This document outlines concepts related to collecting, assigning, and warehousing formula- or model-based bond characteristics.

**Measures of value, longevity, and risk**

General Concepts

Measures of value, longevity, and risk are derived from a price and a set of cash flows (i.e., timing and magnitude of coupon and principal income:

Value measures: Yield and Spread

Yield is a measure of the potential income to be derived from the bond.

Spread is the distance between a bond’s yield and the yield of a treasury with a comparable longevity or a comparable duration. Spread measures the compensation to the investor for the bond’s embedded risk.

Longevity measures: Weighted Average Life and Term to Maturity

Weighted Average Life is the average time to receipt of principal.

Term to Maturity is the time to receipt of the final principal payment. For a non-amortizing security without embedded options, Weighted Average Life and Term to Maturity are the same.

Risk measures: Duration and Convexity

Duration is a measure of the price sensitivity of a bond. Typically, when speaking of a bond’s “duration,” it is in reference to interest-rate duration, i.e., the sensitivity of a bond’s price to a change in the level of treasury rates.

Duration is a first-order effect. Convexity quantifies the portion of price sensitivity not explained by duration.

Spread duration is a specific form of duration that measures the price sensitivity of a bond to changes in spread.

Each measure is associated with a formula. Armed with a price, cash-flow series, and formula, one can readily calculate the bond characteristic. Bond characteristics determined in this manner are said to be *formula-based*. *Spread* is somewhat of an oddity among the formula-based measures; although the formula is a straightforward difference between two yields, the identification of the benchmark yield requires the term structure of treasury rates. Accordingly, spread, unlike the other measures, involves knowledge apart from bond structure.

Price is readily observable, but for certain bond structures, the same may not be true for cash flow. For these structures, cash flow depends on the future path of treasury rates and, as a consequence, the flows cannot be known a priori. When cash flows are not known with certainty, one of two courses of action can be taken to calculate measures of value, longevity, and risk:

* Make two assumptions: (a) define the future path of rates in accordance with the shape of the current yield curve, and (b) exercise the bond’s embedded options rationally. Under these assumptions, we can identify the bond’s most likely redemption date, and from there, can apply formulae to calculate bond characteristics.
* Alternatively, we rely on a model to simulate treasury-rate scenarios. For each simulated trajectory, the model determines the cash-flow series that is likely to result, and applies the standard formulae to derive the yield, weighted average life, duration, etc. If 100 simulation trials were performed, there would be 100 sets of formula-based bond characteristics (one set associated with each simulated trajectory of treasury rates). Most models are agnostic with respect to which simulated rate path is likely to be realized; the model takes a simple average across the simulated results to arrive at the *model-based* measures.

My introductory remarks signal three distinct forms for measures of value, longevity, and risk:

* a formula-based measure that assumes the bond’s maturity is the most likely redemption date
* a formula-based measure that identifies a redemption date other than the stated final maturity
* a model-based measure

Each of these formats associates a naming convention to the various measures as outlined below.

Formula- Formula-

Based To Based To

Measure Maturity Most Likely Model-Based

Yield Yield to Maturity Yield to Worst Effective Yield

Spread Spread to Maturity Spread to Worst Option-Adjusted Spread

Interest-Rate Modified Duration

Duration Modified Duration to Worst Effective Duration

Convexity Convexity Convexity to Worst Effective Convexity

Spread Spread Duration Option-Adjusted

Duration Spread Duration to Worst Spread Duration

Weighted Weighted Average Weighted Average

Average Life Life Life Effective Maturity

Term to Term to Anticipated Term to Maturity/

Maturity Maturity Term to Call Stated Final Term to Maturity

In the second column, the “to Worst” designation implies the most likely redemption date for a callable security is the redemption date associated with the lowest yield. In other words, given the choice between calling a bond and allowing it to extend to maturity, an issuer will compare the prevailing yield to call and the yield to maturity, then exercise the call option if the yield to call is lower than the yield to maturity; in other words, the *lowest* (or *worst*) yield is associated with the most likely redemption date. If the yield to call is lower than the yield to maturity, it provides the issuer an advantage, under the current interest rate environment, to call the bond and re-issue at current rates for the remainder of the bond’s term, rather than allow the bond to remain outstanding to maturity.

When securities have embedded put options, the most likely redemption date is associated with the “best” yield. For this reason, I would prefer to rename the characteristics in the second column as Yield to Most Likely, Modified Duration to Most Likely, etc. However, the “Most Likely” moniker is rarely employed. As a result, although the yield assigned to a putable bond is its yield to best, the yield is entered in a column labeled Yield to Worst in a typical portfolio appraisal report; callable bonds are far more common than putables, making it inefficient to open a new column for Yield-to-Best and have the column populated for only one or two bonds.

In conclusion, setup templates for all security types should have fields for:

Yield to Maturity

Yield to Worst

Effective Yield

Spread to Worst

Option-Adjusted Spread

Modified Duration

Modified Duration to Worst

Effective Duration

Empirical Duration (see discussion below)

Spread Duration

Convexity

Convexity to Worst

Effective Convexity

Term to Maturity

Weighted Average Life

Effective Maturity

[note: I am not suggesting each of these data items must be populated. However, having each of them available can advance our current capabilities to report on the data.]

Convertible bonds may require additional measures of value and risk. Please refer to our current convertible-bond setup template to identify relevant measures of value or risk for convertibles that I may have omitted above.

As will be discussed shortly, it is unlikely each field would be populated for every bond. Instead, should the field be required for a given report, business rules will be available to infer a value when it is missing,

Thus far, we have spoken of formula-based and model-based measures. For risk measures, such as duration, there is a third possible format labeled *empirical.* An empirical measure is derived from market behavior. We know that price action of a bond may not conform precisely to theory; as a consequence, formula- or model-based measures of duration and convexity may not adequately predict price sensitivity. When this occurs, some market participants infer measures of risk from series of daily, weekly, or monthly observations. If a portfolio manager does not find either a model- or formula-based interest-rate duration to be credible, then the availability of an empirical duration field enables us to step in front of the formula or model with an empirically-derived value.

Protocols for sourcing and assigning data

When considering mechanisms for calculating measures of value, longevity, and risk, one option is to source the measures, whether formula- or model-based, from a third party for every security. Under this paradigm, cusips and prices flow to the third-party package at the end of the day, the package crunches numbers during the night, generates a fresh set of calculated measures, then delivers a file from which data can be uploaded. At the moment, we are not aware of a third-party package that has complete coverage of our security set. There is the further downside of cost (licensing fees; CPU charges), and I also do not advocate this approach for two other reasons:

* the approach establishes a vendor dependency from which it would be difficult to disengage
* the approach introduces hefty business risk: the success of portfolio data management hinges on the reliability of the third-party package – if the package fails to deliver results prior to the beginning of the day, then the entire process is shutdown.

Formula-based measures can be sourced from

* Portia analytics
* Bloomberg
* YieldBook
* home-grown spreadsheets
* Index providers (If we have access to an index provider’s constituents, we could potentially map our securities to index-based securities, then abstract the characteristics assigned by the index provider. Doing so, however, requires the leap of faith that a reasonably close correspondence exists between our price and that of the index provider. For corporates, agency debentures, treasuries, and municipals, the mapping process is *not* advisable except when the price correspondence is exact.)

Model-based measures can be sourced from

* Bloomberg
* YieldBook
* Index providers

Our current protocol is as follows:

1. Portia calculates modified duration to worst, modified duration to maturity, term to maturity, yield to worst, yield to maturity, and convexity for every security.

*It is* ***not*** *worthwhile to silence Portia analytics as some may have suggested.* Portia does a credible job under certain circumstances. Specifically, Portia’s values are accurate for fixed-rate non-amortizing securities with either no embedded options or with a *discrete* set of embedded options. My hope is that Portia’s calculations can also be extended to

* Fixed-rate non-amortizing securities with embedded continuous options
* Fixed-rate amortizing bonds with a well-defined amortization schedule
* Floating-rate securities

Digressing for a moment about the distinction between discrete (European style) and continuous (American style) options …. a discrete option is one where the option can be exercised only on a given date while, in contrast, a continuous option can be exercised any time on or after the date with prior notice (usually 30 days). Portia’s current shortcoming is the inability to distinguish between continuous and discrete options. Portia assumes all options are discrete. In so doing, when an option date passes, Portia improperly assumes the option is no longer active. It should not be too much of a stretch to recalibrate Portia so that it continuously rolls the earliest option 30 days forward until the next option date or the maturity date is hit. In this manner, a continuous option is modeled as a discrete option to which Portia’s formula-based measures are amenable.

The ability to handle amortization schedules would be helpful as it would enable Portia to calculate weighted average life for an amortizing bond with a well-defined schedule (such as a sinking fund).

1. Fixed-rate non-amortizing corporate bonds with continuous options

Override Portia’s yield-to-worst and modified duration-to-worst with values abstracted from an Open Bloomberg spreadsheet. My hope, as noted above, is to obviate this step after the upgrade.

1. Bank Loans

Set modified duration = 0.25 years

Typically, a bank loan’s coupon is not known at issuance, and the bond is initially modeled in Portia with a zero coupon. While the bond is in Portia with a zero coupon, we calculate the bond’s yield-to-maturity in a spreadsheet using Excel’s YIELD function. We continue this process until the bond’s coupon is reset in Portia and, at that time, we release the override to allow Portia to calculate the yield going forward.

Spread duration = term to maturity

1. Convertible Bonds **(only those owned in Global Fixed Income portfolios)**

For convertible bonds with non-zero coupons:

Set Yield = Current Yield = Coupon / Price

For convertible bonds with zero coupons:

If price < 100, then set Yield = (100 – price) / days to maturity

Otherwise, set Yield = 1%

The yield calculations are done in a spreadsheet.

1. Common equity **(only those owned in Global Fixed Income portfolios)**

Set modified duration to maturity = 0

Set yield to maturity = 0

Set weighted average life = 0

1. Agency mortgage passthroughs

The Barclays mortgage index is comprised of generics, with each generic representing a collection of specified pools with similar program, coupon, and vintage. “Program” refers to the issuer and loan type (for example, FNMA 30-year loans) and “vintage” refers to the loans’ year of origination. Whenever it is possible to map our mortgage passthroughs to a mortgage generic, we abstract the effective duration, yield to worst, weighted average life, spread duration, and effective convexity from the Barclays constituents file.

1. Securitizations of residential mortgages originated by an entity other than a government-sponsored or government-related agency

Yield to worst is calculated via a spreadsheet model.

Effective duration and weighted average life are calculated via Open Bloomberg.

Spread duration is set equal to weighted average life.

Option adjusted spread = yield-to-worst less 50 basis points

Convexity set equal to zero.

1. All other securities in Global Fixed Income portfolios (except municipals)

Securities that do not meet any of the prior criteria are collected and analyzed in YieldBook. YieldBook calculates effective duration, yield to worst, weighted average life, spread duration, and effective convexity.

1. Municipals

The Municipals group has asked Global Fixed Income not to override Portia’s assigned values for Yield and Duration for any municipals held in the Global Fixed Income portfolios. Once we have a more robust security setup that provides multiple distinct and carefully defined fields for a given risk measure (e.g., modified duration to maturity, modified duration to worst, effective duration) then we will not be faced with the current ambiguity of what a measure (such as duration) refers to. At that time, I doubt if the Municipals group would object to Global Fixed Income populating values for a variety of these fields (like modified duration-to-worst or effective duration). For municipals with sinking fund schedules, properly calculating a formula-based measure such as modified duration-to-worst or weighted average life needs to be done outside of Portia (in a tool such as YieldBook or Bloomberg) because Portia currently does not comprehend the amortization schedule. However, the Municipals group currently chooses not to do so.

1. Option Adjusted Spread

Some clients may have a standing (monthly or quarterly) request for the average option adjusted spread of their portfolio. With the exception of the non-agency securitizations of residential mortgages (see no. 8, above), securities in these portfolios are collected and passed through YieldBook to determine their option-adjusted spread. The option-adjusted spreads of the non-agency residential mortgage-backed securities are determined as outlined in paragraph 8. Bloomberg can also function as a credible source of OAS for sectors (such as corporates) other than securitized product.

Data override process

Currently, for reporting purposes in Portia, there is basically one (generic) field assigned to each of Yield, Interest-Rate Duration, and Term to Maturity. I would prefer to have Portia maintain multiple fields related to these measures, as outlined on page 3, to distinguish and preserve the various types of formula- and model-based bond characteristics. In turn, there will be less need to override, with the upload process instead turning into one of filling boxes, rather than one of correcting data calculations that lie outside Portia’s scope; in other words, distinct fields would accommodate a variety of formula- and model-based characteristics, and these can be drawn upon as needed.

This section outlines the decision rules currently in place to override Portia-calculated measures of value, longevity, and risk. Before turning to the rules, I want to first comment on the upload process. My sense, from the tone of your document, is the anticipation of a straight-through process where data is generated by the analytics source, collected in a spreadsheet or some other file format, then uploaded into the data management system on a scheduled basis. This “hands-off” approach requires careful consideration. I believe it is best to review the data prior to the upload stage so faulty data can be identified and corrected instead of blindly pushing it through, then collecting errors on an exceptions list at the start of the next business day.

The upload currently occurs weekly using close of Friday prices and at month-end using month-end prices. Ideally, the process would occur daily, though this requires someone to work in the evenings and the early morning hours to ensure the portfolios are ready to go at the start of the next business day. Frankly, the absence of this “graveyard shift” resource makes daily uploads impractical. By implementing the weekly process using Friday closes, we have the weekend as breathing space. Currently, the YieldBook import files are typically prepared following the availability of the end-of-day price file. The import files are uploaded to YieldBook and the bonds preliminarily processed to determine if any will be kicked out. The rejects are reviewed and remedial action taken to workaround these issues. The preparatory YieldBook operations are typically completed within one hour of the availability of IDC’s prices in Portia. A batch script schedules the complete analysis for early the next day. The processed file is retrieved from YieldBook on Saturday or Sunday, and the results are assembled in spreadsheet, along with calculated measures from other sources. From here, Portia grabs the data.

By 9:00 PM on Friday evening, the Barclays index constituents file should be ready at the Barclays website. Once the data is available, we can complete our mapping operation for agency mortgage passthroughs, then pass the data to the (staging area) spreadsheet from which Portia would draw the data. On Friday evenings, we can also refresh the Bloomberg-sourced data by passing prices to our Open Bloomberg spreadsheets, thereby permitting the spreadsheets to call the applicable Bloomberg functions.

After the calculated measures are uploaded to Portia, the data is scanned to identify large changes from prior stored values and also identify outliers whose level may be suspect (e.g., a negative yield associated with a taxable bond). Once the data is checked and verified, we re-generate reports that were created by the Portia night job on Friday evening.

The month-end process works similarly, with preparatory steps taken as far as they can go on the evening of the last business day of the month. The validation and report-generation steps are undertaken as early as possible the following morning. Obviously, a month ending on a Friday is always welcome for this gives us the weekend to roll into the new month.

Some security setups might have generic fields for duration, yield, and longevity. If third-party sourced data is available for the characteristic, then it overrides the Portia assigned value. The overwritten value remains in the field until the next override. When a Portia report references one of the measures in a generic fashion, our preferred priority scheme for populating the field is to use a model-based measure (e.g., effective duration) if available; otherwise, we use the formula-based measure to worst; and, if the measure to worst is unavailable, we fall back on the formula-based measure to maturity. Post-upgrade, I envision much the same priority scheme. However, the concept of a Portia data override changes if distinct fields can be set aside for formula-based and model-based characteristics. Once again, referring to page 3, I advocate for a variety of fields (e.g., possible measures of interest-rate duration = {modified duration, modified duration to worst, effective duration, and empirical duration}). Portia might have the wherewithal to calculate the first two (formula-based) measures while the third (model-based) measure is externally sourced and the fourth (empirical) is proprietary. There is no notion of an override; all four measures are preserved, with the model-based measure given priority should a report simply refer to a generic concept, such as “duration.”

**Security Master File**

Objectives

With respect to establishing and maintaining a security master file (SMF), my wish-list of objectives is:

* Develop an efficient approach to transfer a security’s structure and characteristics to the portfolio administration system and the order management system
* Define and implement processes that
* expedite the setup of new issues
* minimize manual collection and input of data
* improve quality control
* disintermediate Compliance from the process
* ensure data is current and setup is complete
* Define security templates that become de facto MacKay standards for our various security types.
* Establish protocols, clearly articulating responsibilities of all agents involved in the process.
* Capitalize on the firm’s collective experience, maintain best practices and structures, relieve bottlenecks, and shore-up weak links.

The process should be implemented for all security types resident at MacKay:

* Corporate bonds
* Bank loans
* Treasuries
* Agency debentures
* Mortgage-backed securities
* Asset-backed securities
* Money-market instruments
* Convertible bonds
* Municipals
* Common equity and equity-linked securities (warrants, options, etc.)
* Credit default swaps
* Current forwards
* Special situations (e.g., PIK bonds)

Vision for Security Setup

Each security-type has a template. The template represents a common standard adopted by all product areas for an asset classes’ comprehensive definition, and is the starting point for security setup. Each data field in the template is assigned one of three labels: priority, mandatory, or optional. By definition, priority fields are mandatory. Each field has a set of potential sources from which the data can originate.

Setup occurs in two phases. The mechanics of phase 1 diverge for securities currently being marketed and those available in the secondary; for phase 2, the mechanics converge.

Phase 1 is the initial security definition. This is a collection of priority data fields which, when taken together, offer a sufficient representation of the security to enable trading through the order management system. A security definition cannot transfer to the order management system unless all priority fields are populated. For securities purchased through the secondary market, the majority of the template should be populated electronically. For securities purchased through the primary market, user intervention will be required.

A centralized data management group (to be formed) takes initial ownership of Phase 1 and should make a best effort to provide accurate data. Some data, such as coupon, may not be known at setup, but if the field is a member of the priority set, a best estimate should be provided. Like the coupon, a maturity date may not be known precisely; however, submitting 2041 as the maturity year, when the maturity year is 2021 is unacceptable. The Phase 1 setup is returned to the product area for review. The product area must accept responsibilities for the consequences of faulty data, such as mistakenly enabling the order management system to include a portfolio within a block trade.

At the close of business, a routine identifies

* securities that were in Phase 1 setup during the day
* securities that have been dormant in Portia and which have re-entered the portfolios after an absence

For each of these securities, an email is generated and sent to the applicable product area and the data management group. This is the start of Phase 2 of the setup. The email contains an annotated review sheet. The review sheet disaggregates the security’s structure in accordance with the security template, identifies data fields that have been populated including their initial values and data source, identifies fields that are empty and mandatory, and identifies fields that are empty and optional. The data management group is initially responsible for carefully scrutinizing the review sheet for accuracy and completeness. Particular attention should be paid to mandatory fields that are empty and fields where calculated data has been sourced from Portia. The latter are likely to be characteristics subject to interpretation (e.g., yield); for these, the product area may prefer to source interpretative data elsewhere (e.g., YieldBook).

At the end of each day, an automated routine generates emails for each security currently in Phase 2 setup. The emails (containing a revised review sheet) are distributed to the applicable product areas. Phase 2 either ends the next morning when the product area signs off on the validity and completeness of the setup, or continues with the data management group if further review is required.

As an ancillary step, a process will be developed to de-populate fields associated with externally-sourced data whenever a security goes dormant (i.e., when the security is no longer resident in any portfolio). This avoids calculated data going stale in the SMF and potentially causing problems should the security revisit the portfolios at some point in the future.

Finally, we should preserve existing processes for ensuring characteristic data (such as ratings) remains current.

Data perspectives

I think it helpful for motivating discussion about security setup and maintenance of SMF data were we to define a vernacular to classify security attributes. Below, I offer three such perspectives, each of which has relevance within a different context.

1. **Precedence**

In the prior section, I had defined three levels of data significance:

- Priority

- Mandatory

- Optional

1. **Temporal**

* Static
* Dynamic

Most data items that define a bond’s attribute tend to be dynamic, i.e., the data items are changeable over time. Few static attributes come to mind.

1. **Source**

* Retrieved – single value

Examples: An issuer’s name is retrieved from the prospectus, via Bloomberg.

Ratings are retrieved from Moody’s, S&P, Fitch, via Bloomberg

* Retrieved – schedule

Examples: coupon schedule retrieved via Bloomberg

call schedule retrieved via Bloomberg

amortization schedule retrieved via the prospectus

* Derived

A derived data attribute is one whose value is derived from retrieved data by simple mathematical or logical operations

Examples: a floating-rate coupon is the sum of an index value and a margin.

a factor is the quotient of an outstanding balance and an original balance

a numeric equivalent to an S&P rating (e.g., BBB+ = 10; BBB = 11; etc.)

* Calculated

A formula-based measure, a model-based measure, or an empirical measure