Factor-Based
Bond Portfolio Performance Evaluation: Evidence from US ETFs

Outline and Reading

- Outline
  - Bond ETF Performance Evaluation Using Bond Factors
  - Alphas and Betas
- Reading
  - PIMCO Monograph on Factor Investing and Asset Allocation http://www.cfapubs.org/doi/pdf/10.2470/rf.v2016.n4.1
  - Factor-Based Investing Spreads from Stocks to Bonds https://www.economist.com/finance-and-economics/2018/08/11/factor-based-investing-spreads-from-stocks-to-bonds

Fund Performance Evaluation: Alphas and Betas

- The performance of a fund, relative to benchmark portfolios or benchmark factors is often measured by its **Jensen's alpha** – the intercept in a time series regression of excess fund returns on the factor excess returns.
- Let R_{pt} = $\mathbf{R}_{pt}$-$\mathbf{R}_{ft}$ be the excess return on the fund in month t, and let $F_{1t},\ldots F_{kt}$ be the excess returns on k benchmark factors.
- Estimate the linear regression model
  $R_{pt} = \alpha + \beta_1 F_{1t} + \ldots + \beta_k F_{kt} + \varepsilon_t$
  in which $E\{R_p\} = \alpha + \beta_1 E\{F_1\} + \ldots + \beta_k E\{F_k\}$
- The **alpha** of the fund is the intercept α, which measures the mean fund return in excess of what investors should require given its exposure to the benchmark risk factors.
- The coefficients $\beta_1,\ldots, \beta_k$ indicate the fund return loadings on the factor returns, like investment weights in the factors.

Interpretation of Alphas and Betas

- The linear regression
  $R_{pt} = \alpha + \beta_1 F_{1t} + \ldots + \beta_k F_{kt} + \varepsilon_t$
  essentially breaks the excess fund return R_{pt} into
  - The return on a portfolio of the factors, $\beta_1 F_{1t} + \ldots + \beta_k F_{kt}$, with investment weights equal to the β's, and
  - a residual return $\alpha + \varepsilon_t$ that is uncorrelated with the factors and has a mean of α.
- If the fund alpha is positive, it can be shown that adding the fund to a portfolio that currently contains only the factor returns will improve its mean-variance efficiency.
- A leverage-invariant version of α is the "information ratio" = $\alpha/\mathrm{vol}\{\varepsilon\}$, which gives the alpha per unit of residual risk.

US Bond ETF Performance Evaluation

- Let's look at **estimates** of the alphas and betas of 8 US bond ETFs with respect to the bond market factors we extracted from the PCA of implied Treasury zero returns.
  - Blackrock iShares 1-3 Year Tsy Bond ETF (SHY)
  - Blackrock iShares 3-7 Year Tsy Bond ETF (IEI)
  - Blackrock iShares 7-10 Year Tsy Bond ETF (IEF)
  - Blackrock iShares 10-20 Year Tsy Bond ETF (TLH)
  - Blackrock iShares 20+ Year Tsy Bond ETF (TLT)
  - Blackrock iShares Core US Aggregate Bond ETF (AGG)
  - PIMCO Total Return Active ETF (BOND)
  - Blackrock iShares iBoxx High Yield Corporate Bond ETF (HYG)

Estimates of Fund Alphas and Betas

- To **estimate** the parameters of the linear regression model, we use data from monthly returns on the funds we're evaluating and the factors we're using as benchmarks, together with traditional regression analysis.
- We construct **ordinary-least-squares (OLS) estimates** of the alphas and betas, i.e., values of alpha and beta that minimize the sum of squares of the **residuals** of the regression (the differences between the actual fund returns and their fitted values).
- These estimates are themselves random variables (functions of the sample), which have **standard errors**, i.e., estimated standard deviations.
- We report **t-statistics** for alpha estimates, which indicate how many standard errors they are from zero.
- By convention, we reject the **null hypothesis** that the true fund alpha is zero only if its t-statistic is larger in magnitude than 2.

US Bond ETF Performance Evaluation: Estimates of 1- and 2-Factor Fund Alphas and Betas from Monthly Returns 2007-2018

ETF	Level Factor Only α	t-stat(α)	β_1	Level & Slope Factors α	t-stat(α)	β_1	β_2
1-3-Yr	0.41%	1.79	0.06	-0.01%	-0.08	0.08	0.21
3-7-Yr	0.51%	1.64	0.21	-0.11%	-1.01	0.24	0.32
7-10-Yr	-0.28%	-0.97	0.38	0.08%	0.36	0.36	-0.18
10-20-Yr	-0.72%	-0.80	0.49	0.90%	1.90	0.40	-0.83
20+-Yr	-1.73%	-0.83	0.71	1.63%	1.19	0.51	-1.72
AGG	1.01%	1.46	0.18	1.42%	2.09	0.16	-0.21
PIMCO	2.37%	3.11	0.22	2.38%	3.13	0.20	-0.10
HYG	5.77%	1.65	-0.07	6.61%	1.86	-0.12	-0.43

- Alphas from monthly regressions are annualized by multiplying by 12.
- Factor loadings of different ETFs are consistent with their stated maturity.
- High alphas of High Yield ETF are attributable to its positive equity beta, not factored out here.

US Bond ETF Performance Evaluation: Estimates of 3-Factor Fund Alphas and Betas from Monthly Returns 2007-2018

ETF	Level, Slope, and S&P500 Factors α	t-stat(α)	β_1	β_2	β_3
1-3-Yr	0.05%	0.46	0.08	0.21	-0.01
3-7-Yr	-0.11%	-1.01	0.24	0.32	0.00
7-10-Yr	0.00%	-0.01	0.36	-0.18	0.01
10-20-Yr	0.72%	1.49	0.40	-0.82	0.01
20+-Yr	2.38%	1.72	0.49	-1.74	-0.06
AGG	0.38%	0.65	0.19	-0.18	0.09
PIMCO	1.20%	1.60	0.21	-0.14	0.09
HYG	-0.52%	-0.21	0.07	-0.21	0.60

- Corporate bonds are bonds with equity-like price sensitivity.
- Including S&P500 (SPY) as a factor reduces the alphas of the funds with corporate bonds in them to statistically insignificantly different from zero.

Add bonds to your stock portfolio?

ETF	S&P500 Factor Only α	t-stat(α)	β_1
1-3-Yr	1.30%	3.74	-0.03
3-7-Yr	3.54%	3.38	-0.08
7-10-Yr	5.13%	2.73	-0.13
10-20-Yr	6.19%	2.38	-0.15
20+-Yr	8.78%	2.19	-0.29
AGG	2.99%	2.58	0.01
PIMCO	3.25%	2.26	0.00
HYG	0.47%	0.19	0.57

Add stock to your bond portfolio?

ETF	Level & Slope Factors α	t-stat(α)	β_1	β_2
S&P 500	11.91%	2.75	-0.32	-0.37

Summary

- Factor-based evaluation of US bond ETFs suggests they are achieving their investment objectives in terms of tracking their stated underlying.
- Funds with corporate bonds in them load positively on the stock market factor, consistent with theory that defaultable corporate bonds have both bond and equity-like price sensitivity, since their payoff in default depends on underlying firm value.
- We see little evidence of alpha relative to the underlying Treasury bond and stock market factors.
- The bond and stock markets are largely uncorrelated, so each offers diversification benefits (alpha) to a portfolio of the other.

Class Problem

- Suppose the fund manager doubles the fund excess returns (for better or for worse) by using leverage.
- How does this change the alpha of the fund?

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