Why Build Fixed Income Credit Curves?

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Constructing fixed income factor models has long been an elusive endeavour owing to a number of challenges, not least of which includes cleansing and organizing the underlying fixed income data, or lack thereof. In this article, we take a look at how we build credit curves to serve as a foundation for fixed income models and the advantages they have over some other methodologies.

Deciding what to model

We want to understand the composition of the total return of a bond, which includes both known and unknown returns. With this information, we can build the risk-and-return profile of a whole portfolio.

We do not need to model known returns (or carry) because this is what the holder expects to receive, unless the issuer defaults. In contrast, we do need to model unknown return and its associated risk, which depends upon price movements.

Underlying interest rates determine a significant portion of bond returns, and while this portion is greatest for higher-rated bonds, the same is still true for all but the very lowest quality credit. Indeed, many credit portfolios are managed with the duration and curve risk hedged out and a separate manager or internal desk dealing with interest rate risk. To align with the way these portfolios are managed, we separate rates from credit spread.

It is now clear what we should model: the risk and return due to changes in spread.

How should we model it?

Different use cases require different answers to this question. For some portfolios a risk model with highly granular factors is appropriate[1], while for others it makes more sense to reduce the number of risk factors to something more manageable.

Much of the literature on creating bond factors recommends ranking all bonds by exposure to a specified factor and bucketing them. At Axioma, we instead isolate individual factors through cross-sectional regression on returns. Why we do this, is beyond the scope of this article, so here we only note that this approach requires solving

Equation 1

$$\boldsymbol{r} = \boldsymbol{B}\boldsymbol{f} + \varepsilon$$

where $\boldsymbol{r}$ is our vector of (known) returns on a single day, $\boldsymbol{B}$ is our matrix of (known) exposures to factors, $\boldsymbol{f}$ is the vector of factor returns we seek to determine, and ε is the vector of residuals we seek to minimize.

Cross-sectional regression with bond data

We could calculate returns r from spread changes or from bond returns in excess of, for instance, a duration-matched government bond or interest rate swap. With perfect or even good data, these approaches could work,

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although the number of bonds could still be a limitation. However, bond data are often not good. Bonds mature: they have rolled prices, missing prices, and price spikes.This poses a real problem for factor construction and for risk modelling in general, which can be quite unforgiving of poor data quality if care is not taken. To clean these data, we need to infer from other bonds what the spread should be.

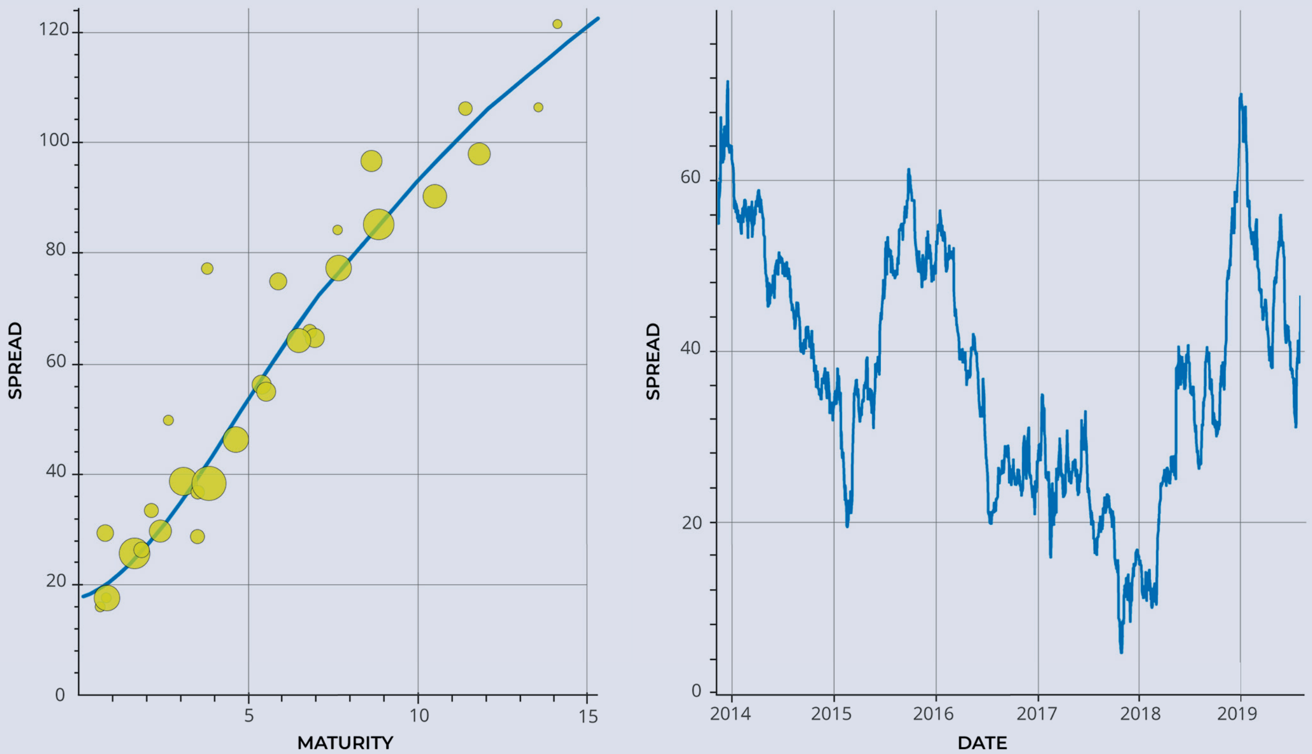
Estimating Specific Risk

Cross-sectional regression needs only the priced bonds, not every bond on every day. For risk calculations, however, the volatility of returns usually requires an estimate of specific risk, vol(ε), which requires a time series. Hence, calculating volatility of returns for new bonds is especially difficult. Instead of relying on a time series, we could set a constant volatility across all bonds, or we could assign different volatilities to investment-grade bonds and to high-yield bonds. To achieve a higher level of granularity, we bucket bonds by currency, issuer, and degree of subordination.

Tackling the Issuers

Shrinking the estimation universe reduces the hazards of using the full set of bonds, but taking a single issuer return for all securities of a given issuer and treating any differences separately seems a step too far. Equity and senior bonds from a single issuer can exhibit very low correlation,

Figure 1: A credit curve built from bonds



(a) Term structure on a single date

(b) 5-year tenor point of the curve through time

Source: Axioma

as can senior and subordinated bonds, albeit to a lesser extent. A single return for each combination of issuer and subordination level is more realistic. This single return can be achieved in several ways:

1. **By selecting a series of on-the-run bonds**
   This is harder than it sounds: the series needs to be maintained, the bonds will have varying maturities, and each bond's maturity will shorten through time until that bond is replaced by a longer-dated one.
2. **By creating an average return**
   This needs to be robust, so outliers need to be removed from a mean. We shouldn't jump between single bonds, so taking the median return wouldn't work. Like the previous approach, this one suffers from maturity mismatches.
3. **By building a credit curve**
   With sufficient effort, we can build a robust curve from which we derive a constant-maturity bond return that overcomes many problems associated with on-the-run bonds and average returns. In particular, it is possible to limit the impact of missing or erroneous prices of a single bond at any given point in time. Curves can therefore be used as a way of retaining the signal coming from bond prices, while removing a lot of the noise.

The advantages of using curves

As Figure 1 illustrates, Axioma builds curves by currency, issuer, and level of subordination.

It is return measures derived from these curves that give us both our vector of returns r in Equation 1 above and the returns we rely on in the granular model. Moreover, unlike an average, a curve has shape, which we can use as we progress from modelling issuer returns to modelling bond returns. Whether for a factor model or a granular risk model, it is this robust approach to building credit curves, combined with duration times spread (DTS) measures, which we believe provides a more responsive model with superior back-testing and estimation capabilities. In development for several years, our proprietary methodology solves for the main challenges inherent in other fixed income risk models. This enhanced visibility ensures that portfolio managers, risk managers and central risk book owners are able to model all corporate and non-corporate credit risk accurately across their portfolios. «

1 Visit www.axioma.com/insights/fixed-income-risk/ to learn more about Axioma's Fixed Income Credit Risk Model.