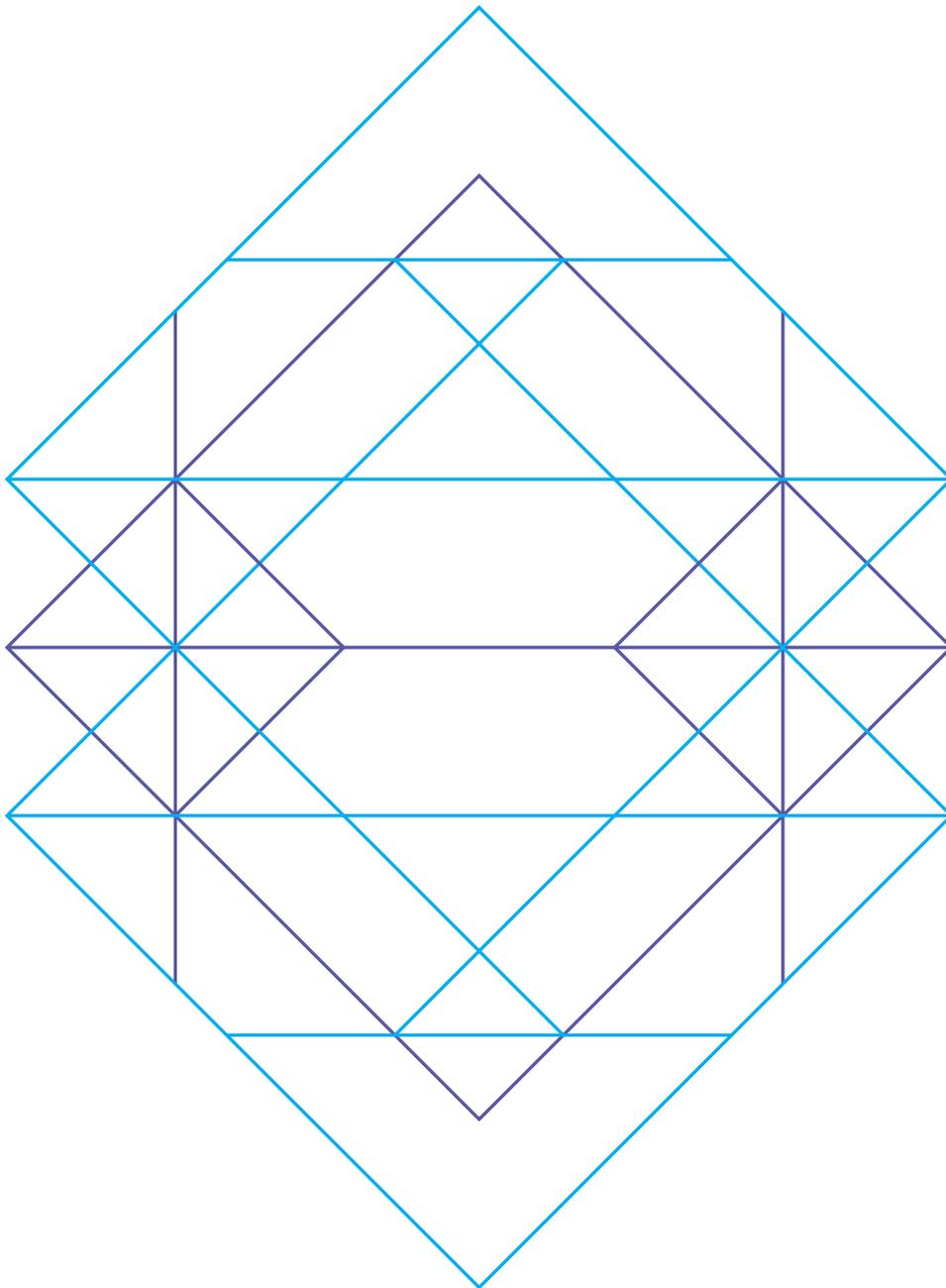# Capital Market Assumptions for Major Asset Classes

Executive Summary

This article has two parts. In the first part, we update our estimates of medium-term (5- to 10-year) expected returns for major asset classes. Selected estimates are summarized below. Compared to last year, expected returns are lower for equities, bonds and credit. From a historical perspective nearly all long-only investments have low expected real returns today. The expected real return of the traditional U.S. 60/40 portfolio is 2.6%, around half its long-term average (since 1900[1]).

In the second part of the article, we explore the historical accuracy of yield-based return estimates, compared to reasonable alternatives. We know that short-term outcomes can deviate hugely from such estimates — in 2017, the real return on the S&P 500 index was nearly 20% (source: Bloomberg), compared to last year's medium-term estimate of 4.2% (returns on bonds and commodities were closer to our forecasts). But how much deviation should we expect over

the longer term? The answer to this question has implications for how we should use such return estimates in practice.

Using over a century of data, we find that yield-based forecasts have been more accurate than alternative methods for a 10-year horizon. But we also show that 10-year outcomes can stray far from forecasts, and that naïve statistical measures such as correlations may be unreliable guides to predictive power.

Investors use various methods to estimate expected returns when designing a strategic asset allocation suited to their investment objectives. On the one hand, our analysis suggests that yield-based measures may be more appropriate than, say, historical returns. On the other hand, the results support our view that such estimates are more useful for setting appropriate expectations than for aggressive tactical allocation decisions.

Exhibit 1

Summary of Expected Medium-Term Real Return Estimates for Major Asset Classes
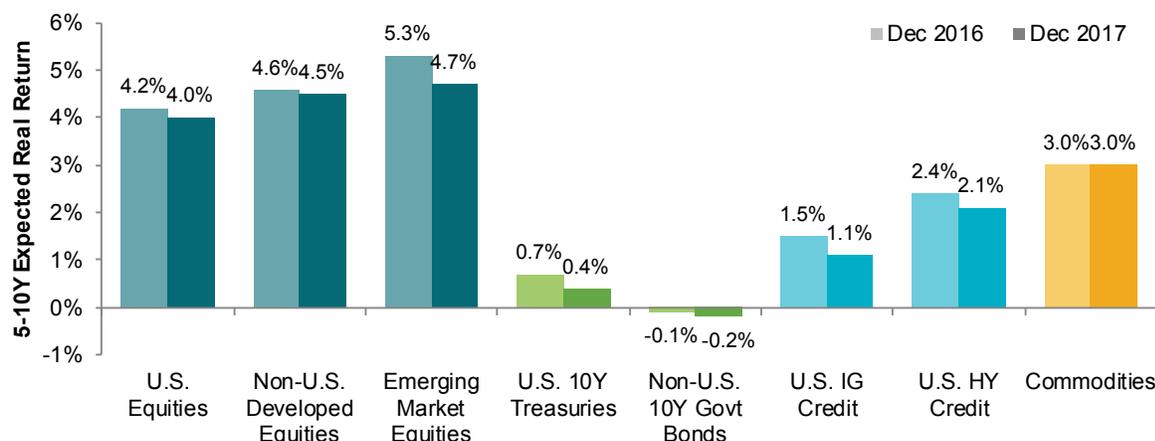
Source: AQR; see Exhibits 2-5 for details. "Non-U.S. developed equities" is cap-weighted average of Euro-5, Japan, U.K., Australia, Canada. "Non-U.S. 10Y govt. bonds" is GDP-weighted average of Germany, Japan, U.K., Australia, Canada. Estimates are for illustrative purposes only, are not a guarantee of performance and are subject to change. Not representative of any portfolio that AQR currently manages.

1   Based on historical real yields for U.S. large-cap equities and 10-year Treasuries; methodology and sources described in Exhibit 6.

CMA Introduction and Framework

For the past four years, the first quarter's *Alternative Thinking* has presented our capital market assumptions for major asset classes, with a focus on medium-term expected returns (see 2014, 2015, 2016 and 2017). We update these estimates annually, and each year we provide additional analysis in the form of new asset classes, revised methodologies or other new material. This year, we update our estimates using the same methodology as last year, and then provide an analysis on the predictive ability of yield-based return forecasts.

As usual, we present real (inflation-adjusted) annual compound rates of return for a horizon of 5 to 10 years. Over such intermediate horizons, initial market yields and valuations tend to be the most important inputs. For multi-decade forecast horizons, the impact of starting yields is diluted, so theory and long-term historical average returns (or yields) may matter more in judging expected returns. For shorter horizons, returns are largely unpredictable and

any predictability has tended to mainly reflect momentum and the macro environment.

Our estimates are intended to assist investors with their strategic allocation and planning decisions, and, in particular, with setting appropriate medium-term expectations. They are not intended for tactical asset allocation or market timing.[2] Indeed, our analysis in the second part of the article clearly illustrates that any point estimates for expected returns come with significant uncertainty. The frameworks for making such estimates may be more useful and informative than the numbers themselves.

We should not be surprised that nearly all long-only investments have low expected returns today. In theory, all assets are priced according to the present value of their expected cash flows. The riskless yield is the common component of all assets' discount rates, and when it is near historical lows it tends to make all assets expensive.

Arithmetic or Geometric Rates of Return?

As in previous years, we report geometric returns, or, to be more precise, logarithmic returns (since our yield-based estimates are not historical means). A variance-related term could be added to give arithmetic or simple returns. This term is much larger for equities and commodities (around 1%) than for bonds (around 0.1%). There are two alternative justifications for our decision to show expected log returns:

1. The probability-weighted mean expected full-period return is generated by compounding the expected simple rate of return, not the expected log return. But where the expected return is an uncertain estimate, the impact of upside and downside errors is asymmetric due to compounding, leading to an upward bias. This may justify making a downward adjustment related to expected variance (i.e., using the expected log return).

2. Investors see only one outcome, and do not have the luxury of averaging over many worlds. The median full-period return may therefore be a more relevant expectation metric than the mean. This is arrived at from the log return. However, we note that where investments are rebalanced within a wider portfolio, compounding effects are diluted and the simple return becomes more relevant (but then point (1) above still applies).

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2   Active allocation decisions should be made on the basis of expected returns *in excess of the risk-free rate*, if at all. We present real returns partly because they are the 'bottom line' for many investors with real liabilities, and partly because they are easier to forecast over intermediate horizons. See Huss, Maloney, Mees and Mendelson (2017) for a discussion of bonds' positive expected excess-of-cash returns.

Equity Markets

Last year we revised our methodology for estimating expected equity real returns.[3] Our starting point is the classic dividend discount model (DDM), under which expected real return is approximately the sum of dividend yield (DY), expected trend growth (g) in real dividends or earnings per share (EPS), and expected change in valuation ($\triangle$v), that is: E(r) ≈ DY + g + $\triangle$v. We take the simple average of two approaches, described below. As usual, we assume no mean reversion,[4] i.e., $\triangle$v = 0.

1. **Earnings-based:** We start from the inverse of the CAPE ratio (cyclically-adjusted P/E, also called the Shiller P/E), which is the 10-year average of earnings, inflation-adjusted to today's price levels, divided by today's price. We multiply by 0.5 (roughly the U.S. long-run dividend payout ratio), and add a real earnings growth rate of 1.5% (roughly the U.S. long-run geometric average). Our earnings-based expected return[5] is therefore:
$$E(r) \approx 0.5 * Adjusted\ Shiller\ E/P + g_{EPS}$$

2. **Payout-based:** Our estimate of net total payout yield (NTY) is the sum of current dividend yield and smoothed net buyback yield for each country. To this we add an estimate of long-term real growth of aggregate payouts that includes net issuance, g_{TPagg}. This country-specific growth estimate is an average of smoothed historical geometric aggregate earnings growth and forecast GDP growth. So our payout-based expected return is: $E(r) \approx NTY + g_{TPagg}$,
where $NTY = DY + net\ buyback\ yield\ (NBY)$

Estimates for most countries are somewhat lower than last year, due to further richening in 2017 (see Exhibit 2), with emerging markets seeing the most significant reduction. Higher valuations are partly offset by slightly higher growth estimates. All estimates are low by historical standards.

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3   See *Alternative Thinking Q1 2017* and its online appendix for details and discussion of the methodology changes.

4   See *Alternative Thinking Q1 2015* for a discussion of mean reversion in stock and bond valuations, and our decision to exclude it.

5   For our earnings-based estimate, we apply a 50% payout ratio to all countries, and use g = 1.5% for all countries except for emerging markets, where we use a higher growth rate of 2%. Adjusted Shiller EP is Shiller EP * 1.075 where the scalar accounts for average earnings growth during the 10-year earnings window of the Shiller EP.

Exhibit 2

Expected Equity Real Return Estimates, January 2018

	1. Earnings-Based			2. Payout-Based				Combined	
	Adjusted Shiller EP	g_{EPS}	0.5 * EP + g_{EPS}	Dividend Yield	NBY	g_{TPagg}	DY+NBY +g_{TPagg}	2018 Estimate	1-Year Change
U.S.	3.7%	1.5%	**3.4%**	1.9%	0.1%	2.7%	**4.6%**	**4.0%**	(-0.2%)
Euro-5	5.2%	1.5%	**4.1%**	2.9%	-0.4%	2.5%	**5.1%**	**4.6%**	(-0.2%)
Japan	3.7%	1.5%	**3.4%**	1.9%	0.1%	2.1%	**4.1%**	**3.7%**	(-0.2%)
U.K.	5.6%	1.5%	**4.3%**	3.8%	-0.3%	2.6%	**6.1%**	**5.2%**	(-0.1%)
Australia	5.3%	1.5%	**4.2%**	4.3%	-1.0%	2.8%	**6.1%**	**5.1%**	(0.0%)
Canada	4.8%	1.5%	**3.9%**	2.8%	-1.4%	2.6%	**4.0%**	**3.9%**	(-0.2%)
Global Developed	4.1%	1.5%	**3.6%**	2.2%	-0.1%	2.6%	**4.8%**	**4.2%**	(-0.2%)
Global Dev. ex US	4.8%	1.5%	**3.9%**	2.9%	-0.3%	2.5%	**5.1%**	**4.5%**	(-0.1%)
Emerging Mkts	6.8%	2.0%	**5.4%**	2.2%	--	--	**4.1%**	**4.7%**	(-0.6%)

Source: AQR, Consensus Economics and Bloomberg. Return assumptions and methodology subject to change and based on data as of December 31, 2017. See main text for methodology. For earnings yield, U.S. is based on the S&P 500; U.K. on the FTSE 100 Index ; "Euro-5" is a cap-weighted average of large-cap indices in Germany, France, Italy, Netherlands and Spain; Japan on the Topix Index; and "Emerging Markets" on the MSCI Emerging Markets Index. The period for net buyback yield (NBY) is 1988 to 2017. For payout-based estimates, all countries are based on corresponding MSCI indices. "Global Developed" is a cap-weighted average. For emerging markets, the payout-based estimate is dividend yield + forecast GDP per capita growth. Hypothetical performance results have certain inherent limitations, some of which are disclosed in the back. Estimates are for illustrative purposes only, are not a guarantee of performance and are subject to change. Not representative of any portfolio that AQR currently manages.

Government Bonds

Government bonds' prospective medium-term nominal total returns are strongly anchored by their yields. For bond portfolios with stable duration, so-called *rolling yield* is a better measure (assuming an unchanged yield curve).[6] For example, a strategy of holding constant-maturity 10-year Treasuries has an expected annual (nominal) return of 2.6%, given the starting yield of 2.4% and expected capital gains from rolldown as the bonds age. Exhibit 3 shows current local rolling yields for six countries, converted to local real return estimates by subtracting a survey-based forecast of long-term inflation.

Real return estimates are little changed since last year, with U.S. Treasuries seeing a small reduction due to a flatter curve (less roll-down) and German Bunds seeing a small increase due to a slightly higher yield level. The estimate for Japan remains negative. Low bond yields should be considered in the context of exceptionally low cash rates. Any adjustment to these expected returns boils down to expected future changes in the yield curve level or shape. Capital gains/losses due to falling/rising yields dominate returns over short horizons but are highly uncertain, and matter less over longer horizons.

6   If we assumed a more realistic random-walk (rather than unchanged) yield curve, our estimate would theoretically need to include convexity and variance drag components. However, since these terms are small and partly offsetting, we ignore them.

Exhibit 3

Expected Local Real Returns for Government Bonds, January 2018

	Y	RR	I	Y+RR-I	
	10-Year Nominal Bond Yield	**Rolldown Return**	**10-Year Forecast Inflation**	**Expected Real 10Y Return**	**1-Year Change**
U.S.	2.4%	0.2%	2.2%	**0.4%**	(-0.3%)
Japan	0.0%	0.4%	1.1%	**-0.7%**	(0.0%)
Germany	0.4%	1.3%	1.7%	**0.0%**	(+0.3%)
U.K.	1.2%	0.8%	2.2%	**-0.3%**	(-0.4%)
Australia	2.6%	0.4%	2.5%	**0.5%**	(-0.4%)
Canada	2.0%	0.2%	2.0%	**0.3%**	(-0.1%)
Global Developed	1.8%	0.4%	2.0%	**0.1%**	(-0.1%)

Source: Bloomberg, Consensus Economics and AQR. Estimates as of December 31, 2017. "Global Developed" is a GDP-weighted average of the country estimates. Rolldown return is estimated from fitted yield curves and based on annual rebalance. Estimates are for illustrative purposes only, are not a guarantee of performance and are subject to change. Not representative of any portfolio that AQR currently manages.

Currency and Cash Considerations

To convert local real returns to expected real returns seen by a foreign investor (E_{int}), we must first correct for any difference in expected inflation (I) in the two countries, and then correct for the expected nominal risk-free rate differential (R, if hedged) or the expected exchange rate return from spot rate changes (E_{FX}, if unhedged).

$$E_{int\ hedged}=E_{local}+(I_{local}-I_{home})+(R_{home}-R_{local})$$
$$E_{int\ unhedged}=E_{local}+(I_{local}-I_{home})+(E_{FX})$$

The significance of these corrections has increased in recent years. For example, expected U.S. inflation is approximately 0.5% higher than in Germany and 1% higher than in Japan, while U.S. risk-free rate differentials are around 1.8% and 1.5% respectively. If those differentials were to persist, a hedged U.S. investor would expect real returns about 1.3% higher and 0.5% higher than local estimates for Germany and Japan respectively.

To estimate excess returns over cash, we would need to subtract the expected real cash return from the expected real market returns we report. Thus, if for simplicity we assume real cash rates to average zero over the coming decade, expected excess returns for all markets would equal their expected real returns.

Credit Indices

To estimate expected returns for credit indices, we apply a haircut of 50% to both IG and HY spreads to represent the combined effects of expected default losses, downgrading bias and bad selling practices.[7] We assume no change in the spread curve, say, through mean-reversion.

Exhibit 4 shows our updated estimates for U.S. credit indices. Haircutting the 2017 year-end OAS gives an expected excess return over duration-matched Treasuries of 0.5% for IG and 1.7% for HY.[8] To this we add the expected real yield of a duration-matched Treasury (currently negative for the lower duration high yield index). Finally, we add rolldown return — both Treasury rolldown and the additional spread curve rolldown as bonds age and roll down the OAS curve. Thanks to the credit spreads (and additional rolldown for IG bonds), the expected real return for credits remains clearly higher than for Treasuries.

Exhibit 4

Expected Real Returns for U.S. Credit Indices, January 2018

| | A. Spread Return | | B. Treasury Real Yield | | | C. Rolldown Return | | | | |
| | S | S * 0.5 | Y | I | Y - I | R_T | R_C | R_T+R_C | A + B + C | |
	Option-Adj. Spread	Exptd Excess Return	Dur-M'tched Treasury Yield	Forec'st Inflation	Dur-M'd Real Treasury Yield	Treasury Roll-down	OAS Roll-down	Total Roll-down	Expected Real Return	1-Year Change
U.S. IG	0.9%	0.5%	2.4%	2.2%	0.2%	0.2%	0.3%	0.5%	**1.1%**	-0.4%
U.S. HY	3.4%	1.7%	2.1%	2.2%	-0.2%	0.5%	0.1%	0.5%	**2.1%**	-0.3%

Source: Barclays, Bloomberg, AQR. Estimates as of December 31, 2017. OAS and duration data is for Barclays U.S. Corporate Investment Grade (IG) Index and Barclays U.S. Corporate High Yield (HY) Index. Duration for Barclays U.S. IG index is 7.6 years while that for Barclays U.S. HY index is 3.9 years. Estimates are for illustrative purposes only, are not a guarantee of performance and are subject to change. Not representative of any portfolio that AQR currently manages.

Commodities

Commodities do not have obvious yield measures, and we find no statistically significant predictability in medium-term returns (*Alternative Thinking Q1 2016*). Our estimate of 5- to 10-year expected return is therefore simply the long-run average return. Exhibit 5 shows the performance of an equal-dollar-weighted portfolio of commodity futures, in early decades holding only 5-6 assets but the universe growing to 13 by 1970 and 22 by 1990. This portfolio has earned about 3% geometric average excess return over cash. If we assume near-zero real return for cash, the expected real return would be 3%.

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7   Consistent with Giesecke et al (2011), who find that over the long term, the average credit risk premium is roughly half the average spread. 'Bad-selling' refers to the practice of selling bonds that no longer meet the rating or maturity criteria of the index.

8   Exhibit 4 shows spreads for cash bonds in the popular Barclays indices. Actively traded synthetic indices (Markit North America CDX) tend to have slightly tighter spreads. This so-called basis between cash and synthetic bonds was small in 2017 after narrowing during 2016.

Exhibit 5

Historical Performance of Equal-Dollar-Weighted Portfolio of Commodity Futures

	1877-2017	1951-2017
Excess-of-Cash Return (AM)	4.6%	4.2%
Excess-of-Cash Return (GM)	3.1%	3.3%
Annualized Volatility	17.6%	13.5%
Sharpe Ratio (AM)	0.26	0.31

Source: AQR, Bloomberg, Chicago Board of Trade, Commodity Systems Inc. Portfolio consists of 5 to 25 of the most actively traded commodity futures, weighted equally and rebalanced monthly, with the universe generally increasing over time as new data becomes available. AM = arithmetic mean. GM = geometric mean. Risk-free rate used to calculate Sharpe ratio is 3M T-bill. Hypothetical data has inherent limitations, some of which are disclosed herein. Data presented is based on hypothetical portfolios and are not representative of any AQR product or investment.

Alternative Risk Premia

Style-Tilted Long-Only Portfolios

We believe a hypothetical value-tilted, diversified long-only equity portfolio that is carefully implemented and reasonably priced may be assumed to have an expected real return 0.5% higher than the cap-weighted index, after fees. A multi-style strategy — which we assume to include balanced allocations to three highly complementary, "tried and true" strategy styles, notably value, momentum and defensive — can be designed to convert its greater expected diversification, as compared to a single style strategy, into a higher expected active return of around 1.0% net. Finally, we think a defensive or low-risk equity portfolio may be assumed to have an expected return similar to that of the relevant cap-weighted index, but may achieve this with lower volatility.[9]

Long/Short Style Premia

Alternative risk premia strategies apply similar tilts as long-only smart beta strategies, but in a market-neutral fashion and often in multiple asset classes. Because long/short strategies can be invested at any volatility level, it makes sense to focus on expected Sharpe ratios. The degree of diversification is essential. A single long/short style applied in a single asset class might have an expected Sharpe ratio of only 0.2-0.3. For a diversified composite, we believe an expected Sharpe ratio of 0.7-0.8, net of trading costs and fees, can be feasible when multiple styles are applied in multiple asset classes. At a target volatility of 10%, such a hypothetical portfolio would have an expected return of 7-8% over cash.[10] We stress that this requires careful craftsmanship in portfolio construction as well as great efficiency in controlling trading, financing and shorting

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9   Style-tilted strategies exhibit so many design variations that it is difficult to generalize, but we try. Our estimates are purely illustrative and do not represent any AQR product or strategy.

10   Consistent with historical data, we assume low correlations between the styles to produce our Sharpe ratio range for a diversified composite of long/short styles. As transaction costs depend on implementation and both transaction costs and fees vary with target volatility, our estimates are based on a transaction-cost-optimized strategy targeting 10% volatility with fees of 1 to 1.5%. Refer to Alternative Thinking, 2015 Q1 for details of our style premia assumptions, which we believe are plausible and conservative. All assumptions are purely illustrative and do not represent any AQR product or strategy.

costs.[11] Strategies that are less well-designed or poorly implemented may have much lower expected returns.

What about current style valuations? Aggregate valuations across multiple styles are somewhat higher than multi-decade averages. Some styles are rich (notably, the defensive style in equities) but not off-the-chart, while others are on the cheap side. Our research suggests there is only a weak link between the value spreads of style factors and their future — or even contemporaneous — returns, due to portfolio turnover, beta mismatch and other issues. It is also difficult to use tactical timing based on style valuations to outperform a strategic multi-style portfolio.[12]

Cash

The prospects for nominal cash returns depend on the expected path of inflation and of real cash rates. Long-term U.S. inflation expectations have remained well-anchored just above 2%. Even though the Federal Reserve is in a policy tightening mode, it has stated it expects to act slowly and keep real policy rates negative or near zero until 2019. The European Central Bank and the Bank of Japan intend to continue quantitative easing amid very low inflation and negative nominal and real short-term rates. In Europe and Japan it remains conceivable that real policy rates stay negative over our forecast horizon.

How Accurate Are Yield-Based Return Forecasts?

We have often stressed that our capital market assumptions are uncertain point estimates with a possibility of large errors, even over a 10-year horizon (deviations in short-term returns can be even larger).[13] Are they any use at all? Perhaps investors should ignore yields and use some even simpler method to inform strategic portfolio construction and long-term expectations. In this section of the article, we test the predictive power of our forward-looking estimates against other reasonable candidates (including backward-looking historical returns), and give a practical interpretation.

Introducing the Horses in Our Race

When testing 10-year forecasts, you need a lot of data — a few decades won't give meaningful results. For our horse-race we first produce long historical time series for our yield-based estimates for U.S. equities and 10-year U.S. Treasuries (the analysis starts in 1900, but we use data from the 1870s onwards). For equities we calculate in-sample (i.e., hindsighted) and out-of-sample versions, and for bonds we use estimates with and without rolldown. We then calculate two intuitive non-yield-based candidates: one is simply the historical average real return up to the date of the forecast, while

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11   See Israel, Jiang and Ross (2017), "Craftsmanship Alpha: An Application to Style Investing".

12   See Ilmanen, Nielsen and Chandra (2015), and Asness, Chandra, Ilmanen and Israel (2017).

13   In this analysis we ignore the theoretical and unobservable distinction between estimation error (error in estimating the 'true' expected return), and the difference between expected and realized return. The consequences for investors are the same.

the other assumes a constant Sharpe ratio of 0.2 for both equities and bonds, and converts this into a real return estimate using historical volatility and real cash return. A list of the candidates is given in Exhibit 6.[14]

Exhibit 6

Simple Expected Real Return Candidates for Equities and Government Bonds

Candidate	Equities	Govt. Bonds	Construction	Hindsighted?
Equity Real Yield (in-sample inputs)	•		Average(adjusted Shiller EP*0.5, DP) + 1.5%	Yes: g = 1.5%, 0.5 payout ratio
Equity Real Yield (out of-sample)	•		Average(adjusted Shiller EP * o-o-s payout, DP) + o-o-s G	Only in use of DDM model (~1956) & CAPE (1988)
Real Bond Yield		•	10-year yield - expected 10-year inflation	No
Real Bond Yield + Roll Estimate		•	10-year yield + rolldown - expected 10-year inflation	No
Historical Real Return (1881-)	•	•	Annualized geometric real return (1881 - forecast date)	No
Constant SR=0.2, Historical Vol	•	•	(0.2 * annualized volatility) + real cash return (1881 - forecast date)	Yes: SR = 0.2

Source: AQR, Shiller data library, Blue Chip Economic Indicators, Consensus Economics and the Federal Reserve Bank of Philadelphia. All inputs based on historical data use expanding windows starting in 1871. Out of sample ('o-o-s') estimates are calculated from available data, using an expanding window. EP and DP are earnings-to-price and dividend-to-price ratios respectively. SR is Sharpe ratio. For illustrative purposes only.

Having defined our estimators, we test their predictive power using quarterly overlapping 10-year periods since 1900. Exhibit 7 shows the evolution of the estimators through time, with the next 10-year real return overlaid to give a visual sense of their efficacy. Not surprisingly, the yield-based measures produce much lower estimates than the other measures in the current low-yield environment (far right of charts). The tables give summary statistics of each candidate's predictive power.

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14   We tested several other candidates, including simpler yield-based methods using only the Shiller EP, the historical arithmetic (rather than geometric) mean return, and a constant real return estimate. We also tested non-overlapping 10-year periods. Results were broadly consistent with the findings we present below. The 0.2 Sharpe ratio is roughly consistent with realized performance over this period for both equities and bonds, when volatility is calculated from quarterly returns.

Exhibit 7

Histories and Summary Statistics for Expected Return Candidates, 1900-2017

A. U.S. Equities
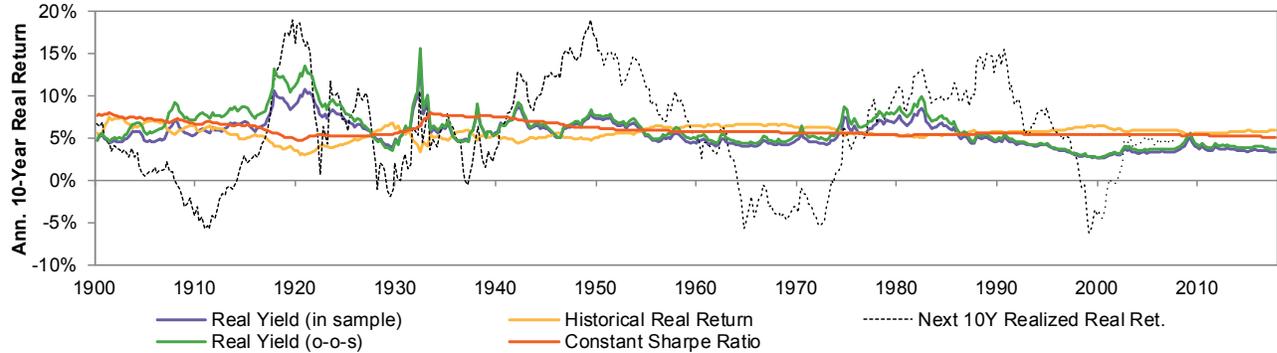
	Full Period 1900-2017				Recent Period 1954-2017			
	Real Yield (in-sample)	Real Yield (o-o-s)	Historical Real Return	Constant Sharpe Ratio	Real Yield (in-sample)	Real Yield (o-o-s)	Historical Real Return	Constant Sharpe Ratio
Correlation to Realized	0.5	0.4	-0.6	-0.2	0.5	0.5	-0.7	-0.2
Significance (adj. t-stat)	4.7	3.7	-5.2	-0.8	11.3	7.6	-5.7	-0.5
Average Forecast (p.a.)	5.7%	6.3%	5.7%	6.1%	4.8%	5.3%	6.0%	5.6%
Average Error (p.a.)	0.1%	-0.5%	0.1%	-0.3%	0.3%	-0.2%	-1.0%	-0.6%
Avg. Error Size (p.a.)	4.3%	4.4%	5.3%	5.1%	4.1%	4.0%	4.8%	4.6%

B. U.S. Treasuries
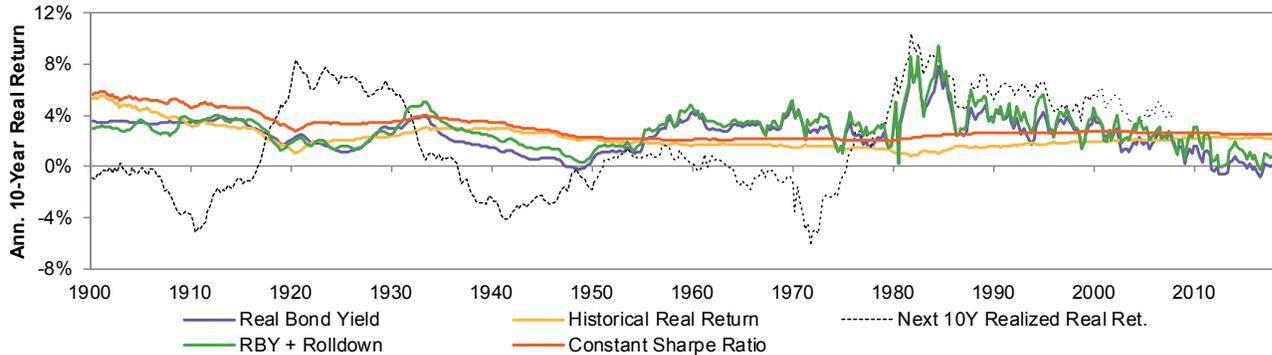
	Full Period 1900-2017				Recent Period 1954-2017			
	Real Bond Yield	RBY + Roll-down	Historical Real Return	Constant Sharpe Ratio	Real Bond Yield	RBY + Roll-down	Historical Real Return	Constant Sharpe Ratio
Correlation to Realized	0.3	0.3	-0.5	-0.3	0.4	0.4	-0.2	0.6
Significance (adj. t-stat)	1.1	1.1	-2.4	-1.2	2.4	3.3	-0.8	4.5
Average Forecast (p.a.)	2.7%	3.1%	2.3%	3.1%	3.2%	3.7%	1.7%	2.4%
Average Error (p.a.)	-0.9%	-1.3%	-0.5%	-1.3%	-0.2%	-0.7%	1.3%	0.6%
Avg. Error Size (p.a.)	3.2%	3.3%	3.8%	3.7%	2.7%	2.6%	3.2%	2.9%

Source: AQR. Based on quarterly overlapping 10-year periods. T-stats are Newey-West adjusted. 'Error' is realized return minus forecast return. 'Average error' is also known as bias. 'Average error size' is mean absolute error, the average size of errors ignoring the sign. All returns are annualized. See Exhibit 6 for construction of each predictor. Results are for illustrative purposes only and are not a guarantee of performance. Not representative of any portfolio that AQR currently manages. There is no guarantee, express or implied, that long-term return targets will be achieved. Realized returns may come in higher or lower than expected. Hypothetical data has inherent limitations, some of which are disclosed herein.

Predictive Power? Yes, But...

A naïve glance at the correlation statistics in Exhibit 7 would seem to suggest that yield-based measures are excellent predictors of next-ten-year returns, while the other methods are mostly worse than useless. But correlations can be very misleading, especially when they relate to overlapping observations.[15]

Exhibit 8 shows a more insightful and intuitive way to gauge past reliability: the distribution of forecast errors for each method. In these 'box plots', the black diamond indicates the mean error from Exhibit 7 — if it lies on the x-axis at zero, the predictor has been unbiased on average. The shaded box shows the inter-quartile range of errors (containing half the observations), and the whiskers indicate the largest upside (top) and downside (bottom) errors.

Exhibit 8

Forecast Errors for Expected Return Candidates, U.S Equities and Bonds 1900-2017
A. U.S. Equities
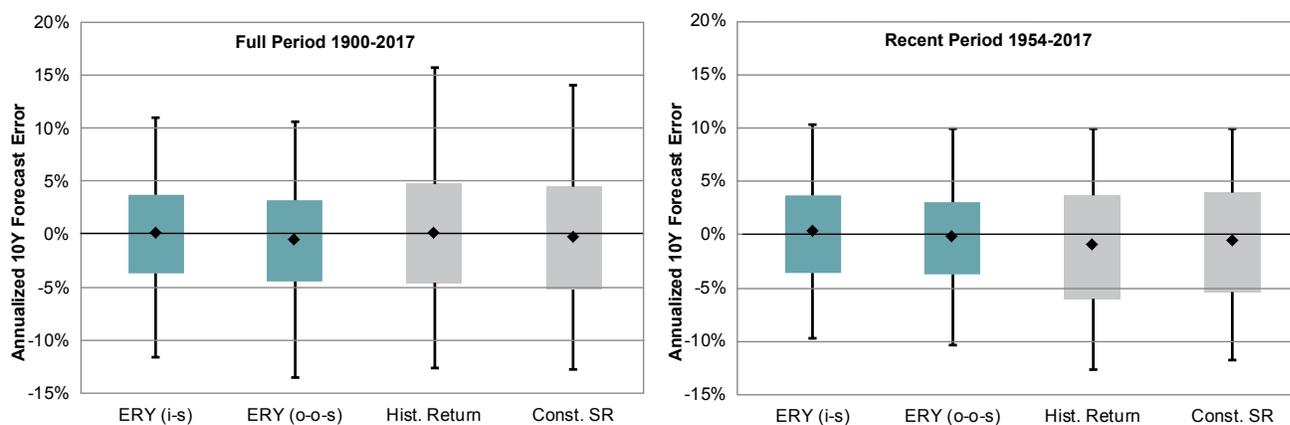
B. U.S. Treasuries
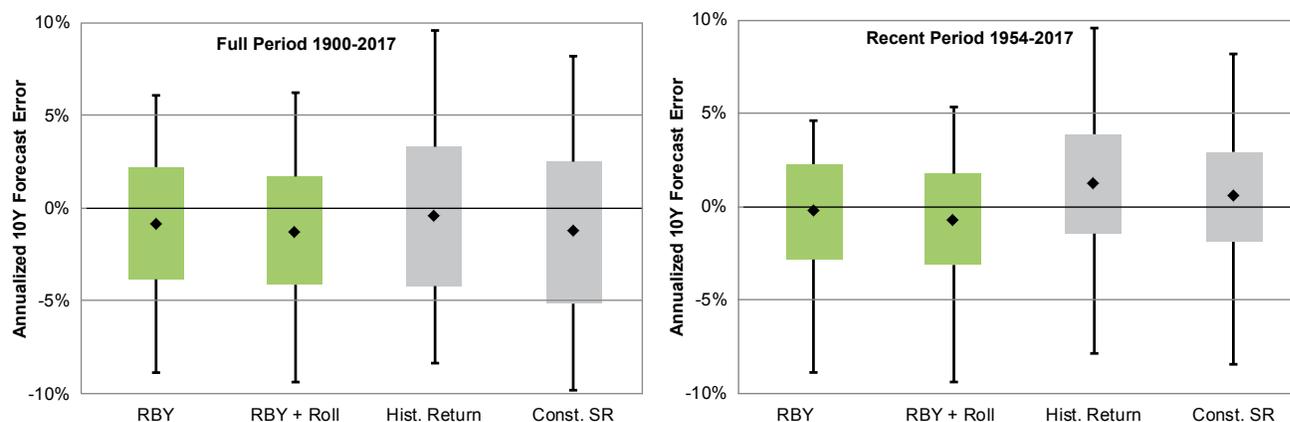
Source: AQR. Based on quarterly overlapping 10-year periods. 'Error' is realized return minus forecast return. See Exhibit 6 for construction of each predictor For illustrative purposes only. Hypothetical data has inherent limitations, some of which are disclosed herein.

15   Even though the t-stats in Exhibit 7 use a popular method for adjusting for overlapping observations (from Newey and West, 1987), they are unreliable indicators of statistical significance, especially where the number of overlaps is large. For an illustration of this point, and for a wider discussion of the statistical perils of long-horizon forecasting, see Boudoukh, Israel and Richardson (2017).

In our sample study, for both equities and bonds, and for both periods, the yield-based methods *have* been more accurate than the alternative methods, producing narrower ranges of errors. However, their advantage is far smaller than the misleading correlation figures might suggest. All methods produce estimates that are highly uncertain,[16] consistent with the average error size figures in Exhibit 7. For equities, the inter-quartile boxes for yield-based estimates roughly span the range +/-3%. We can infer that there is a 50% chance that realized equity market returns *over the next ten years* will under- or overshoot our estimates by more than 3% per annum. For bonds, the corresponding ranges are only slightly narrower.

Concluding Thoughts

Yield-based expected returns for equities and bonds may be our best estimates of medium-term returns, and as of January 2018 they paint a pessimistic picture compared to historical norms. They suggest that over the next decade, many investors may struggle to meet return objectives that reference a rosier past.

In this article we emphasize that even our best return estimates are highly uncertain. These low but uncertain expected returns do *not* in themselves warrant aggressive tactical allocation responses[17] — but they may warrant other kinds of responses. For example, the case for diversifying away from traditional equity and term premia may be even stronger today than in general. And investment objectives may need to be reassessed, even if this necessitates higher contribution rates and lower expected payouts.

Our estimates imply an expected return of just 2.6% over inflation for a 60/40 portfolio of U.S. equities and bonds, over the next decade. But the range of possible outcomes is very wide. Any responses to expected return estimates should consider the breadth of possible outcomes as well as the midpoint. Indeed, our colleagues' recent research[18] suggests that given the small number of independent historical observations, it is possible that yields' apparent historical forecasting ability was just luck and won't hold going forward. That would be good news now, with yields so low. Given the power of yields to forecast in many other places, and our own strong priors that they make economic sense, we wouldn't rely on it — but it's something!

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16   Wide out-of-sample forecast errors are ubiquitous in financial forecasting. Empirical asset pricing literature has found that approaches that require estimating as few parameters as possible tend to forecast better out-of-sample (see, for example, Campbell and Thompson (2008) and Brooks and Tsuji (forthcoming) "Evaluating the forecasting power of CAPE"). This is partly why we use tightly parameterized yield-based estimates, rather than purely data-driven forecasts.

17   For an analysis of the challenges of market timing based on valuation, see Asness, Ilmanen and Maloney (2017). Estimates are for illustrative purposes only and are subject to change.

18   Boudoukh, Israel and Richardson (2017).

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Disclosures

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.

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.