition of the 10yT dynamic. The steady state in the model (0 in the y-axis) is c.2% in this framework, and we see periods of up to 100bp of cheapening vs the steady state (e.g. in late '18) and up to 125bp of richening vs the steady state (e.g. in 1Q20).

[2] European Central Bank, *Financial Stability Review, Nov. 2018,* www.ecb.europa.eu/pub/pdf/fsr/ecb.fsr201811.en.pdf

Exhibit 16: Sign restrictions matrix
Different shocks are defined by different relative dynamics between the underlying variables, e.g. a hawkish monetary policy shocks is defined as driving breakevens tighter, UST yields higher, a stronger dollar, and headwinds for risky assets

	Inflation	Monetary	Demand	Risk
US inflation	+	-	-	
UST10y	+	+	-	-
USNEER		+	-	+
USCAPE	-	-	-	-

Source: BofA Global Research

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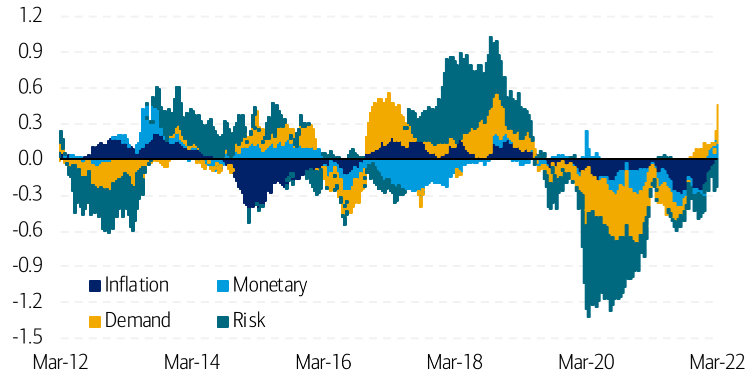
Exhibit 17: BVAR decomposition of the 10yT dynamic
Steady state for 10yT at c.2% (calibration window since '12)



Source: BofA Global Research

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News/Fed/Data decomposition

Another approach that can be used to gauge different drivers behind the 10yT dynamic (or any other tenor on the curve) is to run an attribution analysis similar to the one described in [An unprecedented Fed impact in rates](). Here we run a daily attribution analysis to find the Fed's impact in the markets by netting out impacts of data surprises and other news flow. This is done by designating each day as a data-surprise day, a Fed day, or a news day, and then cumulating the market changes on Fed days as well as on data surprise days. Significantly, we find that ytd '22 the Fed's impact on rates has been by far the largest in our data set going back to '04 (not surprising in a year where the Fed shifts policy from on-hold to tightening). Of the 109bp increase in 10yT yields, 69bp can be attributed to Fed communication, including FOMC meetings and minutes.

Exhibit 18: Breaking the 10y rate change into Fed days, news, and data surprises
Fed impact in 2022 was largest in our data sample back to 2004

10y rate	Market change	Fed	News	Good Data	Bad Data
2022	109	69	23	2	14
2021	60	21	56	49	-66
2020	-100	-35	-41	19	-43
2019	-77	-54	24	21	-67
2018	28	-15	25	22	-4
2017	-4	-4	-16	58	-41
2016	18	-31	25	20	4
2015	10	-14	-5	60	-31
2014	-86	40	-62	23	-87
2013	127	35	0	108	-16
2012	-12	37	-54	43	-38
2011	-142	3	-86	19	-78
2010	-54	-44	-22	28	-16
2009	163	50	-1	28	85
2008	-181	-3	15	115	-308
2007	-68	-31	7	26	-70
2006	31	-35	59	77	-71
2005	17	11	6	15	-15
2004	-3	19	-9	111	-124

Source: BofA Global Research. Bloomberg

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2.4 – Curve dynamic

Up to this point we have focused on RV metrics that look primarily at the level of yields (with few exceptions like PCA flies, the analysis of the dynamic of the NSS parameters, or the Macro framework where we model explicitly the first and second principal components of the yield curve - level and slope). These are to some extent first order RV metrics (RV on the levels, with little information from the dynamic of the slope or the curvature extracted from them).

Any RV analysis across curve sectors based on these is therefore restricted to a view on relative first order RV of one bond/sector vs another, e.g. bond A is rich on Z-Spread and bond B is cheap on the same metric, so sell A and buy B. On a side note, the decision making process is rarely this simplistic. In practice it is advisable to look at RV across different metrics for the two bonds/sectors (spline spreads, Z-Spreads, ASW, etc…) along with carry (or vol adjusted carry) and a macro view for why one should short one bond/sector vs another (extend out the curve, view on the curve dynamic, etc).

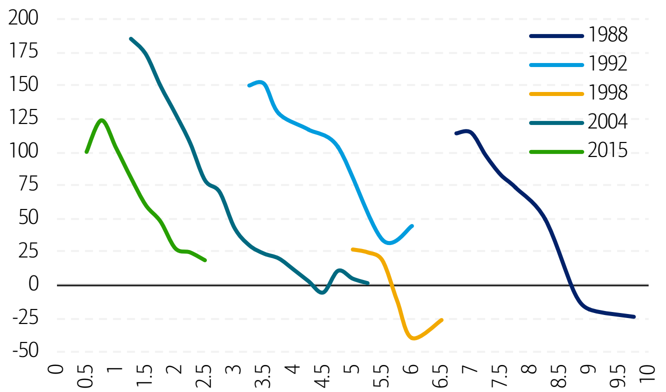
An analysis of RV on the curve itself extends the information set. We discuss a couple of approaches to look at the curve dynamic below.

Curve model - dynamic over tightening and easing cycles

The curve dynamic has four main modes of movement, bull flattening & bear steepening, where backend yields drive most of the dynamic , and bear-flattening & bull steepening where frontend yields and monetary policy decisions drive most of the dynamic. In Exhibit 19 we show the dynamic of the 2s10s curve (y-axis) vs fed funds rates (x-axis) for Fed tightening cycles since the mid-80s. A couple of observations are significant: (1) from a macroeconomic standpoint, the point on the x-axis at which the curves invert it should be the prevailing neutral rate (NR) view for the economy; and (2) these curves look relatively self-similar when shifted across the x-axis. Exhibit 19 suggests that all these different curves are essentially the same curve (a template for how the 2s10s curve flattens as the Fed tightens rates) but under different neutral rate assumptions.

We extract the bear flattening template from the curves in Exhibit 19, and show in Exhibit 20 the likely flattening trajectory for the 2s10s curve vs fed funds contingent on different neutral rate assumptions, along with the current curve forwards. In past cycles these have allowed us to establish ranges for the curve for each level of the fed funds rate, but we can see clearly that the current cycle deviates significantly from historical patterns. This in itself is a significant observation. All models are wrong at some level, and there is a lot to learn and explain when one sees deviations of this magnitude vs. historical patterns. We think the current abnormal dynamic is driven less by a paradigm shift on the curve dynamic and instead reflects the risks of shift in regime on inflation which puts the Fed on a risk management stance and drives expectations for one of the shortest cycles in recent history (see [2s10s curve reflects recession risks]). Despite the current shortcomings, we believe this framework is likely to continue to be useful to understand the dynamic of the UST curve in Fed tightening and easing cycles (see [A Rates Strategist Toolkit] for the easing version of this framework).

Exhibit 19: 2s10s curve vs fed funds for recent tightening cycle
Curve relatively self-similar when shifted across the x-axis



Source: BofA Global Research

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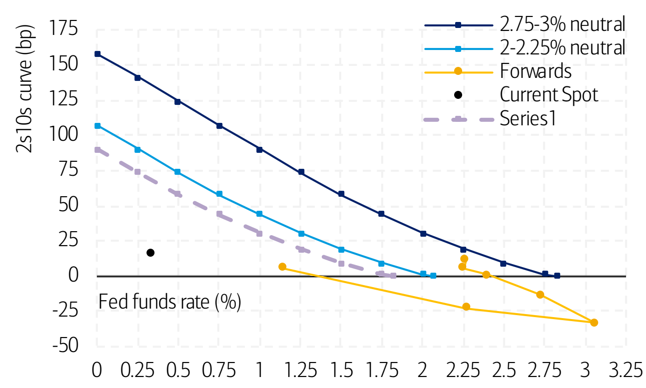
Exhibit 20: 2s10s bear flattening expectations contingent on NR view
Current fwds price a very un-orthodox bear-flattening dynamic



Source: BofA Global Research

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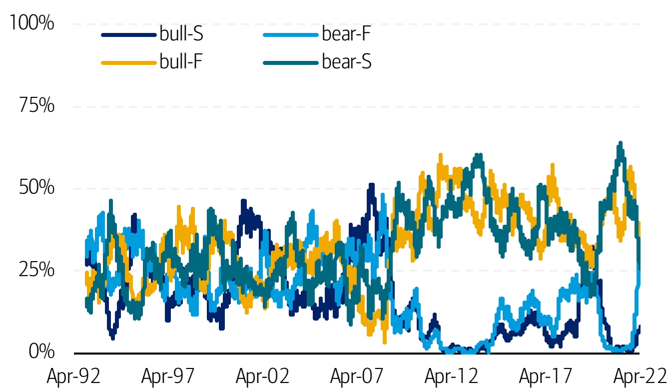
Curve directionality

Another framework that adds to the understanding of the dynamic of the curve is a measure of how frequent the different modes for the curve (bull flattening, bear steepening, bear-flattening and bull steepening) have been in recent history. One can do this by constructing 4 indices, one for each mode, that measures the number of bp moves that can be attributed to that mode in a give historical window vs the sum of absolute moves on the curve over the same period (see Exhibit 21).

Those 4 indices can be grouped into short leg (2yT leg in the 2s10s dynamic) driven moves (adding the bear-flattening and bull steepening indices) and belly (10yT in the 2s10s dynamic) driven moves (adding bull flattening and bear steepening moves) – see Exhibit 22. A couple of observations are in order: (1) there was a clear structural change in the curve dynamic around the '08 great financial crisis (GFC) with a lower degree of freedom for the 2y after the crisis; and (2) the gradual un-anchoring of the 2yT at the end of the '15-'18 tightening cycle, and a particularly aggressive un-anchoring seen in the current cycle since Oct '21.

This framework is useful to gauge the prevailing modes on the curve and understand the periods where the curve is undergoing a shift in its dynamic. In '21 for example we were able to infer how much of the tapering of asset purchases was being priced in by looking at similar charts for 5s30s and comparing the degree of un-anchoring of the 5yT sector in the '13 taper tantrum with the un-anchoring that started to get priced in over 2Q21 (see Exhibit 12 in June FOMC impact on curve and vol).

Exhibit 21: Directionality indices for the 2s10s curve (6m window)
The 4 dynamics can be grouped into frontend and backend driven



Source: BofA Global Research

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Exhibit 22: Change in 2s10s curve regime after the '08 GFC
Significant lower degrees of freedom for the frontend since the GFC

Source: BofA Global Research

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2.5 – Dynamic factor modeling (DFM)

The PCA framework is focused on correlations in a dataset and on capturing the largest part of the variance of the dataset with the smallest possible number of components. However, PCA disregards the trends in the data to a large extent. The DFM framework is an alternative approach to PCA that addresses this shortcoming by capturing the shared covariances in the dataset through hidden state processes (the DFM factors) and also allows for the modeling of the time-varying dynamic of these factors explicitly. In a relatively simple DFM specification, a number of factors (determined a-priori) are defined through a given state equation[3]:

$$x(t) = Bx(t-1) + w(t)$$

[3] cran.r-project.org/web/packages/MARSS/MARSS.pdf

while the independent variables are modeled as a function of these factors:

$$y(t) = Zx(t) + v(t)$$

where:

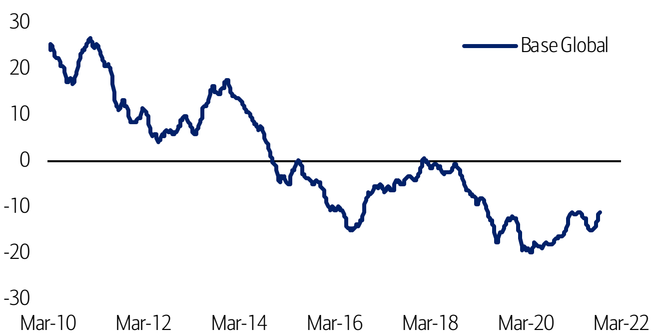
$$w(t) \sim MVN(0, Q),\ v(t) \sim MVN(0, R),\ x(0) \sim MVN(X_0, V_0)$$

The factors (*x's*) are calibrated to explain the dynamic of the independent variables (*y's*) through the linear combinations defined by the calibrated projection matrix (*Z*).

In Exhibit 23, we show the dynamic of the first factor for a dataset of 22 series for 10y sovereign yields across the DM and EM complex. The first factor of global yields shows a broader downward trend in yields over the last decade, with the COVID trough in early '20, and the subsequent rebound. Clear in the dynamic are also the second and third mini-cycles of the last cycle, between '13-'16 and '16-'20, respectively.

The analysis of the relative sensitivity of each individual yield series to the global factor may help define the best position to leverage a view on the expected dynamic of the global factor medium term. This can be done either through an outright exposure (the bonds most leveraged to the global factor) or through a long/short (if the view is for the global factor to continue to rebound one would establish shorts in higher beta bonds vs longs the lower beta ones).

Exhibit 23: Global yield factor defined though a DFM framework on 22 series for 10y sovereign yields
First factor of global yields shows a broader downward trend in yields over the last decade, with the COVID trough in early '20 and subsequent rebound



Source: BofA Global Research; Note: x*Z has dimensions of yield in this framework, but the dimension of the factors alone is arbitrary

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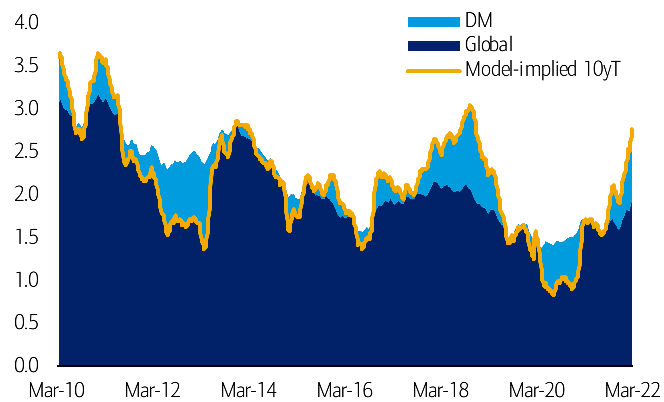
Exhibit 24: Decomposition of 10yT vs global and DM components
DM component of yields major driver of recent cheapening



Source: BofA Global Research

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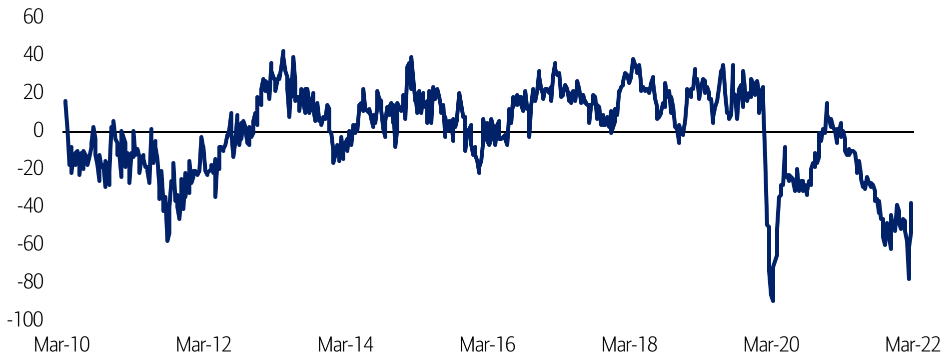
The projection matrix Z can be constrained to add more intuition to the interpretability of the factors. Indeed, the same type of clustering approach that we used in a HPCA approach can be incorporated in the Z constrains by setting some of the elements of the Z matrix as described in the PCA section. The decomposition of the 10yT dynamic in this context, as a function of Global and DM components of global yields, yields a couple of interesting results (see Exhibit 24):

- Fair value for 10yT in this framework is c.2.7%;
- The selloff in late '20 / early '21 was driven primarily by the Global component of yields, while the '22 selloff has been mainly driven by the DM component.

The latter is particularly significant because it illustrates the feedback between the higher yields in the US and the potential for selloffs in other DM yields. A look at the residuals of the 10yT vs. levels implied by this global yield framework suggests a recent change in this dynamic, with persistent richness of 10yT vs the global and DM components of global yields since the '20 recession, and particularly since 2Q21 (see Exhibit 25).

Exhibit 25: Residuals of 10yT yield in our global yield framework

Persistent richness of 10yT vs global and DM components of global yields since the '20 recession



Source: BofA Global Research

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This richness likely reflects the difficulty portfolios have encountered in the current cycle trying to leverage the early/mid-expansion in a context of significant uncertainty, particularly around the EM outlook (see USTs and the '22 allocation backdrop and section on Dynamic of UST around the cycle). Portfolios generally rotate out of safe-havens and into higher beta assets (particularly through higher EM contents) as the cycle turns from a recession and enters its early/mid-expansion phase. In the currency cycle, uncertainty constrained this rotation and left few alternatives but to leverage the expansion into DM risky assets, while hedging exposures and a still significant degree of uncertainty in USTs.

This explains the persistent richness of USTs vs the global and the DM components of global yields. It also suggests that this richness is likely to persist near term given higher recession risks well in the context of strategic asset allocation horizons for portfolios (see 2s10s curve reflects recession risks) and the enhanced level of uncertainty about the outlook. The standard deviation of residuals is c.22bp, and we find a near-term persistence of 10yT richness vs global yields (up to 1 sigma rich) reasonable in a context of heightened uncertainty.

3. Carry & rolldown analysis

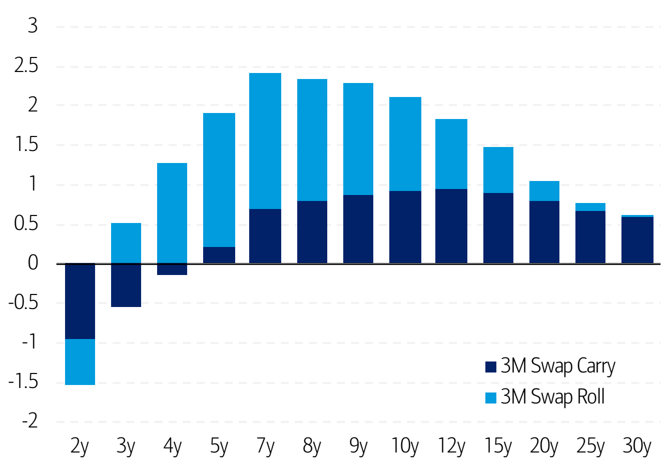
Rolldown and carry (R+C) analysis are important as they measure the staying power on a position. In positive R+C positions the investor has time to let his view unfold, while in negative R+C positions the investor needs to have a higher degree of conviction that his view will materialize sooner rather than later.

Carry is the difference between the coupon and the financing cost of the position. In practical terms bond carry in basis points at a given horizon can be calculated by taking the spread between the spot yield of the bond and the forward yield at that horizon.

Rolldown is the yield gain/loss from sliding the bond position down the yield curve as it matures (positive for a long bond position in an upwards sloping curve). The underlying assumption is that the forward curve will look like the current curve, such that the yield of a bond with maturity T in t months is the yield of a T-t maturity bond today.

As an aside, it is important to highlight some of the differences between R+C calculations between USTs and swap curves: (1) UST carry calculations require a repo assumption and are CUSIP specific as some bonds trade special; (2) the discrete nature of the UST curve implies that rolldown calculations generally involve the use of a spline, as it is not always possible to find a bond of maturity corresponding to the rolldown window (a T-t maturity bond in the example above). R+C calculations for swaps are a lot more straightforward on both these points as they do not require a repo assumption and benefit from a virtually continuous curve. In Exhibit 26 we show the carry and rolldown profile across the swap curve in early '22 (the current profile under a virtually flat curve is rather different but also less illustrative of the more common profile that sees the rolldown peaking for belly tenors). Exhibit 27 shows how the levels in Exhibit 26 translate into R+C profile for curve flattening positions.

Exhibit 26: Carry and Rolldown (C+R) across the US swap curve
Rolldown generally peaks for tenors in the belly, flat at the backend



Source: BofA Global Research; Levels used for illustration only

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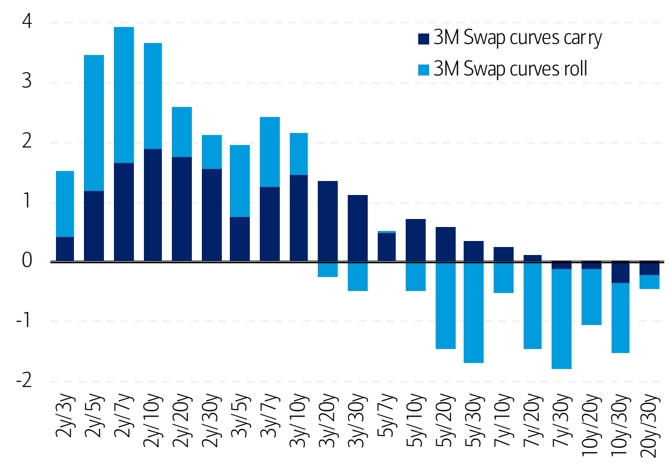
Exhibit 27: C+R for flattening positions on the swap curve
Frontend vs belly flatteners generally have best carry



Source: BofA Global Research; Levels used for illustration only

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A long carry position is inherently short vol. High volatility regimes reduce the likelihood of the investor realize the carry (which is one of the reasons why funding currencies like the Japanese Yen tend to appreciate in shifts to higher vol regimes, because of the collapse of the carry trade leads to reversal of the flow). It makes sense therefore to think of carry in the context of the volatility that one may experience over the holding period, i.e. vol adjusted carry (the ratio of expected carry to the volatility). The 3m carry on a 10yT long position should be cautioned by the 3m historical vol in the 10yT to obtain the vol adjusted carry for 10yT over 3m.

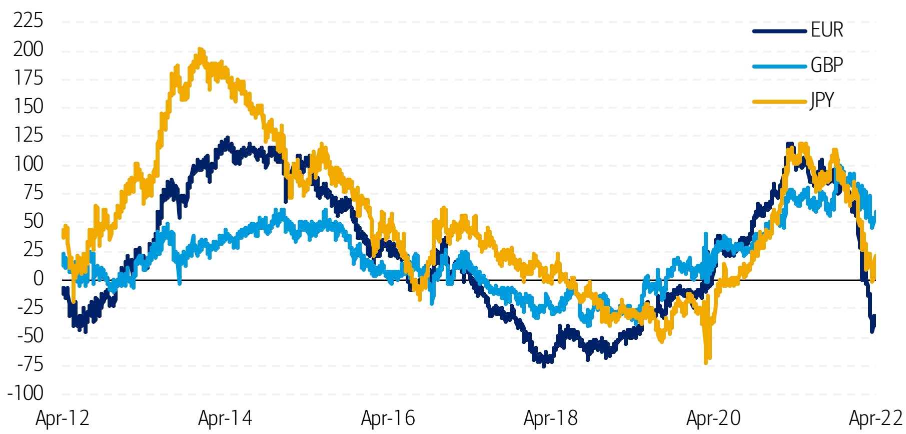
The global yield pickup as a carry trade (FX hedged pickups)

As we noted in the macro model discussion, the dynamic of overseas demand, both official and private, is significant for the analysis of RV on the Treasury curve. In our macro model we established two fair value metrics, unadjusted which is consistent with US fundamentals alone, and adjusted which takes into account the potential flows from overseas investors into Treasuries (through the magnitude of the decoupling between US and other DM yields).

Of this overseas demand, a significant portion is driven by carry considerations. A foreign investor that buys 10yT and hedges the FX exposure for 1y may pickup yield vs its own domestic yields. Significantly, the level at which this investors buys 10yT may be un-economical from the perspective of US fundamentals, but may still be attractive and economical for the overseas investor given the level of pickup relative to his own domestic yield.

This FX hedged duration demand is in essence a carry trade. In the position the investor is not exposed to the FX component, but it is still exposed to the duration component. If the investor picks up 30bp in 10yT over 1y in the position, a 30bp selloff of 10yT vs its domestic yield wipes out this carry advantage. High volatility/uncertainty regimes and high costs for FX hedging (relatively small hedged pickups, as is the case currently – see Exhibit 28) generally lead to a collapse of this FX hedged demand. Over these periods 10yT is likely to trade closer to the un-adjusted fundamental fair value. Conversely, in low vol periods with attractive FX hedged pickups, 10yT are more likely to trade closer to adjusted fair value levels.

Exhibit 28: Hedged pickup in 10yT for EUR, JPY and GBP investors
Collapse of pickups supports 10yT trading closer to fundamental (un-adjusted) fair value



Source: BofA Global Research

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4. RV dynamic around supply

RV signals on the UST curve can be distorted by the dynamic of USTs around supply. The general pattern has dealers creating space on their balance sheet ahead of auctions, which tends to drive some cheapening going into the event. However, this behavior is also contingent on a number of other factors including the view for whether the auction is likely to tail or stop through, expectations for dealers' takedown, etc.

An approach that is often used to gauge the recent UST dynamic around supply is to look at different curve and fly positions and their performance around a series of recent auctions of a given maturity. When we run this exercise we note that:

- The recent bias (over the last year) has been towards 2s10s flattening around 10yT auctions, contrary to the general intuition but in line with the prevailing dynamic of the curve recently - see Exhibit 29 ...
- ... And being short the belly on flies, e.g. being short the belly in the 2s3s10s fly round the last twelve 10y auctions – see Exhibit 31

Exhibit 29: Average performance from in 2s10s steepeners around the last twelve 10yT auctions

Bias towards flatteners more recently, in line with broader curve dynamic

Avg	-8	-6	-4	-2	0	2	4	6	8	10
-10	-1.1	-2.7	-2.0	-2.5	-1.5	-4.4	-4.4	-5.9	-9.1	-11.9
-8		-1.6	-0.9	-1.4	-0.4	-3.3	-3.4	-4.8	-8.0	-10.9
-6			0.6	0.2	1.2	-1.7	-1.8	-3.2	-6.4	-9.5
-4				-0.4	0.5	-2.4	-2.4	-3.9	-7.1	-8.8
-2					1.0	-1.9	-2.0	-3.4	-6.6	-7.7
0						-2.9	-3.0	-4.4	-7.6	-7.6
2							0.0	-1.5	-4.7	-4.0
4								-1.5	-4.6	-4.2
6									-3.2	-3.6
8										-0.5

Source: BofA Global Research; Levels used for illustration only

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Exhibit 30: Hit ratios on the performance 2s10s steepeners around the last twelve 10yT auctions

Recent bias towards flatteners, in line with broader curve dynamic

HR	-8	-6	-4	-2	0	2	4	6	8	10
-10	50%	33%	50%	58%	50%	42%	33%	33%	25%	17%
-8		17%	50%	50%	50%	42%	33%	33%	17%	8%
-6			58%	50%	42%	33%	33%	50%	33%	8%
-4				50%	50%	33%	25%	33%	25%	17%
-2					58%	50%	33%	50%	17%	0%
0						25%	25%	17%	8%	8%
2							50%	42%	8%	25%
4								33%	33%	25%
6									25%	17%
8										50%

Source: BofA Global Research; Levels used for illustration only

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Exhibit 31: Average performance from being short belly in the 2s/3s/10s fly around the last twelve 10yT auctions

Bias towards being short the belly and entering the position 4-10 days ahead of the auction vs exiting 4-10 days after

Avg	-8	-6	-4	-2	0	2	4	6	8	10
-10	-0.4	-0.1	0.4	1.2	1.4	4.7	6.4	6.8	9.2	12.8
-8		0.3	0.8	1.6	1.8	5.1	6.8	7.2	9.6	13.3
-6			0.5	1.3	1.6	4.9	6.6	7.0	9.4	13.3
-4				0.8	1.0	4.3	6.0	6.4	8.8	11.4
-2					0.2	3.5	5.3	5.7	8.0	10.6
0						3.3	5.0	5.4	7.8	9.1
2							1.7	2.1	4.5	5.3
4								0.4	2.8	3.8
6									2.4	4.0
8										1.2

Source: BofA Global Research; Levels used for illustration only

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Exhibit 32: Hit ratios on the performance from being short belly in the 2s/3s/10s fly around the last twelve 10yT auctions

Hit ratios broadly >70% when entering the position 4-10 days ahead of the auction vs exiting 4-10 days after

HR	-8	-6	-4	-2	0	2	4	6	8	10
-10	58%	42%	67%	58%	67%	75%	75%	75%	75%	83%
-8		67%	67%	67%	75%	75%	83%	75%	83%	83%
-6			67%	58%	67%	75%	83%	83%	83%	83%
-4				67%	50%	75%	83%	75%	67%	75%
-2					58%	83%	83%	75%	75%	75%
0						75%	99%	99%	83%	92%
2							75%	58%	83%	58%
4								58%	75%	67%
6									58%	75%
8										58%

Source: BofA Global Research; Levels used for illustration only

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These patterns change over time, obviously, and it is useful to monitor these patterns to understand the recent bias for the dynamic of the curve around supply (along with monitoring the broader auctions statistics like dealer takedown, bid/cover ratio, etc).

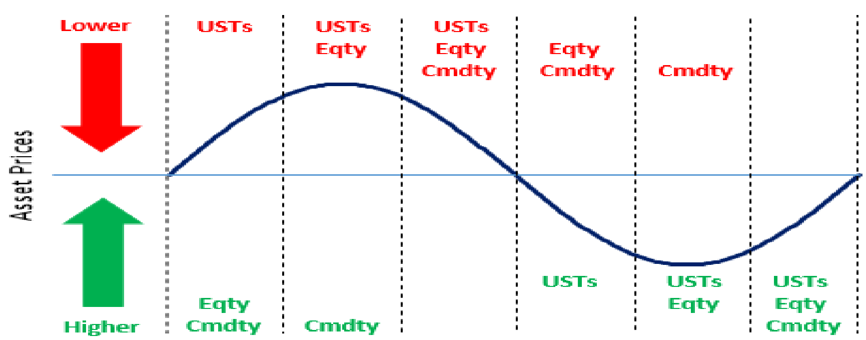
5. Dynamic of UST around the cycle

When looking at RV across the curve it is also important to understand the dynamic of demand across the cycle. The economic cycle is usually divided into different phases. It is generally useful to characterize these cycle phases in terms of the relative dynamic of the different asset classes. Exhibit 33 illustrates the broad relative dynamic of asset classes over the cycle:

1. As the market enters a new expansion (left of Exhibit 33), better fundamentals and eventually more Fed optionality drives the underperformance of USTs, while risky asset valuations stay broadly supported by the expansion. This is the context that drove the reflation trade of late-'20/early-'21;
2. At some point the Fed start to tighten policy, and as the tightening process progresses it caps the potential for equities to outperform;
3. As the Fed reaches the neutral rate and overshoots it to cool down the economy (remember Chair Powell ultimately misguided comment in late-'18 on how the Fed was a long way from neutral), commodities follow equities and bonds into negative performance territory;
4. Eventually policy tightening drives an economic contraction (remember Chair Yellen comment on how expansions don't "die of old age"), the Fed eases monetary policy supporting UST performance even as risky assets stay under pressure;
5. Equities start to recover on peak levels of accommodation, even as commodities lag as global demand for commodities requires clear signs of a recovery to recover;
6. The economy bounces from the bottom of the cycle, USTs and equities stay supported by monetary policy and commodities recover as global growth starts to pickup and drive demand. To some extent this corresponded to the mid-'20 context.

Demand for Treasuries therefore picks up in the late expansion and recession phase of the cycle (right of Exhibit 33), as portfolios shift to more conservative allocations and hedge their risky asset exposure. This generally implies a rich bias of Treasuries vs fundamental metrics (e.g. the BVAR or the macro model described above).

Exhibit 33: View for the dynamic of assets over the cycle
Market evolving from left (where it currently sits, with USTs selloff and risky assets higher) to right



Source: BofA Global Research

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In the early and mid-expansion phases of the cycle, on the other hand, demand for Treasuries wanes as portfolios generally rotate towards higher beta assets (HY, EM etc) to leverage the growth phase of the cycle (left of Exhibit 33). The frontend in particular comes under significant bearish pressure (and the curve under bear-flattening pressure) around the middle of the mid-expansion phase of the cycle as the Fed starts to tighten monetary policy. Over these early phases one should expect a cheap basis for Treasuries on broader fundamental metrics of RV.

5.1 - Mapping the economic cycle to the curve dynamic

Significantly, the dynamic of the yield curve maps relatively well to the different stages of the cycle (this is rather useful as understanding where the current market dynamic stands in the context of the broader economic cycle is critical for asset allocators – see To everything there is a season):

- Early expansion / Bear steepening: Better fundamentals support higher 10y and 30y yields, but the Fed continues to anchor the front end to support a recovery, analogous to 4Q20-1Q21 in the current cycle. The market eventually exhausts the early cycle bear-steepening dynamic – the level for the 2s10s curve at which this happens is contingent on the prevailing view for the neutral rate. In the transition between the early- and mid-cycle phases of the cycle, the market starts to price a higher degree of optionality for the Fed. The belly of the curve un-anchors and starts to lead on bearish rates moves. The 5s30s curve starts to move sideways. This transition was clear by mid-Jun '21 (Exhibit 34 shows a higher percentage of moves in the 5s30s curve driven by the 5y leg in 2Q21).

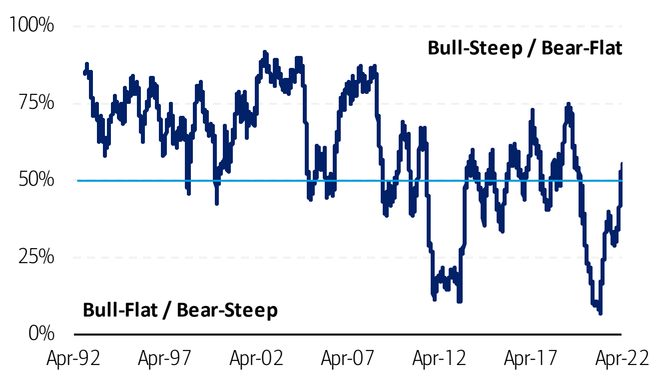
- Mid-cycle / Bear flattening: The curve shifts decisively towards bear-flattening when the market starts to price a significant probability of Fed hikes over the next 6-12m (see Exhibit 35 and Where is the US curve going?).

- Late-cycle / Bull flattening: As policy rates peak and growth slows, the 2s10s nominal curve continues to flatten but the dynamic is now helped by the long end of the curve. The curve inverts, but the 2s10s term premium curve hits a floor, which defines the inflection in a hockey stick relationship between the two (see Exhibit 36 and The curve, the "rock" and the "hard place"). On the way to inversion, the transition to a late cycle dynamic is generally also evident in the collapse in the dispersion of 1y forward rates (like we saw in the last cycle in 1Q18 – Exhibit 37).

- End Cycle & Recession/ Bull steepening: As the growth slowdown becomes evident, the Fed starts to signal rate cuts. The curve shifts into a bull steepening dynamic, with the extent of the steepening also dictated by the consensus view for the terminal/neutral rate in the cycle as we argued in Duck and cover where we called for a fair value for 2s10s at the lower zero bound at c.30-60bp.

It is critical to understand how these broader cycle forces impact the dynamic of rates and curve, to be able to put the RV relationships into this macro context.

Exhibit 34: 5s30s curve directionality
Un-anchoring of the belly in the current cycle evident by mid-June '21



Source: BofA Global Research

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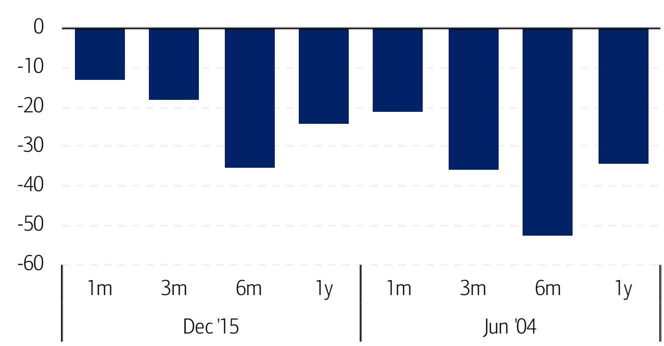
Exhibit 35: 2s10s dynamic at different horizons ahead of liftoff in the last two tightening cycles
Flattening bias more significant 6m ahead of liftoff



Source: BofA Global Research

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Exhibit 36: 2s10s TP vs nominal curve...
... over the '04/06 Fed tightening cycle

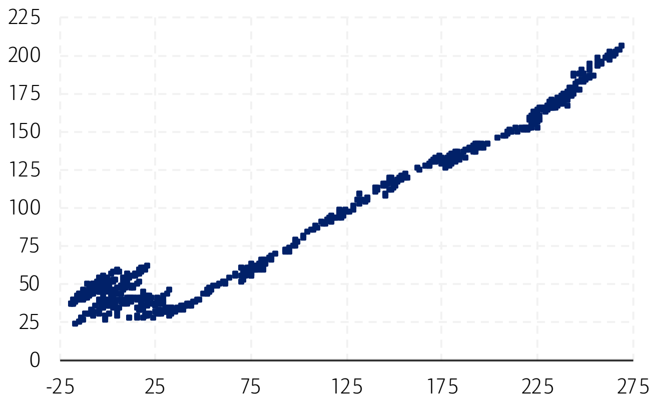

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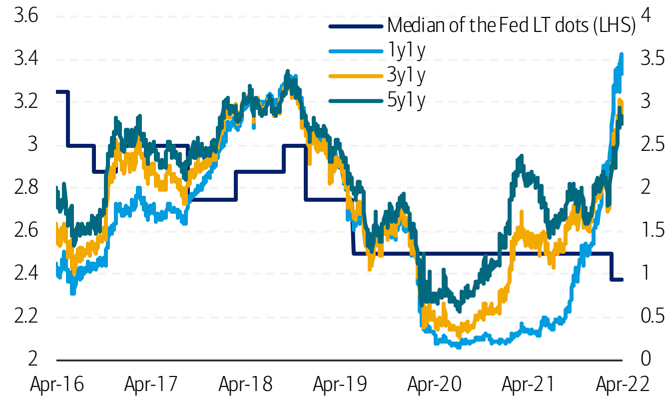
Exhibit 37: Dispersion of 1y forwards collapses at late-cycle transition
... like it happened in the last cycle in 1Q18



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