

## US Aggregate Enhanced Yield Index

The Bloomberg Barclays US Aggregate Enhanced Yield Index uses a rules-based approach to reweight sub-components of the flagship US Aggregate Index with the goal of achieving a higher yield, while broadly retaining the risk characteristics of the underlying benchmark. Yield can typically be increased by shifting exposure along any of a number of different risk dimensions, including sector exposure (i.e., Treasury, agency, credit, securitized), interest rate risk (i.e., duration) and credit risk (i.e., spread). Since the US Aggregate Enhanced Yield Index is designed to broadly preserve the risk characteristics of the US Aggregate Index, risk is quantified as tracking error against it. The index was launched in June 2015, with history backfilled to August 2002.

### Historical Average Yields - US Aggregate Enhanced Yield vs US Aggregate



### Summary Statistics - US Aggregate Enhanced Yield vs US Aggregate

	US Agg Enhanced Yield	US Agg
Annualized total return	4.94%	4.43%
Annualized volatility	4.12%	3.45%
Total return / volatility	1.20	1.28
Realized TEV vs. US Agg	33bp	
Duration	6.96	5.95
Yield	3.14	2.57
Additional yield vs US Agg	0.57%	
Average additional yield since inception	0.64%	

Note: Data as of February 2017. Annualized return and volatility values calculated since August 2002.

### Methodology & Calculations

#### Overview

The index uses a rules-based approach to reweight the US Aggregate Index such that yield is increased, while risk characteristics are broadly preserved. Four steps are used in the calculation of weights/allocations and returns/statistics:

1. Specification of Buckets
2. Determination of Constraints
3. Determination of Bucket Weights
4. Calculation of Returns and Statistics

#### Step 1:

#### Specification of Buckets

The Enhanced Yield Index reweights major sub-components of the US Aggregate Index (rather than individual securities) using 20 "buckets" (Figure 1). The buckets are chosen to allow for meaningful yield differentials between components based on their primary risk characteristics (sector, duration and credit quality), while retaining adequate size for liquidity and trading purposes. Individual securities within each bucket retain identical market value weights between the Enhanced Yield Index and the US Aggregate Index.

Figure 1. Buckets Comprising the US Aggregate Enhanced Yield Index

Risk Dimension	Rates		Spread		
	Sector	Treasury	Agency	Credit	
Bucket	Tsy	Tsy 1-5 Yr	Agy 1-5 Yr	Credit 1-5 Yr Aaa-Aa	Credit 5-10 Yr Baa
		Tsy 5-10 Yr	Agy 5-10 Yr	Credit 1-5 Yr A	Long Credit Aaa-Aa
		Long Tsy	Long Agy	Credit 1-5 Yr Baa	Long Credit A
	Credit			Credit 5-10 Yr Aaa-Aa	MBS Conv 30 Yr
				Credit 5-10 Yr A	MBS Conv 15 Yr
					MBS GNMA 30 Yr

## Methodology & Weight Calculations

<b>Step 2:</b>	An optimizer is used to set the weight of each of the 20 bucket in the Enhanced Yield Index with the objective of maximizing the yield of the index, subject to certain constraints that are designed to control risk and limit turnover. The optimizer is subject to the following constraints:
	<ul style="list-style-type: none"> <li>The forecasted tracking error volatility (TEV) of the Enhanced Yield Index relative to the US Aggregate is less than 35bp/mo.</li> <li>The duration of the Enhanced Yield Index cannot be more than one year longer than the duration of the US Aggregate.</li> <li>The notional weight of each Enhanced Yield Index bucket in Figure 1 cannot deviate from its weight in the US Aggregate by more than 10%, except for CMBS and ABS, which cannot deviate by more than 5%.</li> <li>The total notional weight of each of the asset classes in Figure 1 (Treasuries, agency, credit and securitized) cannot deviate from their weights in the US Aggregate by more than 20%, 10%, 20% and 20% respectively.</li> <li>The total notional weight of the Baa buckets in the Enhanced Yield Index (US Credit 1–5 Year Baa, US Credit 5–10 Year Baa and US Long Credit Baa) cannot deviate from their total notional weight in the US Aggregate by more than 20%.</li> <li>The portfolio turnover due to monthly reweighting of the buckets must be less than 5% per month.</li> <li>In the event that the optimizer cannot find a solution given the above constraints, the turnover limit shall be increased by 1% in a step-wise fashion until a solution is found.</li> </ul>

<b>Step 3:</b>	Using May 2015 month-end weights, the following example demonstrates how the weights within the Enhanced Yield Index were determined for June 2015. Figure 2 shows the yield, market value and weight of each bucket in the US Aggregate Index. As additional constraints are added to the optimizer (whose objective is to maximize yield), the effect on each bucket's weight is shown. In practice, constraints are not actually added sequentially, but rather, the weights are derived with all the constraints simultaneously in place.
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Figure 2. Sequential Optimization of Index Bucket Weights by Constraints

Enhanced Yield Index Bucket	Change in Weight vs US Aggregate Weight								Final Enhanced Yield Weight (I)
	Bucket Yield in US Agg	Bucket Weight in US Agg	No Constraints (D)	TEV Constraint (E)	+ Duration Constraint (F)	+ Weight Deviation Constraints (G)	+ Turnover Constraint (F)		
Tsy 1–5 Year	0.89%	22.0%	-22.0%	-22.0%	-22.0%	-10.0%	-10.0%	12.0%	
Tsy 5–10 Year	1.86%	9.6%	-9.6%	-9.6%	-9.6%	-4.6%	-6.3%	3.2%	
Long Tsy	2.80%	5.0%	-5.0%	-5.0%	-5.0%	-5.0%	-3.3%	1.8%	
Agy 1–5 Year	0.98%	2.6%	-2.6%	-2.6%	-2.6%	-2.6%	-2.6%	0.0%	
Agy 5–10 Year	2.19%	0.3%	-0.3%	-0.3%	-0.3%	-0.3%	-0.3%	0.0%	
Long Agy	3.04%	0.3%	-0.3%	6.2%	6.2%	1.7%	-0.3%	0.0%	
Credit 1–5 Yr Aaa-Aa	1.17%	3.5%	-3.5%	-3.5%	-3.5%	-3.5%	-3.5%	0.0%	
Credit 1–5 Yr A	1.71%	5.0%	-5.0%	-5.0%	-5.0%	-5.0%	-5.0%	0.0%	
Credit 1–5 Yr Baa	2.27%	3.8%	-3.8%	24.7%	24.7%	2.7%	1.3%	5.1%	
Credit 5–10 Yr Aaa-Aa	2.42%	1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	0.0%	
Credit 5–10 Yr A	2.94%	3.1%	-3.1%	-3.1%	-3.1%	7.5%	9.9%	13.0%	
Credit 5–10 Yr Baa	3.58%	4.4%	-4.4%	37.3%	37.3%	9.6%	9.6%	14.0%	
Long Credit Aaa-Aa	3.96%	1.2%	-1.2%	9.0%	9.0%	-1.2%	-0.1%	1.1%	
Long Credit A	4.33%	3.5%	-3.5%	-3.5%	-3.5%	2.9%	-0.6%	2.9%	
Long Credit Baa	4.96%	4.5%	95.5%	-4.5%	-4.5%	7.0%	8.5%	12.9%	
Aggregate CMBS	2.28%	2.0%	-2.0%	-2.0%	-2.0%	5.0%	5.0%	7.0%	
ABS	1.42%	0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	0.0%	
MBS Conv 30 Yr	2.14%	15.8%	-15.8%	-2.8%	-2.8%	9.2%	8.6%	24.4%	
MBS Conv 15 Yr	1.56%	3.8%	-3.8%	-3.8%	-3.8%	-3.8%	-3.8%	0.0%	
MBS GNMA 30 Yr	1.80%	7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-4.9%	2.6%	
<b>Index Yield<sup>1</sup></b>	<b>2.06%</b>		<b>4.96%</b>	<b>3.02%</b>	<b>3.02%</b>	<b>2.76%</b>	<b>2.75%</b>	<b>2.75%</b>	

<sup>1</sup>Yield is not the published US Aggregate yield-to-worst. Weighted average yield is based on yield-to-worst for all index buckets except for the three mortgage buckets: US MBS 30 Yr Conventional, US MBS 15 Yr Conventional, and US MBS GNMA 30 Yr. For these buckets, the yield used is calculated as the yield-to-worst of a Treasury bond whose maturity matches the average life of the mortgage security plus the option-adjusted spread (OAS) of the mortgage security.

## Methodology & Weight Calculations

Step 3: Determination of Bucket Weights (continued)	Discussion of Impact of Each Constraint on Index Bucket Weights	
	Constraint	Impacts
	No Constraints (Column D)	If no constraints were imposed, the bucket with the highest yield would be assigned 100% of the weight (eg, the Long Credit Baa bucket weight would have increased by 95.5%, while the weight of the other buckets would be set to 0, and the index would have a yield of 4.96%).
TEV Constraints (Column E)		An index containing long maturity, Baa- rated credit securities only is not very similar in nature to the broad-based US Aggregate Index. Its forecasted TEV is 223bp/mo, indicating its riskiness with respect to the US Aggregate. In order to create a yield enhanced index that retains the broad risk characteristics of the US Aggregate, a forecasted tracking error volatility constraint of 35bp/mo (Constraint 1 in Figure 2) is introduced. After applying this constraint, the resulting portfolio no longer includes Long Credit Baa bonds because its yield is not as attractive as several other buckets (Long Agency, Credit 1–5 Year Baa, Credit 5–10 Year Baa, Long Credit Aaa–Aa and MBS Conventional 30 Year). This portfolio has a forecasted tracking error of 35bp/mo and a yield of 3.02%, both lower than the corresponding TEV and yield of the unconstrained version. More detailed information on the TEV calculation can be found below in the section "Calculation of Tracking Error Volatility".
Duration Constraint (Column F)		Further constraints are introduced on duration, weight deviations and turnover to control the risk of the final index. The application of the duration constraint in this example (Constraint 2 in Figure 2) had no effect on the weights since the TEV constraint selected a portfolio that resulted in a duration that was less than one year longer than that of the US Aggregate.
Weight Deviation Constraints (Column G)		The results of applying the various weight deviation constraints (Constraints 3–5 in Figure 2) are shown in Column G. At this stage, many of the highest and lowest yielding buckets have been allocated all of, or are close to, their maximum overweight or underweight allocations and no bucket deviates from its market value weight by more than 10%. ABS is overweight by the maximum allowed 5%; total credit exposure is overweight nearly 20%; and total Treasury exposure is underweight nearly 20%. The introduction of this constraint lowers the index yield.
Turnover Constraint (Column H)		Finally, the turnover constraint is applied to limit excessive rebalancing and trading costs. Normally, weights should not deviate by large amounts month-over-month since relative yields and risk estimates across buckets typically would not change dramatically from one month to the next. However, in especially volatile environments, the forecasted risk of an asset class may change by a considerable amount resulting in large, undesired weight changes. The turnover constraint reduces this rebalancing activity and guides the portfolio to adapt to a new risk environment smoothly over time, rather than bearing large portfolio turnover and trading costs in stressed market environments. The introduction of this constraint resulted in some changes in weight for the June 2015 rebalance, but did not significantly lower the overall index yield.
The final portfolio weights are shown in Column I. The Enhanced Yield Index for June 2015 has a yield of 2.75%, nearly 70bp higher than the market value weighted average yield of the buckets, while maintaining diversification across asset classes and maintaining a forecasted tracking error of 35bp/mo.		
Step 4: Calculation of Returns and Statistics	Once the weights are derived for each of the 20 buckets, total return is calculated by multiplying the weight of the bucket by its month-to-date return (e.g., to calculate the total return for June 2015, the weights derived in Figure 2, Column I will be multiplied by the total return of the corresponding bucket and then summed). While total return is the official measure of performance of the index, excess return (return over duration neutral Treasuries) is also published. Several average statistics for the index are also calculated by multiplying the bucket weight by the corresponding statistic of that bucket. Average statistics published include: option-adjusted duration (OAD), yield, price, and option-adjusted spread (OAS).	

## Yield and Tracking Error Volatility Calculations

Yield Calculation	Yields used in the optimization for determining the bucket weights are based on yield-to-worst except for the three mortgage buckets: US MBS 30 Yr Conventional, US MBS 15 Yr Conventional, and US MBS GNMA 30 Yr. For these buckets, the yield used is calculated as the yield-to-worst of a Treasury bond whose maturity matches the average life of the mortgage security plus the option-adjusted spread (OAS) of the mortgage security
Determination of TEV	The forecasted tracking error volatility (TEVi) of each bucket in the Enhanced Yield Index is a function of the deviation of the bucket's weight ( $w_i$ ) from the US Aggregate and the forecasted covariance of its returns ( $\Sigma$ ) with that of all the other buckets' returns. This can be expressed as the following: $TEVi = (\text{wt } \Sigma)w_i$ . The TEV of the Enhanced Yield Index is the sum of the TEV of each of the 20 buckets. The forecasted covariance matrix of the buckets' returns is constructed from exponentially-weighted moving averages of the volatilities and correlations of the buckets' historical returns. Volatilities and correlations are forecasted separately to allow for slightly different models to be used to appropriately forecast the volatilities of different buckets as well as to reduce measurement error that can be present in joint estimation.

## Yield and Tracking Error Volatility Calculations

For all the buckets in the "Rates" asset class in Figure 1, volatility is forecasted from historical total return volatility. For the buckets in the "Spread" asset class Figure 1, we incorporate a forward-looking risk measure, DTS, to better forecast volatility. We first decompose the returns of these buckets into a rates component and a spread component. The volatility of the rates component is forecasted from historical returns volatility, as it is with all the buckets in the Rates asset class. The volatility of the spread component, however, is forecasted using Duration Times Spread (DTS<sup>2</sup>). This measure incorporates current market information (spreads) and, thus, is more responsive to changes in market environments and risk than historical estimates.

## Rebalancing Rules

<b>Frequency</b>	For each index, Bloomberg maintains two universes of securities: the Returns (Backward) and the Projected (Forward) Universes. The composition of the Returns Universe is rebalanced at each month-end and represents the fixed set of bonds on which index returns are calculated for the next month. The Projected Universe is a forward-looking projection that changes daily to reflect issues dropping out of and entering the index but is not used for return calculations. On the last business day of the month (the rebalancing date), the composition of the latest Projected Universe becomes the Returns Universe for the following month.
<b>Index Changes</b>	During the month, indicative changes to securities (credit rating change, sector reclassification, amount outstanding changes, corporate actions, and ticker changes) are reflected daily in the Projected and Returns Universe of the index. These changes may cause bonds to enter or fall out of the Projected Universe of the index on a daily basis, but will affect the composition of the Returns Universe at month-end only, when the index is next rebalanced.
<b>Reinvestment of Cash Flows</b>	Intra-month cash flows from interest and principal payments contribute to monthly index returns but are not reinvested at a short-term reinvestment rate between rebalance dates. At each rebalancing, cash is effectively reinvested into the returns universe for the following month so that index results over two or more months reflect monthly compounding.
<b>New Issues</b>	Qualifying securities issued, but not necessarily settled on or before the month-end rebalancing date, qualify for inclusion in the following month's index if the required security reference information and pricing are readily available.

## Pricing and Related Issues

<b>Sources &amp; Frequency</b>	<ul style="list-style-type: none"> <li>Most index-eligible bonds are priced on a daily basis by Bloomberg's evaluated pricing service, BVAL. Some market segments are priced by 3rd party pricing sources.</li> <li>MBS generics are priced daily based on a weighted average price of underlying pools. The pools are priced by BVAL on a same-day settlement basis.</li> </ul>
<b>Pricing Quotes</b>	Bonds can be quoted in a variety of ways, including nominal spreads over benchmark securities/treasuries, spreads over swap curves, or direct price quotes as a percentage of par. For securities quoted on a spread basis, daily security price changes will result from movements in the underlying curve (swap or treasury) and/or changes in the quoted spread. Prices from third-party sources are quoted as a percentage of par.
<b>Timing</b>	<ul style="list-style-type: none"> <li>3pm (New York time) for all securities except taxable municipal bonds which use 4pm (New York time).</li> <li>On early market close, prices are taken as of 1pm (New York time), unless otherwise noted.</li> <li>If the last business day of the month is a public holiday, prices from the previous business day are used.</li> </ul>
<b>Bid or Offer Side</b>	Bonds in the index are priced on the bid side. The initial price for new corporate issues entering the index is the offer side; after the first month, the bid price is used.
<b>Settlement Assumptions</b>	T+1 calendar day settlement basis for all securities. At month-end, settlement is assumed to be the first calendar day of the following month, even if the last business day is not the last day of the month, to allow for one full month of accrued interest to be calculated.
<b>Verification</b>	Daily price moves for each security are analyzed by the index pricing team to identify outliers. Index users may also challenge price levels, which are then reviewed and updated as needed using input from various sources.
<b>Currency Hedging</b>	Returns hedged to various non-USD currencies are published for the US Aggregate Enhanced Yield Index. The indices' FX hedging methodology takes rolling one-month forward contracts that are reset at the end of each month and hedges each non-reporting currency-denominated bond in the index into the reporting currency terms. No adjustment is made to the hedge during the month to account for price movements of constituent securities in the returns universe of the index.
<b>Calendar</b>	The US Aggregate Enhanced Yield Index follows the US bond market holiday schedule.

<sup>2</sup> Excess returns due to spread changes can be decomposed into duration times the spread change, and further decomposed into DTS times the percentage spread change:  $ER \cong -D * \delta S = -D * S * \frac{\delta S}{S} = -DTS * \frac{\delta S}{S}$ . The volatility of percentage spread changes tends to be relatively stable; thus, excess return volatility is roughly proportional to DTS. Since DTS includes current spreads (i.e., the latest market information), the DTS-based forecast allows the model to be more responsive to changes in perceived risk.

May 2, 2017

### Monthly Returns in USD, 2006-2017 (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTD
Year	-0.02	0.56	-1.34	-0.27	-0.27	0.18	1.54	1.82	1.04	0.82	1.38	-0.77	4.72
2006	-0.01	1.83	-0.32	0.67	-0.84	-0.48	0.35	1.03	0.86	1.10	0.90	0.28	5.48
2008	0.98	-0.35	0.02	0.26	-0.58	-0.37	-0.29	0.75	-2.62	-4.01	2.42	3.75	-0.26
2009	-0.52	-0.47	1.53	0.62	1.11	0.72	1.88	1.32	1.36	0.54	1.31	-1.65	7.96
2010	1.90	0.54	-0.05	1.41	0.84	1.92	1.32	1.78	0.40	0.31	-0.72	-1.41	8.50
2011	0.24	0.48	0.04	1.55	1.53	-0.55	2.01	1.46	0.76	0.20	-0.17	1.44	9.33
2012	1.30	0.22	-0.63	1.39	1.09	0.17	1.83	0.26	0.43	0.59	0.19	-0.13	6.89
2013	-0.81	0.62	0.14	1.37	-2.14	-2.32	0.27	-0.68	1.10	1.17	-0.55	-0.41	-2.31
2014	1.71	0.82	-0.03	1.16	1.44	0.19	-0.30	1.30	-1.01	1.11	0.72	0.03	7.34
2015	2.22	-0.76	0.41	-0.39	-0.40	-1.52	0.64	-0.41	0.59	0.31	-0.28	-0.66	-0.30
2016	0.97	0.80	1.69	0.77	0.05	2.18	1.03	0.08	-0.11	-0.81	-2.74	0.28	4.17
2017	0.34	0.94	-0.04	1.04	-	-	-	-	-	-	-	-	2.30

### Accessing Index Data

Bloomberg Professional® service	Bloomberg benchmarks are the global standard for capital markets investors. <ul style="list-style-type: none"> <li>INDEX&lt;Go&gt; – The Bloomberg Indices Introduction page is a dashboard for index-related information on the terminal. Find daily and monthly index returns for key indices from each index family as well as index publications including methodologies, factsheets, monthly reports, updates and alerts.</li> <li>IN&lt;Go&gt; – The Bloomberg Index Browser displays the latest performance results and statistics for the indices as well as history. IN presents the indices that make up Bloomberg's global, multi-asset class index families into a hierarchical view, facilitating navigation and comparisons. The "My Indices" tab allows a user to focus on a set of favorite indices.</li> <li>PORT&lt;Go&gt; – Bloomberg's Portfolio &amp; Risk Analytics solution includes tools to analyze the risk, return, and current structure of indices. PORT includes tools to analyze performance of a portfolio versus a benchmark as well as models for performance attribution, tracking error analysis, value-at-risk, scenario analysis, and optimization.</li> <li>DES&lt;Go&gt; – The index description page provides transparency into the current and projected index universe including membership information, aggregated characteristics and returns, and historical data.</li> </ul>
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Data Distribution	Index subscribers may choose to receive index data in files. Files may include: <ul style="list-style-type: none"> <li>Index level and/or constituent level returns and characteristics for any indices</li> <li>Automatic delivery of files via email or SFTP following the completion of the index production process after market close</li> <li>Clients may receive standard files or may customize file contents</li> <li>Index data is also available via authorized redistributors</li> </ul>

May 2, 2017

## Bloomberg Total Return Index Value Tickers

Ticker (USD Unhedged)	Index	Ticker (CAD Unhedged)	Index
BAYDTRUU	US Aggregate Enhanced Yield	BAYDTRDU	US Aggregate Enhanced Yield

Total Return Index Values are available in other currencies and on a hedged basis. Attributes such as yield and duration, are also available. Please refer to Accessing Bloomberg Barclays Index Data Using Bloomberg Tickers for a full list of tickers and attributes that are available.

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