Asset Allocation in a Low Yield Environment

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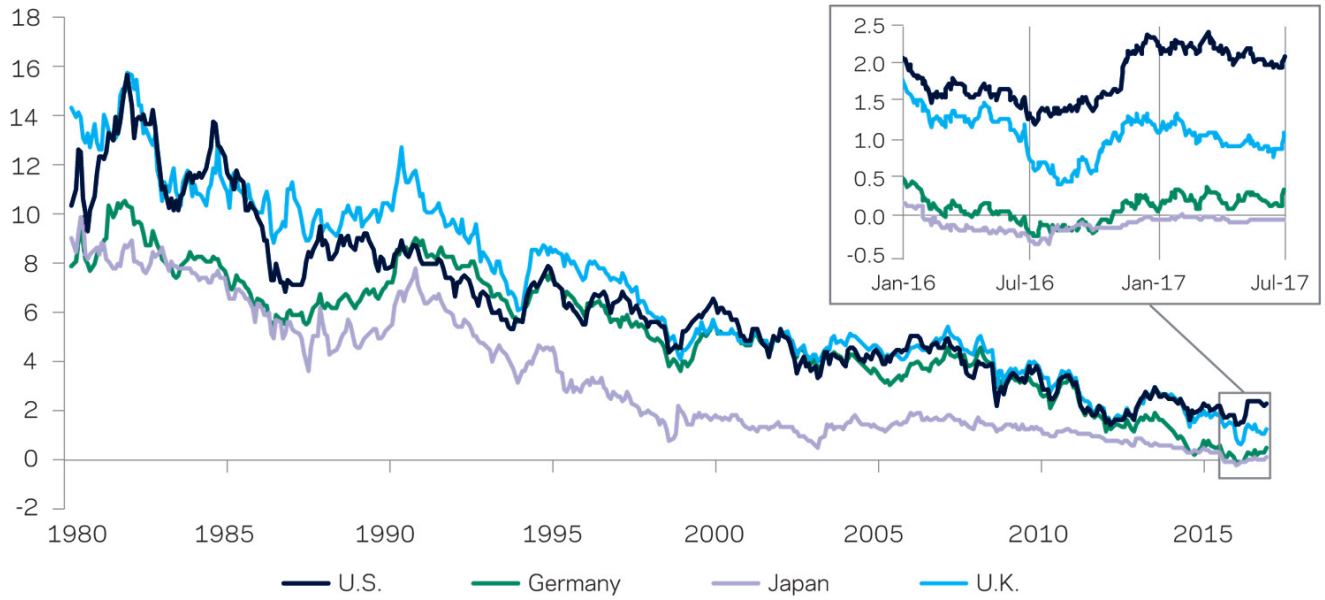
Executive Summary

In 2016, bond yields fell to unprecedented low levels in major markets — below zero, in some cases. This phenomenon challenged long-held assumptions about asset allocation. Many investors asked themselves whether holding very-low-yielding bonds was pointless, especially given expectations of future rises in yields.

Does this exceptional environment demand exceptional action? We have long argued for strategic risk diversification across many return sources — including bonds — with, perhaps, modest tactical tilts. In this article we question the premises behind that preference in light of the current yield environment and find that they are still sound. Specifically, we argue that:

1. For asset allocation decisions, what matters is expected return *in excess of the investor's risk-free rate*, not expected total return. Expected total return matters more broadly, of course, but asset allocation decisions only act directly on excess returns.
2. Mechanically and empirically, positive long term excess returns in bond markets are not generated by high (or low) yield levels but rather the average upward slope of yield curves.
3. Some measures of expected excess returns *are* low relative to history for bonds, as well as for equities. But tactical timing has an unimpressive track record, especially when based solely on valuation, and humility is therefore warranted in sizing tactical tilts. Even in a low yield environment, there are plausible scenarios where yields could go much lower.
4. While bonds should not be considered risk-reducing hedges, evidence does suggest they can remain useful

Exhibit 1: Nominal 10-Year Bond Yields for Four Developed Markets 1980-2017



Source: AQR, Bloomberg. For illustrative purposes only. Please read important disclosures at the end of this document.

diversifiers in many market environments. Investors should be cautious about forgoing potential diversification benefits, both within bond portfolios and across asset classes.

Unexplored Territory for Bond Yields

Nominal 10-year bond yields in a few major developed markets dropped below zero in 2016, though they have since rebounded slightly (see Exhibit 1). The events of 2016 contradicted a basic assumption about financial markets; in the past, most investors, including us, assumed the lower bound on nominal yields would be somewhere very close to zero. Very low interest rates raise important questions — for bond investors, but also for investors in equities and other assets. Are the near- zero or negative yields we observe just a short-term aberration? Do they imply that owning bonds, or at least some bonds, is pointless or a guaranteed loss? Can yields only go up from here or is it possible for yields to go even lower? In the following pages, we examine the implications of this peculiar situation for asset allocators.

Do Low Yields = Low Expected Returns for Bonds?

It's a common assumption that over a long period, a bond's yield is equal to its expected return. So, if yields are zero or less, the total return on bonds should be no better. Despite this being roughly true,[1] yield levels are astonishingly not as relevant for asset allocation as you might think! To demonstrate why, we first need to separate investment returns into two parts:

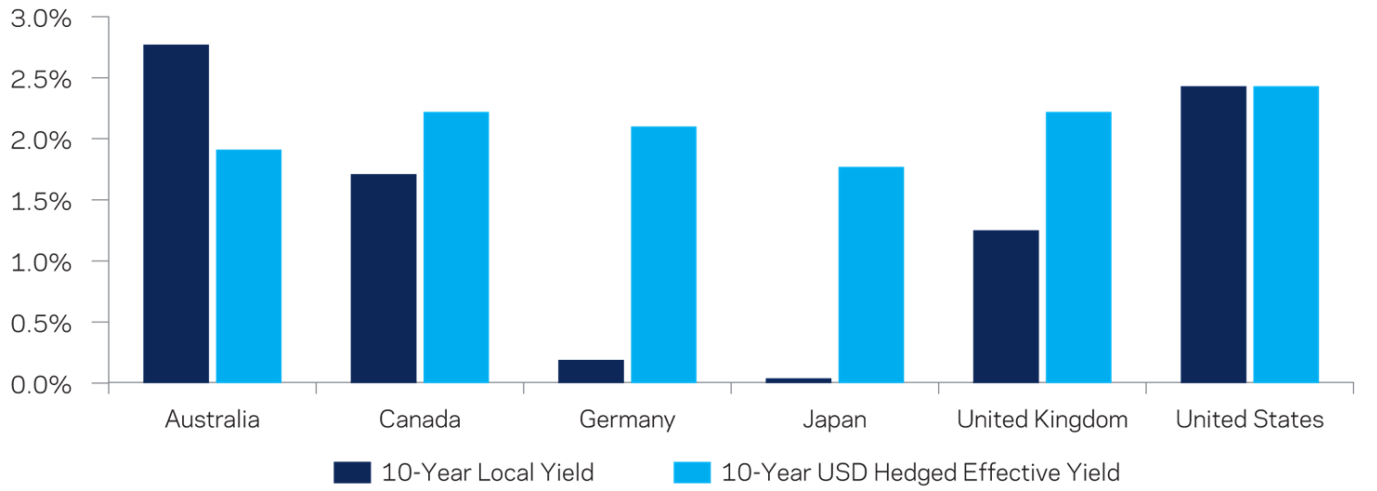
Total Return = Risk-Free Rate + Excess Return

The above formula is just a tautology, but it's crucial to understanding the implications of the current environment. The risk-free rate, as its name suggests, is what you get as basic compensation merely for *saving* (rather than *consuming*), but it does not include the return on taking risk. Excess return, on the other hand, is the return for taking the risk associated with investing, and also potentially the return on investment insight or acumen. Since excess return is the only part of the equation which differs among assets, it is also the key consideration when allocating among them. The immediate implication is that, all else equal, if either the risk-free rate or excess returns are particularly low, then it's likely that the total return on the asset will be low as well. In a world of exceptionally low risk-free rates, whatever the return for risk-taking might be, the return for taking no risk (i.e., the return for saving) is so low that the sum of the two, the total return, is starting at a disadvantage. This applies equally to all investments, including equities.

One important note on the risk-free rate: investors can only earn the risk-free rate of their home currency. When investing in an asset denominated in a foreign currency, the investor either hedges the currency risk, thereby transparently earning interest at a rate close to their home currency risk-free rate, or the investor doesn't hedge and any increase (or decrease) in expected return is accompanied by currency risk (and thus not risk- free); either way, the investor's risk-free return is the same — it's the risk-free rate of their home currency.

Exhibit 2 on the next page shows headline 10-year yields for six major bond markets (dark blue) as well as the effective yield for a hedged U.S.-based investor (light blue). As you can see, the hedged U.S. investor's yield can be dramatically different from the yield earned by a local investor in each market. Indeed, for U.S., U.K., Canadian, or Australian investors, the effective yields earned on hedged 10-year bonds are clearly above zero for bonds from all G6 markets. Unfortunately, for investors domiciled in the Eurozone and Japan, expected total returns on global bonds are currently lower because euro and yen risk-free rates are lower. These investors need to start with lower total return expectations than their American or British peers because their risk-free rate is lower.

Exhibit 2: 10-Year Bond Yields for Six Developed Markets in a Hedged U.S. Investor's Portfolio



Source: AQR, Bloomberg. Yields as of December 31, 2016. Major government 10-year bond yields for G6 countries. The difference between hedged U.S. and local yields reflects the market implied short-term (3-month) interest rate differential between the U.S. dollar and the foreign currency, which is based largely on the difference in actual local risk-free rates, and also on relative supply and demand, deviating from covered interest rate parity. Deviations currently favor hedged U.S. investors and have in practice become more common since 2008, and may raise or lower currency-hedged yields, depending on the country. For illustrative purposes only. Please read important disclosures at the end of this document.

Exhibit 3: Average Yield vs. Average Subsequent 10-Year Stock and Bond Local Total Return

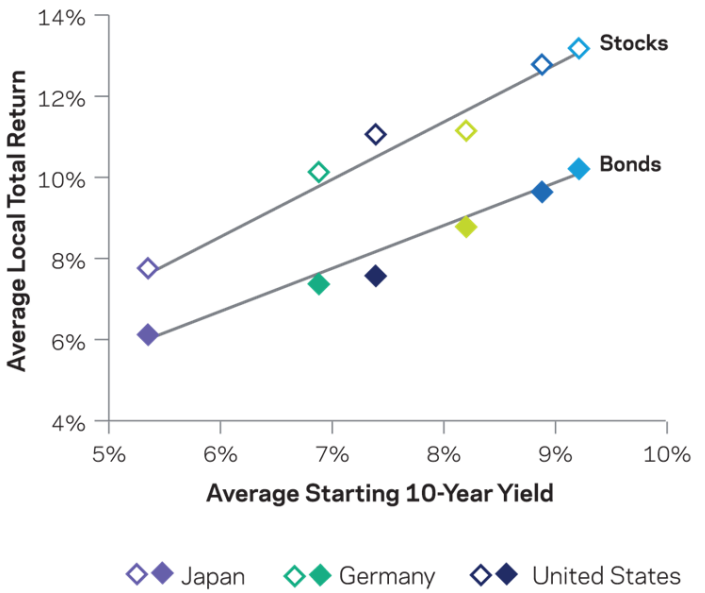
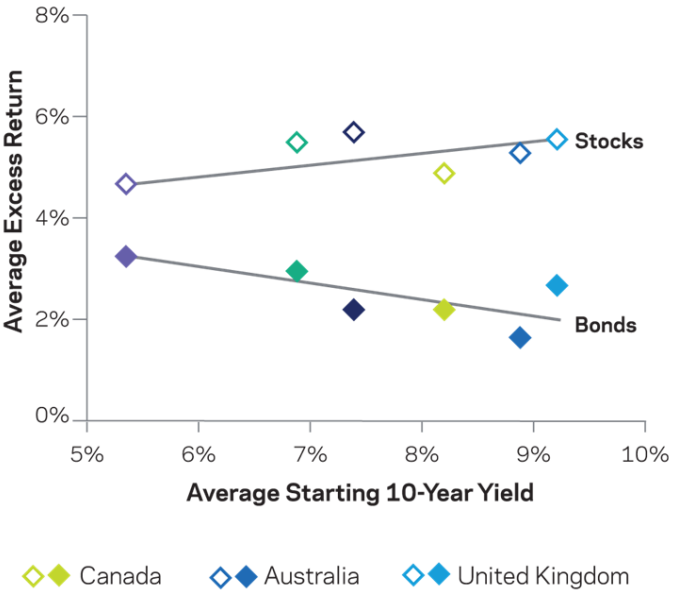


Exhibit 4: Average Yield vs. Average Subsequent 10-Year Stock and Bond Excess Return



Source: AQR, Global Financial Data, DataStream, MSCI, Ibbotson, Bloomberg. January 1966 – December 2016. Government 10-year bond returns for G6 countries are defined as DataStream 10-Year Total Return indices and, prior to DataStream availability, Global Financial Data Total Return indices. Equity returns for G6 countries are defined as MSCI Total Return indices and, prior to MSCI availability, Global Financial Data Total Return indices, except for the U.S. which is defined as the S&P 500 Total Return and is sourced from Ibbotson prior to Bloomberg availability. Returns are excess of local currency Global Financial Data T-Bill Total Return indices. For illustrative purposes only. Please read important disclosures at the end of this document.

The Relationship between Yield Levels and Returns

In Exhibit 3 we use 50 years of data to compare the average level of 10-year bond yields to average subsequent 10-year stock and bond local total returns for six developed markets. We find a strong positive relationship.

This relationship is consistent with most investors' intuition, but interestingly it is the same for both stocks and bonds. Note also that these are the local total returns earned by six different investors each investing in their home country.

What about a single investor investing across all six markets? Excess return and the investor's own risk-free rate drive total returns in that case, since allocating to foreign markets does not, for better or worse, allow you to earn the risk-free return of those markets.[2] Furthermore, you can't do anything about your own risk-free rate; your investment decisions don't affect it, you just have to accept it. When we compare yield levels to subsequent excess returns across markets, we find a far weaker (actually non-existent or even backwards) relationship (Exhibit 4).

What is driving the difference between how excess returns and total returns are related to yield levels? The differences between the two figures are the differences in the average risk-free rates of these six markets. For instance, Japan has not only had the lowest average 10-year yield, but also the lowest risk- free rate. Over this 50-year period, a U.S. investor in Japanese bonds earned the U.S. risk-free rate plus the relatively healthy Japanese bond excess return, realizing a very different return outcome than a Japanese investor who earned the same excess return but a lower total return. This data reaffirms most investors' intuition that lower yields result in lower local total returns, and we also find the same is true for stocks. While it is nice to gain total return insight, when that insight doesn't translate to excess returns, it isn't helpful in making asset allocation decisions, since asset allocation decisions affect only excess returns.

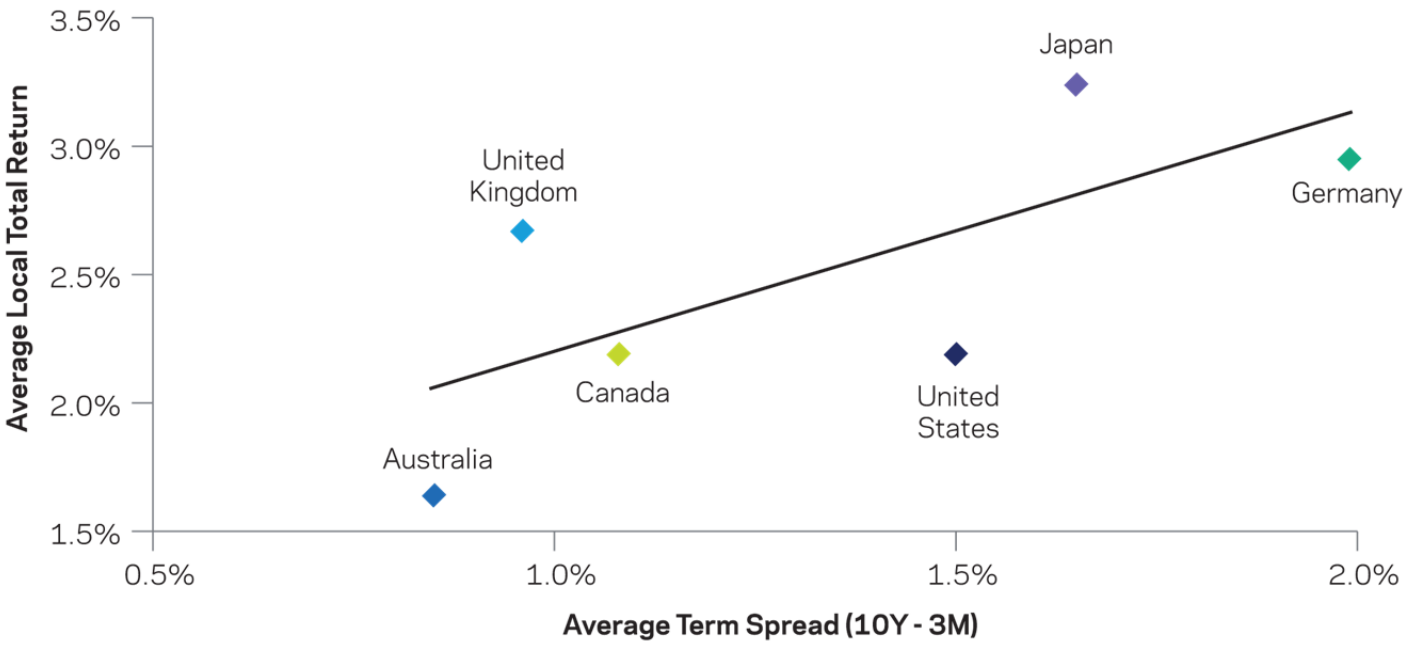
We've shown that markets with lower average yield levels have not delivered lower excess returns. It follows that recent low yields don't mechanically imply a low Sharpe ratio (and hence reduced allocation) for fixed income.[3] But, if yield levels aren't the source of excess returns for bonds, what is?

The Term Premium as the Source of Excess Return

Bond excess returns are comprised of two parts: the term premium and capital gains/losses from unexpected changes in yields. The term premium is the excess return bond investors expect to earn for taking duration risk – that is for holding a long-term asset whose price can rise and fall with yield levels, rather than just buying a near-riskless asset like a 3-month Treasury bill.

The term premium itself has a (positive) average level but may also vary over time and across markets. How do we observe and measure the average term premium given its variation? We start by recognizing that the slope of the yield curve (difference between long-term and short-term yields) reflects some combination of the term premium and the expected future path of short rates. Over the long term, we expect changes in short rates to average out to zero.[4] So our estimate of the long-term average term premium is just the long-term average slope of the yield curve. Exhibit 5 compares the average slope of the yield curve (10-year yield minus 3-month yield) to subsequent 10-year excess return on bonds across countries; we observe a strong positive relationship. In other words, bonds' positive long-term excess returns (their risk premium) originate from the average upward slope of yield curves, not the level of yields.

Exhibit 5: Average Yield Spread vs. Subsequent 10-Year Bond Excess Return



Source: AQR, Global Financial Data (GFD), DataStream, MSCI, Ibbotson, Bloomberg. January 1966 – December 2016. Average yield slope is the average monthly difference between local 10-year yields and local 3-month yields. See Exhibit 3 for additional source information. For illustrative purposes only. Please read important disclosures at the end of this document.

In the previous section we explained that there is no mechanical relationship that would cause low yield levels to impair bonds' ability to generate excess returns. Both our economic intuition and empirical studies imply that a structurally flat or inverted yield curve over the long term would reduce expected excess returns.

While the average slope of the yield curve explains average excess returns, year-on-year volatility is driven almost entirely by changes in the level of interest rates. Exhibit 6 shows the average level and time variation of these two components for U.S. Treasuries since 1954. Changes in yields have contributed almost nothing to average excess returns (as we would expect since these yield changes have averaged out to about zero), but they have driven almost all the volatility (blue bar).

Since we can identify the source of the long-term positive excess returns associated with the term premium, you might expect that we can easily identify and profit from its variation through time. Unfortunately, estimating the time-varying component of the term premium — the basis of a tactical view — is difficult, and any forecasting power is easily overwhelmed by unexpected changes in yields. In other words, timing bond markets is hard. But evidence suggests that the yield curve slope does have some ability to predict future excess returns. Notably, this simple measure of "carry" is more effective on paper as a tactical timing indicator than popular measures of valuation such as the real bond yield (the nominal yield minus expected inflation over the corresponding period).[5]

How Reliable Are Carry and Value Signals?

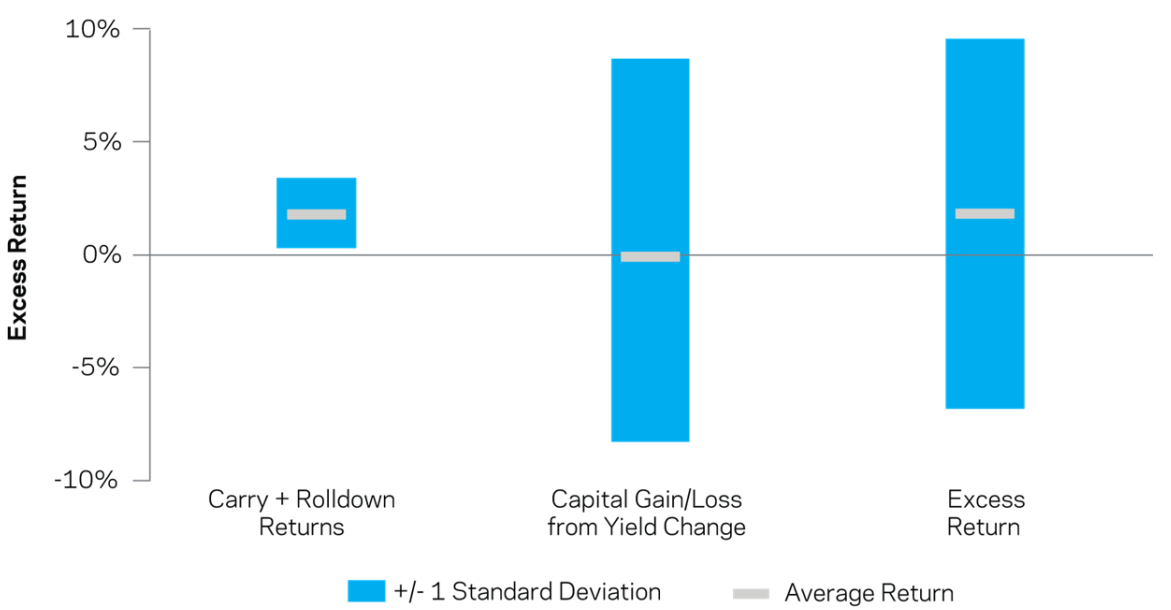
Exhibit 7 on the following page shows both measures for U.S. Treasuries since 1930. At the end of 2016, real bond yield (0.2%, 7th percentile) is near historical lows while slope (2.0%, 63rd percentile) is above average. While "best guess" estimates of medium-term expected bond returns should account for both real yield levels and slope,[6] Exhibit 7 shows that both indicators are fairly weakly related to subsequent near-term excess returns. Real bond yield levels that are high or low compared to their own history have often preceded the opposite return outcome, and an inverted yield curve (the most bearish carry signal) has often been followed by strong returns.

While a time series chart gives some historical perspective, it's hard to ascertain how much confidence we should have in these signals. To get a clearer picture, in Exhibits 8 and 9, both on the following page, we use box plots[7] to compare the distribution of realized 1-year excess return outcomes for different quintiles of starting yield curve steepness and real bond yield. The full sample, denoted by the green box in both exhibits, shows that the majority of 1-year outcomes (the middle 80%) fall between -5% and +10% with an average annual excess return of about +2%.

When sorting return outcomes by the slope of the yield curve we do find that the average subsequent excess return increases with steepness, confirming our economic intuition. However, we also see that only the quintiles at the two extremes have averages meaningfully different from the full sample average. Furthermore, the majority of the realized outcomes across the quintiles (the blue boxes) fall in ranges which largely overlap across the quintiles. Even taking this historical study at face value (the many potential pitfalls of any study on trading signals being outside the scope of this paper), the results indicate that current yield curve slope may contain useful information on future excess returns, but uncertainty still dominates future outcomes.

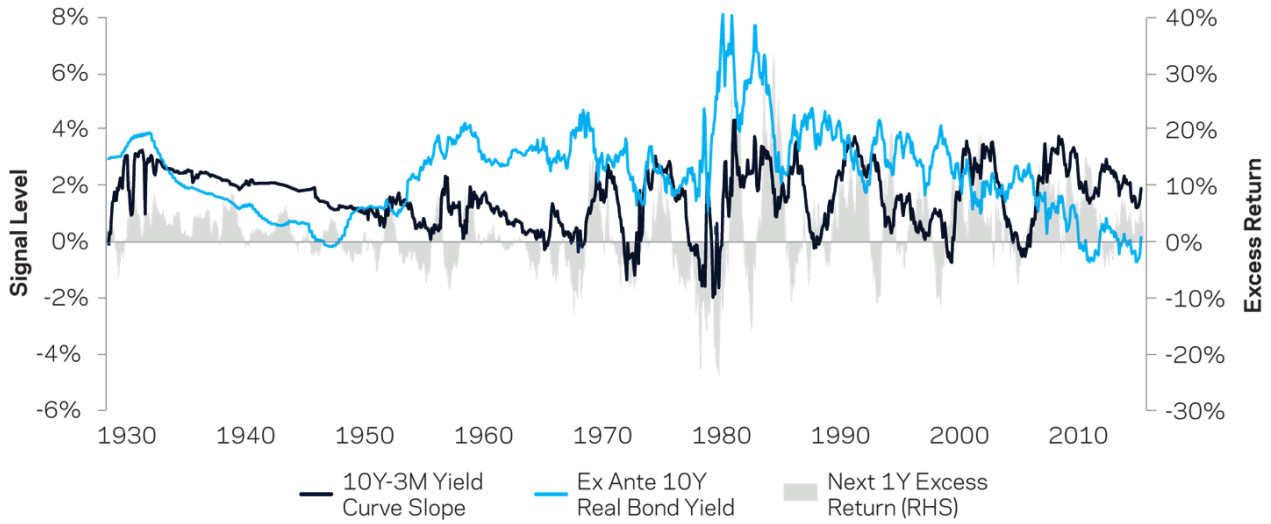
The story is similar when we sort return outcomes on starting real bond yield. On average, top quintile real yields have been

Exhibit 6: Decomposition of U.S. 10-Year Treasury Excess Return



Source: AQR, Bloomberg, Federal Reserve Economic Data. January 1954 – December 2016. Carry and rolldown returns are based on curve steepness and duration, capital gain/losses are based on changes in yields and average duration over the time period. The risk-free rate is assumed to be the U.S. 3-month T-Bill. For illustrative purposes only. Please read important disclosures at the end of this document.

Exhibit 7: U.S. Treasury Slope, Real Yield and Subsequent Excess Returns 1930 – 2016



Source: AQR, Bloomberg, Kozicki-Tinsley (2006), Federal Reserve Bank of Philadelphia, Blue Chip Economic Indicators, Consensus Economics. Real bond yield is 10-year real Treasury yield over 10-year inflation forecast as in Expected Returns (Ilmanen, 2011), with no rolldown added. Yield Curve Slope is 10-year Treasury yield minus 3-month Treasury bill yield. For illustrative purposes only. Please read important disclosures at the end of this document.

associated with higher one- year excess returns, though there is no discernable relationship across the other four quintiles. The overlapping range of realized outcomes across the quintiles again tells us that whatever the level of real yields, subsequent excess returns can vary greatly. Once again, the data makes only a modest case for using real yields as a signal for timing bonds.

Of course, there are myriad potential market timing signals beyond curve slope or real bond yield (momentum being another well-known candidate),[8] but our goal in this section was not to discredit or discourage all market timing strategies. Rather, we hoped to illustrate that humility has historically been warranted when attempting to tactically time bond markets, even when including insights on the source of bonds' strategic returns. We ask in the next section whether the current environment is a special case that might warrant a more confident tactical view.

Tactical Views in the Current Environment: Can Yields Only Go Up?

So far we've shown that nothing about the current yield environment contradicts the ability of bonds to continue to provide, on average, a risk premium (an excess return for taking risk). We've also documented the challenges of using estimates of

Exhibit 8: U.S. Treasury Excess Returns Sorted by Yield Curve Slope

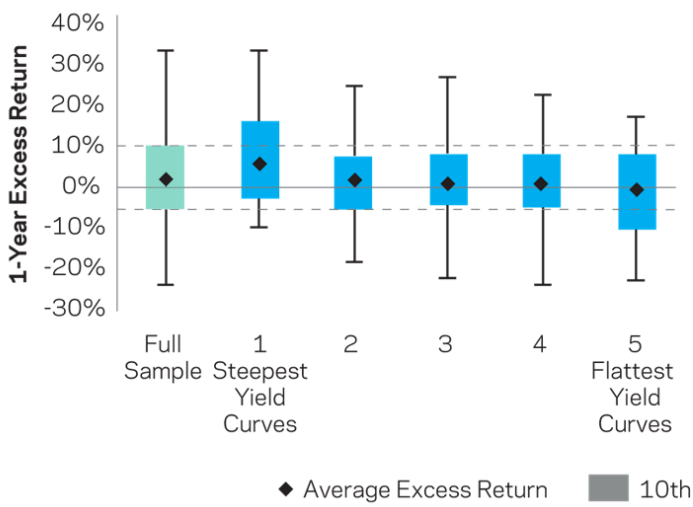
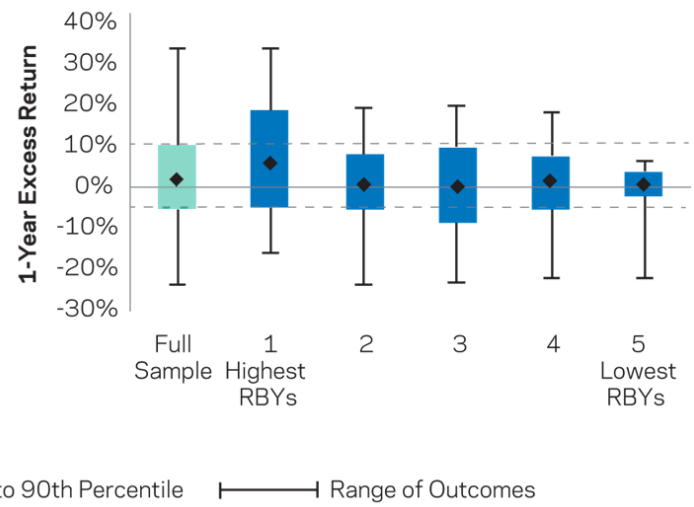


Exhibit 9: U.S. Treasury Excess Returns Sorted by Real Bond Yield



Source: AQR, Bloomberg, Kozicki-Tinsley (2006), Federal Reserve Bank of Philadelphia, Blue Chip Economic Indicators, Consensus Economics. See Exhibit 7 for additional sourcing information. For illustrative purposes only. Please read important disclosures at the end of this document. For illustrative purposes only. Please read important disclosures at the end of this document.

a time-varying term premium to profitably time bond markets. But isn't the current environment a special case? If there is a lower bound on yields somewhere near zero, prices of the lowest-yielding bonds can only fall. Surely, then, a more aggressive underweight is called for? Over the last several years as central banks in many countries continued to push interest rates lower and lower, many (including us) thought that it was reasonable to assume that yields could not go negative. The obvious reason for this is that paper money would provide an arbitrage; everyone could just hold cash in physical form rather than electronically. However, what we and many others have come to realize is that this "arbitrage" isn't practical in the real world. The zero lower bound is challenged by storage issues, transportation and transactional difficulties, and the ability and willingness of authorities to exacerbate these. At least three countries (Sweden, Denmark and Switzerland) have been able keep their interest rates materially below zero, which has contributed at times to a large stock of bonds with negative yields. At this point, we don't know where the lower bound on rates is located.

Another perspective on our newfound uncertainty on the lower bound for interest rates is the amount central banks have historically had to cut them in order to combat recessions. In past recessions, when unhindered by proximity to a perceived lower bound, central banks have had to cut rates by an average of 5%[9] in order to stabilize economic growth and inflation. With Federal Reserve policy rates expected to peak below 3%[10] before the next easing cycle (and other central banks jealously eyeing such rates from below), it is quite possible that negative interest rates might be a feature of future central bank policy both in the U.S. and abroad in the event of an economic downturn (they would likely employ other stimulative tools as well).

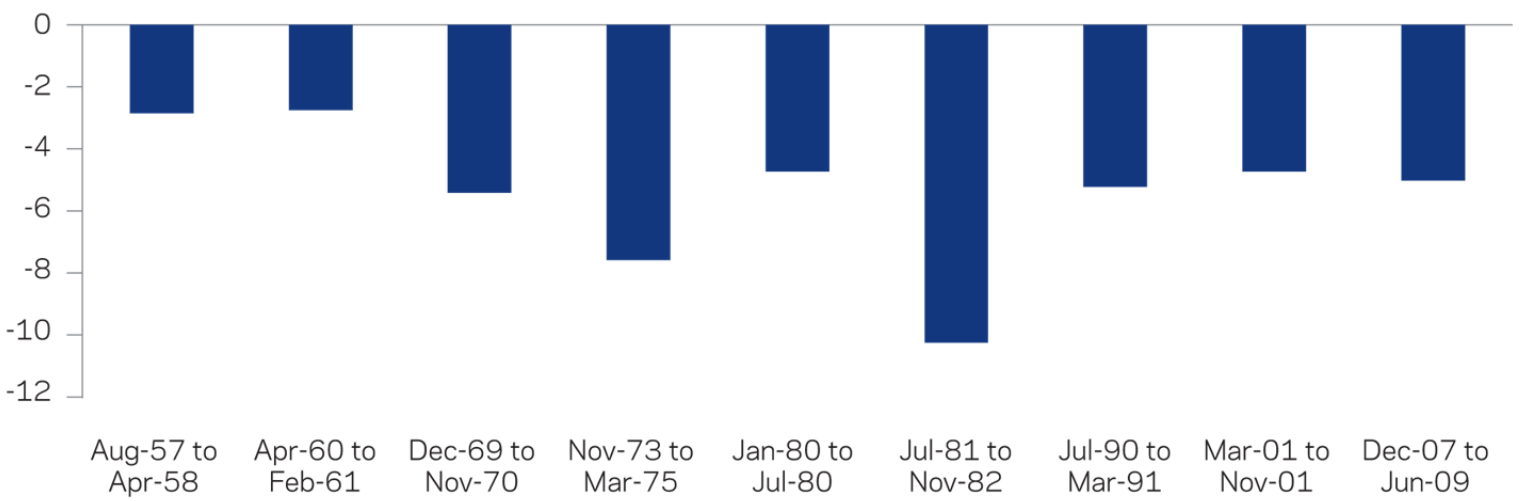
Depending on what economic scenario materializes in the coming years, we could see very different outcomes for yields. An improvement in labor markets and wages as central bank stimulus begins to work, or an increase in inflation as commodity prices recover, could lead to the higher yields many expect.[11] Alternatively, a movement towards recession or a continuation of below-trend growth and inflation across developed and emerging markets could keep yields low or even push them lower. In Exhibit 10, we observe that in each of the nine U.S. recessions since the data begins in 1954, the amount of easing required to stabilize the economy would result in a meaningfully negative fed funds rate in every instance, if begun from today's levels.

Note that we are not predicting a further significant fall in yields. We are simply acknowledging the possibility.[12] In short, we do not believe the current environment has caused yield changes to become suddenly easier to predict. The failure in recent years of valuation-driven models to accurately predict the prolonged bull market in bonds is an obvious example of the continued challenge.

Of course, just because predicting yield changes remains difficult does not mean tactical signals must be ignored entirely. When applying modest tactical tilts to a strategic base, there is a diversification benefit from combining multiple signals which is similar to the diversification benefit from allocating to multiple asset classes. Some bond market signals were bullish at the end of 2016 (e.g., 12-month trends in most markets), some were neutral (carry factors, since yield curves are close to average steepness), and others were bearish (negative short-term trends in most countries and longer-term valuation measures).

Even if all these different signals were in agreement, we would still favor only a modest tilt away from the strategic base. The size of

Exhibit 10: Fed Fund Rate Cuts in Last 9 Recession



Source: Federal Reserve, the Federal Reserve's Monetary Policy Toolkit: Past, Present, and Future. David Reifschneider (2016), "Gauging the ability of the FOMC to Respond to Future Recessions," Finance and Economics Discussion Series 2016-068 (Washington: Board of Governors of the Federal Reserve System, August) Note: For recessions prior to 1990, the total amount of easing is the difference between the maximum and the minimum monthly average of the effective fed funds rate in the period extending from six months prior to the start of the recession to six months after it ends. For the last three recessions, the periods of continuous reduction in the intended federal funds rate are June 1990 to Sept. 1992, Dec. 2000 to Jan. 2002, and Aug. 2007 to Dec. 2008. For illustrative purposes only. Please read important disclosures at the end of this document.

the tilt should depend both on the conviction in the view and on how much diversification the investment provides. We turn to this topic of diversification in our final section.

When Yields Are Low, Can Bonds Still Be Diversifying in a Portfolio?

We have explained why we think yields could conceivably move up or down even from low levels. It follows that bonds can still be useful diversifiers. However, to address the question of diversification more directly, we can observe the historical correlation of bonds to other asset classes across a range of yield change environments.

First, it is important to note that we do not consider bonds to be a "hedging asset". That is, we don't need bonds to exhibit negative correlation with other asset classes to add value as a diversifier (although in recent years they have indeed acted as valuable safe havens, negatively correlated to equity markets, especially in difficult environments). Rather we expect the correlation between bonds and other asset classes to average about zero — which is plenty diversifying (and consistent with long-term historical averages — substantial negative correlations are not the norm).

In Exhibit 11 we can see that over the past 70 years the average correlations between bonds and both stocks and commodities have indeed been close to zero. Furthermore, we see that for various definitions and phases of rising rates environments, equity-bond correlations are modestly higher but remain low in absolute terms (about 0.2 in both secular and rapidly rising rate periods). None of this means, of course, that in the next cycle we won't see significantly positive correlations (which would reduce — but not eliminate — the diversification benefit of a meaningful allocation to bonds within a portfolio), but the long-term evidence shows low correlations between bonds and other asset classes tend to persist across interest rate environments.

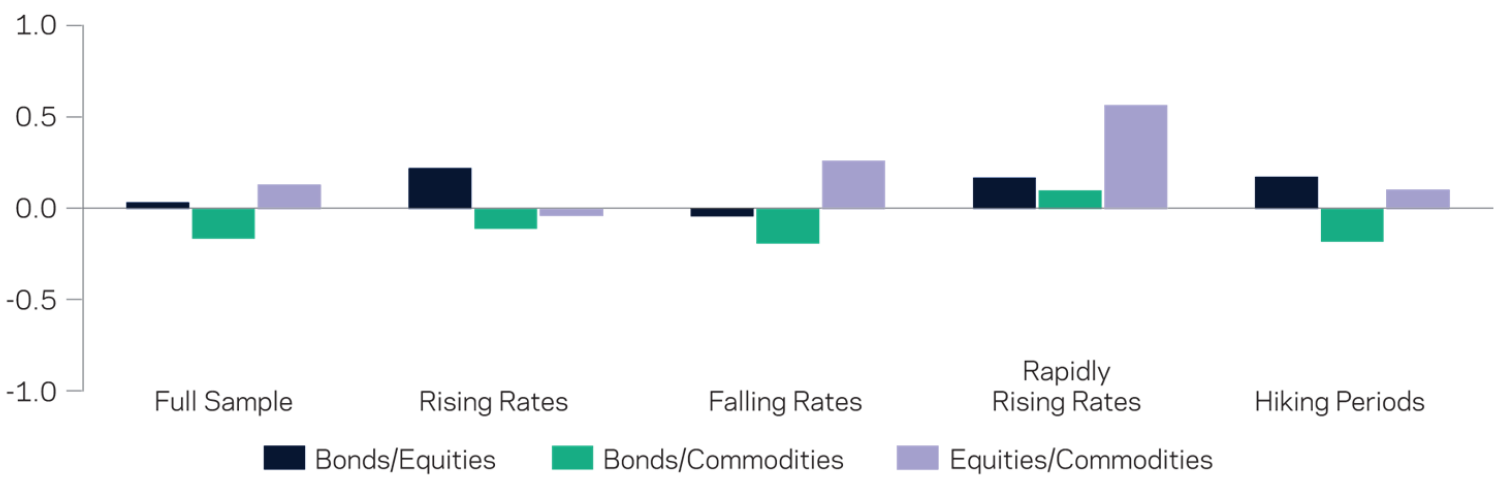
Conclusion

We think key parts of the current environment are often misunderstood — specifically the difference between the return on savings via the risk-free rate and what we earn from the risky portion of our investments, excess returns. We have demonstrated that low yields don't mechanically imply a low risk premium or low excess returns. We've shown that the risk premium for bonds, the term premium, has been related to yield curve slope rather than to yield level. We also have reason to believe yields can still move in either direction, and could potentially go negative again in certain environments. Finally, we've shown evidence that bonds have been diversifying to stocks and commodities, even in rising rate environments.

Predicting the variation in excess returns (yield changes and term premium) is still a difficult task. Even though we do think we have useful tactical signals for making predictions about future returns, we believe that no tactical signal is powerful enough to warrant wholesale changes to a well-balanced strategic asset allocation.

Low risk-free rates are a material headwind to investors' total returns, regardless of asset allocation. We say this because today's risk-free rates affect more than just bonds and investors can't do much about them. The decisions we do make, particularly on asset allocation, affect only excess returns, about which the low yield environment says little. Our conclusion then is that the odd environment that prevailed in 2016 and persists in 2017 does not contradict the strategic case to maintain a diversified asset allocation. Rather, it highlights the continued need for investors to diversify across more traditional and alternative return sources and size those return sources so they matter in their portfolio.

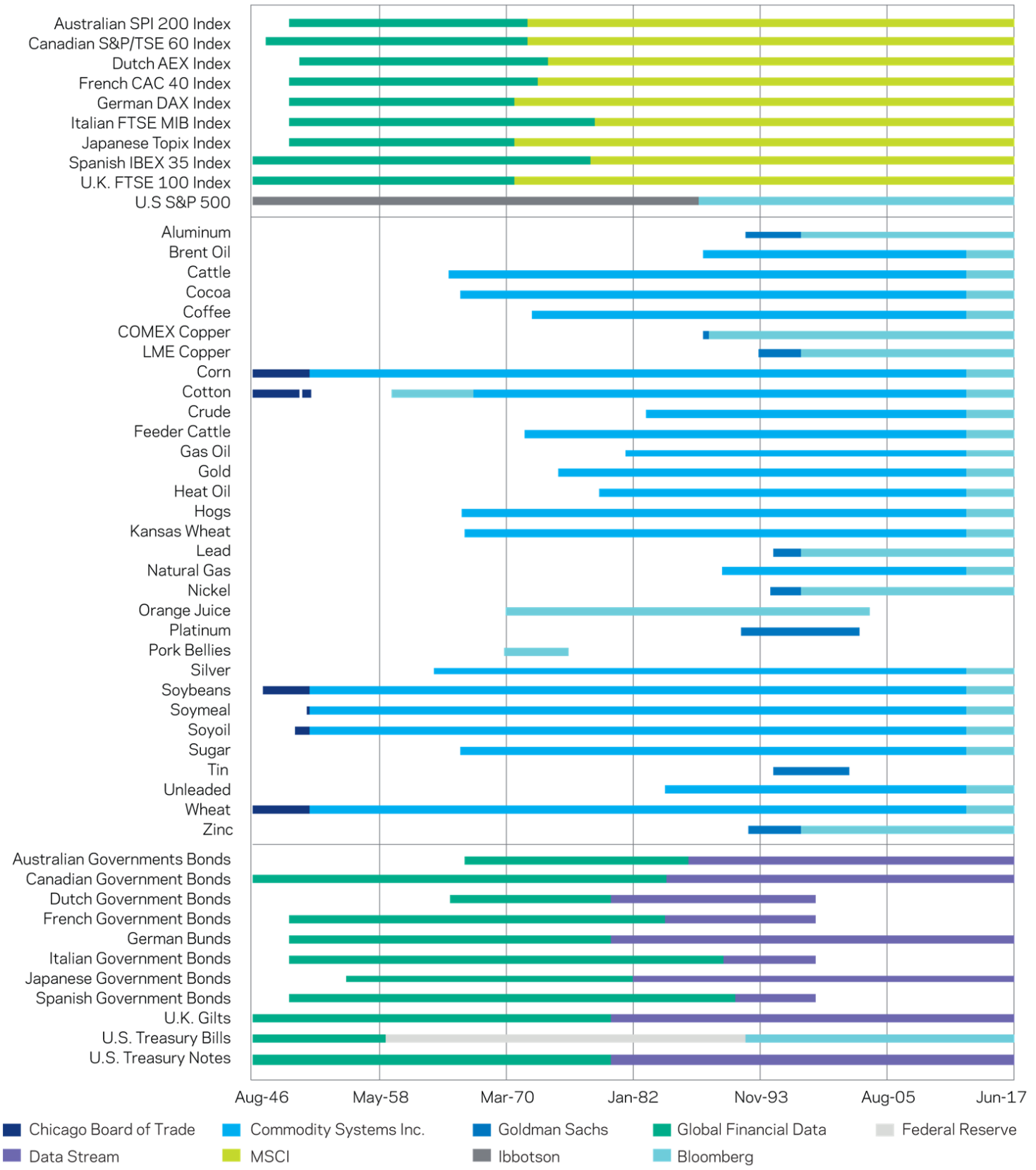
Exhibit 11: Asset Class Correlations in Different Environments 1946-2016



Source: AQR, Bloomberg, Federal Reserve Economic Data. Equities are GDP-weighted among available developed market large-cap indices. Bonds are GDP-weighted among available developed market 10-year government bonds. Commodities are equal-weighted among available commodity futures. Please see the Appendix for greater construction detail. Rising rates period is defined as May 1953 through September 1981. Falling rates period is defined as October 1981 through September 2016. Rapidly rising rates period is defined as October 1979 through September 1981. Hiking periods historical data is based on the effective fed funds rate, target fed funds rate, discount rate, and published records of intended policy actions. For illustrative purposes only. Please read important disclosures at the end of this document.

Appendix

GDP-weighted global equities, GDP-weighted global government bonds, and equal-weighted commodities, as shown in Exhibit 11, are based on the following data availability and sources.



Endnotes

1. Yield is approximately equal to nominal holding-period return (but not necessarily real return) for a hold-to-maturity investor.

2. There is some evidence that holding unhedged short-term debt in foreign currencies with higher risk-free rates has been a profitable trade on average, but this is not the same as accessing another market's risk-free rate (as it is certainly not risk-free).

3. There are some scenarios where the risk-free rate could influence asset allocation. For example, an investor with a total return objective may feel compelled to hold a sub-optimal allocation when the risk-free rate is low.

4. To be precise, we are assuming that market participants' expected changes in short rates averages out to zero. In so much as investors overestimated future rate increases on average, both the slope of the curve and excess returns would increase, but due to beneficial unexpected yield changes rather than a larger risk premium. In any case, the average shape of the curve (rather than the yield level) would be the explanatory factor for bond excess returns.

5. See for example Ilmanen (2011). The real bond yield is commonly used as a measure of valuation as it adjusts the nominal yield at each point in time by inflation expectations at that time.

6. See AQR *Alternative Thinking*, Q1 2017: "Capital Market Assumptions for Major Asset Classes." At very long horizons, starting yields matter less as future reinvestment yields dominate.

7. These plots show information about the distribution of return outcomes over the full sample (green box) and for different quintiles of the signal (blue boxes). The solid box denotes the middle 80% of each distribution, the diamond indicates the median, and the whiskers are the extreme maximum and minimum outcomes.

8. See also Asness, Ilmanen and Maloney (2016), which documents disappointing long-term performance for timing both equity and bond markets based on valuation measures in particular.

9. Agarwal, Ruchir, and Miles Kimball. "Enabling Deeper Negative Rates by Managing the Side Effects of a Zero Paper Currency Interest Rate Policy." www.brookings.edu/wp-content/uploads/2016/05/Managing-Side-Effects-of-Neg-Rates-20160606-Brookings-20-min.pdf.

10. Bloomberg. FOMC median members long-term prediction for the Fed Funds target rate.

11. But note that with the cushion of an upward-sloping yield curve, rising yields do not necessarily mean negative bond returns.

12. At the time of writing, the Federal Reserve continues to communicate an expectation of gradual interest rate increases. A change in this policy in either direction would likely affect bond yields.

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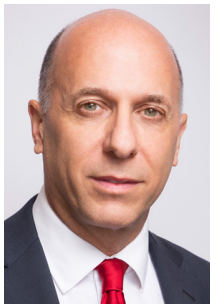
Authors' Bios



Michael A. Mendelson
AQR Capital Management

Michael is portfolio manager of AQR's risk parity strategies and a member of both the firm's strategic planning and risk committees. Prior to AQR, Michael was a managing director at Goldman Sachs & Co., where he founded the quantitative trading group. He has been a member of the Managed Funds Association's board of directors and Chairman of its Trading and Markets Committee and is currently Chairman of its Government Affairs Committee. Michael earned an S.B. in mathematics, an S.B. in management, an S.B. in chemical engineering and an S.M. in chemical engineering, all from the Massachusetts Institute of Technology, and an M.B.A. from the University of California at Los Angeles.

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John is a senior researcher on AQR's Global Asset Allocation team and a portfolio manager for the firm's Alternative Total Return strategies. In these roles, he manages macroeconomic and portfolio construction research for Risk Parity and other asset allocation strategies. Prior to rejoining AQR, where he first worked from 2004 to 2008, he was a vice president in RBC's Global Arbitrage and Trading division and a systematic portfolio manager for Tudor Investment Corp. John earned an S.B. in mathematics from the Massachusetts Institute of Technology.

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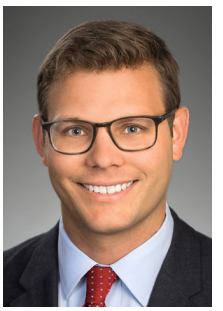
Thomas is a member of the Portfolio Solutions Group, where he focuses on conducting investment research and using AQR's capabilities to enhance client portfolios. He contributes to white papers, engages clients on topics such as capturing alternative sources of return, and strategic asset allocation. He is co-author of several published articles, including "Exploring Macroeconomic Sensitivities" (JoPM) and "Understanding Style Premia" (JOI). Prior to AQR, he was a senior quantitative analyst and portfolio manager at Brevan Howard Asset Management, specializing in quantitative macro strategies and portfolio construction. Thomas earned an M.Phys. in physics with first-class honors from the University of Oxford.



Zachary Mees, *CFA*
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Zachary is a product specialist on AQR's Global Asset Allocation team focused primarily on the firm's Alternative Total Return strategies. In this role, he monitors portfolio performance, reviews accounts with clients, and presents risk parity strategies to investors. Prior to AQR, he was an asset allocation and risk analyst at The Ford Foundation. Zach earned a B.S. in engineering management from the University of Arizona and an M.S. in quantitative finance from Fordham University.