



Smarter Saving and Investing in a Lower Expected Return World

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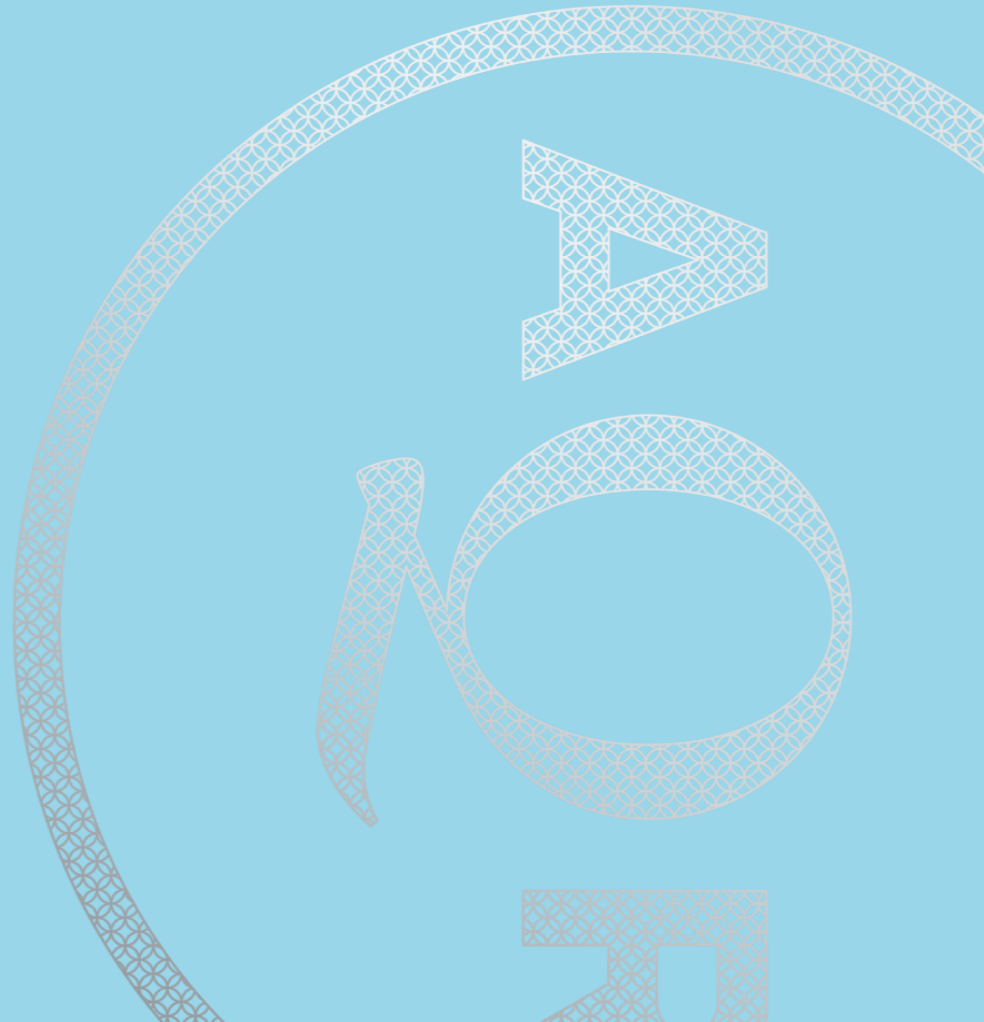
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The Low Expected Return Challenge

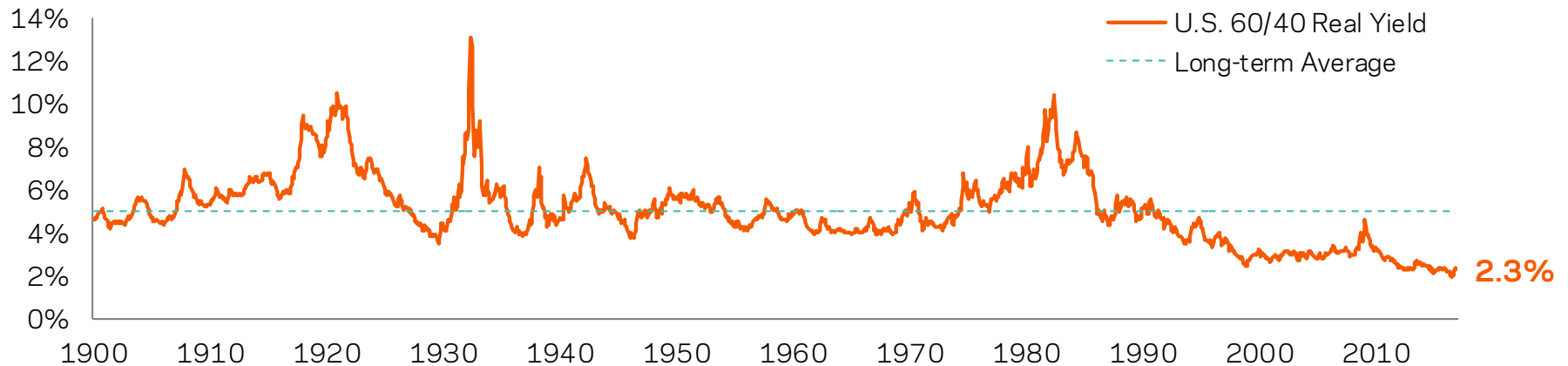


A World of Lower Expected Returns

Expected Returns for Long-Only Assets Are Lower Than in the Past

Expected Real Return of the U.S. 60/40 Stock/Bond Portfolio

January 1900–December 2016



Expected returns for 60/40 averaged 5% real in 1900s, fell to 2-2.5% in recent years. Not just bonds but also stocks have starting yields low compared to history.

Can apply to *all* long-only investments when the common part of discount rates is near all-time lows

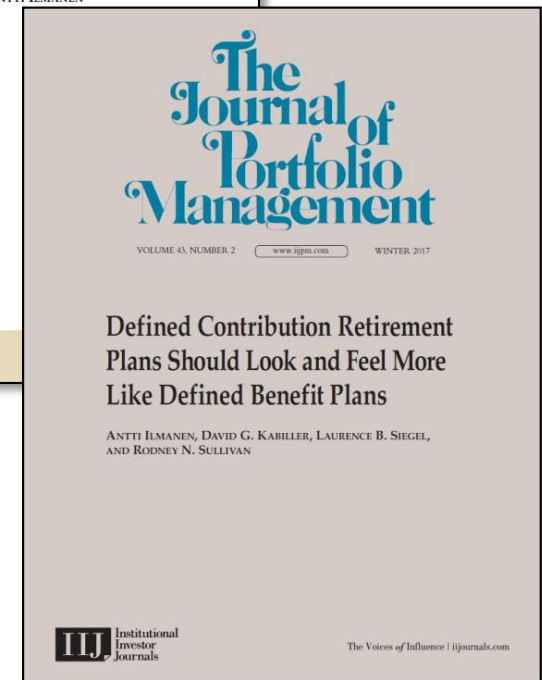
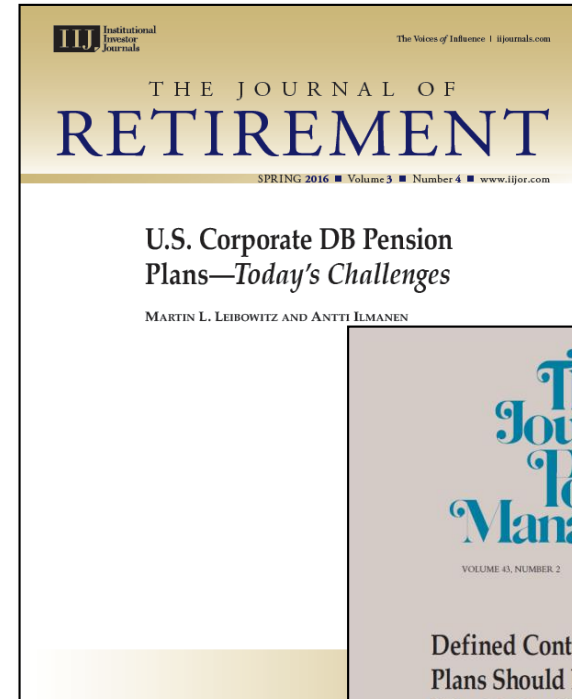
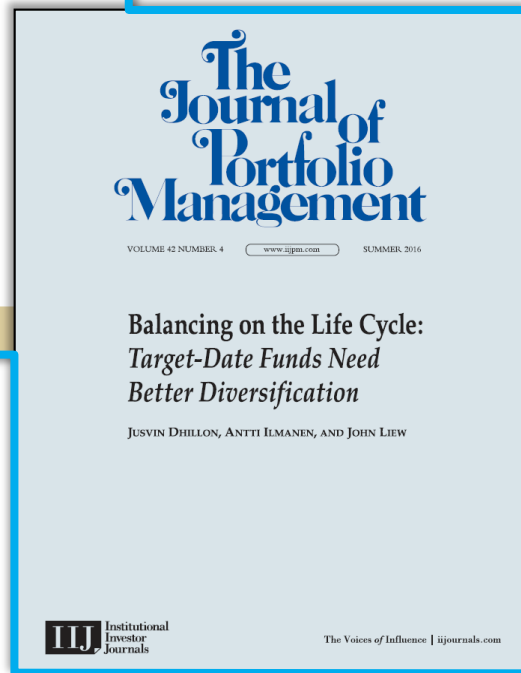
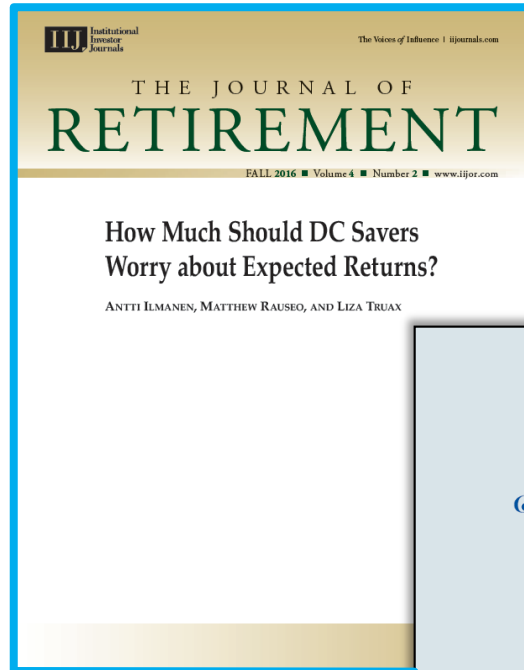
These yield-based estimates are of little use for tactical market timing but they give a useful anchor for next 5-10-year returns, and maybe beyond



Sources: AQR, Robert Shiller's web site, Kozicki-Tinsley (2006), Federal Reserve Bank of Philadelphia, Blue Chip Economic Indicators, Consensus Economics, Morningstar. Prior to 1926, stocks are represented by a reconstruction of the S&P 500 available on Robert Shiller's web site which uses dividends and earnings data from Cowles and associates, interpolated from annual data. After that, stocks are the S&P 500. Bonds are represented by long-dated Treasuries. The 60/40 Expected Real Yield is represented by Stocks/Bonds. The equity yield is a 50/50 mix of two measures: 50% Shiller E/P * 1.075 and 50% Dividend/Price + 1.5%. Scalars are used to account for long term real Earnings Per Share (EPS) Growth. Bond yield is 10 year real Treasury Yield over 10 year inflation forecast as in *Expected Returns* (Ilmanen, 2011), with no rolldown added. Chart is for illustrative purposes only. Past performance is not a guarantee of future performance. Please read important disclosures in the Appendix.

Maybe *The Generational Problem* for the Coming Decades

We Try to Quantify the Challenge and Offer Solutions for Various Investor Types



How Much Should DC Savers Worry About Expected Returns?



Overview

How Much Should DC Savers Worry About Expected Returns?

Many plan sponsors assume that long-term returns will be similar to those of the past few decades

Unfortunately, current market yields indicate that both stocks and bonds may deliver lower returns

This may mean that participants need to significantly increase their savings rates to reach a given retirement target income

We believe that for participants to achieve their retirement goals, plan sponsors should focus on: incentivizing saving **and** identifying investments that have the potential to enhance returns (with reasonable risk).



Source: AQR. Past performance is not a guarantee of future performance.

The Retirement Income Replacement Ratio

What Return Assumptions Are Embedded?

Retirement Income Replacement Ratio (RR) is an estimate of the percentage of final income that a participant can expect annually in retirement

RR is a function of (i) a participant's savings rate and time, (ii) real return of a participant's DC portfolio

Most research has been focused on issues which impact savings rates (employer matches, auto enrollment, auto escalation of contributions)

We extend this research by looking at capital market returns, the other main input to RR estimates

In order to achieve a given RR, what savings rates are needed in various return scenarios?

- Almost all the literature has anchored on the benign historical experience (higher starting yields, windfall capital gains) even in forward-looking analysis

Traditional Assets and 60/40 Portfolio Historical Performance

	Compound Real Returns		
	S&P 500	U.S. 10-Year Bonds	U.S. 60/40
1951-2015 (past 65 years)	7.4%	2.2%	5.6%
1976-2015 (past 40 years)	7.7%	3.7%	6.4%



Source: AQR, Bloomberg. U.S. 60/40 is 60% S&P, 40% U.S. 10 Year bonds, rebalanced monthly. Past performance is not a guarantee of future performance.

Base Case

If Historical Returns Are Repeated, 8% Savings Rate May Be Enough

We first assume that the DC saver holds the U.S. 60/40 portfolio, which delivers the historical real return of approximately 5.5% p.a.

Other assumptions:

- 2% p.a. real income growth over a 40-year saving period
- 25-year annuity purchased at retirement (the income from which is used to compute RR)
- Target total RR of 75%, where 30% is assumed to come from sources outside the plan, and 45% comes from DC savings

Based on these assumptions, an **8% annual savings rate** is required to achieve a 75% RR



Source: Morningstar, GFD, Datastream, AQR. S&P 500 is the SBBI series “U.S. Large Stock TR USD.” U.S. 10 Year bonds provided by GFD prior to 1980 and Datastream thereafter. U.S. 60/40 is 60% S&P, 40% U.S. 10 Year bonds, rebalanced monthly. Historical return calculated over period 1951-2015. Returns are excess of CPI. Time periods are chosen to represent a savings and retirement period (~65 years) and just a savings period (~40 years). Assumptions are discussed in Ilmanen, Rauseo and Truax (2016) Appendix A. 2% real income growth reflects both productivity growth and career progression. 75% target RR balances likely lower cost of housing, need for saving, and spending dependents versus the potentially higher cost of health care. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix hereto. Please read important disclosures in the Appendix.

The Trade-Off Between Returns and Savings Rates

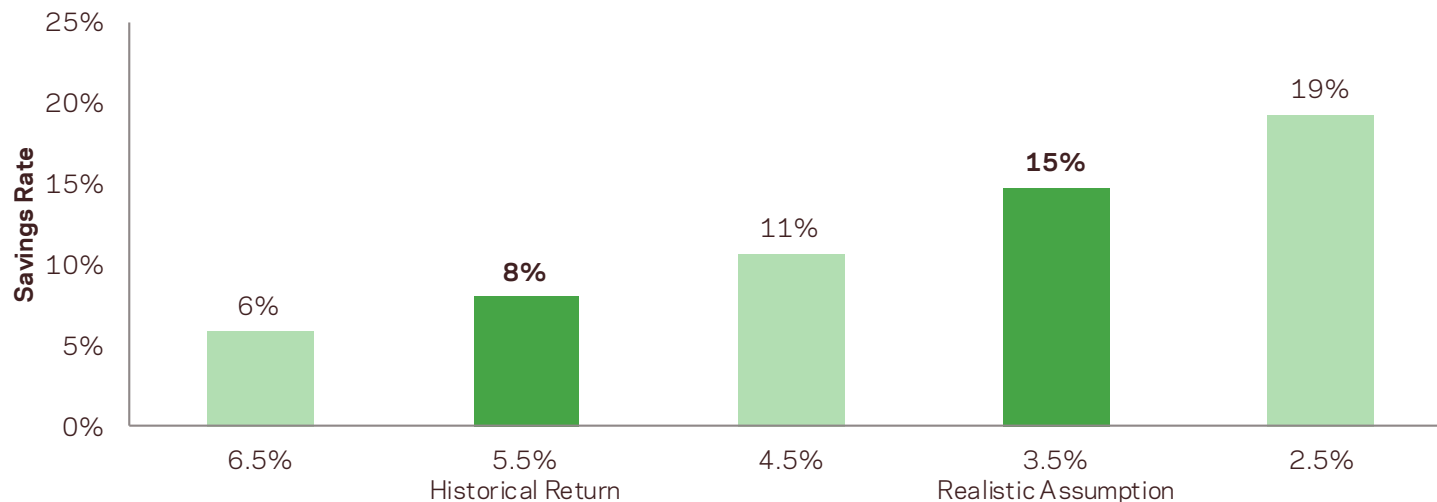
Lower Expected Returns = Higher Required Savings

Below we show required savings rates for a range of different return assumptions

Lower real return assumptions anchored to current real yields* imply a **15% required savings rate**, compared to 8% savings rate using historical returns

- We assume 5% for stocks, 1% for bonds; ca. 3.5% for 60/40 (still above next-decade outlook)
- Each 1% decrease in expected returns leads to a 2-5% increase in required savings rate
- In order to compensate for lower returns, participants may have to save meaningfully more

Impact of Lower Return Expectations on Savings Rate Required to Achieve 75% RR



U.S. 60/40 annual real return expectation

* See AQR Alternative Thinking Q1 2017: *Capital Market Assumptions for Major Asset Classes*. Real return assumptions of 5% for equities and 1% for bonds reflect low current real yields but also assume some normalization over the saving period.

Source: AQR, calculated using the assumptions laid out on this and the previous slide. U.S. 60/40 Annual Return Expectations reflect a portfolio invested 60% in U.S. equities and 40% in U.S. bonds. U.S. equities and U.S. bonds are based on simulations using the returns stated in this section. U.S. equities is meant to be representation of a large capitalization broad U.S. equity index like the S&P 500 index; U.S. bonds is meant to be representative of a broad bond index like the Barclays U.S. Aggregate. Historical return is based on period 1951-2015. We only show savings rates in full percentage points to avoid false precision of our estimates. For illustrative purposes only. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix hereto. Please read important disclosures in the Appendix



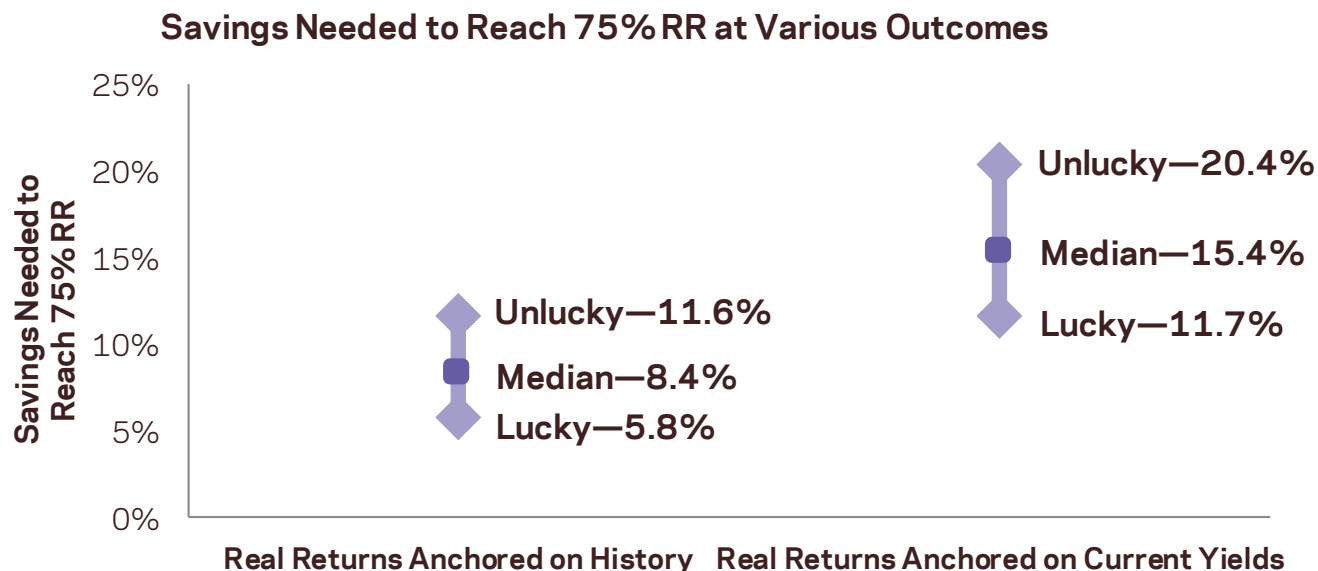
Incorporating Uncertain Outcomes

Participants May Want To Prepare For Being “Unlucky”

In the real world, participants need to take into account the risk that capital markets deliver returns below expectations

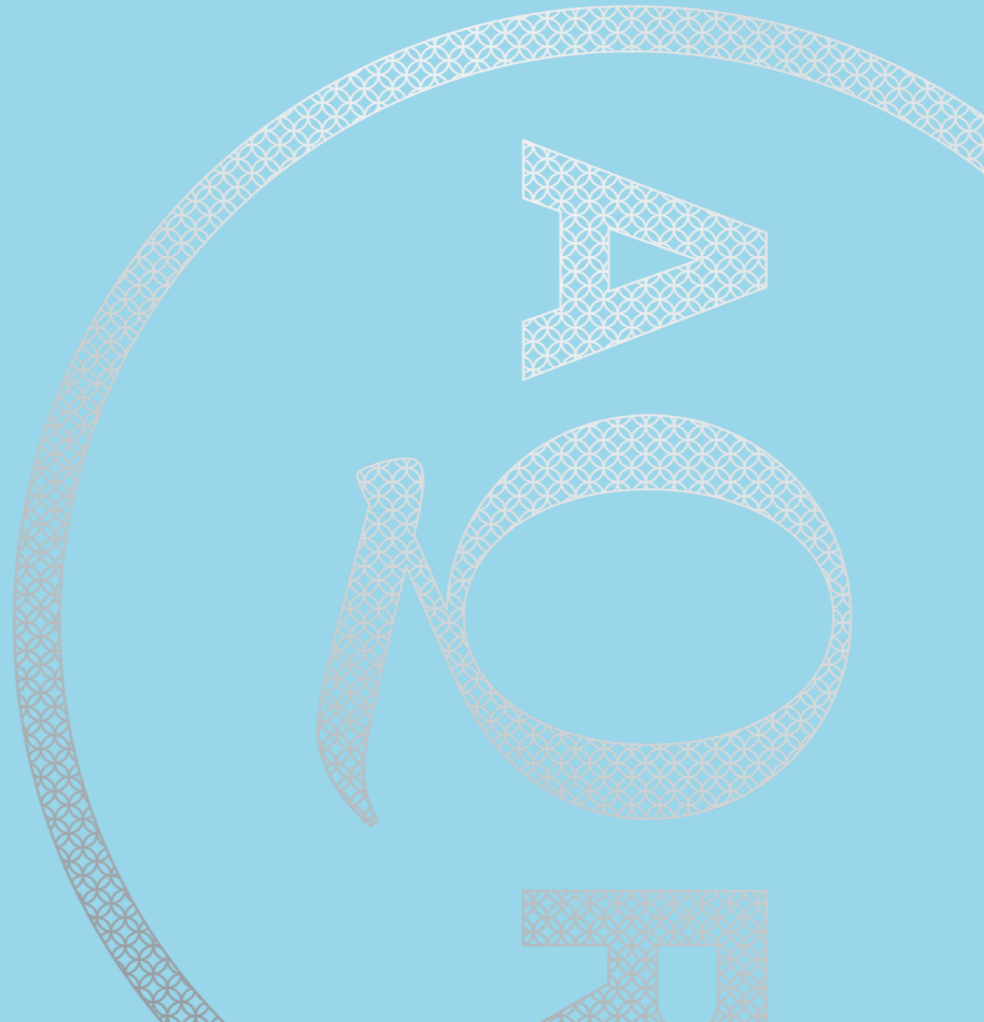
Also, participants tend to use a glide path approach

Incorporating these two elements, we now look at not only the median but also “lucky” (top 20%) and “unlucky” (bottom 20%) outcomes for the two main scenarios



Source: AQR. Replacement ratios are calculated using the methodology described on previous two slides. Scenario 1 (left hand side) returns sampled monthly throughout the glide path from a distribution that assumes average annual returns of 7.5% for equities and 2.5% for bonds (based on historical rates of return from period 1951-2015). Scenario 2 (right hand side) assumes average annual returns of 5% for equities and 1% for bonds (reflecting low current real yields but also assuming some normalization over the saving period). Both scenarios assume standard deviations of 15% and 5% for U.S. equities and U.S. bonds, respectively. “Lucky” corresponds to the 80th percentile across 1000 simulations, “Median” corresponds to the 50th percentile, and “Unlucky” corresponds to the 20th percentile. Hypothetical data has inherent limitations, some of which are disclosed in the Appendix hereto. For illustrative purposes only. Please read important disclosures in the Appendix.

Better Investing: The Big Picture



What Can Investors Do?

Three Broad Paths to Address the Low Expected Return Challenge

Possible Solution	Motivation	Challenges
1. More Equities	CAPM Beliefs: Highest conviction potential long-term return source	Concentration: already dominant risk to many; not cheap
2. Add Illiquids	Endowment Model Beliefs: High returns historically; perceived illiquidity premium	Illiquidity; contain much equity beta; also historically expensive
3. Add Factor Tilts and Alternative Risk Premia	Multi-Factor Beliefs: Evidence on multiple rewarded factors, potential diversification benefits	Leverage and other tools are required to meet return targets



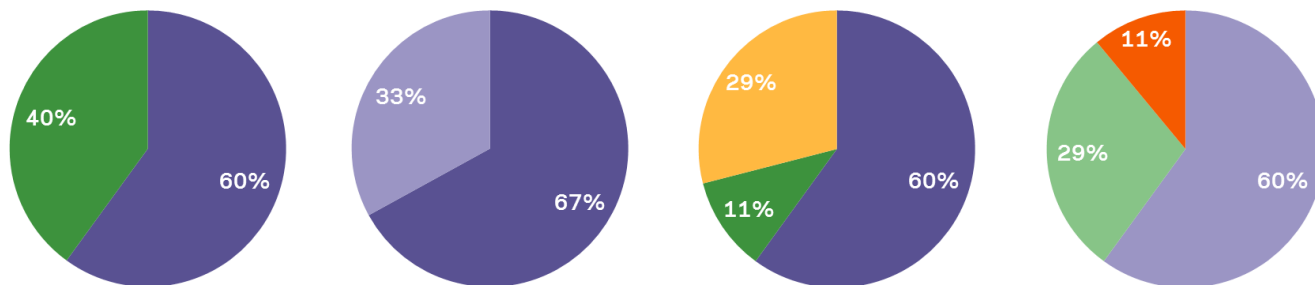
Source: AQR. Diversification does not eliminate the risk of experiencing investment losses. Past performance is not a guarantee of future performance

What Can Investors Do?

Three Broad Paths to 5% Expected Real Return, Even Today

Investment	60/40 (cap-wtd)	1. Go to Equities	2. Add Illiquids	3. Add Factor Tilts and ARP
Global Equity (cap-weighted)	60%	67%	60%	
Global FI (cap-weighted)	40%		11%	
Private Equity			29%	
Global Equity (factor-tilted)		33%		60%
Global FI (factor-tilted)				29%
Alternative Risk Premia				11%

- Global Equity (cap-weighted)
- Global FI (cap-weighted)
- Private Equity
- Global Equity (factor-tilted)
- Global FI (factor-tilted)
- Alternative Risk Premia



Investment	60/40 (cap-wtd)	1. Go to Equities	2. Add Illiquids	3. Add Factor Tilts and ARP
Leverage (look-through)	No	No	Yes	Yes
Expected Volatility	9%	15%	13%	9%
Expected Real Return	3%	5%	5%	5%

Source: AQR. For illustrative purposes only and not representative of an actual portfolio AQR manages. Allocation analysis is based on expected real return, volatility, correlation and leverage assumptions shown in the Appendix. For further details and discussion on long-term expected return estimates, see AQR *Alternative Thinking* Q1 2017: *Capital Market Assumptions for Major Asset Classes*. For volatility and correlation assumptions: Global Equity (cap-weighted and factor-tilted) is based on the MSCI World Index; Global Fixed Income (cap-weighted and factor-tilted) is based on the Barclays Global Aggregate Index (hedged); Private Equity is based on the Cambridge Associates LLC U.S. Private Equity Index, with returns adjusted to account for smoothing; Alternative Risk Premia is based on a hypothetical multi-asset long/short style strategy as described in the appendix. There is no guarantee, express or implied, that long-term return and/or volatility targets will be achieved. Realized returns and/or volatility may come in higher or lower than expected. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the Appendix. Please read important disclosures in the Appendix.



Long-Term Capital Market Assumptions

Ex Ante Assumptions for Investments in “5% Real” Recipes

Investment	Expected Real Return	Volatility
Global Equity (cap-weighted)	4.5%	15.0%
Global FI (cap-weighted)	1.0%	5.0%
Private Equity	7.5%	15.0%
Global Equity (factor-tilted)	6.0%	15.0%
Global FI (factor-tilted)	2.0%	5.0%
Alternative Risk Premia	7.5%	10.0%
Cash	0.0%	

Expected Real Return assumptions are based on yield-based estimates for equities and bonds; assumed illiquidity premium for private equity; and for alternative risk premia and factor tilts a combo of discounted hypothetical performance and judgment

For cash, the assumption of 0% real return reflects the current low-yield environment with some expectation of normalization

Volatilities and correlations based on hypothetical and proxy index performance, rounded

Correlations

Investment	Global Equity (cap-wtd)	Global FI (cap-wtd)	Private Equity	Global Equity (factor tilted)	Global FI (factor tilted)	Alternative Risk Premia
Global Equity (cap-weighted)	1.0					
Global FI (cap-weighted)	0.0	1.0				
Private Equity	0.9	0.0	1.0			
Global Equity (factor-tilted)	1.0	0.0	0.9	1.0		
Global FI (factor-tilted)	0.0	1.0	0.0	0.0	1.0	
Alternative Risk Premia	0.0	0.0	0.0	0.0	0.0	1.0

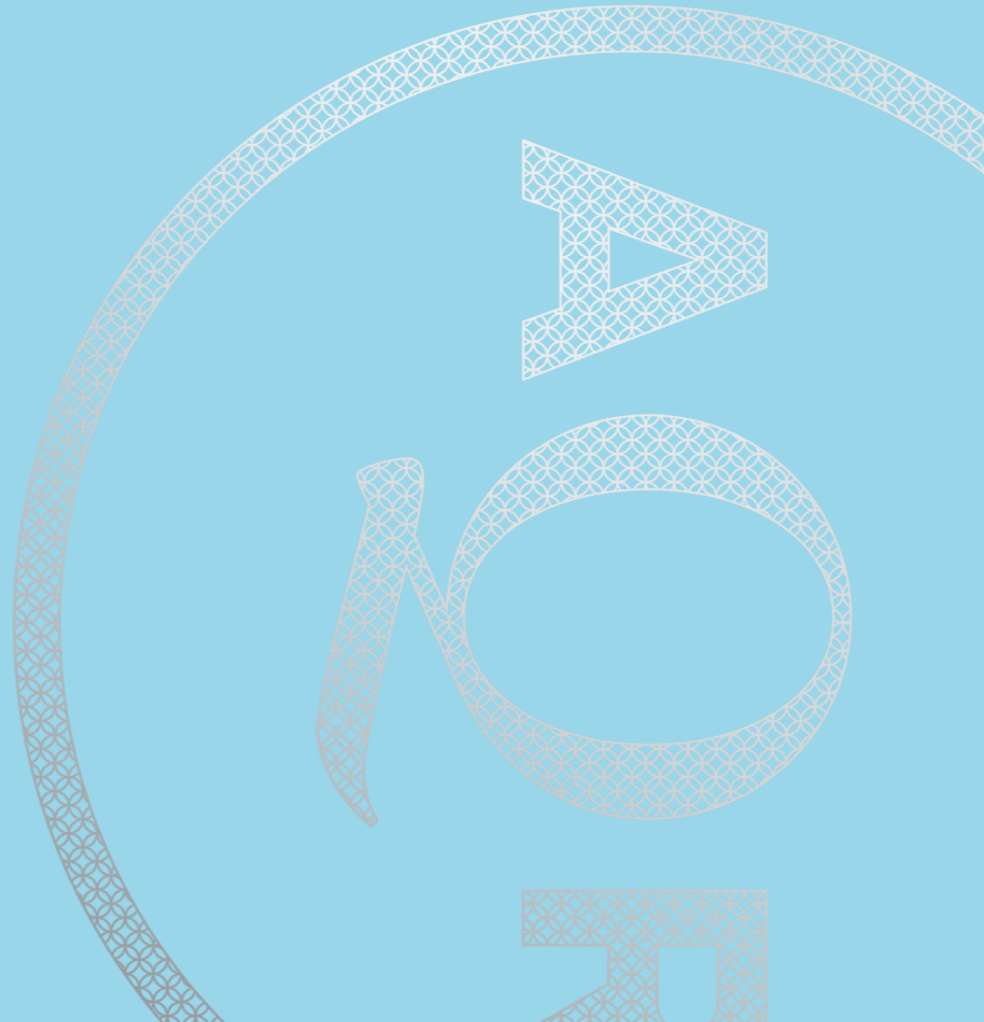
* For further details and discussion on long-term expected real return assumptions, see AQR *Alternative Thinking* Q1 2017: *Capital Market Assumptions for Major Asset Classes*.

Source: AQR. For volatility and correlation assumptions: Global Equity (cap-weighted and factor-tilted) is based on the MSCI World Index; Global Fixed Income (cap-weighted and factor-tilted) is based on the Barclays Global Aggregate Index (hedged); Private Equity is based on the Cambridge Associates LLC U.S. Private Equity Index, with returns adjusted to account for smoothing; Alternative Risk Premia is based on a hypothetical multi-asset long/short style strategy as described in the appendix. There is no guarantee, express or implied, that long-term return and/or volatility targets will be achieved. Realized returns and/or volatility may come in higher or lower than expected. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the Appendix. Please read important disclosures in the Appendix.



Example of 'Better Investing' Given Multi-Factor Beliefs: Balancing on the Life-Cycle – Improving Under-diversified TDFs*

* This example is not directly tied to the previous section because we use risk parity rather than alternative risk premia as the main way to improve risk diversification



How Traditional Target Date Funds (TDFs) Might Be Improved

Diversification, Diversification, Diversification

Shortcoming / Source of Under-Diversification	Proposed Solution / Source of Better Diversification
1. Home-Biased Investing	Invest Globally
2. Few Inflation-Protection Assets	Add Commodities (etc.)
3. Equity Risk Concentration	Risk Balanced Allocations
4. Sensitivity To Volatile Periods	Dynamic Risk Targeting
5. Lack of Diversifying Alternatives	Incorporate Trend-Following (etc.)

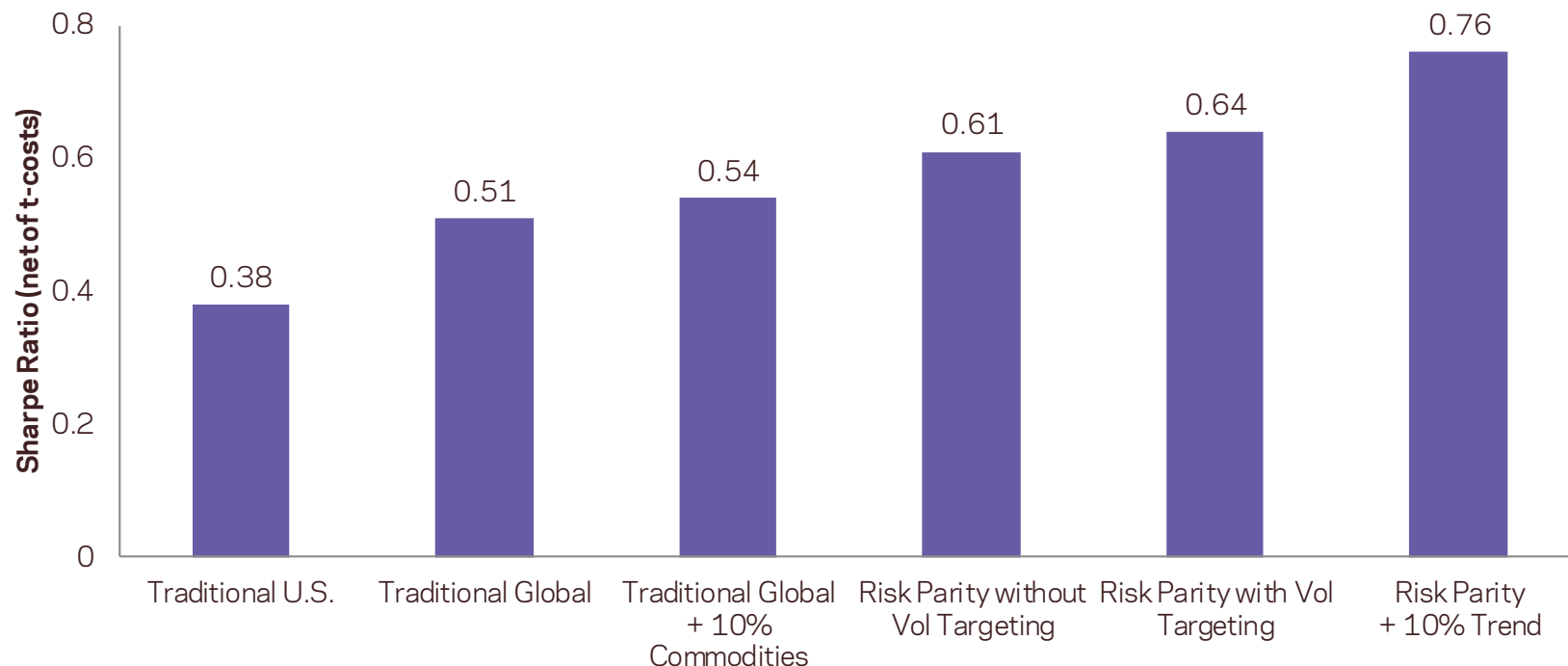


Source: AQR. This list may not be comprehensive. Diversification does not eliminate the risk of experiencing investment losses.

Empirical Benefits of Better Diversification(Full Shift)

Addressing Each of These Shortcomings Has Improved Hypothetical Results

Stepwise Sharpe Ratio Improvement of Hypothetical Simple Portfolio, 1903-2014

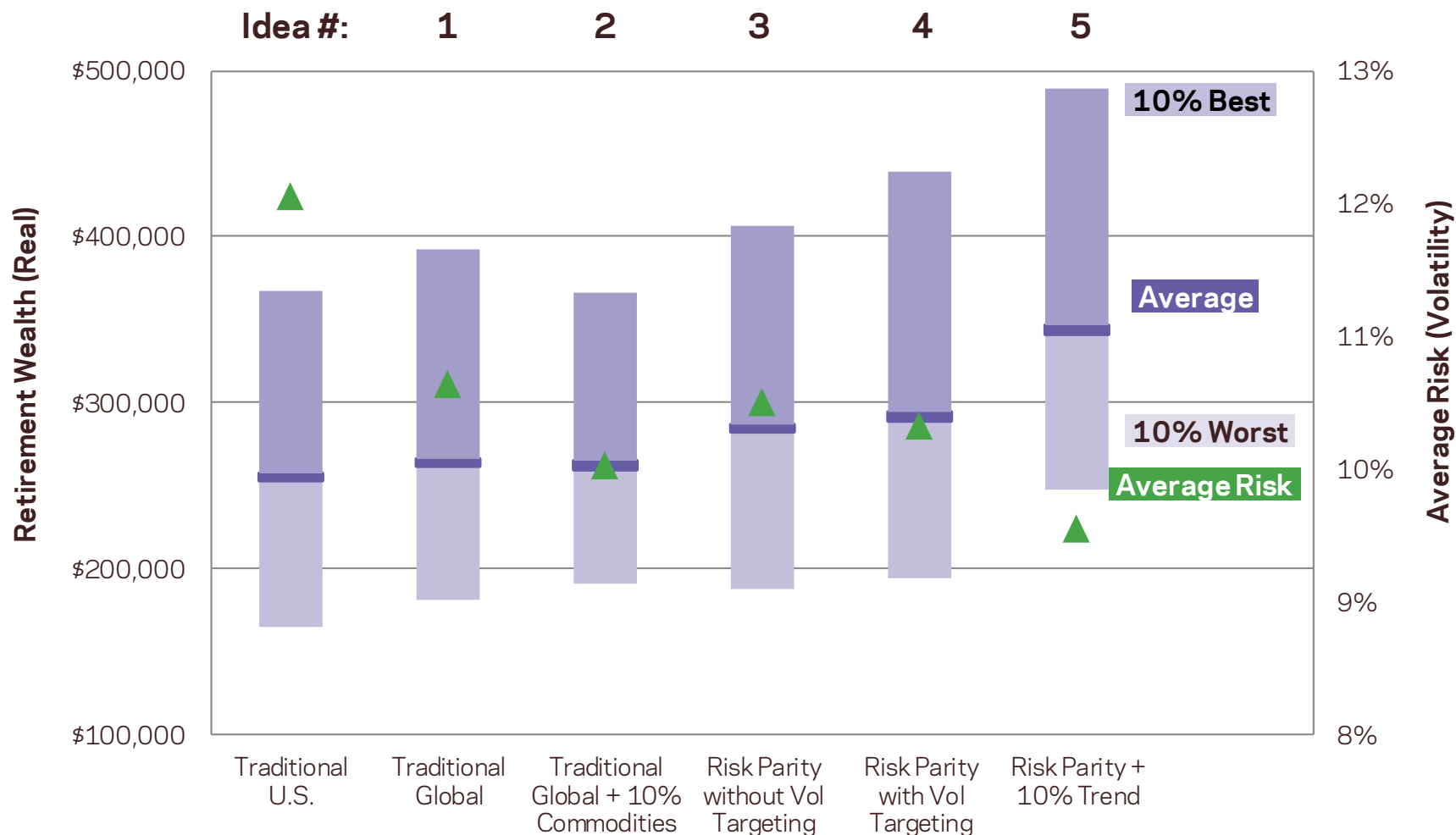


Source: AQR. For illustrative purposes only and not based on an actual portfolio AQR manages. Please see slide 28 for an explanation of the methodology used and slide 31 for detail on the underlying dataset. Hypothetical analysis is gross of fees and t costs. Traditional U.S. is domestic 80% U.S. equities/20% U.S. fixed income. Traditional Global is 80% global equities/20% global fixed income. Traditional Global + 10% Commodities is 72% global equities/18% global fixed income/10% commodities. Global equities and global fixed income are GDP-weighted across available countries. Commodities is an equal-weighted portfolio of available commodities. Risk Parity without Vol Targeting is a simple equal risk portfolio of global equities, global fixed income, and commodities. Risk Parity with Vol Targeting is a simple equal risk portfolio of global equities, global fixed income, and commodities that targets a constant annual volatility. Risk Parity + 10% trend is 90% Risk Parity with Vol targeting and 10% Trend-Following. Hypothetical data has inherent limitations, some of which are disclosed in the appendix hereto. Please read important disclosures in the Appendix.



Adding as a Component to Traditional TDFs (Partial Shift)

Each Solution May Add Value, a Combination May Be Even Better



Source: AQR. For illustrative purposes only and not based on an actual portfolio AQR manages. Please see slide 28 for an explanation of the methodology used and slide 31 for detail on the underlying dataset. TDF strategies are gross of fees and t-costs and use the average glide path across the three largest TDF providers as of June 2014. Hypothetical risk parity and trend strategies are gross of fees and net of t costs. Please see footnote on the previous slide for an explanation of the composition of each portfolio shown. Hypothetical data has inherent limitations, some of which are disclosed in the appendix hereto. 10% Best and 10% Worst are averages. "Average Risk" is the average volatility each cohort faced over its savings period. Please read important disclosures in the Appendix.

Conclusion of the TDF Analysis

Better Diversification May Also Help Returns

We believe these ideas address lifetime investing goals through:

- A more-explicit focus on risk management
- Less importantly, inclusion of return-enhancing strategies
- Benefiting from better risk balance across asset classes and strategies
- Addressing tail risk, particularly in the last decade before retirement

Thoughts for implementation:

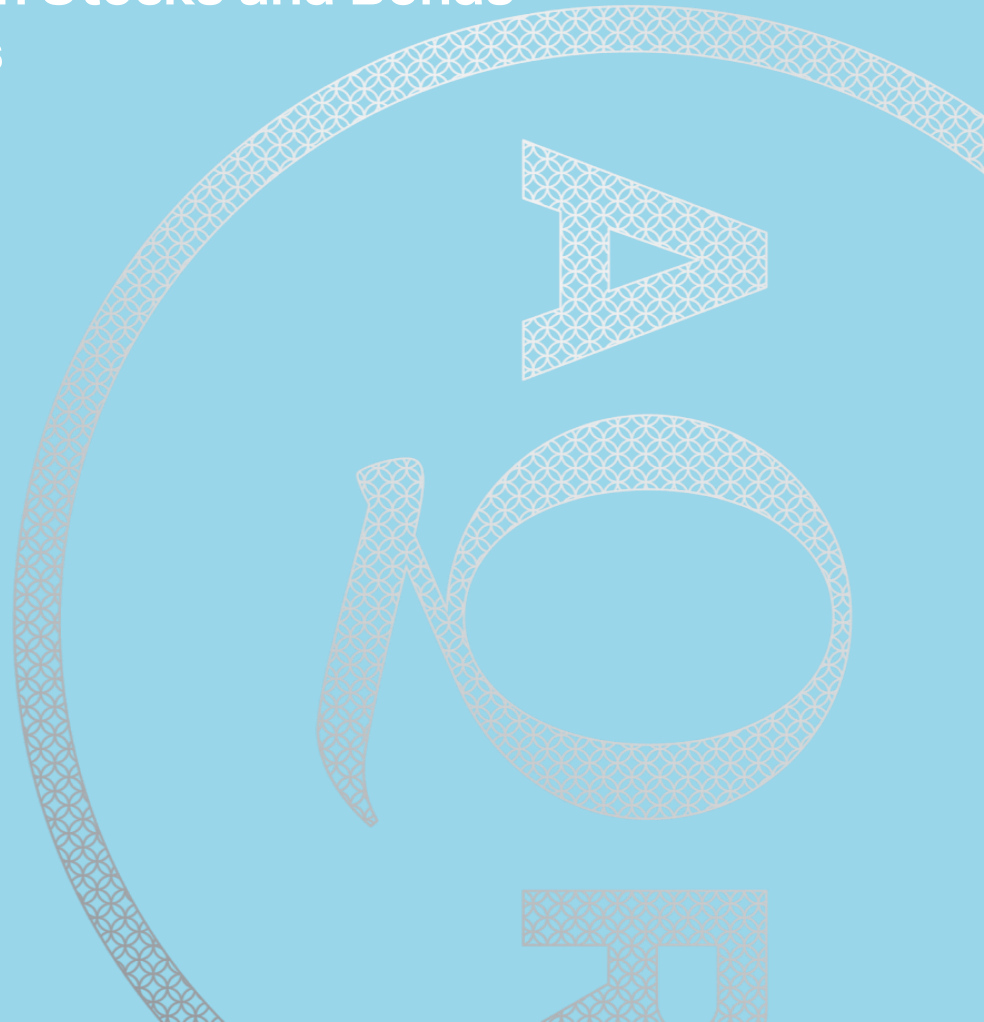
- These solutions are “alternative” (unconventional; efficient diversification would require manager use of shorting and leverage)
- However, few are “new” to the investment scene, many have 10+ year institutional track records, are supported by academic research, and are increasingly used by institutional investors
- Likelihood of success may be better as a diversifying “sleeves” within a TDF: Evolution rather than revolution is more realistic, given common constraints.



Source: AQR. Hypothetical data has inherent limitations, some of which are disclosed in the appendix hereto. Diversification does not eliminate the risk of experiencing investment losses.

Appendices

- Expected Real Return History on Stocks and Bonds
- Other Long-Run Return Sources
- Some Empirical Evidence
- Real-World Constraints
- Details on the TDF Analysis

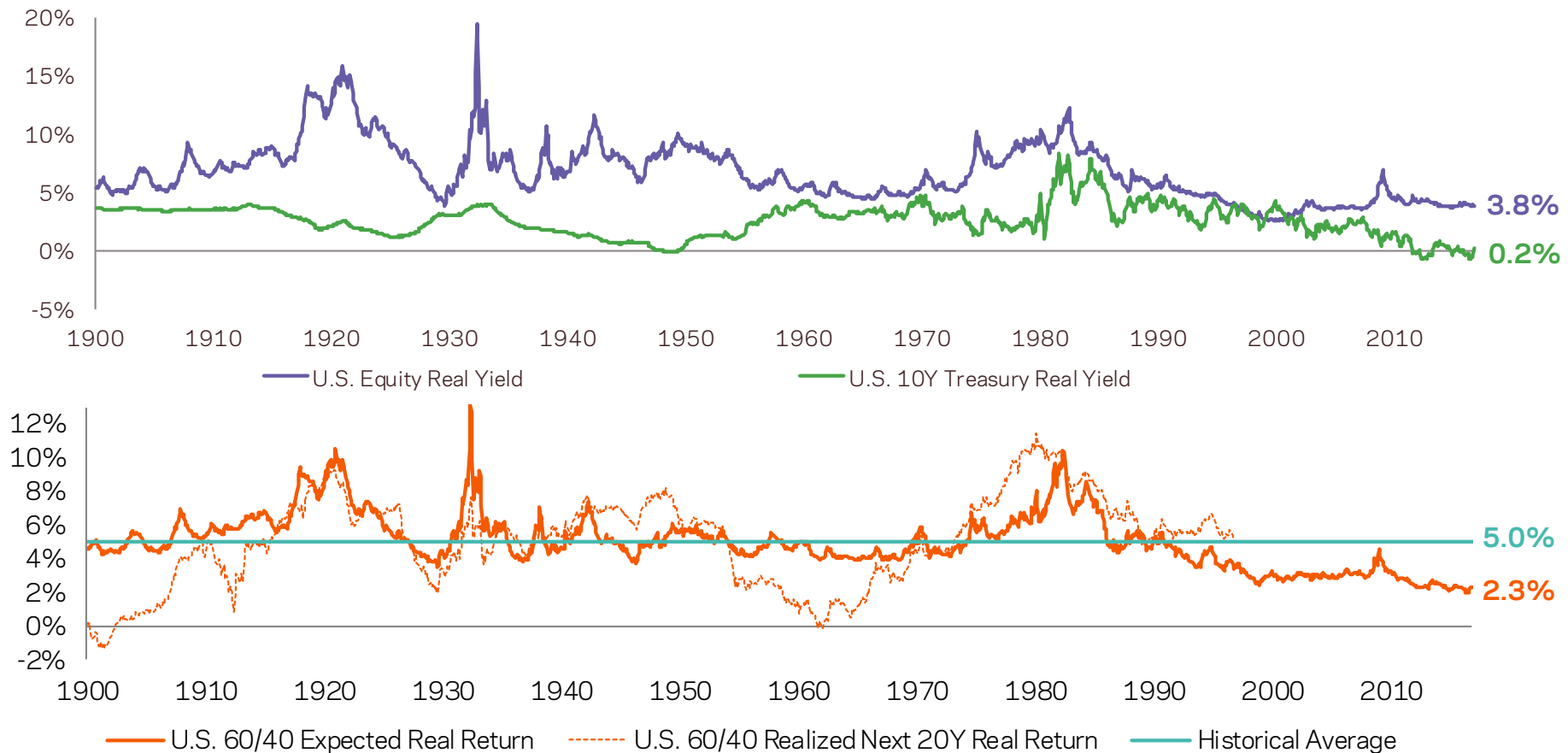


Challenge: A World of Low Expected Returns

Prospective Real Returns Are Low For Both Stocks and Bonds

Expected Real Return of U.S. Stocks, Bonds and the 60/40 Portfolio

January 1900–December 2016



Sources: AQR, Robert Shiller's web site, Kozicki-Tinsley (2006), Federal Reserve Bank of Philadelphia, Blue Chip Economic Indicators, Consensus Economics, Morningstar. Prior to 1926, stocks are represented by a reconstruction of the S&P 500 available on Robert Shiller's web site which uses dividends and earnings data from Cowles and associates, interpolated from annual data. After that, stocks are the S&P 500. Bonds are represented by long-dated Treasuries. The 60/40 Expected Real Yield is represented by Stocks/Bonds. The equity yield is a 50/50 mix of two measures: 50% Shiller E/P * 1.075 and 50% Dividend/Price + 1.5%. Scalars are used to account for long term real Earnings Per Share (EPS) Growth. Bond yield is 10 year real Treasury Yield over 10 year inflation forecast as in *Expected Returns* (Ilmanen, 2011), with no rolldown added. Chart is for illustrative purposes only. Past performance is not a guarantee of future performance. Please read important disclosures in the Appendix.

Multiple Rewarded Factors

Well-Known, Global Return Premia as Long-Run Sources of Return

Market Risk Premia

Equities	Returns from the equity risk premium	 Traditional driver of risk
Bonds	Returns from bearing interest rate risk	
Inflation	Returns from inflation-sensitive assets	

Relative-Value Style Premia

Value	The tendency for relatively cheap assets to outperform relatively expensive ones
Momentum	The tendency for an asset's recent relative performance to continue in the near future
Carry	The tendency for higher-yielding assets to provide higher returns than lower-yielding assets
Defensive	The tendency for lower risk and higher-quality assets to generate higher risk-adjusted returns

Directional Style Premia

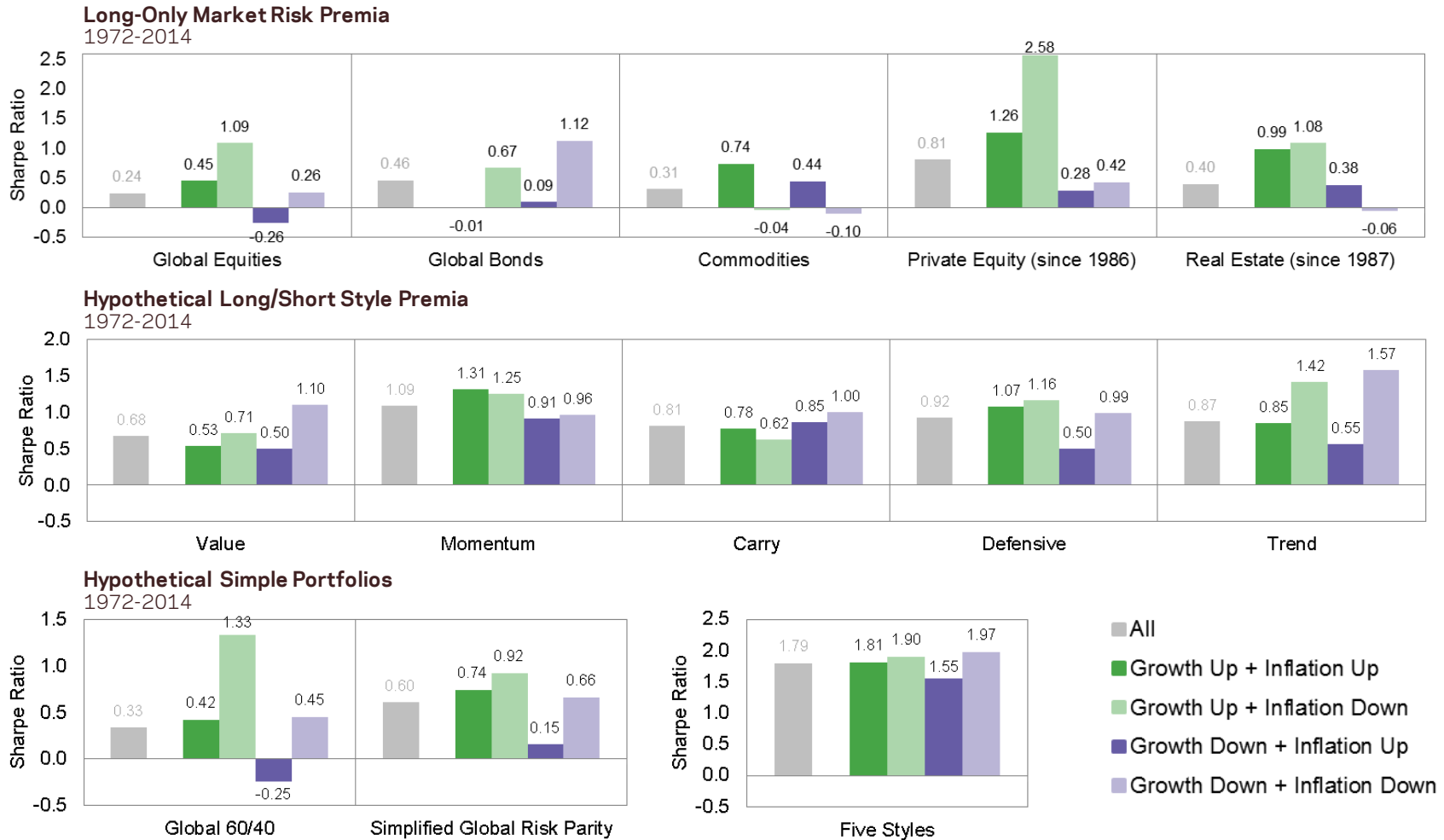
Illiquidity	The tendency for illiquid assets (e.g., PE, small-caps stocks) to outperform more liquid ones
Trend	The tendency for an asset's recent performance to continue in the near future



Source: AQR. Diversification does not eliminate the risk of experiencing investment losses. Past performance is not a guarantee of future performance.

Multi-Factor Performance Across Growth and Inflation Environments

Macro Diversification: Mapping Investments to Macro Risks



Sources: Bloomberg, Cambridge Associates and AQR. Data from January 1972 - December 2014. The risk-free rate used in Sharpe ratio calculations is the Merrill Lynch 3 Month Treasury Bill Index. Global Equities is the MSCI World Index. Global Bonds is a GDP weighted composite of Australian, German, Canadian, Japanese, U.K. and U.S. 10-year government bonds. Commodities is an equal dollar-weighted index of 24 commodities. Private Equity and Real Estate are represented by Cambridge Associates indices. Long-Short Style Premia are backtests of style premia as described in the Appendix. Global 60/40 is 60% Global Equities and 40% Global Bonds. Simplified Global Risk Parity is an equal risk allocation to Global Equities, Global Bonds and Commodities. Five Styles is an equal dollar-weighted composite of the five long/short style premia. Please see the Appendix for more details on the construction of the return series and macroeconomic environmental indicators. The analysis is based on hypothetical returns gross of trading costs and fees. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the Appendix. Please read important disclosures in the Appendix.

Real-World Considerations

Investor Constraints Limit the Use of Diversifying Alternatives

Each investor's chosen recipe will be determined by **beliefs** and **constraints**

Typical return and correlation assumptions (including ours) would imply large allocations to alternative risk premia, but it is likely to be only a small part of the solution

Why?

- **Conviction:** investor uncertainty about the sustainability of other premia than equity
- **Constraints:** aversion to leverage, shorting and derivatives
- **Conventionality:** “better to fail conventionally” —Keynes
- **Capacity:** limitations may apply especially for very large investors

Many investors choose (or are constrained to) long-only implementations

Harvest known return sources efficiently, then add unique alpha if you can find it!



Source: AQR.

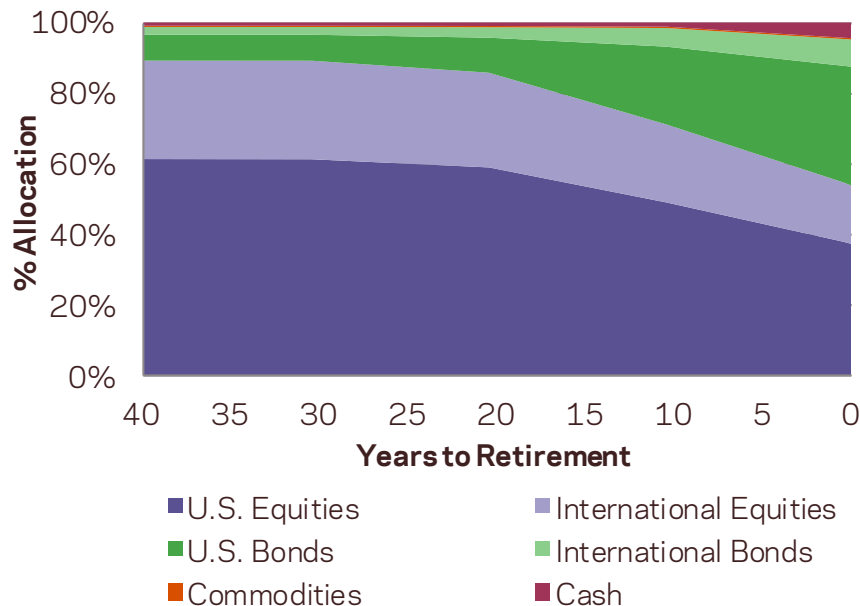
TDF: How Traditional TDFs Work

Equity Exposure Decreases Through Time

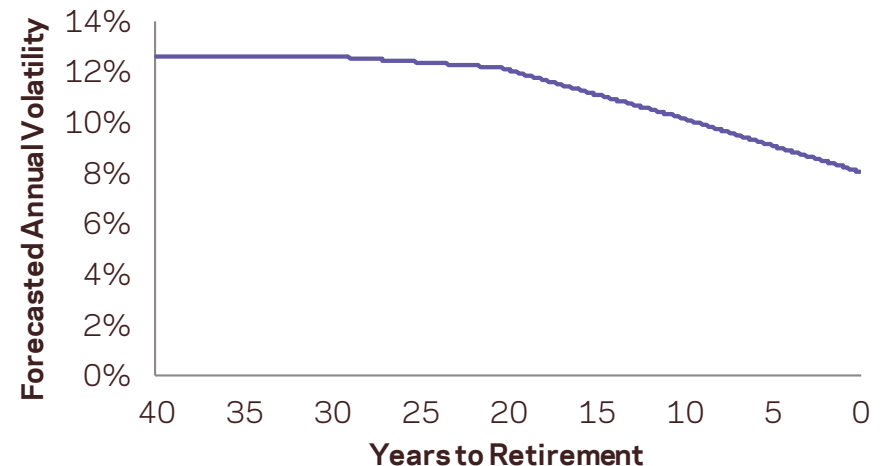
As participants age, their risk tolerance decreases

- Most TDFs thus glide from an equity-heavy portfolio to a more capital “balanced” portfolio

Traditional Recommended Asset Allocation vs. Years to Retirement*



Estimated Annual Volatility of Recommended Asset Allocation vs. Years to Retirement



Source: AQR. *Averaged glide path allocations from Fidelity, Vanguard and T Rowe Price Fund Weights as of June 2014. While we show averages, it's worth noting that there are not substantial differences in the recommendations across the three firms.

TDF: Comparing Two Different Approaches to a Glide Path

Traditional Vs. Risk Parity

MODEL Traditional Strategy

- Uses allocations from average glide path of largest three providers *
- Holds almost exclusively stocks and bonds
- Reduces equity allocation from ~90% at outset, to ~50% near retirement
- Volatility glides from 12.7% down to 8.1%
- Gross of T-Costs

MODEL Risk Parity Strategy**

- Constructs GDP-weighted portfolios for global equities and bonds, and equal weighted portfolio for Commodities
- Estimates the risk of each asset class using rolling volatilities
- Combines asset classes to have portfolio with equal volatility contributions from each
- Targets a volatility equal to the expected volatility of the corresponding traditional portfolio at that point in time
- Imposes a leverage constraint on each asset class of 200%
- Net of estimated T-Costs



Source: AQR. *Averaged glide path allocations from Fidelity, Vanguard and T Rowe Price Fund Weights as of June 2014. While we show averages, it's worth noting that there are not substantial differences in the recommendations across the three firms. **Please see appendix for additional details on t cost assumptions.

TDF: Comparison Methodology

A Multi-Cohort Comparison Over a Century

- We use monthly returns from January 1900 through December 2014, with the first 3 years for risk estimates
- Cohorts are 40 years, with the first cohort ending in December 1942, rolling forward each year
- In this manner, we track 73 investor cohorts, with 40-year life-cycle strategies*
- Savings strategy begins by \$1,000 in December, growing by 2.8% real each year, peaking at \$3,000 in real terms
- Portfolio risk is reduced over time by either adjusting the equity/bond weights (traditional) or by targeting lower volatility (risk parity)
- The final example of the main text focuses not on 'revolution' (fully switch TDF to risk parity plus trend following) but on 'evolution' (partial shift: 20% of a portfolio to risk-diversifying alternatives)



Source: AQR. *While we have over 100 years of data, we should note that we have less than three independent / non-overlapping observations. For further detail see *Balancing on the Life Cycle: Target-Date Funds Need Better Diversification* (Dhillon, Ilmanen, Liew, 2015)

Today's Presenter

Antti Ilmanen, *Principal, Portfolio Solutions Group*

Antti Ilmanen, a Principal at AQR, manages the Portfolio Solutions Group, which advises institutional investors and sovereign wealth funds, and develops AQR's broad investment ideas. Before AQR, Antti spent seven years as a senior portfolio manager at Brevan Howard, a macro hedge fund, and a decade in a variety of roles at Salomon Brothers/Citigroup. He began his career as a central bank portfolio manager in Finland. Antti earned a Ph.D. in finance from the University of Chicago and M.Sc. degrees in economics and law from the University of Helsinki. Over the years, he has advised many institutional investors, including Norway's Government Pension Fund Global and the Government of Singapore Investment Corporation. Antti has published extensively in finance and investment journals and has received the Graham and Dodd award and the Bernstein Fabozzi/Jacobs Levy award for his articles. His book *Expected Returns* (Wiley, 2011) is a broad synthesis of the central issue in investing.



Methodology for Macroeconomic Sensitivity Analysis

Macro Indicators

Each of our macro indicators combines two series, which are first normalized to Z-scores: that is, we subtract a historical mean from each observation and divide by a historical volatility. When we classify our quarterly 12-month periods into, say, 'growth up' and 'growth down' periods, we compare actual observations to the median so as to have an equal number of up and down observations (because we are not trying to create an investable strategy where data should be available for investors in real time, we use the full sample median).

The underlying series for our **growth** indicator are the Chicago Fed National Activity Index (CFNAI) and the "surprise" in industrial production growth over the past year. Since there is no uniquely correct proxy way to capture "growth," averaging may make the results more robust and signals appropriate humility. CFNAI takes this averaging idea to extremes as it combines 85 monthly indicators of U.S. economic activity. The other series – the difference between actual annual growth in industrial production and the consensus economist forecast a year earlier – is narrower but more directly captures the surprise effect in economic developments. We use median forecasts from the Survey of Professional Forecasters data as published by the Philadelphia Fed. While data surprises a priori have a zero mean, this series has exhibited a downward trend in recent decades, reflecting the (partly unexpected) relative decline of the U.S. manufacturing sector.

Note that our growth indicator is constructed from fundamental economic data, rather than asset market returns. Market-based proxies of economic growth – which might include equity market returns, the relative performance of cyclical industries, dividend swaps, and estimates from cross-sectional regressions of asset returns on growth surprises – are "too close" to the patterns we try to explain. Our choice brings its own challenges: macroeconomic data are backward-looking, published with lags and later revised, while asset prices are clearly forward-looking. The impact of publication lags and the mismatch between backward- and forward-looking perspectives can be mitigated by using longer windows. Thus, we use contemporaneous annual economic data and asset returns through our analysis (past-year data with quarterly overlapping observations). Arguably composite growth surprise indices are the best proxies of economic growth news, but such composites are available at best from the 1990s. Forecast changes in economist surveys as well as business and consumer confidence surveys may be the next best choices because they are reasonably forward-looking and timely. We focus on U.S. data, which have the longest histories. Finally, it is not clear how real economic growth ties to expected corporate cash flow growth (e.g., earnings per share) that influence stock prices, or to real yields that influence all asset prices but especially those of bonds.

Our **inflation** indicator is also an average of two normalized series. One series measures the de-trended level of inflation (CPIYOY minus its mean, divided by volatility), while the other measures the surprise element in realized inflation (CPIYOY minus consensus economist forecast a year earlier).

Investment Return Series

The investment return series we study include both asset class premia and style premia. The former are long-only returns but expressed in excess returns over the Treasury bill rate. The latter are long-short returns and scaled to target or realize 10% annual volatility. We subtract no trading costs or fees, which makes a bigger difference for the long-short strategies.

The asset class premia are global equities (MSCI World), global bonds (GDP-weighted average of 10-year government bonds in six countries), and an equal-weighted composite of 24 commodity futures.

The market-neutral style premia (Value, Momentum, Carry and Defensive) are hypothetical long/short strategies applied in multiple asset classes: stock selection, industry allocation, country allocation in equity, fixed income and currency markets, and commodities. Each style premia strategy allocates 50/50 risk weights to stock and industry selection (SS) and asset allocation (AA) strategies. For AA we use the same relative risk weights for asset classes as "Investing With Style" (AQR white paper, 2012, available upon request): 33% equity country allocation, 25% fixed income, 25% currencies, 17% commodities. We combine several data sources to produce a dataset long enough to capture many different macroeconomic environments:

- Since 1990, we use value, momentum, carry and defensive style premia strategies as described in "Investing With Style" (AQR white paper, 2012, available upon request). For SS value, momentum and carry we use 50/50 risk weights between stock selection within industries and across industries (to be in line with the common but arguably inefficient practice of letting across-industry positions matter as much as within-industry positions). For SS carry (not included in the white paper) we use the dividend yield strategy returns in Ken French's data library.
- For 1972-1989, we source value and momentum style returns from "Value and Momentum Everywhere" (*Journal of Finance*, 2013), defensive style returns from "Betting Against Beta" (*Journal of Financial Economics*, 2013), and SS carry from the dividend yield strategy returns in Ken French's data library. We construct the AA carry style premia before 1990 as well as some early histories of AA value, momentum and defensive styles using AQR in-house backtests. These backtests are similar to those described above, but over a narrower universe.

While the SS style premia proxies we use since 1990 are beta-neutral, the value and momentum premia before 1990, and the SS carry premium throughout, are 'only' dollar-neutral and may contain moderate empirical beta exposures. The defensive style premia are beta-neutral throughout (we buy larger amounts of low-risk investments than we sell high-risk investments), which means that they are actually not as 'defensive' as a dollar-neutral defensive style.

In addition to the four market-neutral style premia, we include the market-directional Trend style, which applies 12-month trend-following strategies in four asset classes: equities, fixed income, currencies and commodities. While the style is nearly uncorrelated with equity markets in the long run, at any point in time it can be directionally long or short. For data since 1985, we use "Time Series Momentum" (*Journal of Financial Economics*, 2012). For 1972-1984, we use in-house backtests based on the same asset classes, but including 1-, 3- and 12-month momentum, and starting with a smaller asset universe that grows during the period as more assets become available.



Construction of Trend-Following Strategy

Trend-Following Strategy

The Trend-Following Strategy was constructed with an equal-weighted combination of 1-month, 3-month, and 12-month Trend-Following strategies for 67 markets across 4 major asset classes – 29 commodities, 11 equity indices, 15 bond markets, and 12 currency pairs – from January 1880 to June 2015. Since not all markets have return data going back to 1880, we construct the strategies using the largest number of assets for which return data exist at each point in time. We use futures returns when they are available. Prior to the availability of futures data, we rely on cash index returns financed at local short rates for each country.

In order to calculate net-of-fee returns for the time series momentum strategy, we subtracted a 2% annual management fee and a 20% performance fee from the gross-of-fee returns to the strategy. The performance fee is calculated and accrued on a monthly basis, but is subject to an annual high-water mark. In other words, a performance fee is subtracted from the gross returns in a given year only if the returns in the fund are large enough that the fund's NAV at the end of the year exceeds every previous end of year NAV. The transactions costs used in the strategy are based on AQR's 2012 estimates of average transaction costs for each of the four asset classes, including market impact and commissions. The transaction costs are assumed to be twice as high from 1993 to 2002 and six times as high from 1880–1992, based on Jones (2002). The transaction costs used are as follows:

Asset Class	Time Period	One-Way Transaction Costs (as a % of notional traded)
Equities	1880-1992	0.34%
	1993-2002	0.11%
	2003-2013	0.06%
Bonds	1880-1992	0.06%
	1993-2002	0.02%
	2003-2013	0.01%
Commodities	1880-1992	0.58%
	1993-2002	0.19%
	2003-2013	0.10%
Currencies	1880-1992	0.18%
	1993-2002	0.06%
	2003-2013	0.03%

The 2014 estimate of assets under management in the BarclayHedge Systematic Traders index is \$280 billion. We looked at the average monthly holdings in each asset class (calculated by summing up the absolute values of holdings in each market within an asset class) for our time series momentum strategy since 2000, run at a NAV of \$280 billion, and compared them to the size of the underlying cash or derivative markets. For equities, we use the total global equity market capitalization estimate from the October 2014 World Federation of Exchanges (WFE) monthly statistics tables. For bonds, we add up the total government debt for the 15 developed countries with the largest debt using Bloomberg data. For currencies, we use the total notional outstanding amount of foreign exchange derivatives, excluding options, which are U.S. dollar denominated in the first half of 2014 from the Bank for International Settlements (BIS) November 2014 report. For commodities, we use the total notional of outstanding OTC commodities derivatives, excluding options, in the first half of 2014 from the BIS November 2014 report and add the aggregate exchange futures open interest for 31 of the most liquid commodities.

	Average Position size in \$280B Time Series Momentum Portfolio (bn)	Total Market Size (bn)	Percentage of Total Market
Commodities	134	2,300	5.8%
Equities	99	63,000	0.2%
Bonds	758	33,000	2.3%
Currencies	226	62,000	0.4%



Performance Disclosures

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There is no guarantee, express or implied, that long-term return and/or volatility targets will be achieved. Realized returns and/or volatility may come in higher or lower than expected. **PAST PERFORMANCE IS NOT A GUARANTEE OF FUTURE PERFORMANCE.** Diversification does not eliminate the risk of experiencing investment losses.

Hypothetical performance results (e.g., quantitative backtests) have many inherent limitations, some of which, but not all, are described herein. No representation is being made that any fund or account will or is likely to achieve profits or losses similar to those shown herein. In fact, there are frequently sharp differences between hypothetical performance results and the actual results subsequently realized by any particular trading program. One of the limitations of hypothetical performance results is that they are generally prepared with the benefit of hindsight. In addition, hypothetical trading does not involve financial risk, and no hypothetical trading record can completely account for the impact of financial risk in actual trading. For example, the ability to withstand losses or adhere to a particular trading program in spite of trading losses are material points which can adversely affect actual trading results. The hypothetical performance results contained herein represent the application of the quantitative models as currently in effect on the date first written above and there can be no assurance that the models will remain the same in the future or that an application of the current models in the future will produce similar results because the relevant market and economic conditions that prevailed during the hypothetical performance period will not necessarily recur. There are numerous other factors related to the 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 actual trading results. Discounting factors may be applied to reduce suspected anomalies. This backtest's return, for this period, may vary depending on the date it is run. Hypothetical performance results are presented for illustrative purposes only. In addition, our transaction cost assumptions utilized in backtests, where noted, are based on AQR's historical realized transaction costs and market data. Certain of the assumptions have been made for modeling purposes and are unlikely to be realized. No representation or warranty is made as to the reasonableness of the assumptions made or that all assumptions used in achieving the returns have been stated or fully considered. Changes in the assumptions may have a material impact on the hypothetical returns presented. Hypothetical performance is gross of advisory fees, net of transaction costs, and includes the reinvestment of dividends. If the expenses were reflected, the performance shown would be lower. Where noted, the hypothetical net performance data presented reflects the deduction of a model advisory fee and does not account for administrative expenses a fund or managed account may incur. Actual advisory fees for products offering this strategy may vary.

Gross performance results do not reflect the deduction of investment advisory fees, which would reduce an investor's actual return. For example, assume that \$1 million is invested in an account with the Firm, and this account achieves a 10% compounded annualized return, gross of fees, for five years. At the end of five years that account would grow to \$1,610,510 before the deduction of management fees. Assuming management fees of 1.00% per year are deducted monthly from the account, the value of the account at the end of five years would be \$1,532,886 and the annualized rate of return would be 8.92%. For a ten-year period, the ending dollar values before and after fees would be \$2,593,742 and \$2,349,739, respectively. AQR's asset based fees may range up to 2.85% of assets under management, and are generally billed monthly or quarterly at the commencement of the calendar month or quarter during which AQR will perform the services to which the fees relate. Where applicable, performance fees are generally equal to 20% of net realized and unrealized profits each year, after restoration of any losses carried forward from prior years. In addition, AQR funds incur expenses (including start-up, legal, accounting, audit, administrative and regulatory expenses) and may have redemption or withdrawal charges up to 2% based on gross redemption or withdrawal proceeds. Please refer to AQR's ADV Part 2A for more information on fees. Consultants supplied with gross results are to use this data in accordance with SEC, CFTC, NFA or the applicable jurisdiction's guidelines.



Performance Disclosures

Broad-based securities indices are unmanaged and are not subject to fees and expenses typically associated with managed accounts or investment funds. Investments cannot be made directly in an index.

There is a risk of substantial loss associated with trading commodities, futures, options, derivatives and other financial instruments. Before trading, investors should carefully consider their financial position and risk tolerance to determine if the proposed trading style is appropriate. Investors should realize that when trading futures, commodities, options, derivatives and other financial instruments one could lose the full balance of their account. It is also possible to lose more than the initial deposit when trading derivatives or using leverage. All funds committed to such a trading strategy should be purely risk capital.

AQR backtests of Value, Momentum, Carry and Defensive theoretical long/short style components are based on monthly returns, undiscounted, gross of fees and transaction costs, excess of a cash rate proxied by the Merrill Lynch 3-Month T-Bill Index, and scaled to 12% annualized volatility. Each strategy is designed to take long positions in the assets with the strongest style attributes and short positions in the assets with the weakest style attributes, while seeking to ensure the portfolio is market-neutral. Please see below for a description of the Universe selection.

Stock and Industry Selection: approximately 2,000 stocks across Europe, Japan, and U.S. **Country Equity Indices:** Developed Markets: Australia, Canada, Eurozone, Hong Kong, Japan, Sweden, Switzerland, U.K., U.S. Within Europe: Italy, France, Germany, Netherlands, Spain. Emerging Markets: Brazil, China, India, Israel, Malaysia, Mexico, Poland, Singapore, South Africa, South Korea, Taiwan, Thailand, Turkey. **Bond Futures:** Australia, Canada, Germany, Japan, U.K., U.S. **Yield Curve:** Australia Germany, United States. **Interest Rate Futures:** Australia, Canada, Europe (Euribor), U.K. and U.S. (Eurodollar). **Currencies:** Developed Markets: Australia, Canada, Euro, Japan, New Zealand, Norway, Sweden, Switzerland, U.K., U.S. Emerging Markets: Brazil, Hungary, India, Israel, Mexico, Poland, Singapore, South Africa, South Korea, Taiwan, Turkey. **Commodity Selection:** Silver, copper, gold, crude, Brent oil, natural gas, corn, soybeans.

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