How to position a retirement investor's bond portfolio in a rising/inverting rate environment

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1. Introduction

Inverted yield curve signals an upcoming recession. In 2017-18 as the Federal Reserve started signaling short-term interest rate hikes, this accepted wisdom gets repeated numerous times a day. In this paper we start by briefly reviewing the evidence on the link between the lagged shape of the yield curve and the subsequent GDP growth. It turns out that it is true that the majority of the recessions in the last 50 years followed an inverted yield curve. However, there is no evidence of causality. The sequence can be explained by the Fed's proactive raising of the interest rates during an upswing in the business cycle.

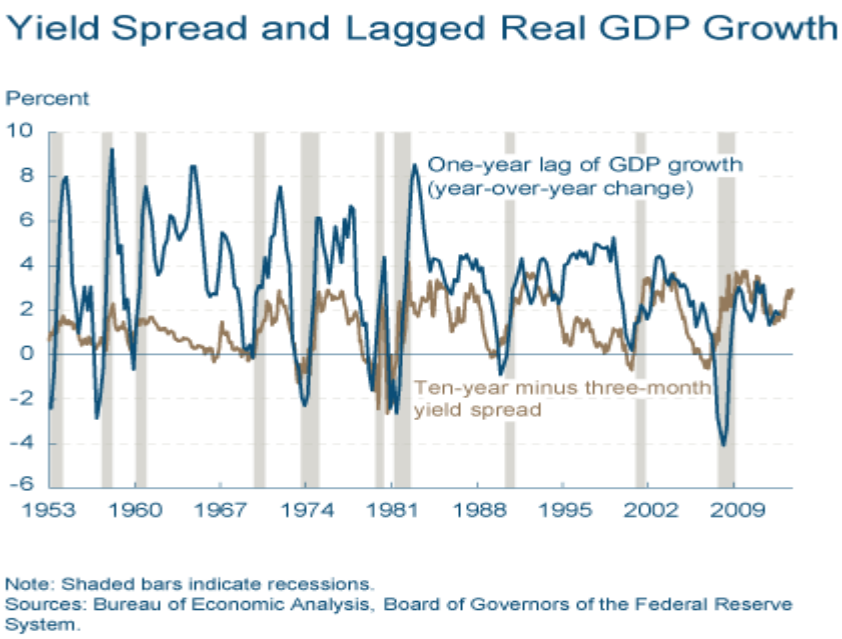
The second piece of wisdom being repeated is the prescription that in the environment of the Fed hikes, the best bond portfolio strategy is to shorten the modified duration of the portfolio to limit capital losses. Yet it is not hard to see that the second advice does not easily reconcile with the first. If the Fed raises short-term rates aggressively, then in the standard expectations hypothesis view where the short rates propagate only slowly to the long rates, the curve is likely to invert, especially if the starting curve is not steep.

In this paper, we investigate what the best strategy is for a retirement investor's allocation to fixed income when facing a mildly upward sloping yield curve with a prospect of several Fed hikes. We find that the standard prescription to shorten the duration is often wrong. We also find that corporate bond portfolio strategies are better than Treasury strategies. We start by investigating the literature on the link between the yield curve and subsequent GDP growth. The literature offers convincing evidence that it is the short end of the curve and not necessarily the slope of the curve that has strong correlation to a one-period forecasted log GDP. We run scenarios of bond portfolios through alternative paths of interest rate changes accounting for the duration and convexity effects on price as well as coupon flow and curve roll-down effect on the total return of a bond portfolio. We find that in many cases investors should not sacrifice coupon rates and choose lower yielding shorter bonds. Our conclusions are even stronger when the fixed income allocation uses corporate bonds rather than Treasurys.

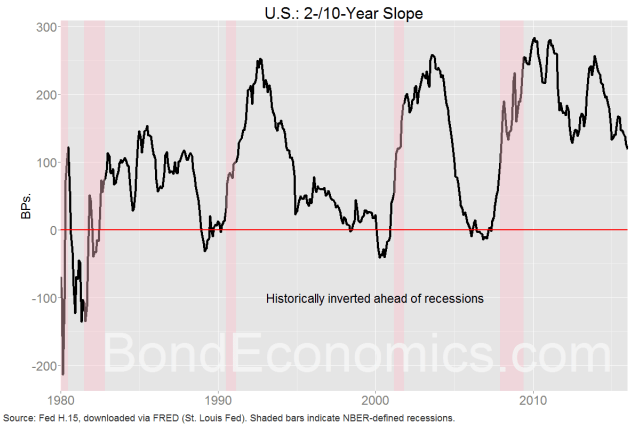
2. The Yield Curve and the GDP Growth

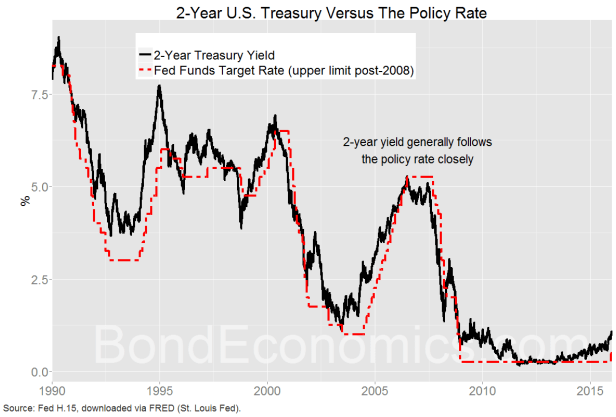
There are numerous studies on the relationship between the yield curve and consumption, output and inflation going back to Harvey (1988), and Estrella and Hardouvelis (1991). Estrella and Mishkin (1996) document how the spread between the 10-year Treasury note and the three-month T-Bill beats all other financial and macroeconomic indicators as the best predictor of recessions two to six quarters ahead. Recently in anticipation of several Fed hikes in 2018 there have been numerous updates to these studies using ten-year Treasurys vs 3-month, 2-years or even 5-years.

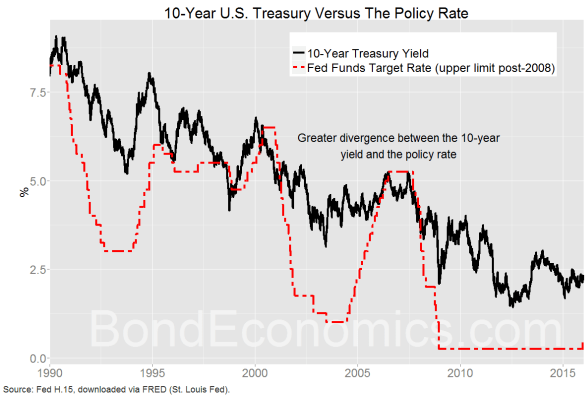
Moss (2014) shows the relationship of tens minus 3-month vs one-year lagged GDP.



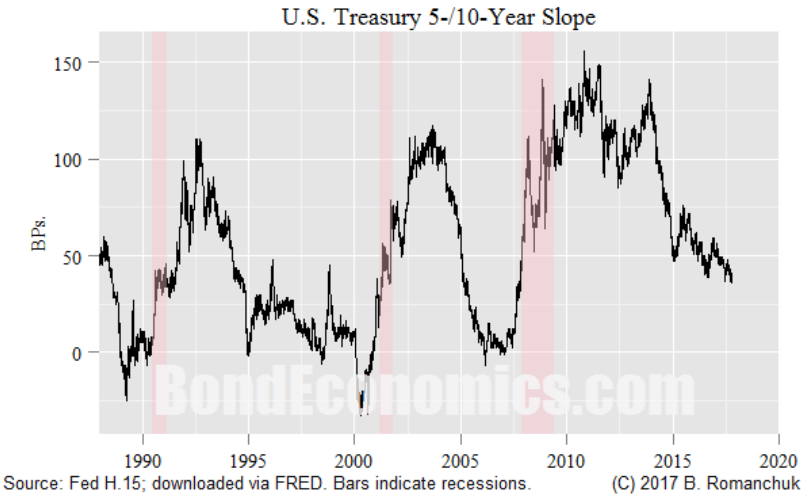
Arteta et al (2015) analyze the impact of the tightening on the real economic activity in all the developed economies. Romanchuk (2016) focuses on the ten-year minus the two-year vs GDP growth separating the two year as closely following the policy rate of the Fed and the ten year as the average policy rate over a long period of time.



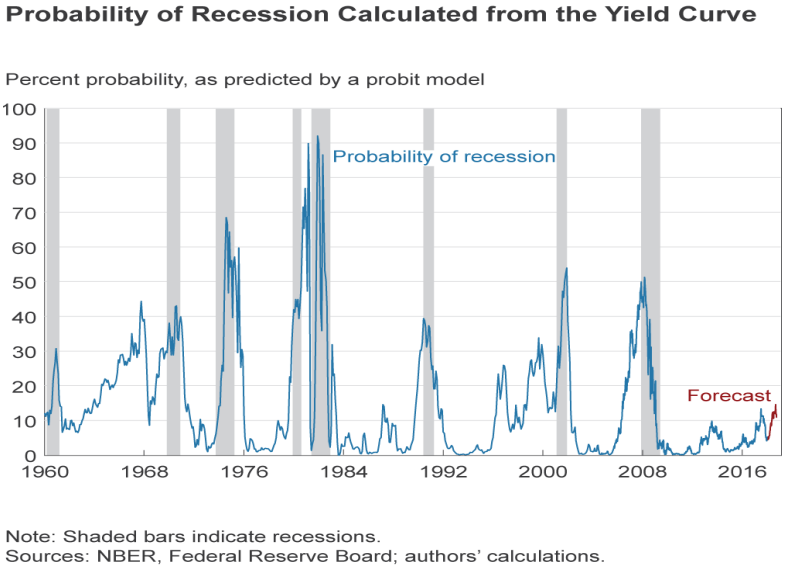




Romanchuk (2017) updates by looking at the ten year vs the five year and showing similarly strong correlation between the slope and the actual GDP one year later.



The Federal Reserve Bank of Cleveland provides a monthly update of the relationship between the ten year note minus the 3-month bill and the predicted lagged actual GDP as well as a probit-based probability of recession model.



The Federal Reserve Bank of New York provides on its website a link to a constantly updated recession prediction chart.

Yet problems with this simplistic view of the relationship between the slope of the curve and the lagged GDP series have been pointed out as early as in Ang, Piazzesi and Wei (2006). They explain that simple OLS models do not account for regressor endogeneity. Their vector autoregressive model of zero

coupon yields on maturities up to 20 quarters demonstrates that the short rate has much more predictive power than any term spread. A factor decomposition shows that the first principal component related to the short rate accounts for 97.2% of the variation of the yields, the term slope only adding 2.5%. In VAR models including GDP they show Granger-causality between high short-term rates and low GDP growth, but statistically insignificant for the term spread. They recommend adding lagged GDP to the mix and using the longest maturity possible to estimate the slope in order to improve out-of-sample GDP forecasts.

Estrella and Trubin (2006) also focus on building the best yield curve-based recession signal in real time. They conclude that in subtracting from the ten year, the 3-month point beats any other short maturity like 1-year or 2-year. They show that the 10-year minus the 3-month slope perfectly predicted recessions when it was negative, irrespective of how negative, as long as the negative differential was persistent for many days not just intra-day. Most importantly, they show that the negative differential was a superb predictor irrespective of what happened to the 10-year point, i.e. whether it went up or down as the short rate went up. In line with the Ang, Piazzesi and Wei (2006), Estrella and Trubin (2006) confirm that the pro-active monetary policy of the Fed and the rising 3-month rate are the dominant factors leading to recessions.

In summary, the evidence is strong that in all recessions since the 1960s, the rising short rate leads to a curve inversion and statistically causes 12-month lagged GDP declines. In all those cases, the short rate increases are engendered by the policy response as the Federal Reserve reacts to the imbalances in the economy during the boom cycles.

3. The Performance of Treasurys through a Yield Curve Inversion

We take as a given that an investor worried about an inverting yield curve, the looming recession and stock market drop, likely shifts their portfolio allocation from equities to fixed income and then reallocates within fixed income. The central question we then try to answer is the following. What do we allocate into within fixed income: long or short bonds? What duration profile do we try to achieve? In this section, we analyze strategies involving individual Treasury bonds. The next section will look into using bond funds and corporate bonds.

Admittedly, our research question depends on the type of investor. A short term trader's objectives are very different from those of a long-term retirement investor. A trader might not worry at all about whether the yield curve is shifting upwards or downwards. Rather, the trader would worry about the size of the inversion. The appropriate strategy for such a trader would be a duration-weighted short position in the 2-year note and a long position in the 10-year note. The duration weighting would ensure that the strategy makes money irrespective of the overall move in the yields, as long as the curve flattens or inverts relative to the current level. Then the trader unwinds.

An infinite-horizon retirement saver would invest in long-term bonds and would add to that position to maintain the desired stock/bond allocation. The investor would choose long-term bonds since the yield curve is upward sloping more than 2/3 of the time and the investor would want to capture the higher coupon cash flow. The investor would do nothing prior to the curve inversion; s/he would never reshuffle his/her fixed income portfolio.

Our focus is on a finite horizon retirement investor that worries about intermediate-term losses in their bond allocation. The situation is similar to tactical quarterly or annual tilting of equity portfolios. The investor does not have a perfect foresight, cannot predict recessions, and therefore does not the equity position, s/he simply tactically tilts it. Similarly with bonds, we do not know if the curve will shift up or down and whether it will invert. So we do not exit our fixed portfolio, we tactically position it to get through a down period. What we will show is that the conventional wisdom of duration shortening may be the wrong way to go about it.

Our data set is a snapshot of Treasury yields and prices on February 16, 2018, presented in Table 1. The yields to maturity are semiannual Act/Act. The last two columns show the modified duration of each security and the spread to the 10-year. The starting point is a 0.677% spread between the 2-year and the 10-year Treasury.

Table 1. Treasury Yield Curve on 2/16/2018

Term	Maturity	Coupon	Yield	Price†	MDuration	10yr−Yld
3m	5/17/2018	0.00	1.585%	99.634	0.2302	1.290%
6m	8/16/2018	0.00	1.834%	99.121	0.4790	1.041%
1y	1/31/2019	0.00	1.996%	98.152	0.9299	0.879%
2y	1/31/2020	2.00	2.198%	99.626	1.8889	0.677%
5y	1/31/2023	2.38	2.631%	98.821	4.6206	0.244%
10y	2/15/2028	2.75	2.875%	98.922	8.6587	0.000%
30y	2/15/2048	3.00	3.133%	97.426	19.5132	-0.258%

†T-Bill discount yield market quotes converted to Act/Act prices. (The last column shows the 10-yr minus the yield.)

Let us consider two investors. The first hold the entire fixed income allocation in 2-year bonds. The second holds it in 10-year bond. We consider a two-year holding horizon and run five scenarios of what might happen to the yield curve. Panel b is a no-change benchmark. Panel a has a 0.5% steepening scenarios. Panels c-d have curve flattening/inversions paired with yields shifting up. The Table assumes no coupon reinvestment. The analysis focuses on the performance attribution. As the curve moves up, each bond will have a loss in value due to the (tangent) duration effect offset by a small gain due to convexity (the difference between the actual and the duration-predicted). Over the two-year horizon, each bond's maturity will shorten by two years. With an upward sloping curve, that is normally a positive effect, as the 10-year bond becomes an 8-year bond even with no shift in the rates. In our analysis, instead of interpolating the curve, we approximate that maturity effect by simply shifting the date and keeping the coupon constant. The bonds also earn coupon interest over the holding horizon. So the performance of the strategy comes from decomposition of the capital gain into three price components: duration, convexity and time values, and from the coupon return.

Panel b shows that the 10-year investor wins if the yield curve does not move. This is mainly due to the higher coupon accrual over the holding horizon. The price of the two year converges to par while that of the 10-year moves little. Similar to the infinite-horizon investor, if we do not know what is going to happen to the yield curve and the median forecast is for no change, we are better off sticking to long bonds to take advantage of the higher coupon flow.

In Panel a, the curve steepens because the 10-year yield goes up. In this case, the 2-year returns the same as in the no-change scenario, but the 10-year price action is negative and takes away from the coupon flow.

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Table 2. Performance Attribution of 2-yr and 10-yr Treasury Bonds after Two Years under Yield Shifts Up

a) Shifts	**2-yr**	**0%**	**10-yr**	**0.5%**		
TNote	Duration	Convexity	Maturity	Total Price	Coupon	Total Return
2-yr	0.0000%	0.0000%	0.3753%	0.3753%	3.8885%	4.2638%
10-yr	-4.3294%	0.1028%	0.8974%	-3.3292%	5.3848%	2.0556%
b) Shifts	**2-yr**	**0%**	**10-yr**	**0%**		
TNote	Duration	Convexity	Maturity	Total Price	Coupon	Total Return
2-yr	0.0000%	0.0000%	0.3753%	0.3753%	3.8885%	4.2638%
10-yr	0.0000%	0.0000%	0.1875%	0.1875%	5.3848%	5.5723%
c) Shifts	**2-yr**	**0.5%**	**10-yr**	**0.25%**		
TNote	Duration	Convexity	Maturity	Total Price	Coupon	Total Return
2-yr	-0.9444%	0.0045%	1.3139%	0.3739%	3.8885%	4.2624%
10-yr	-2.1647%	0.0254%	0.5507%	-1.5887%	5.3848%	3.7961%
d) Shifts	**2-yr**	**1.5%**	**10-yr**	**0.5%**		
TNote	Duration	Convexity	Maturity	Total Price	Coupon	Total Return
2-yr	-2.8333%	0.0469%	3.1576%	0.3712%	3.8885%	4.2597%
10-yr	-4.3294%	0.1028%	0.8974%	-3.3292%	5.3848%	2.0556%
e) Shifts	**2-yr**	**2.5%**	**10-yr**	**1%**		
TNote	Duration	Convexity	Maturity	Total Price	Coupon	Total Return
2-yr	-4.7222%	0.1328%	4.9579%	0.3684%	3.8885%	4.2569%
10-yr	-8.6587%	0.4088%	1.5438%	-6.7061%	5.3848%	-1.3214%

Panels c-e illustrate the main result of the study. The two-year is little affected by the yield curve shift because whatever loss we may have had due to the duration effect is completely offset by the shortening maturity of our holding. That is not the case for the 10-year, but this has nothing to do with the inversion. It has all to do just with the rise in the 10-year yield.

All strategies in Table 2 have positive returns except in the extreme case of the 10-year rising by a full percentage point in Panel c.

4. The Performance of Bond Funds through a Yield Curve Inversion

The main difference between holding individual bonds and bond funds is in the maturity or time effect on the price. With individual bonds, the bond becomes shorter. In real life, this has two effects, the discounting time itself and a yield to maturity sliding down the upward sloping curve. In Table 2, we only accounted for the first effect. Individual holding bond funds, do not get either of the maturity effect on the price assuming they stay in the same fund, and the fund maintains its duration mandate.

Table 3 shows the performance of a bond fund strategy. We revalue each bond two years later shifting the yield yet assuming the same time to maturity as at the outset, and allocate the price change to the negative duration effect (along the tangent) and the positive convexity effect. We also accrue the

coupon flow, which is not reinvested to keep it simple. The total returns are lower for both strategies in all scenarios since the positive maturity effect is now zeroed out. However, the 10-year not only outperforms in the no change Panel b but also in the mild inversions paired with small moves in the 10-year in Panels c-d. When the curve inverts and rises dramatically in Panel e, both strategies have negative returns, but this time the 10-year underperforms by much less than in Table 2e scenario.

Table 3. Performance Attribution of Bond Funds with 2- and 10-yr Maturity after Two Years under Yield Shifts Up

a) Shifts	**2-yr**	**0%**	**10-yr**	**0.5%**		
TNote	**Duration**	**Convexity**	**Maturity**	**Total Price**	**Coupon**	**Total Return**
2-yr	0.0000%	0.0000%	0.0000%	0.0000%	3.8885%	3.8885%
10-yr	-4.3294%	0.1028%	0.0000%	-4.2265%	5.3848%	1.1583%
b) Shifts	**2-yr**	**0%**	**10-yr**	**0%**		
TNote	**Duration**	**Convexity**	**Maturity**	**Total Price**	**Coupon**	**Total Return**
2-yr	0.0000%	0.0000%	0.0000%	0.0000%	3.8885%	3.8885%
10-yr	0.0000%	0.0000%	0.0000%	0.0000%	5.3848%	5.3848%
c) Shifts	**2-yr**	**0.5%**	**10-yr**	**0.25%**		
TNote	**Duration**	**Convexity**	**Maturity**	**Total Price**	**Coupon**	**Total Return**
2-yr	-0.9444%	0.0045%	0.0000%	-0.9400%	3.8885%	2.9486%
10-yr	-2.1647%	0.0254%	0.0000%	-2.1393%	5.3848%	3.2455%
d) Shifts	**2-yr**	**1.5%**	**10-yr**	**0.5%**		
TNote	**Duration**	**Convexity**	**Maturity**	**Total Price**	**Coupon**	**Total Return**
2-yr	-2.8333%	0.0469%	0.0000%	-2.7864%	3.8885%	1.1021%
10-yr	-4.3294%	0.1028%	0.0000%	-4.2265%	5.3848%	1.1583%
e) Shifts	**2-yr**	**2.5%**	**10-yr**	**1%**		
TNote	**Duration**	**Convexity**	**Maturity**	**Total Price**	**Coupon**	**Total Return**
2-yr	-4.7222%	0.1328%	0.0000%	-4.5895%	3.8885%	-0.7009%
10-yr	-8.6587%	0.4088%	0.0000%	-8.2499%	5.3848%	-2.8651%

The conclusion is quite intuitive. Unless we have perfect foresight and know exactly what is going to happen to both ends of the yield curve, it is not clear that dumping a long bond fund in favor of the short one makes any sense. The longer the holding horizon, the less sense it makes. The primary determinant of the appropriate strategy is not the curve inversion but the size of the shift in the long end of the curve.

There is another finer point here. Most long bond funds (they used to be defined by Morningstar as those with the duration of 6 and higher before Morningstar switched to dynamic definitions) have full discretion over their duration as long as it is "long" (over 6). The same is true for short and intermediate funds. The press is full of accounts of long bond fund managers shortening their durations in anticipation of yield curve shifts while staying within their duration mandates. Naturally, total return funds have even more flexibility in that regard. Our argument here is that since the managers are already doing it, there is no need for investors to shift into shorter duration bond portfolios.

The last point is in regards to the use of corporate bonds, corporate bond funds and changes in corporate bond spreads. If the corporate bond spread curve is upward sloping (as it normally is), then long-term corporate bonds of the same issuer enjoy larger yield-to-maturity premia than short-term

bonds. In Tables 2-3, the 10-year Treasurys enjoyed 1.5% higher coupon flows than 2-year notes. This coupon difference is then likely to be larger for corporate bonds and is likely to fully offset any negative price effects. The way to think about it in the context of Tables 2-3 is to add to the coupon flow of the 10-year the slope of the spread curve times the day count over two years as the extra coupon.

As the curve moves up, the yield curve inverts, and the possibility of a recession rises, the spread curve will also change. The effect is likely to be different on high credit quality issuers from that on high yield issuers. Our reasoning here is consistent with the distinction between credit analysis (default and survival probability given corporate cash flow expectations) and equity analysis (with equity viewed as an option on the assets of the firm with the debt as the strike price). High-grade issuers' short term spreads may increase more than long-term spreads (even while the yield overall goes up) as they would be perceived to survive the recession without a default. The effect on subprime issuers might be opposite as their junk bonds might become substitutes for equities as the default probabilities rise toward bankruptcy. In that case, short-term spreads might be contained reflecting some probability of survival, while long-term spread would explode since their long-term bonds would become equity. Investors sticking to long-term high-grade corporate bonds and bond funds might then benefit from the positive effect of the higher coupon (relative to Treasuries) and might not suffer a larger spread widening (relative to the short bonds).

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