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March 2018

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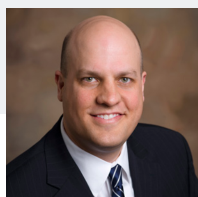
Fixed Income
A UNIQUE APPROACH TO BOND INDEXING



Robert Larkins, CFA
Portfolio Manager, US Aggregate Bond Index Strategy

EXECUTIVE SUMMARY

- By design, passive fixed income strategies routinely fall short of benchmark performance after deducting management fees, while accepting tracking error as an inevitable part of the indexing process.
- Recognizing that there will always be some amount of inherent tracking error, the T. Rowe Price US Aggregate Bond Index Strategy explicitly targets a low, "index like" level of tracking error. We aim to convert it into a modest amount of positive excess return, with the goal of matching or slightly exceeding benchmark returns after expenses.
- To achieve this objective, we capitalize on the structural inefficiencies of the Bloomberg Barclays U.S. Aggregate Bond Index. We focus on less volatile sources of return within the benchmark to optimize yield, while replicating key index risk factors to minimize tracking error.
- A secondary aspect of our approach is to take advantage of T. Rowe Price's credit research capabilities to seek to generate incremental alpha and manage risk.
- Our bond index strategy has a track record of generating minimal tracking error and consistent net-of-fee index performance. The average passive strategy, in contrast, experienced performance volatility versus the index but provided no compensating excess return.

As the debate about the pros and cons of active versus passive management rages on, investment vehicles that track market indexes have continued to garner robust cash flows, steadily gaining market share from their active counterparts. Once largely an equity phenomenon, passive investing has more recently gained momentum in fixed income. A large portion of these passive fixed income flows have poured into strategies that attempt to mirror the Bloomberg Barclays U.S. Aggregate Bond Index as investors seek low-cost, high-quality bond portfolios to generate income and hedge equity risk. In an effort to consistently deliver benchmark returns after expenses, T. Rowe Price has developed a unique approach to bond indexing that capitalizes on the bond market's structural inefficiencies to optimize returns while carefully matching key index risk factors.

TRACKING ERROR UNAVOIDABLE WITH BOND INDEXING

Notwithstanding the proliferation of passively managed fixed income assets, "pure passive"—or full index replication—is not viable using conventional bond benchmarks. While it is possible to fully replicate equity benchmarks such as the S&P 500 Index, which focuses on the largest, most liquid U.S. stocks, bond

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indexes are a more complex animal. The widely followed Bloomberg Barclays U.S. Aggregate Bond Index, for example, includes more than 9,500 individual bonds from disparate sectors with varying degrees of liquidity and efficiency.

Bond benchmarks experience significantly higher turnover than common equity indexes. New issuance, maturities, early redemptions, and credit rating changes are among the factors that cause the composition of bond indexes to continually change. This is problematic in largely over-the-counter bond markets, where specific bond issues are often not available in the desired size, and trading costs can be punitive to performance.

Due to these sorts of challenges, bond index strategies use various sampling techniques to approximate index sector weightings and risk characteristics. Sampling bias, along with transaction costs and cash flow disparities, leads to inherent tracking error—or volatility in portfolio returns relative to benchmark returns. Tracking error is essentially a measure of how closely portfolio performance follows the index and is an inevitable part of any indexing strategy.

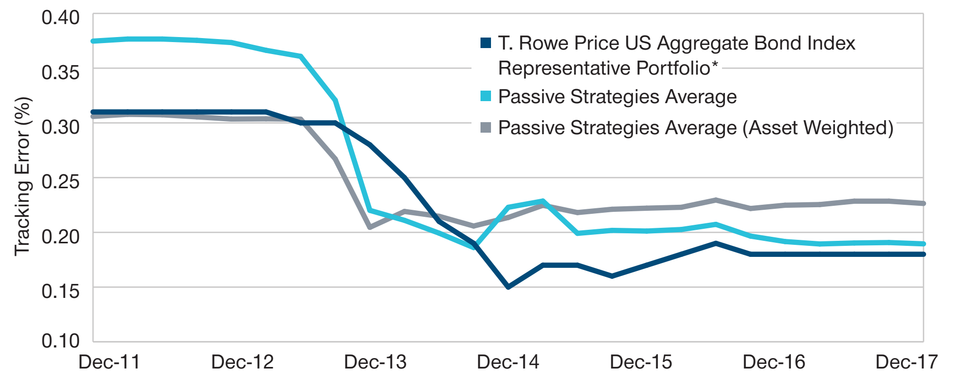
A BETTER APPROACH TO INDEXING

Like its passive peers, the T. Rowe Price US Aggregate Bond Index Strategy also strives to track the index closely. But rather than simply seeking to minimize tracking error, we target a low "index like" tracking error that is in line with passive peers. To guide portfolio construction, we employ a multifactor risk model to forecast tracking error and isolate the sources of risk. As shown in Figure 1, the strategy's tracking error has been consistent with its passive institutional peers over time.[1]

The key difference between our approach to bond indexing and that of the typical passive strategy is how we think about tracking error. By design, passive strategies routinely fall short of benchmark performance after deducting management fees, while accepting tracking error as part of the process. We believe there is a better approach: Rather than simply accepting tracking error as an inevitable part of indexing, we aim to convert it into a modest amount of positive excess return in order to match or slightly exceed benchmark returns after expenses.

FIGURE 1: **Tracking Error Comparison**

Q4 2011–Q4 2017



Sources: eVestment and T. Rowe Price.

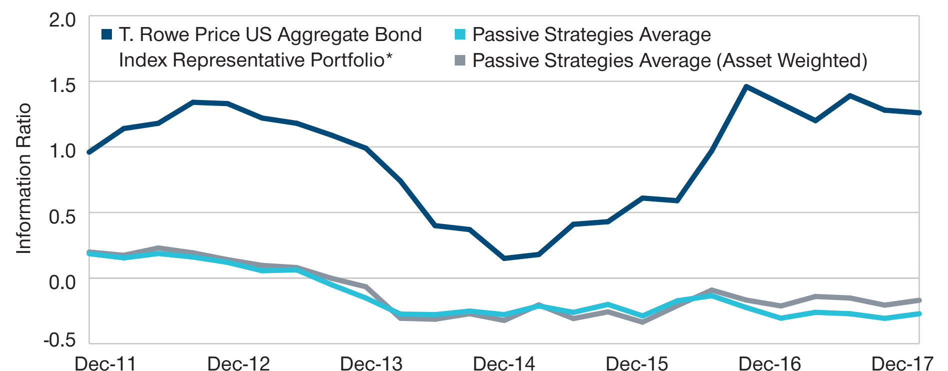
Annualized (rolling 60-month periods calculated quarterly). Tracking error calculation for the T. Rowe Price US Aggregate Bond Index Representative Portfolio based on 3 p.m. ET pricing versus the benchmark.

Past performance cannot guarantee future results. Quarterly statistics are based on gross returns. Returns would have been lower as the result of the deduction of applicable fees.

*The representative portfolio is an account in the composite we believe most closely reflects current portfolio management style for the strategy. Performance is not a consideration in the selection of the representative portfolio. Information regarding the representative portfolio and, where applicable, the other accounts in the composite is available upon request. Please see the GIPS® Disclosure page for additional information on the composite. Supplemental information.

FIGURE 2: **Information Ratio Comparison**

Q4 2011–Q4 2017



Sources: eVestment and T. Rowe Price.

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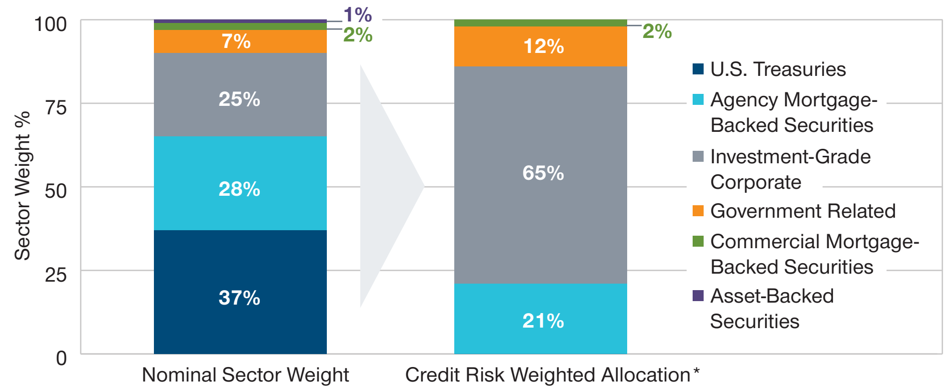
[1]Please see Appendix A for passive peer group construction methodology.

As depicted in Figure 2, the strategy has consistently generated a positive information ratio, which measures a portfolio's excess returns versus the benchmark per unit of tracking error. This indicates that we have generated low tracking error volatility and successfully transformed much of it into a modest amount of alpha. The average passive strategy, in contrast, generated volatility versus the index but provided no compensating excess return.

FIGURE 3: Nominal Index Sector Weights Provide Limited Insight Into Credit Risk

Bloomberg Barclays U.S. Aggregate Bond Index, as of December 31, 2017



Source: Barclays POINT.

*Calculated as each spread sector's percentage contribution to total benchmark spread volatility. Treasuries are excluded from the chart on the right because they are assumed to be free of credit risk.

Source for Bloomberg Barclays index data: Bloomberg Index Services Ltd. Copyright ©2018. Bloomberg Index Services Ltd. Used with permission.

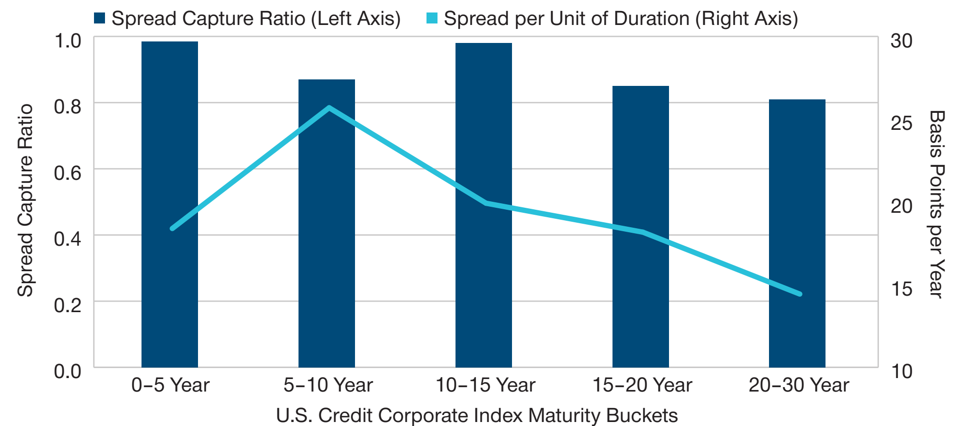
APPEARANCES CAN BE DECEIVING IN FIXED INCOME

When trying to approximate bond index characteristics, another challenge for index trackers is that sector weightings alone provide limited insight into risk. A portfolio can maintain sector weightings that are identical to the benchmark but possess a very different risk profile given the many nuances of fixed income investments. Therefore, it is more instructive to look below the surface to more deeply analyze underlying risk factors. In a core U.S. bond portfolio, the primary risks include spread, duration, and curve exposures.

Spread risk within the Bloomberg Barclays U.S. Aggregate Bond Index derives from fluctuations in credit spreads as investors' perceptions of credit quality change. Using nominal sector weight percentages to assess spread risk can be highly misleading. As a case in point, investment-grade corporate bonds constitute about a quarter of the benchmark in terms of nominal sector weight. However, because corporate spreads can be more volatile than spreads of other high-grade sectors, corporates actually dominate the index when analyzing each sector's contribution to total spread volatility (Figure 3). It is therefore critical to think in terms of risk metrics rather than simple weight percentages.

FIGURE 4: Greater Spread Pickup per Unit of Duration Risk in Shorter-Term Corporates

Bloomberg Barclays U.S. Aggregate Bond Index, as of December 31, 2017



Source: Barclays POINT.

Note: The option-adjusted spread (OAS) capture ratio equals excess returns divided by OAS between August 30, 1996, and December 31, 2017. The chart excludes the 30+ year maturity bucket as it represents a minimal portion of the index.

Source for Bloomberg Barclays index data: Bloomberg Index Services Ltd. Copyright ©2018. Bloomberg Index Services Ltd. Used with permission.

MORE EFFICIENTLY REPLICATING THE BENCHMARK

To achieve our objective of modestly outperforming the benchmark after expenses, we aim to exploit the benchmark's structural inefficiencies to enhance yield while simultaneously replicating index risk factors to minimize tracking error. Our primary method is utilizing quantitative analysis to emphasize areas of the market that offer lower volatility of excess returns, while deemphasizing areas where excess returns are more volatile.

For example, as shown in Figure 3, corporate credit risk is responsible for much of the index's spread volatility.

Our corporate credit team's research has found that short- and intermediate-term corporate bonds have historically generated stronger risk-adjusted returns than longer-dated corporates. Although shorter-term corporates typically offer lower yields, they have historically provided more spread per unit of duration risk. Moreover, more of that spread can be successfully "captured"—or converted into excess returns (Figure 4). As time to maturity increases, so do

risks that can reduce the spread that investors effectively capture (e.g., ratings downgrades, defaults, and early redemptions).

MANAGING THE UNDERLYING COMPONENTS OF RISK WITHIN SECTORS

We take advantage of these inefficiencies by building the portfolio's corporate risk factor using the more efficient parts of the corporate universe. This means underweighting the long end of the corporate credit curve in favor of the more efficient short and intermediate sections. To match the index's corporate spread risk factor, we need to buy more short- and intermediate-term corporate bonds to compensate for the amount that we are underweight at the long end. We offset these differences by buying fewer intermediate-term Treasuries and more long-term Treasuries to keep overall duration and yield curve exposures consistent with the index.

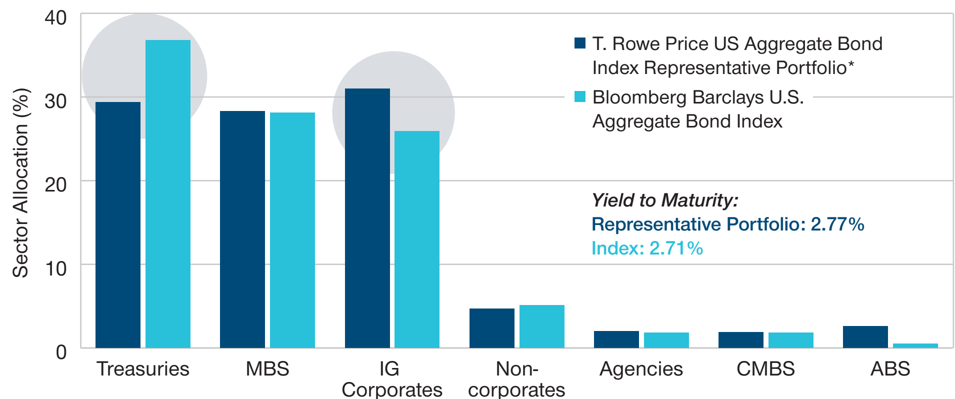
Optically this makes the portfolio appear overweight corporates and underweight Treasuries on a simple percentage-weighting basis. However, the reality is that the risk profile is nearly identical. This carefully designed structure matches the index's risk factors but does so with slightly higher yield (Figure 5).

Similarly, our optimization model has shown that short-dated asset-backed and commercial mortgage-backed securities (ABS and CMBS, respectively) are an attractive source of less volatile excess returns. Slightly overweighting these high-quality securitized credit sectors, which possess very small weightings in the index, can boost yield while only slightly increasing tracking error. Again, this highlights how we utilize our low defined tracking error more efficiently to add value.

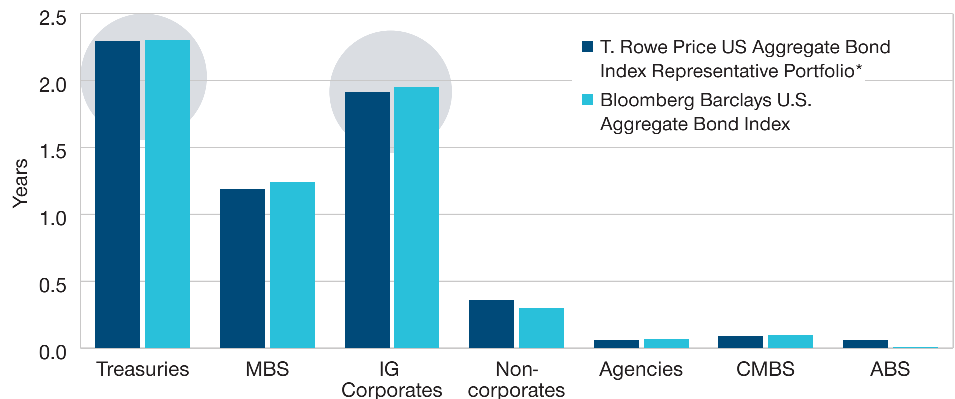
FIGURE 5: **Matching Key Index Risk Factors in a More Yield-Advantageous Manner**

As of December 31, 2017

Allocation by Notional Sector Weight



Sector Contribution to Duration



Source: T. Rowe Price.

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Yield and share price will vary with interest rate changes. Investors should note that if interest rates rise significantly from current levels, bond portfolio total returns will decline and may even turn negative in the short term.

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OPTIMIZING DURATION AND CURVE EXPOSURES

Duration is the main driver of total return and risk in a high-quality bond portfolio. A modest duration mismatch can significantly impact relative performance, particularly when rates move sharply. However, managing the portfolio with a bias to being structurally slightly longer in terms of duration posture can add a small amount of additional carry and also act as a positive carry hedge to the slightly increased credit exposure.

Different areas of the yield curve can also be more efficient than others. We have generally favored a "bulleted" posture that places slightly more emphasis on the intermediate section of the curve. This area of the curve provides more attractive yields than the front end with less volatility than the long end. Moreover, steepness in the intermediate section of the curve can provide positive "roll down" return. Assuming that interest rates hold steady, bond prices usually rise as time passes when the curve is upward sloping. The long end of the curve is currently much flatter, providing less potential to earn roll-down return.

It is important to note that duration and curve deviations can add tracking error very quickly. We therefore keep any differences small and monitor duration and curve exposures closely.

FIGURE 6: **Solid, Consistent Performance vs. Benchmark and Institutional Passive Peers**

Figures are Calculated in U.S. Dollars

		Annualized Returns			
Periods Ended December 31, 2017	**1 Year**	**3 Years**	**5 Years**	**7 Years**	**10 Years**
T. Rowe Price US Aggregate Bond Index Composite (Gross)	3.90%	2.52%	2.34%	3.41%	4.33%
T. Rowe Price US Aggregate Bond Index Composite (Net)*	3.82	2.44	2.26	3.33	4.24
Bloomberg Barclays U.S. Aggregate Bond Index	3.54	2.24	2.10	3.20	4.01
Passive Strategies Simple Average	3.49	2.16	2.03	3.12	3.97
Passive Strategies Asset-Weighted Average	3.51	2.16	2.02	3.10	3.95
Value Added vs. Bloomberg Barclays U.S. Aggregate Bond Index (Gross)	0.36	0.28	0.24	0.21	0.32
Value Added vs. Passive Strategies Simple Average (Gross)	0.41	0.36	0.31	0.29	0.36
Value Added vs. Passive Strategies Asset-Weighted Average (Gross)	0.39	0.36	0.32	0.31	0.38

Sources: eVestment and T. Rowe Price. See Appendix A for peer group construction methodology.

Source for Bloomberg Barclays index data: Bloomberg Index Services Ltd. Copyright© 2018. Bloomberg Index Services Ltd. Used with permission.

*Net-of-fees performance reflects the deduction of the highest applicable management fee (Model Net Fee) that would be charged based on the fee schedule appropriate to you for this mandate, without the benefit of breakpoints. Please be advised that the composite may include other investment products subject to management fees that are inapplicable to you but are in excess of the Model Net Fee. Therefore, the actual performance of all the portfolios in the composite on a net-fee basis will be diff erent and may be lower than the Model Net Fee performance. However, such Model Net Fee performance is intended to provide the most appropriate example of the impact management fees would have by applying management fees relevant to you to the gross performance of the composite.

Past performance cannot guarantee future results. It is not possible to invest directly in an index.

Yield and share price will vary with interest rate changes. Investors should note that if interest rates rise significantly from current levels, bond portfolio total returns will decline and may even turn negative in the short term.

Supplemental information. Please see the GIPS® Disclosure page for additional information on the composite. Monthly composite performance is available upon request.

LEVERAGING A STRONG GLOBAL RESEARCH PLATFORM

In addition to using quantitative tools to more efficiently replicate the benchmark's major risk factors, a secondary aspect of our approach is to take advantage of T. Rowe Price's credit research capabilities to seek to generate incremental alpha and manage risk. Rather than relying on stratified sampling and randomly selecting bonds that meet certain criteria, we prefer to hold bonds from issuers that our analysts closely monitor and are comfortable owning based on a thorough analysis of credit quality and relative value. This is important in fixed income given the asymmetrical risk profile of the asset class, where downside risk from deteriorating credit quality usually exceeds the upside potential from improving credit metrics.

Being able to tap the firm's sector and asset allocation expertise also enables us to tactically adjust sector exposures when valuations for a particular market segment are at extreme levels. Even in an index-constrained portfolio, it is suboptimal, in our view, to blindly follow the index and buy very expensive securities or ignore compelling relative value opportunities. That said, any deviations from the index are constrained by our tight risk budget to ensure that we maintain index-like portfolio characteristics and tracking error (typically no more than 20 basis points).

CONSISTENT RESULTS VERSUS THE INDEX AND PASSIVE PEERS

This slightly different approach to bond indexing, which exploits the inefficiencies embedded in fixed income benchmarks while replicating the index's key risk characteristics, has resulted in consistent, modest outperformance versus the Bloomberg Barclays U.S. Aggregate Bond Index on a net-of-fees basis. Meanwhile, the average passive strategy has persistently fallen short of benchmark performance (Figure 6). If tracking error is inevitable in inefficient bond markets, why should investors settle for underperformance from an indexed portfolio instead of trying to make the most of inherent return volatility?

APPENDIX A: PEER GROUP CONSTRUCTION METHODOLOGY

To compare the performance of the T. Rowe Price US Aggregate Bond Index Strategy with similar institutional passive index strategies, we constructed a custom peer group average using data from the eVestment database as of December 31, 2017. We looked at strategies in eVestment's U.S. passive core fixed income universe that are benchmarked to the Bloomberg Barclays U.S. Aggregate Bond Index (or its float-adjusted equivalent). We then calculated a simple average and an asset-weighted average for annualized returns, tracking error, and information ratio statistics using available eVestment data.

For the asset-weighted average performance figures, we factored in the size of each strategy's total assets under management as a percentage of the total assets of the peer group to reflect the fact that a few bond index strategies have an outsized market share and, therefore, have a large impact on the overall category's performance and risk characteristics. Using eVestment data, we calculated a weighting factor for each strategy based on its total assets under management reported as of December 31, 2017. We then multiplied each strategy's weighting factor by its respective performance statistics for each period. The sum of these numbers provided the asset-weighted results for the overall peer group.

APPENDIX B: GIPS® DISCLOSURE AND FEE SCHEDULE

GIPS® DISCLOSURE

US Aggregate Bond Index Composite

Period Ended December 31, 2017. Figures Shown in U.S. Dollars.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Gross Annual Returns (%)	5.02	7.86	6.65	7.65	4.63	-1.96	6.26	0.66	3.04	3.90
Net Annual Returns (%)[1]	4.94	7.77	6.56	7.56	4.55	-2.04	6.18	0.58	2.95	3.82
Bloomberg Barclays U.S. Aggregate Bond Index (%)	5.24	5.93	6.54	7.84	4.21	-2.02	5.97	0.55	2.65	3.54
Composite 3-Yr St. Dev.	3.92	4.05	4.10	2.75	2.37	2.72	2.67	2.94	3.09	2.87
Bloomberg Barclays U.S. Aggregate Bond Index 3-Yr St. Dev.	3.97	4.11	4.17	2.78	2.38	2.71	2.63	2.88	2.98	2.78
Composite Dispersion	N/A	1.24	0.03	0.11	0.13	0.11	0.04	0.05	N/A	N/A
Comp. Assets (Millions)	2,330.7	2,735.9	3,042.1	4,104.2	4,189.1	4,380.0	3,796.4	3,796.0	665.6	890.3
# of Accts. in Comp.	8	8	7	8	8	8	7	7	3	3
Total Firm Assets (Billions)	275.7	395.2	485.0	4.93.1	579.8	696.3	749.6	772.4	817.2	1,000.2

[1]Reflects deduction of highest applicable fee schedule without benefit of breakpoints. Investment return and principal value will vary. **Past performance cannot guarantee future results.** Monthly composite performance is available upon request. See below for further information related to net-of-fee calculations.

T. Rowe Price (TRP) has prepared and presented this report in compliance with the Global Investment Performance Standards (GIPS®). TRP has been independently verified for the 21-year period ended June 30, 2017, by KPMG LLP. The verification report is available upon request. Verification assesses whether (1) the firm has complied with all the composite construction requirements of the GIPS standards on a firmwide basis and (2) the firm's policies and procedures are designed to calculate and present performance in compliance with the GIPS standards. Verification does not ensure the accuracy of any specific composite presentation.

TRP is a U.S. investment management firm with various investment advisers registered with the U.S. Securities and Exchange Commission, the U.K. Financial Conduct Authority, and other regulatory bodies in various countries, and holds itself out as such to potential clients for GIPS purposes. TRP further defines itself under GIPS as a discretionary investment manager, providing services primarily to institutional clients with regard to various mandates, which include U.S., international, and global strategies but exclude the services of the Private Asset Management group. The minimum asset level for equity portfolios to be included in composites is $5 million; and prior to January 2002 the minimum was $1 million. The minimum asset level for fixed income and asset allocation portfolios to be included in composites is $10 million; prior to October 2004 the minimum was $5 million; and prior to January 2002 the minimum was $1 million. Valuations are computed and performance reported in U.S. dollars.

Gross performance returns are presented before management and all other fees, where applicable, but after trading expenses. Net-of-fees performance reflects the deduction of the highest applicable management fee that would be charged based on the fee schedule appropriate to you for this mandate, without the benefit of breakpoints. Gross and net performance returns are net of nonreclaimable withholding taxes on dividends, interest income, and capital gains. Effective June 30, 2013, portfolio valuation and assets under management are calculated based on the closing price of the security in its respective market. Previously portfolios holding international securities may have been adjusted for after market events. Policies for valuing portfolios, calculating performance, and preparing compliant presentations are available upon request. Dispersion is measured by the standard deviation across asset-weighted portfolio returns represented within a composite for the full year. Dispersion is not calculated for the composites in which there are five or fewer portfolios.

Some portfolios may trade futures, options, and other potentially high-risk derivatives, which generally represent less than 10% of a portfolio.

Benchmarks are taken from published sources and may have different calculation methodologies, pricing times, and foreign exchange sources from the composite.

Composite policy requires the temporary removal of any portfolio incurring a client-initiated significant cash inflow or outflow greater than or equal to 15% of portfolio assets. The temporary removal of such an account occurs at the beginning of the measurement period in which the significant cash flow occurs and the account reenters the composite on the last day of the current month after the cash flow. Additional information regarding the treatment of significant cash flows is available upon request.

The firm's list of composite descriptions and/or a presentation that adheres to the GIPS® standards are available upon request.

A portfolio management change occurred effective March 1, 2007. There were no changes to the investment program or strategy related to this composite.

FEE SCHEDULE

US Aggregate Bond Index Composite

As of December 31, 2017

The US Aggregate Bond Index Composite seeks to approximate the total return performance of the U.S. fixed income market for publicly traded securities as represented by major fixed income benchmarks, including the Bloomberg Barclays U.S. Aggregate Bond Index. The strategy applies qualitative and quantitative management techniques to achieve its investment objectives. (Created June 2006) (Formerly known as US Enhanced Aggregate Bond Composite)

First 50 million (USD)	8 basis points
Next 50 million (USD)	7 basis points
Next 150 million (USD)	5 basis points
Above 250 million (USD)	4 basis points
Minimum separate account size	50 million (USD)

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Key Risks—The following risks are materially relevant to the strategy highlighted in this material: Transactions in securities denominated in foreign currencies are subject to fluctuations in exchange rates which may affect the value of an investment. Debt securities could suffer an adverse change in financial condition due to ratings downgrade or default which may affect the value of an investment. Investments in High Yield involve a higher element of risk.

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