FIXED INCOME
Methodology Overview
# TABLE OF CONTENTS

## OVERVIEW
- What is This Document? .................................................. 1
- Time Horizon ................................................................. 2

## FIXED INCOME
- Asset Class Overview .................................................. 3
- Expected Return Methodology ....................................... 5
  - Yield ........................................................................ 5
  - Roll Return ............................................................ 11
  - Credit Loss ............................................................. 12
  - Valuation Change .................................................... 13
- Results ........................................................................... 14

## REFERENCES ......................................................................... 15
What is This Document?

“We understand that some of our insights will never find their way into products, but we provide them in support of investors and the finance community.”
— ROB ARNOTT
CHAIRMAN & CEO

This is one in a series of plain-language white papers setting forth Research Affiliates’ building block approach to developing long-term capital market expectations by asset class. (For information about the objectives and guiding principles of our asset allocation initiative, please refer to “Capital Market Expectations: Methodology Overview,” the first of these white papers.) In working out our risk and return forecasts and making them publicly available, we keep three criteria in mind: transparency, robustness, and timeliness. By describing the conceptual framework and calculations behind the projected asset class risks, returns, and correlations in these papers, we hope to achieve a meaningful level of transparency without excessive details. By constructing simple, economically sound models for major asset classes, we strive to achieve a fitting standard of robustness for forecasting to a 10-year horizon. By initially refreshing our expectations on a quarterly basis, we seek to provide information that is updated with useful frequency. We will continue to refine our methods, extend the scope of our capital market expectations, and improve this documentation over time. The remainder of this document addresses how we think about fixed income asset class returns from a building block perspective, and provides transparency into the methods employed to develop these return expectations.
**Time Horizon**

One of the major considerations when embarking on the journey to generate asset class return expectations is the issue of time horizon. Because the focus here is on generating capital market expectations for strategic asset allocation, and not tactical overlays, a significantly long time horizon of 10 years was selected.

The 10-year time horizon is not meant to imply a 10-year buy-and-hold strategy, but instead incorporates a strategy consisting of asset classes with constant duration targets. Said another way, asset classes with shorter durations (e.g., fixed income) need to be periodically rebalanced to maintain the constant duration. The rebalance period chosen here is one year which means that a two-year bond, for example, will be held for one year, at which time the bond with one year remaining to maturity would be sold and the proceeds are used to purchase a new two-year bond. Asset classes with significantly long duration (e.g., equities) can be considered buy-and-hold because the change in duration from the passage of 1, 2, or even 10 years on these types of assets is minimal.
Fixed Income

Asset Class Overview

Fixed income securities, also known as debt instruments, represent one of the major ways that entities, such as governments and corporations, raise capital. Since 1980, the fixed income landscape has grown in size and complexity. Figure 1 shows that total debt outstanding expanded almost sixfold in the past 35 years in real terms (Securities Industry and Financial Markets Association, n.d.).

**FIGURE 1**

*Growth in Real 2014 USD Total Debt Outstanding by Instrument Type*

Source: Research Affiliates, based on data from SIFMA

Fixed income indices come in all shapes, sizes, and flavors; however, from an asset allocation perspective, we are most interested in categorizing issues based on their risk dimensions, such as duration, credit quality, and geography. For example, when looking at a market, it’s important to be able to price securities of all maturities, credit quality bands (e.g., sovereign, investment-grade, and high-yield debt), and geographies (countries and regions).
The abundance of fixed income indices and vehicles allows investors to isolate the factors where exposure is desired. Table 1 shows a sample of fixed income asset classes and examples of representative indices. This is by no means the entire universe of fixed income asset classes, nor are these representative indices the only ones that describe these asset classes.

**TABLE 1**

*Sample Fixed Income Asset Classes and Representative Indices*

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Representative Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Term U.S. Treasuries</td>
<td>Barclays U.S. Treasury 1-3 Year Index</td>
</tr>
<tr>
<td>Intermediate Term U.S. Treasuries</td>
<td>Barclays U.S. Treasury Intermediate Index</td>
</tr>
<tr>
<td>Long-Term U.S. Treasuries</td>
<td>Barclays U.S. Treasury Long Index</td>
</tr>
<tr>
<td>U.S. Intermediate Investment-Grade Corporate Bonds</td>
<td>Barclays U.S. Intermediate Corporates Index</td>
</tr>
<tr>
<td>U.S. Long Term Investment-Grade Corporate Bonds</td>
<td>Barclays U.S. Long Corporates Index</td>
</tr>
<tr>
<td>U.S. High-Yield Debt</td>
<td>Barclays Corporate High Yield Index</td>
</tr>
<tr>
<td>TIPS</td>
<td>Barclays U.S. TIPS Index</td>
</tr>
<tr>
<td>Long TIPS</td>
<td>Barclays U.S. Inflation 10+ Year Index</td>
</tr>
<tr>
<td>U.S. Core Bonds</td>
<td>Barclays U.S. Aggregate Index</td>
</tr>
<tr>
<td>Global Core Bonds</td>
<td>Barclays Global Aggregate Ex-U.S. Index</td>
</tr>
<tr>
<td>All Country Core Bonds</td>
<td>Barclays Global Aggregate</td>
</tr>
<tr>
<td>Emerging Market (Hard Currency) Bonds</td>
<td>JP Morgan EMBI+ Index</td>
</tr>
<tr>
<td>Emerging Market (Local Currency) Bonds</td>
<td>JP Morgan GBI-EM Index</td>
</tr>
</tbody>
</table>

Source: Research Affiliates

Some of the indices listed in Table 1, such as the Barclays U.S. Aggregate and Global Aggregate Indices, are composed of other indices. To maintain consistency, these indices are modeled as weighted averages of the underlying constituent indices that comprise the aggregate. Similarly, indices that contain debt instruments from a variety of countries, such as the JP Morgan GBI-EM Index, are modeled country by country, and the total expected return of the index is calculated as a weighted average based on the mix of countries in the index.
Expected Return Methodology

The model for forecasting fixed income returns is adapted from a model detailed by Antti Ilmanen (1995), and incorporates five components: yield, roll return, credit loss, change in interest rates and spreads, and currency adjustment. The currency adjustment is included to address instances where the asset class is denominated in a currency other than the investor’s currency of choice. The currency adjustment is included in the equation below for completeness; however, details on the calculation and methodology of the currency adjustment are left to “Domestic & Foreign Cash Methodology Overview,” another white paper in this series.

\[
\text{FI Return} = \text{Yield} + \text{Roll Return} - \text{Credit Loss} + \Delta \text{Interest Rates & Spreads} + \text{Currency Adjustment}
\]

This model is similar to the component framework used for the other asset classes. Yield is the average cash flow per unit of investment expected to be received in the future by an investor.\(^1\) Because cash flows are generally fixed for the life of a bond,\(^2\) there is no explicit growth component. Instead, we include a component for roll return, which captures the fact that the price and yield of a debt security with fixed cash flows will change based on the passage of time and the shape of the yield curve. Credit losses reflect the fact that, due to a borrower’s ineffectiveness in paying debts, investors may never receive the cash flows they are owed on an investment. Thoughtful investors must therefore expect a percentage loss on all debt investments. This loss is often forecasted based on the credit quality of the borrower. Finally, as time passes, interest rates and interest rate spreads will move. If rates rise, the fixed rate bonds in an investor’s portfolio will lose value. If rates fall, the opposite will occur.

YIELD

The yield of a fixed income security or portfolio is the interest rate that ties the stream of future cash flows to the current price. Although fixed income indices are not strictly constant duration, their duration often remains sufficiently constant that the indices can be thought of as duration-targeted.\(^3\) For example, Figure 2 shows the duration of the Barclays US Aggregate has for only brief periods drifted from its long term average duration of 4.6.

---

1. Our use of the term yield here is meant to imply total yield, not just sovereign yield (i.e., it includes any spread over local sovereign yield).
2. We disregard floating rate securities for the purpose of this discussion.
3. See the overview document, “Capital Market Expectations: Methodology Background,” on the desirability of maintaining a duration-targeted portfolio.
In the case of a duration-targeted portfolio, yield alone can provide a lot of information regarding future expected returns of the index. To show the importance of yield in forecasting returns, **Figure 3** plots the starting nominal yield of the Barclays U.S. Aggregate Index against the future 10-year realized nominal return of the index. The correlation of these two series is over 90%.

---

**Figure 2**

*Duration of Barclays U.S. Aggregate Around Its Long-Term Average*

Source: Research Affiliates, based on data from Barclays and Bloomberg

---

4 Although the rest of this document deals with real yields and returns, it is worth briefly turning to nominal yields for this discussion.
With correlation this high, it can be tempting to assume the future 10-year return of all fixed income indices can be quickly approximated from the initial yield. However, that is certainly not the case. In addition to having a near-constant duration, the reason starting yield does such a good job of forecasting 10-year returns has to do with the relationship between duration and time horizon. Research shows that the largest correlation between starting yield and future returns occurs at a time horizon roughly equal to twice the duration minus 1 year (2 × Duration − 1 year). (Leibowitz, Horner, and Kogelman, 2013.) Figure 4 shows that the highest correlation for the Barclays U.S. Treasury Intermediate Index with a duration just over three years occurs at future 4–5 year returns.
Because the focus here is on prospective 10-year returns, starting yield is not the proper measure to use for shorter duration securities. A model of the level and path of future interest rates over the entire time horizon will enable us to forecast the yield at the duration of the index.

Forecasting Real Yield Curves

It’s quite difficult, if not impossible, to have a view on future fixed income returns without having a view on changes in interest rates. At the most basic level, yield curves can be forecasted as a combination of three factors: level, slope, and curvature. Level describes the level of the shortest term debt instruments, also known as the level of cash rates. The slope of the yield curve is the difference between the yield of a bond with a tenor of 10 years (i.e., a bond with 10 years remaining to maturity) and the cash rate. Curvature models the concavity or convexity of the middle tenors of the yield curve.

Our first step in forecasting future real interest rates\(^5\) is to determine the target level, slope and curvature for each market. Forecasting the real yield curve level is described in detail in “Domestic & Foreign Cash Methodology

\(^5\) Although the focus here is on real interest rate curves, it is the change in nominal curves which actually affect the value of debt instruments. We acknowledge the importance of inflation to this discussion; however, at this point we model constant inflation over the investment horizon and therefore are focusing on real yields.
Overview,” in this series. The slope and curvature of the yield curve in the United States are derived directly from the historical data. We assume that in in 10 years the slope and curvature of the U.S. yield curve will be equal to the average of the current slope and curvature and their long-term averages.6

Applying this methodology globally comes with the challenge that many countries do not have the rich historical data that is available for the United States. Because data covering a relatively short timeframe may be biased due to recent market events, the average slope and curvature of the U.S. yield curve are used for other countries as well.

With yearly cash rate forecasts, the current yield curve and the 10-year yield curve in place, it is possible to define the path of interest rates from now until then. The path of interest rates is driven by the path of future cash rate yields as detailed in the currency/cash rate methodology document in this series of white papers. For example, if the cash rate in year two moves 10% of the way from the current cash rate to the 10-year forecasted cash rate, each tenor along the curve is expected to move 10% from the current rate to the 10-year forecasted rate for that tenor. For simplicity in calculation, we derive another curve, the average yield curve, which is simply the average of each annual yield curve over the 10-year horizon. Figure 5 shows the current real yield curve,7 the average forecasted curve, and the 10-year point forecast curve.

---

6 On a technical note, in order to model debt instruments of all maturities, it is important to forecast each tenor of the yield curve; however, not all tenors are normally published. For example, U.S. Treasury curve data is published for maturities of 1 year, 2 years, 5 years, 10 years, etc., but often doesn’t have a readily available value for an 8-year maturity. In order to locate the yield at eight years, it is necessary to interpolate more yield curve maturities. For this model, the interpolation was done using a model from Diebold and Li (2006). This equation reproduces the yield curve based on three beta factors which can be interpreted as level, slope, and curvature of the curve, and can be used to interpolate all maturities of the yield curve. Details of this model are left to the interested reader who may want to review the authors’ original research paper.

7 The current real yield curve is calculated by subtracting the current inflation swap term structure from the nominal U.S. Treasury curve.
The average forecasted curve is the curve utilized to determine the correct yield component for each fixed income asset class. The yield over the investment horizon is then simply the rate on the average curve associated with the duration of each asset class. For those asset classes that also include a credit spread component, a forecasted spread is then added.

**Forecasting Credit Spreads**

In addition to forecasting the yield curve, it is also necessary to forecast credit spreads in order to value non-sovereign securities. Credit spreads are forecasted in a similar fashion to the yield curves, by estimating the level and slope factors. The level is based on the long-term average of short-term spreads for a particular credit rating (see Figure 6). In the United States, the average A-rated bond spread is about 0.75%, while the average high-yield spread (reflecting a 50/50 combination of BB and B ratings) has been roughly 3% since the early 1990s.
The slope is similarly based on the historic average. For A-rated investment-grade bonds, this slope is about 0.40%. In addition to the 10-year to 3-month slope, the spread forecasting methodology also looks at the 30-year—10-year difference for the long end of the curve. This difference is much smaller at 0.15% for investment-grade and 0.25% for high-yield. Unlike the path of yields which are based on the movement in cash rates, the path of spreads from the current level to the level in 10 years is assumed to be linear.

ROLL RETURN

Roll return with respect to a fixed-rate fixed income portfolio captures the fact that the value of the portfolio will change due to the passage of time under the assumption that the yield curve remains stationary. The idea of roll return is that if the yield curve is upward (downward) sloping, the value of a fixed income portfolio will increase (decrease) as time passes and the portfolio gets closer to maturity.
In this equation, duration is the current effective duration of the index, and convexity (the rate of change in duration) is the current convexity of the index. The change in interest rates is the difference between the rate at the current duration of the portfolio and the rate at a point on the current yield curve that is one year shorter than the duration of the portfolio. The assumption of annual rebalancing is the reason roll return is calculated based on tenors that are one year apart. More or less frequent rebalancing would therefore imply using different points on the curve and annualizing the results.

As an example, consider a 10-year duration Treasury portfolio valued at par with a yield of 2.8%. If the yield curve is upward sloping, one year from now, nine-year yields must be less than 2.8%, say 2.5%. Because the portfolio, which is still yielding 2.8%, has the same remaining life as portfolios that are only yielding 2.5%, it will increase in value, returning roughly 2.7% from rolling down the curve.

CREDIT LOSS

Fixed income instruments face two types of potential loss events: transitions (also called downgrades) and defaults. The credit rating of the investment is the primary factor determining credit loss risk. For an instrument with an investment-grade rating, the major concern is a downgrade, and, in particular, a rating change that places the instrument below investment-grade. For these securities, defaults do occur, but when dealing with a large, diverse portfolio or index, the idiosyncratic risk of any individual issuer is diversified away and the overall default risk is small. In fact, since 1981, the average default loss from investment-grade U.S. corporate debt has been on the order of 0.10% per year (S&P 2012 Annual U.S. Corporate Default Study and Rating Transitions, 2013).

Downgrades affect portfolios when index providers rebalance their indices based on a set of predefined rules governing the characteristics of securities in the index. Securities that no longer meet the criteria of the index drop out and new securities are added. For example, with an investment-grade index, companies that initially were rated investment-grade may fall on hard times and be downgraded by the ratings agencies. The investment-grade portfolio manager must then remove the securities from the portfolio (which will have fallen in price as their yields rise due to their declining creditworthiness) and replace them with higher priced investment-grade securities, thus selling at a loss to buy at a premium.

The amount of expected losses due to downgrades can be calculated on the basis of the spread curve forecasts described above. The estimated credit loss amount is the duration of the index multiplied by the spread between the investment-grade and high-yield credit curves at the point on the curve equal to the duration of the index. For speculative grade debt, also known as high-yield, the primary credit risk is from losses due to borrowers defaulting on their obligations. The expected default loss is slightly mitigated by the effect of upgrade transitions for issuers whose credit ratings are changed from high-yield to investment-grade status. From an investor’s perspective, loss from default depends on both the average default rate of the instruments in their possession and the average recovery rate for issues in default. Looking at empirical data, a high-yield recovery rate of 40% is a good ex ante assumption. In the current implementation of Research Affiliates’ fixed income model, the forecast for default rates of high-yield bonds is based on the long-term average rate since 1981, which is the first year S&P publishes this data.
Figure 7 shows net losses and recovery estimates per year for the Barclays High Yield Index, with the total bar height equaling the annual default rate. It’s easy to see the relationship between losses and the credit spread, shown here as the difference in yield of the Barclays High Yield Index and the Barclays Intermediate Treasury Index. Periods when spreads exceeded losses—as they did in 2008—were wonderful buying opportunities.

**VALUATION CHANGE**

The valuation change component refers to the change in price of the bond that occurs from the yield curve moving from today’s real rates to the forecasted rates 10 years from now. The change in rates includes changes to both the yield and spread components.

\[
\Delta \text{Valuation} = -(\text{Duration} - 1) \times \Delta r_{(t,t+10)} + \frac{1}{2} \text{Convexity} \times (\Delta r_{(t,t+10)})^2
\]

If the expectations hypothesis held, and forward rates were a perfect predictor of future interest rates, roll return and valuation change would perfectly offset each other, leaving only yield and credit losses as the components.
of return. However, because forward rates are not a perfect predictor of future rates, there will be a difference between roll return and valuation change in most instances.

**Results**

As Figure 8 illustrates, future expected returns are very different from historical realized returns. This is due to lower starting yields which both mute the income received from bond investments and reduce the potential to receive capital gains from falling interest rates. The Barclays US Aggregate Index is shown here, but the same issues affect most fixed income indices over the investment horizon.

**FIGURE 8**

*Comparison of Forecasted and Realized Returns for Barclays U.S. Aggregate*

Source: Research Affiliates, based on data from Barclays and Bloomberg
REFERENCES


**DISCLAIMER**

The information contained herein regarding Asset Allocation and Expected Returns may represent real return forecasts for several asset classes and not for any Research Affiliates ("RA") fund or strategy. These forecasts are forward-looking statements based upon the reasonable beliefs of RA and are not a guarantee of future performance. Forward-looking statements speak only as of the date they are made, and RA assumes no duty to and does not undertake to update forward-looking statements. Forward-looking statements are subject to numerous assumptions, risks, and uncertainties, which change over time. Actual results may differ materially from those anticipated in forward-looking statements.

All projections provided are estimates and are in U.S. dollar terms, unless otherwise specified. Given the complex risk-reward trade-offs involved, one should always rely on judgment as well as quantitative optimization approaches in setting strategic allocations to any or all of the above asset classes. Please note that all information shown is based on qualitative analysis. Exclusive reliance on the above is not advised. This information is not intended as a recommendation to invest in any particular asset class or strategy or as a promise of future performance. Note that these asset class and strategy assumptions are passive only—they do not consider the impact of active management. References to future returns are not promises or even estimates of actual returns a client portfolio may achieve. Assumptions, opinions and estimates are provided for illustrative purposes only. They should not be relied upon as recommendations to buy or sell any securities, commodities, derivatives or financial instruments of any kind. Forecasts of financial market trends that are based on current market conditions or historical data constitute a judgment and are subject to change without notice. We do not warrant its accuracy or completeness. This material has been prepared for information purposes only and is not intended to provide, and should not be relied on for, accounting, legal, tax, investment or tax advice. There is no assurance that any of the target prices mentioned will be attained. Any market prices are only indications of market values and are subject to change.

Hypothetical or simulated performance results have certain inherent limitations. Unlike an actual performance record, simulated results do not represent actual trading, but are based on the historical returns of the selected investments, indices or investment classes and various assumptions of past and future events. Simulated trading programs in general are also subject to the fact that they are designed with the benefit of hindsight. Also, since the trades have not actually been executed, the results may have under or over compensated for the impact of certain market factors. In addition, hypothetical trading does not involve financial risk. No hypothetical trading record can completely account for the impact of financial risk in actual trading. For example, the ability to withstand losses or to adhere to a particular trading program in spite of the trading losses are material factors which can adversely affect the actual trading results. There are numerous other factors related to the economy or markets in general or to the implementation of any specific trading program which cannot be fully accounted for in the preparation of hypothetical performance results, all of which can adversely affect trading results.

The asset classes are represented by broad-based indices which have been selected because they are well known and are easily recognizable by investors. Indices have limitations because indices have volatility and other material characteristics that may differ from an actual portfolio. For example, investments made for a portfolio may differ significantly in terms of security holdings, industry weightings and asset allocation from those of the index. Accordingly, investment results and volatility of a portfolio may differ from those of the index. Also, the indices noted in this presentation are unmanaged, are not available for direct investment, and are not subject to management fees, transaction costs or other types of expenses that a portfolio may incur. In addition, the performance of the indices reflects reinvestment of dividends and, where applicable, capital gain distributions. Therefore, investors should carefully consider these limitations and differences when evaluating the index performance.

No investment process is risk free and there is no guarantee of profitability; investors may lose all of their investments. No investment strategy or risk management technique can guarantee returns or eliminate risk in any market environment. Diversification does not guarantee a profit or protect against loss. Investing in foreign securities presents certain risks not associated with domestic investments, such as currency fluctuation, political and economic instability, and different accounting standards. This may result in greater share price volatility. The prices of small- and mid-cap company stocks are generally more volatile than large-company stocks. They often involve higher risks because smaller companies may lack the management expertise, financial resources, product diversification and competitive strengths to endure adverse economic conditions.

Bond prices fluctuate inversely to changes in interest rates. Therefore, a general rise in interest rates can result in the decline of the value of your investment. High-yield bonds, also known as junk bonds, are subject to greater risk of loss of principal and interest, including default risk, than higher-rated bonds. Investing in fixed-income securities involves certain risks such as market risk if sold prior to maturity and credit risk especially if investing in high-yield bonds which have lower ratings and are subject to greater volatility. All fixed-income investments may be worth less than original cost upon redemption or maturity. Income from municipal securities is generally free from federal taxes and state taxes for residents of the issuing state. While the interest income is tax-free, capital gains, if any, will be subject to taxes. Income for some investors may be subject to the
federal alternative minimum tax (AMT).

There are special risks associated with an investment in real estate, including credit risk, interest-rate fluctuations and the impact of varied economic conditions. Distributions from REIT investments are taxed at the owner’s tax bracket.

Hedge funds or alternative investments are complex, speculative investment vehicles and are not suitable for all investors. They are generally open to qualified investors only and carry high costs and substantial risks and may be highly volatile. There is often limited (or even nonexistent) liquidity and a lack of transparency regarding the underlying assets. They do not represent a complete investment program. The investment returns may fluctuate and are subject to market volatility so that an investor’s shares, when redeemed or sold, may be worth more or less than their original cost. Hedge funds are not required to provide investors with periodic pricing or valuation and are not subject to the same regulatory requirements as mutual funds. Investing in hedge funds may also involve tax consequences. Speak to your tax advisor before investing. Investors in funds of hedge funds will incur asset-based fees and expenses at the fund level and indirect fees, expenses and asset-based compensation of investment funds in which these funds invest. An investment in a hedge fund involves the risks inherent in an investment in securities as well as specific risks associated with limited liquidity, the use of leverage, short sales, options, futures, derivative instruments, investments in non-U.S. securities, junk bonds and illiquid investments. There can be no assurances that a manager’s strategy (hedging or otherwise) will be successful or that a manager will use these strategies with respect to all or any portion of a portfolio. Please carefully review the Private Placement Memorandum or other offering documents for complete information regarding terms, including all applicable fees, as well as other factors you should consider before investing.

Buying commodities allows for a source of diversification for those sophisticated persons who wish to add commodities to their portfolios and who are prepared to assume the risks inherent in the commodities market. Any purchase represents a transaction in a non-income producing commodity and is highly speculative. Therefore, commodities should not represent a significant portion of an individual's portfolio. Buying gold, silver, platinum and palladium allows for a source of diversification for those sophisticated persons who wish to add precious metals to their portfolios and who are prepared to assume the risks inherent in the bullion market. Any bullion or coin purchase represents a transaction in a non-income-producing commodity and is highly speculative. Therefore, precious metals should not represent a significant portion of an individual’s portfolio.

Trading foreign exchange involves a high degree of risk. Exchange rates between foreign currencies change rapidly do to a wide range of economic, political and other conditions, exposing one to risk of exchange rate losses in addition to the inherent risk of loss from trading the underlying financial product. If one deposits funds in a currency to trade products denominated in a different currency, one's gains or losses on the underlying investment therefore may be affected by changes in the exchange rate between the currencies. If one is trading on margin, the impact of currency fluctuation on that person's gains or losses may be even greater.

Investments that are concentrated in a specific sector or industry increase their vulnerability to any single economic, political or regulatory development. This may result in greater price volatility.

This information has been prepared by RA based on data and information provided by internal and external sources. While we believe the information provided by external sources to be reliable, we do not warrant its accuracy or completeness.

Research Affiliates is the owner of the trademarks, service marks, patents and copyrights related to the Fundamental Index methodology. The trade names Fundamental Index®, RAFI®, the RAII logo, and the Research Affiliates corporate name and logo among others are the exclusive intellectual property of Research Affiliates, LLC. Any use of these trade names and logos without the prior written permission of Research Affiliates, LLC is expressly prohibited. Research Affiliates, LLC reserves the right to take any and all necessary action to preserve all of its rights, title and interest in and to these terms and logos.

Various features of the Fundamental Index® methodology, including an accounting data-based non-capitalization data processing system and method for creating and weighting an index of securities, are protected by various patents, and patent-pending intellectual property of Research Affiliates, LLC. (See all applicable US Patents, Patent Publications, and Patent Pending intellectual property located at http://www.researchaffiliates.com/Pages/legal.aspx#d, which are fully incorporated herein.)

© Research Affiliates, LLC. All rights reserved. Duplication or dissemination prohibited without prior written permission.