



THE YIELD CURVE AND ITS 3 KEY RISKS: DURATION, VOLATILITY AND CREDIT



With the current flattening of the US yield curve to around 20-30 bps on a constant-maturity Treasury (CMT) basis and to 10-20 bps on a US Swap rate basis, a lot of economist, investor, and media attention has been devoted to the consequences of a potential yield curve inversion on the US economy and financial markets.

With the exception of difficult-to-translate PhD academic research papers, the typical mainstream analysis we've come across on this topic can be abbreviated as follows:

The US 2s10s CMT term spread (10yr - 2yr yields), a widely used barometer of yield curve steepness, is currently at a decade low of around 20-30 bps. Furthermore, if the 30-day Fed Funds futures curve is an accurate prediction of actual FOMC rate increases, the US yield curve could potentially invert in 2019 if longer term rates hold steady. If it does invert, previous post-WWII cycles would suggest that, best case scenario, we are late-to-very-late cycle; worst case scenario, we get a US recession within a year or so...

The above narrative is an important one...one which is backed by the perfect historical track record of prior post-WWII yield curve inversions that have all signaled near-term US recessions. However, many analyses have tended to fixate solely on what a *potential* yield curve inversion *would likely* signal about a future US recession. In doing so, a key topic of discussion has often gone overlooked. In Jack Schwager's *Hedge Fund Market Wizards*, a quote from Colm O'Shea of Comac Capital fits perfectly: "*Fundamentals are not about forecasting the weather for tomorrow, but rather noticing that it's raining today.*" In focusing on an uncertain future event (i.e., an inverted yield curve), much of the recent analyses has overlooked the important signals that the yield curve is *currently* telling us today, well before any potential inversion.

As such, we thought it a worthwhile endeavor to highlight how the market is currently pricing 3 key risks inherent in fixed income investing: duration, volatility, and credit risk. However, we attempt to do so through the lens of the benchmark US Treasury (UST) yield curve. Ultimately, what we wish to show is that the genesis of these 3 key risks often can be traced back to the level and shape of the benchmark yield curve. We do so in the hope readers come away with a broader exposure to how the yield curve shapes today's markets.

But first, a re-introduction to yield curve arithmetic: spot rates, forward rates, and the yield curve

Those that are already fluent in the linguistics of bond arithmetic may find it a better use of time to skip ahead to the next sections. It will be helpful to start the discussion by clarifying a few concepts and terminologies. For starters, a yield curve is a graphical representation of the (maturity) term structure of interest rates at a given point in time. In plain English, it's a snapshot of interest rates (y-axis) as a function of their time-to-maturity (x-axis) for an entire series of related bond or bond-like securities.

While the above definition is intentionally quite broad (as there is a wide range of different types of yield curves), the focus of this write-up will be on the various forms of the "benchmark" UST yield curve (i.e., spot rate curve, par rate curve, and forward rate curve). The interest rates that comprise this curve are (or approximate) the default-risk-free cost of money, the Time Value of Money, and the term structure of default-risk free required rates of return.

The par, spot, and forward rate curves are all mathematically related; if you know the rates within one of these curves, you can figure out the other two. In fact, they are simply different mathematical representations of the same thing (default-risk-free rates) and are essential to the accurate valuation of any risky or risk-less bond.

A zero-coupon "spot" rate curve can be mathematically derived from the US CMT par curve (published daily by the Federal Reserve [here](#)) through a process called "bootstrapping" (details not pertinent for this discussion). Additionally, a zero-coupon spot rate is mathematically equivalent to the geometric average of the 1-Year spot rate and a series of forward rates.

Alternatively, forward rates are simply the derived "arbitrage-free" marginal discount rates of the spot curve. A baseball analogy might help here. Let's imagine that a spot rate curve is treated as the entire season's batting average and the forward rate, the marginal batting average of each game: if the marginal game's batting average is higher than the season's batting average, the season's batting average (which includes the current game) will rise, and vice versa. If you're not a baseball fan, it might be helpful to think of forward rates in 1 of 2 ways:

- 1) The marginal rate of return that's locked in by extending an investment's duration (i.e., maturity).
- 2) The breakeven marginal rate of return that would eliminate arbitrage opportunities between maturities.

As proof of the iterative mathematical relationships above, when the spot yield curve is perfectly flat, so too is the forward yield curve at around the same level as spot rates (theoretically, liquidity or term premiums would account for any deviation). In other words, the yield curve is flat and is priced to stay flat in the forward market, so spot rates are "expected" to stay unchanged in the future. Only when the spot curve gains shape (either positively or negatively sloped) will forward rates diverge from spot rates. In fact, the steeper the spot curve becomes, the wider the spread between forward rates and spot rates.

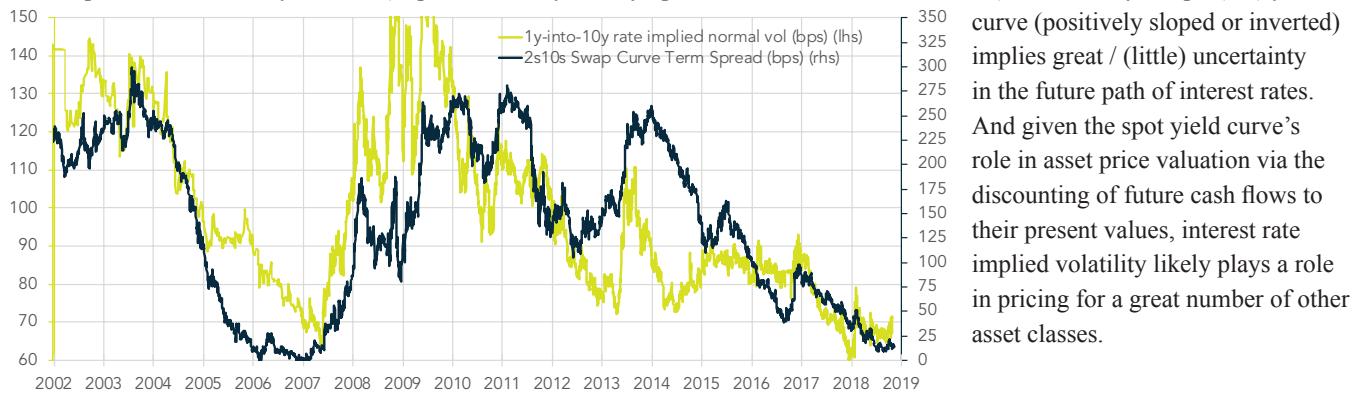
Yield Curve, Duration Risk, and Interest Rate Implied Volatility

As time passes, forward rates and spot rates must eventually converge to form a new spot rate, though the exact path of convergence is uncertain. Will forward rates gravitate toward spot rates or spot toward forwards? If forward rates were perfect predictors of future spot rates (spot rates converge to forwards), all bonds regardless of maturity would earn the same realized risk-free returns (the Yr. 1 spot rates) and active bond management would cease to exist. Since this isn't the case, all else equal, the wider the distance between forward rates and spot rates (i.e., the steeper the yield curve), the wider the distribution of potential outcomes for future spot rates.

Derivatives and options markets are an important aspect of fixed income markets, not only because a great number of fixed income securities have embedded options (i.e., callable and putable bonds), but also because rates, bonds, credit, and loans are widely traded explicitly through derivatives. And uncertainty is reflected in option pricing as Implied Volatility. As such, interest rate implied volatility should rise and fall with the steepness of the yield curve: if the spot yield curve is relatively flat, uncertainty about the future path of rates is low (due to a relatively flat forward curve as well), so the demand and therefore price for protection against this uncertainty will also be low (i.e., low implied volatility).

In terms of duration, a relatively flat yield curve (and thus a narrow spread between spot and forward rates) implies that there is little marginal reward or potential benefit for incurring additional risk by extending one's duration along the yield curve (by investing further out the yield curve).

And this is exactly what we see below: the US swap rate 2s10s term spread (a measure of curve steepness and a proxy for potential excess returns achieved by extending one's duration) is at a cycle low of 14 bps while the implied volatility of options on the 10-yr US swap rate is also near cycle lows (implied volatility of a 1y option is shown in the chart below). Thus a very steep / (flat) yield



Source: Bloomberg

curve (positively sloped or inverted) implies great / (little) uncertainty in the future path of interest rates. And given the spot yield curve's role in asset price valuation via the discounting of future cash flows to their present values, interest rate implied volatility likely plays a role in pricing for a great number of other asset classes.

Yield Curve and Credit Spreads

Think of a credit spread as follows: the incremental risk premium required for owning a credit-risky bond versus a default-free benchmark government bond. Now, notice that until the US yield curve started to steepen from 20 to 30 bps at the start of October 2018, the US 2s10s CMT term spread and the US Corporate High Yield (HY) option adjusted credit spread (OAS) were at or near their post 2007 lows.

While there are several intuitive reasons for why the shape of the yield curve is closely related to overall market prices of credit risk, one reason is likely an underlying relationship between the level of uncertainty over future rates (i.e., the shape of the curve

and implied volatility) and the probability of default being priced into markets. Recall that credit spreads can be modeled by making assumptions on: 1) Probability of Default (PD %) and 2) Loss Given Default (LGD %). While this relationship is far from perfect, the general trends over the cycle are hard to miss.



Source: Bloomberg

Review

The yield curve is constantly relaying important information about the market implied price of risk of various forms, including duration, volatility, and credit risk. In this paper, we began with a re-introduction to basic bond math and yield curve arithmetic to provide a stronger base for better understanding the minutiae of the yield curve. We showed how when the spot rate curve is relatively flat, the forward rate curve will also be flat (positively or negatively sloped), and the spread between spot rates and forward rates will be relatively thin. This creates lower uncertainty over the future path of spot rates due to a relatively thin distribution of potential likely outcomes. As a consequence, this uncertainty is often reflected in lower market prices for implied volatility of interest rates. The flatness of the curve also explains the disincentive for taking on incremental duration risk by extending one's duration (maturity) along the yield curve. Finally, we described how the yield curve and implied rate volatility are related to the price of credit risk via corporate credit spreads, which are now starting to increase off cycle lows.

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