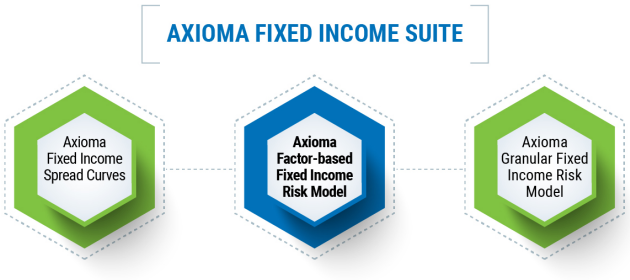

Deeper Insight Into Fixed Income Portfolios

Factor-based Attribution and Portfolio Construction with a DTS-style Risk Model

January 2020

Innovations in Fixed Income Factor Estimation

The ability to attribute portfolio risk and performance to key factors, such as overall market exposure, rates, sectors, and quality, is an essential tool for helping portfolio managers to understand their risk and interpret their results. A parsimonious factor risk model can also support advanced portfolio construction goals, such as minimizing benchmark tracking error or realizing factor exposure tilts. It is notoriously difficult, however, to build such models for bond portfolios, as a myriad of data quality concerns arises, driven by a vast, frequently illiquid market. Advanced modeling techniques are required to trim outliers and infer term structure shapes from limited and noisy data, so that the factor returns used to measure portfolio risk reliably capture systemic risk rather than noise. Factors derived from sector or rating weighted-average spread levels tend to have lower explanatory power for bond returns, suggesting risk is largely idiosyncratic. Portfolio construction and risk modeling with a parsimonious model require a more sophisticated approach.

The Axioma Factor-based Fixed Income Risk Model improves upon current risk modeling techniques in a number of innovative ways. It is derived from a spread-based cross-sectional regression on thousands of issuer-level spread returns, combined with key rate factors for sovereign rate curves. This provides portfolio and risk managers with an unprecedented ability to analyze fixed income factors with detailed insight into systemic risk, including style factors such as value and momentum, as well as issuer specific risk estimated natively through the regression. Coverage includes corporate, emerging market hard currency, agency and sovereign bonds. Major challenges that arise in other fixed income risk models, such as thin sector factors, strong sensitivity to ratings migration, volatility estimates dominated by noisy data instead of risk signals, etc., have been addressed through sophisticated data processing and advanced curve-construction techniques. Key innovations of the risk model include:

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- **Risk Entity**: New methodology identifies debt-issuing entities within complex organizational hierarchies for the purpose of curve building. This allows bonds with similar risk profiles to be mapped to issuer curves and assigned appropriate country and sector of risk, while separating out bonds with different risk characteristics. Proper issuer classification greatly improves the stability and accuracy of issuer curves over traditional ultimate parent or single subsidiary approaches.
- **Issuer Curves**: Proprietary methodology allows the construction of over 11,000 full term structure issuer spread curves and issuer spread return curves on a daily basis with a 15-year history, leveraging sophisticated outlier detection to produce robust, market-consistent spread curves that are stable through time. Well-constructed, stable issuer spread returns are crucial in estimating factor returns with strongly significant explanatory power.
- **Issuer and Issue-Specific Risk**: The issuer-specific risk is captured natively in the cross-sectional model through the residual in the regression, coupled with a shrinkage estimator linked to a curve quality measure. Issue-specific risk is then captured as additional variance derived from deviations of bond spread returns from issuer spread returns, stabilized through the use of a second shrinkage estimator. The noise is greatly reduced in this approach compared to sector-average models, where spread residuals are used directly to estimate specific risk.
- **DTS-based Factors**: By using relative issuer spread returns in the cross-sectional regression to estimate factor returns, bond-specific duration times spread (DTS) naturally pairs with the factor exposure in the bond portfolio risk model. Here the DTS component is computed as price sensitivity to relative changes in spread, while factor exposures are derived from fundamental issuer characteristics or z-score transformations of factor descriptors.
- **Fixed Income Style Factors**: In addition to market, currency and sector factors, the cross-sectional regression framework allows us to estimate style factor returns for the risk model based on issuer spread and bond characteristics. Factors include beta to the market return, momentum, value, steepness and size. Inclusion of these factors in the risk model is important for optimal portfolio construction of factor tilt and smart beta portfolios, as well as for risk attribution.

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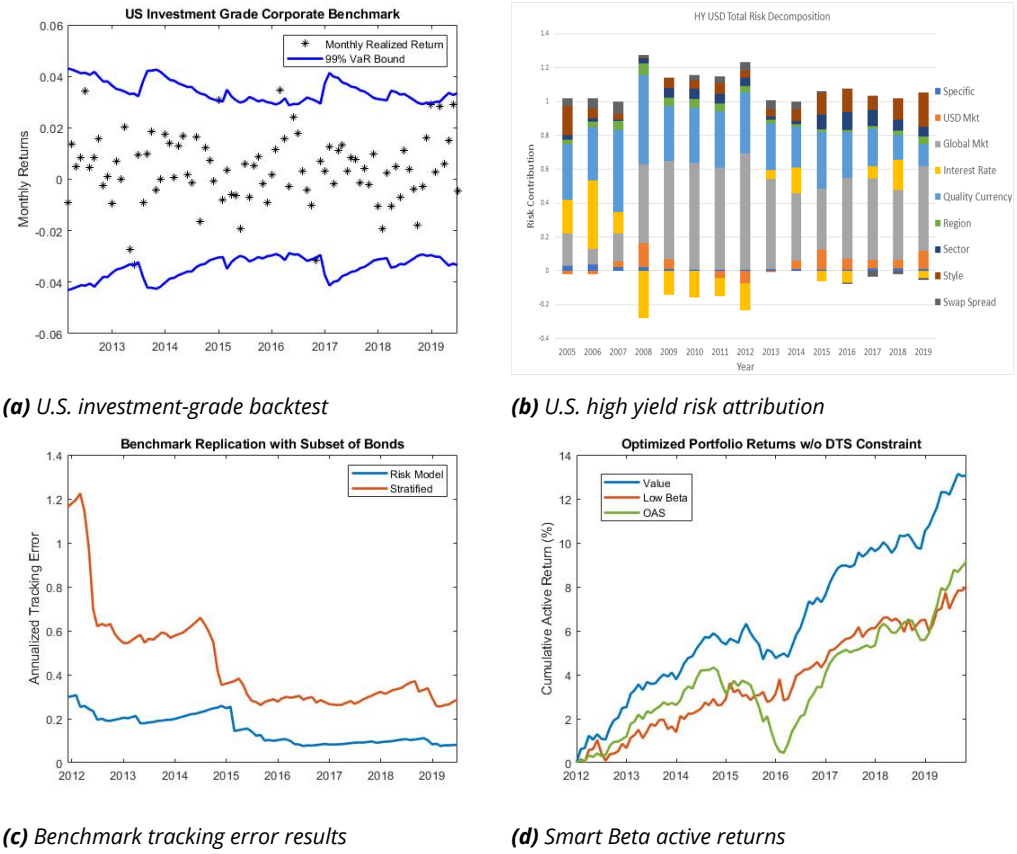
Exceptional Risk Analysis and Portfolio-Construction Capabilities

These innovations allow the new factor-based fixed income risk model to deliver superior results along a number of dimensions, as highlighted in Figure 1.



(a) *U.S. investment-grade backtest*

(b) *U.S. high yield risk attribution*

(c) *Benchmark tracking error results*

(d) *Smart Beta active returns*

Figure 1: *Risk analysis and portfolio construction results obtained with the new Axioma Factor-based Fixed Income Risk Model*

Chart 1a shows a backtest for monthly returns of a U.S. investment-grade corporate benchmark portfolio. The predicted two-sided 99% risk confidence interval is also plotted. The results show that the predicted risk tracks the realized return volatility well, and that the 99% risk boundary captures the extreme returns accurately with two relatively small exceedances over the 90 months.

Chart 1b shows the risk attribution over time of a US high yield benchmark portfolio, illustrating how, in times of market stress, rate risk can have a diversifying effect, as well as the varying degree to which the market, sector and style factors contribute to risk.

Chart 1c shows the minimized tracking error of a replicating portfolio for a liquid US investment-grade benchmark that holds between 240 and 1,000 bonds (compared with the benchmark's 600 to 2,500 bonds through time). For reference, results are shown for a more standard stratified sampling tracking portfolio that matches duration and sector weights. This suggests that overall tracking risk can be

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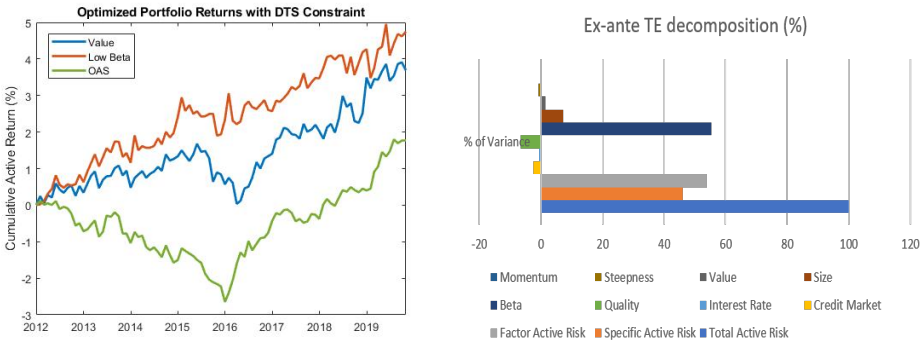

(a) *DTS-constrained Smart Beta active returns* ***(b)*** *Low Beta DTS-constrained risk decomposition*

Figure 2: *Concentrated factor exposure obtained through key rate duration and DTS neutrality relative to the benchmark.*

lowered when some DTS and sector overweights are allowed (key-rate durations have been matched to within 0.01 years), and thus provides an additional tool that may be applied in benchmark replication.

Finally, Chart 1d shows the cumulative return results for an investment grade smart-beta portfolio construction exercise, in which portfolios are rebalanced monthly using the factor risk model to optimize exposure to the various style factors subject to tracking error, turn-over, key-rate duration and other constraints, while allowing some active credit market exposure by not imposing constraints on DTS exposure. The period studied is the relatively benign credit environment since the beginning of 2012, and the results for the Value (blue) and Low Beta (red) strategies are shown. For reference, a simple strategy of maximizing the option-adjusted spread of the portfolio (green) is also plotted. The results suggest that the style factors earn significant positive active returns relative to the benchmark over this period.

In Figure 2, the results are shown for portfolios constrained to have weighted average DTS exposure within 0.005 of the benchmark DTS exposure, leading to a more pure factor exposure. Chart 2a shows the cumulative active returns for portfolios rebalanced on a monthly basis to maximize exposure to the Value and Low Beta factors, subject to the DTS and other benchmark tracking constraints, along with the corresponding OAS-maximizing portfolio returns for reference. The overall active performance is more muted compared with Chart 1d as the ability to take active market positions has been limited. The restriction on taking larger active spread positions impacts OAS and Value the most, with Low Beta retaining much of its performance.

Most interesting, however, is how the DTS constraint leads to a more focused exposure to the factor, as can be seen in the risk decomposition for the Low Beta strategy shown in Chart 2b. Here we see that 55% of the total active variance comes from the Low Beta factor, corresponding to over 100% of the total systematic active variance (due to the negative correlation of certain factors). Thus the risk models provides a mechanism for constructing a portfolio where the desired factor risk dominates the risk of all other factors as well as the specific risk while still tracking the benchmark.

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Unprecedented Coverage and Flexibility

Beyond the 5,000 issuer spread curves that form the estimation universe for the factor risk model, there are more than 12,000 additional issuer and rating-sector-currency aggregate curves produced daily, with more than 15 years of history, available for DTS-exposure calculation and issue specific risk estimation offering unprecedented levels of risk coverage. For example, over 94% of the Global Agg bonds that are within scope of the coverage of the new spread risk model can, in fact, be mapped to issuer-specific spread curves, while the remaining bonds can be fully covered by the aggregate curves. For portfolio construction, when coupled with Axioma Portfolio Optimizer™, the new factor-based fixed income risk model offers a new realm of analysis capabilities.

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