

## **FolioBeyond Fixed Income Algorithm**

### **Summary**

FolioBeyond's fixed income model is an advanced factor-based optimization algorithm that captures the major drivers of performance and risk in the bond markets. It is a robust, automated institutional quality algorithm calibrated with proper out-of-sample and sensitivity testing. It is designed to provide an optimal framework for enhancing portfolio allocations using advanced analytical techniques while systematically incorporating all the major relevant factors that impact performance of bond sectors. This algorithmic process is automated and updated daily with current market prices and analytical measures. It can also be utilized for fixed income portfolio applications in various financial industry verticals. Additionally, the model is highly customizable, and it can be tuned to match the requirements of specific investment criteria and risk goals.

### **Market Dynamics**

Fixed income markets are driven by quantitative factors that are measurable using various analytical tools. On a high level, the market is generally dominated by institutional players who utilize advanced portfolio and risk management tools to manage investment portfolios and asset/liability profiles of balance sheets. Retail investors, therefore, have a distinct disadvantage in lacking the proper tools to evaluate fixed income products. Institutional investors, however, have varying degrees of expertise in applying advanced analytical methods for portfolio management. Additionally, there are various risk, accounting, and regulatory constraints that govern and constrain the investment and rebalancing activities of different types of institutions. For example, insurance companies may be ratings-driven with a focus on insurance industry-specific ratings produced by the NAIC. Bank investors are constrained by regulatory capital requirements as well as asset/liability limitations based on their mix of deposits and other funding maturities. Pensions are driven by longer term liability requirements. In summary, the portfolio management processes of varied participants in the marketplace create both temporary and longer-term dislocations and opportunities.

### **Model Description**

The above backdrop relating to fixed income market dynamics implies that a robust, algorithmic asset allocation process will be able to capture alpha generation opportunities and monetize both income and total return opportunities. A robust model will need to utilize a proper combination of tool sets that encapsulate both theoretical analytical measures and practical secondary market considerations. With these dynamic market factors in mind, FolioBeyond has developed and calibrated a state-of-the-art, advanced algorithmic process for optimizing portfolio allocations across a diverse set of risk return profiles in the fixed income industry. The major aspects of our model are described below:

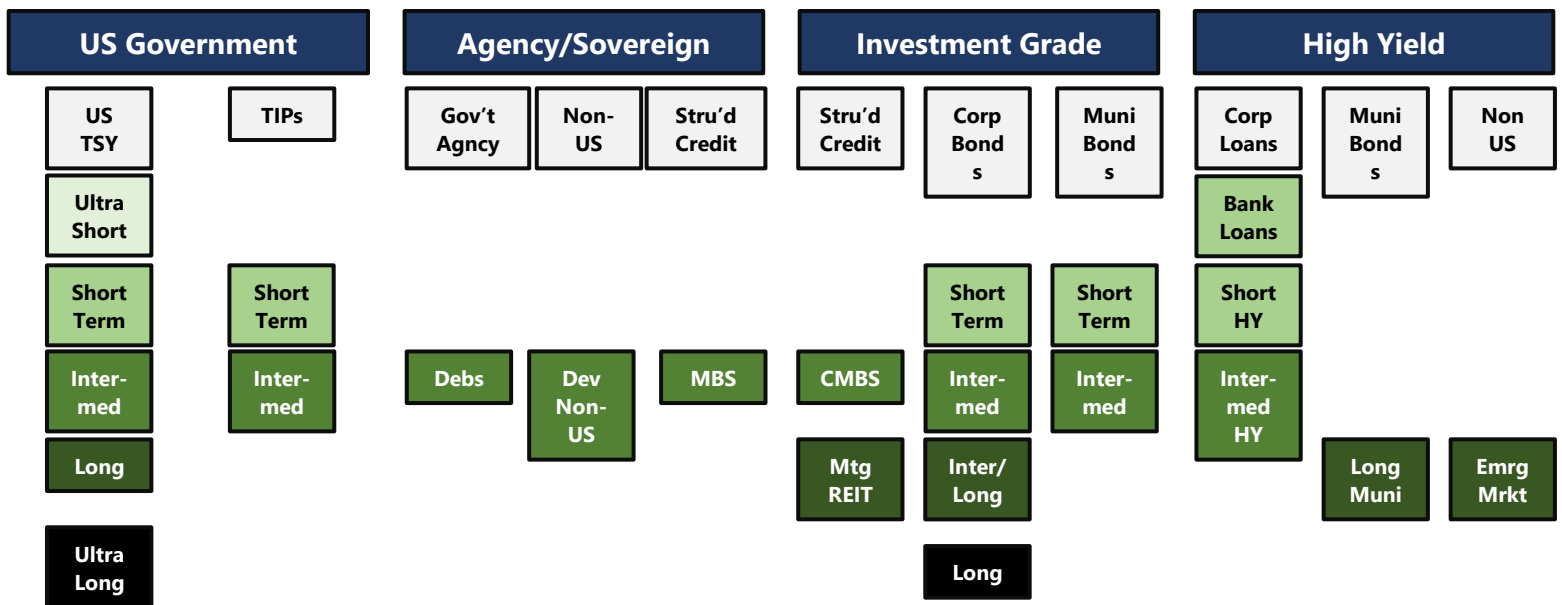
- Forward-looking yield and return measures are quantified, adjusted for effects of options (e.g. prepayment risk in MBS, callable risk in corporate bonds), defaults, inflation, taxes, and other relevant variables. This allows the model to compare relative value on a net, adjusted-yield basis. In contrast, most of the automated tools currently available in the marketplace rely on backward looking returns which can lead to significant mis-valuation of fixed income instruments. These basic models were generally designed for equity markets and have been inappropriately applied to fixed income instruments.
- Risk is measured on a multi-dimensional basis, combining momentum effects, historical and implied volatility levels, correlations and stress testing.

- Momentum is captured using a proprietary two-factor momentum model that captures both short- and long-term momentum effects. This momentum variable is then directly linked to the risk level in the optimization model. Various structural aspects of the fixed income markets, as discussed above, result in the persistence of both short-term and longer-term momentum effects in the secondary markets.
  - Recent historical return volatility is used as the initial foundation for measuring the base level of risk. However, it is critical to incorporate current implied volatility levels to measure forward-looking risk levels. Implied volatility as measured in the swaption market is used to scale historical volatility appropriately.
  - Correlation effects are captured by computing the recent cross-correlations across all sub-sectors of the markets.
  - Stress testing is performed based on one of the most stressful time periods the markets have experienced (Q3/Q4 of 2008). The model is constrained to limit the downside under this scenario. This constraint captures the adverse movements of fixed income instruments during periods of illiquidity and serves to limit the downside in these environments.
- The various factors of the model described above are all incorporated into an advanced optimization framework that optimizes portfolio allocations subject to various risk constraints. Our base model targets the return volatility of the Bloomberg Barclays U.S. Aggregate Bond Index (“AGG”) and dynamically optimizes portfolio allocations across the 23 sector ETFs we have carefully identified and are listed below. Historical simulations going back to 2005 has shown our algorithm to outperform the AGG by more than 200 basis points annually.
  - The rebalancing threshold is a feature of the model that reduces excessive rebalancing transactions. It specifies a deviation of risk versus the target that would trigger a rebalancing of the portfolio. Currently, our base model has this threshold set to a level that, on average, leads to a minor portfolio rebalancing once or twice a month.

### **ETF Components**

The continual growth of sector ETFs in the fixed income markets during the past ten years has made effective implementation of dynamic, algorithmic, asset allocation strategies a viable and potentially optimal alternative. FolioBeyond has performed extensive analysis of the ETF space and our well-calibrated, algorithmic strategy allows investors to maximize their return targets while adhering to specific risk and sector constraints.

The underlying components included in performing our portfolio optimization is currently based on 23 sub-sector ETFs in the fixed income market. We have carefully reviewed the major fixed income ETFs and selected best-of-breed ETF products representing 23 discrete sub-sectors, with exposures defined based on credit, duration and product type as summarized in the chart below. It is important to note that these components can be varied and customized with significant flexibility. For example, the components can be restricted to investment grade sectors to produce a high-grade strategy. Another example would be to use firm-specific products (including mutual funds, custom portfolios or other types of fund entities) to provide optimized solutions. Subject to being able to run both historical and ongoing analytics on the underlying holdings, our existing modeling framework can be utilized to produce optimized portfolio solutions. This potential customization is described further below.



### Customization

FolioBeyond's algorithms have been designed for easy customization to address specific applications. Some examples of customization features are:

- Easily modify suite of allowable investment components in models
- Include partner products in the mix (e.g. bank CDs, mutual funds, ETFs, or insurance products)
- Adjust tuning dials to control total market exposure
- Control drawdown risk versus upside
- Layer on additional risk and sector constraints
  - Duration constraints for fixed income-oriented portfolios
  - Cap on sub-IG credit, emerging market exposure, or other sectors
  - Exclude specific equity sub-sectors as required

### Conclusion

Fixed income markets are diverse with unique but quantifiable variables that impact risk and return. FolioBeyond's algorithmic asset allocation process aims to optimize portfolio allocations to maximize returns while maintaining desired risk targets. The sector rotation alpha generated from this systematic approach emanates from efficiently capitalizing on changing valuations, momentum effects and risk parameters to capture excess returns based on a robust, quantitative approach. The algorithm was developed and calibrated over multiple years combining FolioBeyond's experience and expertise in fixed income asset management, risk management, secondary market trading and advanced quantitative modelling. The end result is a highly efficient and effective approach for maximizing risk-adjusted returns at low cost using a robust modeling framework.