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Risk-Based Asset Allocation

Shaken, but unstirred

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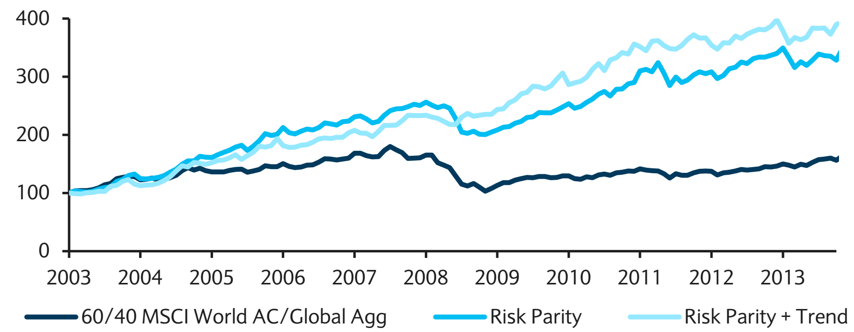
Risk parity portfolios, the darlings of the previous decade, are encountering heightening skepticism. As investors turn increasingly toward pro-growth assets and central banks scale back quantitative easing, multi-asset risk parity portfolios are viewed as particularly vulnerable. The main criticism centers on the inability of backward-looking risk estimation to account for the likely future direction of the market. We revisit the broader portfolio allocation process and examine the underlying assumptions behind the various construction methodologies, build a longer-term history and discuss the implications for investors today. Two particular areas of interest are whether large notional allocations to rates still have a place in investors' portfolios and how risk budgeting and tilting are natural extensions to risk parity that enable managers to express views. We construct a tradable risk parity portfolio based on liquid, unfunded instruments spanning five asset classes. Our modular approach provides investors with efficient and transparent access to a cross-asset, risk-based portfolio. We show that the combination of this portfolio with a trend-based strategy has produced an attractive risk profile over the past 10 years.

- **Overview of risk-based portfolio construction**: We provide a brief summary of the mechanics and assumptions of asset class-based risk-weighted portfolios and analyze 40 years of data to establish a longer-term history.
- **Efficient, modular and unfunded access:** Using futures contracts as building blocks, we develop a risk parity strategy. The flexible nature of the framework allows for bespoke multi-asset class portfolios.
- **A closer examination of rates**: Based on scenario analysis using POINT®, we assess the effect of rising rates on fixed income and risk parity returns.
- **Accounting for differences in expected returns:** We introduce risk budgeting as a natural extension to risk parity and illustrate how a systematic trend-based signal can be used in this context to improve the portfolio's properties.

FIGURE 1

Strategy performance: 60/40, risk parity and risk parity + trend



Note: To make the time series graphically comparable, all three have been volatility equalized using in-sample data. Source: Barclays Research

Introduction

It used to be a simpler world for asset allocators. Buy stocks, buy bonds, mix them in reasonable proportions and then tactically tilt from one to the other depending on views on the prospects of the economy. A quick review of asset allocation literature today reveals a complex landscape where a variety of assets are part of the investable asset mix, derivatives are used to separate the various sources of risk within each security and a fierce debate continues over the "optimal" portfolio construction methodology.

We argued in prior publications (see *Investing with Risk Premia Factors* (Gabudean 2012) and *Barclays Capital Risk Premia Family: Sequencing the strategy genome* (Rennison 2011)) that expanding the investable universe, isolating risk premia embedded in asset returns and using risk-based portfolio construction methods can be beneficial for investors. At the same time, we are cognizant of the fact that additional complexity can be detrimental if the resulting system's behavior is not well understood. In those previous publications, we shed light on the various aspects that affect risk-based portfolio construction. In particular, we discussed questions such as:

- What are the criteria for adding an asset or risk premium to the asset mix?
- Are the properties of risk premia stable over long time periods?
- What are the characteristics, rationale and underlying assumptions of various risk-based portfolio construction methods?

While we can paint a very clear picture to answer the last question – for example, the risk parity methodology works best if the underlying assets have similar (positive) Sharpe ratios – verifying the underlying assumptions is more difficult. The datasets for some asset classes have relatively short reliable histories. Even when data span multiple decades it is still difficult to draw actionable conclusions with significant statistical confidence primarily because of the dynamic nature of the markets and the economy. In particular:

- Both markets and the economy are evolving. What happened during the past 50 years is not necessarily a good prediction of the next 50 years.
- The economy has super-cycles that necessitate very long data history to avoid a biased sample. Interest rates are a prime example; it is generally believed that the attractive risk-adjusted performance of the past 30 years is unlikely to be indicative of the (very) long-term average.
- Long-term performance of assets is not useful to portfolio managers who are evaluated on much shorter horizons. Performance conditional on the current state is the holy grail of asset allocation. To inform that question using historical data requires the identification of historical periods "similar" to the current period. Even if we were to ignore the difficulty of identifying appropriate states, this exercise requires much richer datasets.

To further complicate the picture, the notion of portfolio optimality is not well defined. While historical Sharpe ratios are widely used as the metric to rank portfolios, a number of additional factors must be evaluated:

- Leverage: Many risk-balanced portfolios have very low volatility and consequently realize low returns. Leverage is required to attain a target portfolio return and this could have an adverse effect on portfolios either via trading costs, market effect or the amplification of losses during periods of distress.

- Tail Risk: Most risk-based portfolio construction methods use historical estimates of assets' risks. A sudden change in market conditions can alter the risk profile of the portfolio and lead to significant losses.

- Liquidity/Scale: The inclusion of asset classes with lower trading volumes and capacity, coupled with the need to use leverage, can prove problematic for large portfolios.

- Liability Matching: Every portfolio construction exercise must be informed by the liabilities that the portfolio is expected to service. Often, risk-based portfolio construction methodologies do not include liabilities as a benchmark.

- Deviation from well-established benchmarks: For all the reasons just discussed, the skepticism with which investment boards and senior decision makers view new portfolio construction techniques generates a negatively skewed reward profile for portfolio managers. Significant underperformance versus a well-established asset allocation benchmark may have disproportionate consequences for a manager relative to outperformance of a similar magnitude. Portfolio managers must clearly lay out expectations of performance under various scenarios and take into consideration deviations from standard asset allocation methodologies.

From the discussion above, it is clear that designating a particular portfolio construction methodology as the "best" is a fallacy, and we have always refrained from doing so. On the other hand, we do believe that a well-informed risk-based portfolio construction approach that incorporates a rich set of risk premia provides significant advantages over simpler portfolio construction methodologies. We present an approach that facilitates the construction and analysis of portfolios of liquid instruments, capturing a well-diversified set of asset class risk premia. This allows users to construct bespoke portfolios using several methodologies from simple, static portfolios to dynamic portfolios using risk-based methodologies such as maximum diversification, risk parity and risk budgeting.

To address the key issues facing investors, we divide the paper into two sections. In the first part, we discuss the asset class construction process and introduce an unfunded, tradable implementation of risk parity within the wider framework of mean-variance optimization. In an attempt to study the optimization approaches within a broader historical context, we then study a 40-year history. In the second section, partly motivated by the current concern about the prospect of rising interest rates, we expand the discussion to views-based investing. This is done by extending the risk parity framework to risk budgeting and tilting. The features of the portfolio construction approach we employed are summarized below:

- Provide funded or unfunded access to a diversified set of risk premia by incorporating a number of liquid futures and forward contracts across equities, interest rates, credit, commodities and foreign exchange. Users can expand or restrict the instruments used based on their portfolio liquidity requirements or use exposure caps for individual instruments.

- Provide investors with both flexibility and transparency because the risk-based construction methodologies can be selected independently at each of two levels. Futures and forwards are first combined to construct standalone asset class portfolios, followed by risk weighting across these asset class buckets to produce a cross-asset portfolio.

- Allow for the use of risk measures that are not restricted to the second moment (variance).

- Allow for volatility targeting.

- Provide flexibility to employ any number of signals or user inputs to tilt baseline risk-based allocation along with the ability to incorporate tail risk mitigation strategies.

While we discuss the need for careful analysis and the economic intuition to balance risk factor exposures, we do not explicitly discuss the use of tail risk-based objective functions. Rather, we approach the topic slightly differently, choosing to focus on constituent selection and risk budgeting/tilting as a means to manage tail risk. As discussed earlier, the flexibility of our approach allows readers to modify and adapt our risk measures to suit their individual needs. One tail risk management technique that has been proposed is the use of tail risk measures instead of covariance as the input into risk-based portfolio construction. Although this is theoretically appealing, it is challenging in practice due to the estimation difficulty of tail risk measures (especially tail correlation) given short samples for many of the inputs. Nevertheless, portfolios that use a small set of liquid assets and rebalance at higher frequencies may be able to employ such methodologies. For typical asset allocators who rebalance portfolios monthly, a more realistic approach is to impose exposure constraints at the instrument, asset class or portfolio level.

Constructing Access to Asset Class Risk Premia

Sensible portfolio construction dictates that even for the most quantitative of portfolios a degree of qualitative input grounded in economic intuition is used to select the underlying instruments and asset classes. In this section we focus on constructing an unfunded, cross-asset class risk parity portfolio. A key advantage of the unfunded implementation is the ability to access returns via an overlay format, potentially allowing for more efficient deployment of capital. The construction process can be divided into three steps: identifying market risk premia that provide expected long-run excess returns, isolating tradable instruments linked to these market risk premia and estimating the appropriate exposures to each of these instruments.

Identifying exposures

Portfolio constituents are often selected based on empirical evidence that suggests the continued, albeit time-varying, existence of positive excess returns. In other words, asset classes believed to have a positive market risk premium form the basic building blocks of risk parity portfolios. All asset classes have one or more risk factors that influence the returns of individual securities within the asset class. This is usually evident in the high correlations of individual securities' returns within an asset class. It is particularly pronounced in equities, where one common factor – the "equity market factor" or "beta" – explains most of the variability of returns of individual stocks. Portfolio construction techniques such as mean-variance optimization and maximum diversification take correlation matrices as given (realized correlations are de facto perfect forecasts). Techniques such as risk parity and risk budgeting recognize that correlation estimates can be noisy and place less emphasis on forecasted correlations. Regardless of the treatment of the correlation matrix, imbalances in security selection can over-expose the portfolio to certain risk factors. This typically occurs when a disproportionately large number of portfolio constituents are highly correlated. To account for this, we make asset class portfolios the starting point as it allows individual securities that are exposed to common risk factors to be grouped together into a single, high-level portfolio building block. The asset class building block can be the market value-weighted portfolio of securities in the asset class or it can be constructed by applying a risk-based construction methodology on the securities within the asset class.

We identify five asset classes that investors widely perceive as offering compensation for taking on long-only exposure: interest rates (changes in real rates and inflation risk), equities (earnings and growth risk), credit spreads (growth and default risk), emerging market currencies[1] (country growth and inflation risk) and commodities (growth, inflation and production risk). Additional asset classes, such as mortgage-backed securities and inflation-linked securities, are also recognized as having established risk premia. However, they are not included in this implementation due to the difficulties in trading them via liquid unfunded instruments and isolating their asset class-specific risk exposures from that of interest rates risk. Illiquid asset classes such as real estate, timberland and private equity are also excluded from this implementation for similar reasons.

A set of tradable instruments for each of the five asset classes, selected based on liquidity criteria are:

1. Interest rates: Government bonds futures in the U.S. (2y, 5y, 10y), Germany (2y, 5y, 10y), U.K. (10y) and Japan (10y)

2. Equities: Equity index futures in the U.S. (S&P 500 futures), U.K. (FTSE 100 futures), Europe (Euro Stoxx 50 futures), Germany (DAX futures), Australia (AS51 futures), Japan (NIKKEI 225 futures), Taiwan (TAMSCI futures) and Hong Kong (HIS futures)

3. Credit: Credit Default Swap Indices in European Investment Grade (Markit iTraxx Europe), Europe High Yield (Markit iTraxx Europe Crossover), North American Investment Grade (Markit CDX.NA.IG) and North American High Yield (Markit CDX.NA.HY)

4. EM FX: Short dollar currency forwards relative to 15 currencies across Latin America, Asia and EEMENA (ARS, BRL, CLP, COP and MXN; IDR, INR, KRW, PHP and THB; HUF, PLN, RUB, TRY and ZAR)

5. Commodities: Futures contracts on aluminium, Brent crude, copper, corn, gasoil, gold, heating oil, natural gas, nickel, RBOB, silver, soybeans, sugar, wheat, WTI crude and zinc.

In the following subsections, we discuss how we use these instruments to construct tradable baskets for each asset class and then use risk parity-based portfolio construction to create a risk-balanced cross-asset portfolio.

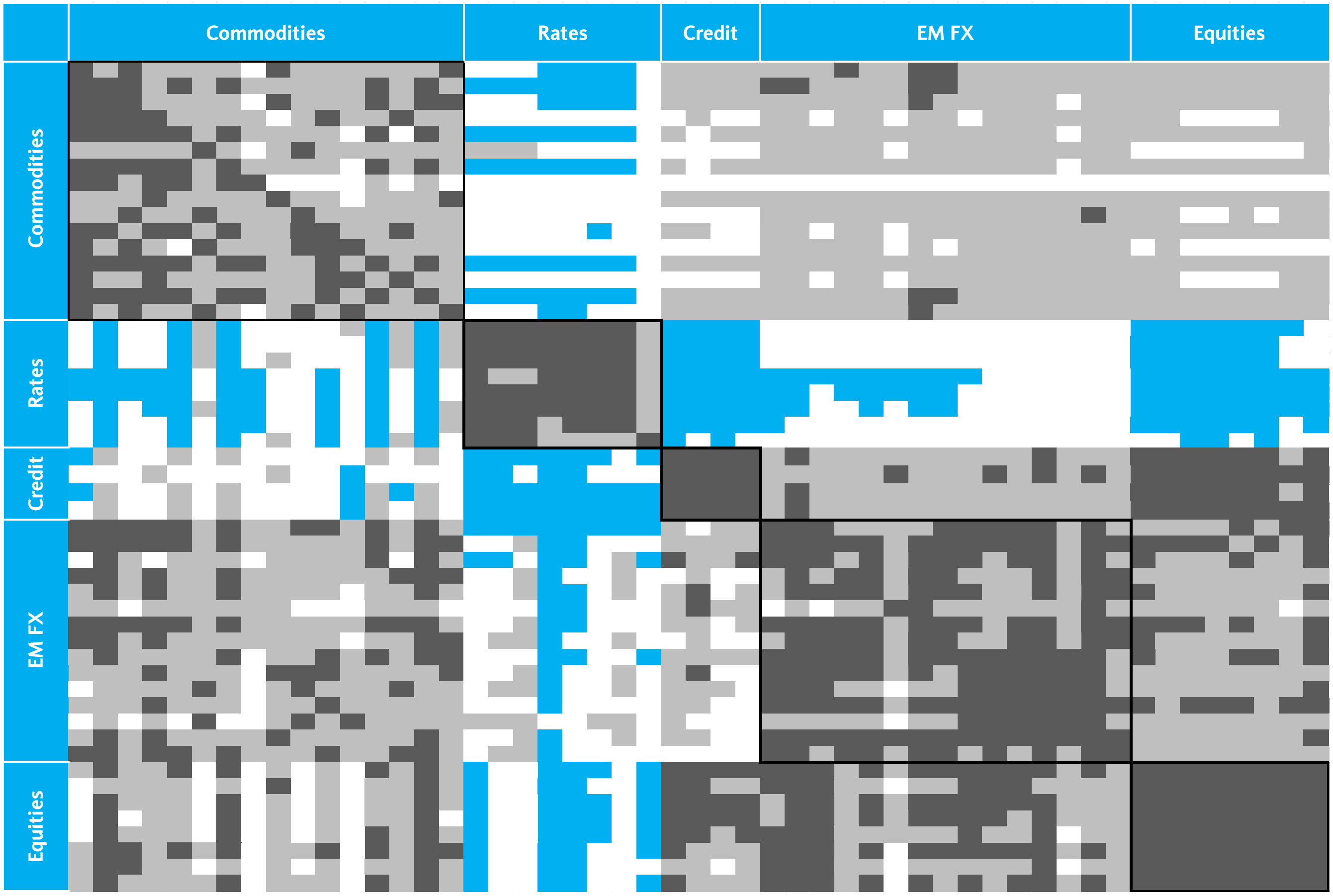
Confirming correlations

Figure 2, which displays the cross asset correlations for returns spanning 2003-14, supports the use of asset classes as distinct portfolio building blocks. Correlations are divided into four categories: negative (below -0.2), uncorrelated (between -0.2 and 0.2), moderate (between 0.2 and 0.5) and high (above 0.5). For ease of display, the cells are color-coded blue, white, gray and dark gray, respectively. High correlations within the asset classes show individual instrument returns are related by common factors. The exception is commodities, where our choice of instrument bucketing is determined by market convention rather than realized correlations and common risk factors. Instruments within commodity subsectors often display high correlation, which is not necessarily the case across commodity subsectors. However, since investors traditionally view commodities as a single entity (often trading the aggregate S&P GSCI or DJ-UBS index), we group all commodities into a single asset class input. For a detailed treatment of commodity investments to target core inflation and inflation shocks, see *Refining commodity beta to protect against inflation shocks*.

[1] Passive developed market foreign exchange exposures may not necessarily provide investors with excess returns.

FIGURE 2

Correlation matrix (2003-14): Full period correlations above diagonal; correlations during crisis below diagonal



Source: Barclays Research

The average correlation cannot always be relied on to be the sole determinant of asset class groupings, with a good illustration being credit and equity. In Figure 2, instruments from these asset classes display a consistently high level of correlation. Despite this, we maintain two distinct buckets because of the inherent differences in the underlying risks factors, which might cause divergent performance under different economic regimes. During the 1970s and 1980s, these two asset classes were often negatively correlated as economic growth and inflation expectations caused the respective outlooks of earnings growth risk and default risk to diverge significantly.

Constructing asset class portfolio building blocks

We use equal volatility weights instead of market value weights to create risk-balanced asset class building blocks. The interpretation of market value varies by asset class. In the equity markets, it typically refers to market capitalization, while in the rates and credit markets it can refer to either the free-float or the size of issuance. A measure of liquidity such as open interest is commonly used in commodities, and there is no standard measure in currency markets with a default allocation being equal notional weights. Several studies have found that deviating away from market value weights to a process that allocates equal risk or volatility contributions to constituents improves downside risk and risk-adjusted returns relative to the market value-weighted strategy[2]. The performance of the equities, rates and commodities building blocks relative to their market value-weighted benchmarks

[2] The benefits of diversification on returns is well-established: Booth and Fama (1992) and Fernholtz et al (1998).

is shown in Figure 3. Over the period examined, the equal volatility construction produced higher risk-adjusted returns consistently across asset classes. In this report, we create equal volatility-weighted asset class portfolios that target 10% annualized volatility to serve as asset class building blocks for the cross-asset risk parity portfolio.

We believe risk diversification at multiple levels is prudent in a risk-based portfolio construction. Given the constraint of selecting unfunded instruments with sufficient liquidity in each asset class, the equal volatility construction relative to a funded (cash) market value-weighted benchmark introduces differences in exposures. In rates, while equal volatility weighting increases risk diversification, it does not contribute to increasing geographical diversification. The equal volatility weighting scheme promotes equal volatility contributions from each underlying rates instrument regardless of geography (three US, three German, one UK and one Japanese instrument)[3]. The inclusion of shorter maturity points within the same geography allows for access to both the level as well as the slope factor in rates. In commodities, the 16 instruments selected form a smaller universe than the 24 contracts in the S&P GSCI. This restricted universe of securities also invests in deferred points on the curve, not strictly the nearby contracts. As a result, the commodities construction takes on exposure to the curve premium not inherent in the S&P GSCI. In equities, the equal volatility construction uses underlying indices that are market value-weighted. The equal volatility construction allows for geographical diversification, sourcing equal volatility contributions from each country-specific index. Risk diversification at multiple levels inherently produces differences from the traditional market value-weighted benchmark. The results show the enhanced risk-adjusted performance for each asset class relative to its market value-weighted benchmark, as summarized in Figure 3[4].

FIGURE 3

Performance Statistics: Equal Volatility-Weighted vs. Market Value-Weighted Benchmarks (2003-14)

	Rates		Equities		Commodities	
	Equal Volatility Construction	Barclays Global Treasury Index	Equal Volatility Construction	MSCI World AC Index	Equal Volatility Construction	S&P GSCI
Full Period (Apr 2003 - Apr 2014)						
Annualized Excess Return	5.8%	3.1%	5.9%	7.8%	10.5%	1.4%
Annualized Volatility	9.1%	7.0%	9.2%	16.2%	11.8%	23.2%
Sharpe ratio	0.64	0.45	0.64	0.48	0.89	0.06
Maximum Drawdown	20.8%	11.3%	33.4%	56.3%	29.5%	67.8%
Drawdown/Volatility	2.30	1.62	3.61	3.48	2.50	2.92
Skewness	-0.04	0.04	-0.91	-0.96	-0.48	-0.71

Source: Barclays Research

[3] We are restricted from attempting to gain roughly equal geographical diversification by the limitations on available liquid, tradable instruments at the desired capacity.

[4] We inverse-volatility weight individual tradable securities to create asset class portfolios. The securities themselves may refer to market value-weighted or equal-weighted universes. For example, S&P 500 equity futures reference a market value-weighted universe of 500 U.S. stocks.

Risk weighting instruments

Risk-based portfolio construction can be applied at the asset class level, as well as within the asset classes. Risk parity or maximum diversification portfolio construction requires estimation of the correlations between instruments. The additional complexity of correlation estimation has marginal added value when the correlations between instruments are generally positive and have similar magnitudes. Accordingly, we find equal volatility weighting provides sufficient risk diversification within asset classes. Each asset class building block is constructed by simultaneously equal volatility weighting the individual instruments and targeting 10% annualized volatility for the overall asset class block. Targeting a specific volatility benefits the covariance estimation, which is separated into volatility and correlation estimation. The performance of the asset class building blocks is presented in Figure 4.

FIGURE 4

Portfolio Building Blocks (2003-14)

	Rates	Equities	Commodities	EM FX	Credit
Full Period (Apr 2003 - Apr 2014)					
Annualized Excess Return	5.8%	5.9%	10.5%	4.5%	2.9%
Annualized Volatility	9.1%	9.2%	11.8%	14.9%	14.3%
Sharpe ratio	0.64	0.64	0.89	0.30	0.21
Maximum Drawdown	20.8%	33.4%	29.5%	38.6%	41.5%
Drawdown/Volatility	2.30	3.61	2.50	2.60	2.90
Skewness	-0.04	-0.91	-0.48	-0.88	-1.82
Pre-crisis: April 2003 - May 2007					
Annualized Excess Return	-1.6%	15.7%	24.4%	17.9%	14.8%
Annualized Volatility	8.9%	8.1%	10.7%	13.1%	9.1%
Sharpe ratio	-0.18	1.94	2.27	1.37	1.62
Maximum Drawdown	17.9%	10.9%	9.0%	13.0%	22.9%
Drawdown/Volatility	2.01	1.34	0.84	0.99	2.51
Crisis: May 2007 - Mar 2009					
Annualized Excess Return	16.9%	-16.4%	-1.3%	-13.1%	-24.2%
Annualized Volatility	4.6%	7.5%	10.0%	5.0%	5.9%
Sharpe ratio	3.66	-2.18	-0.13	-2.60	-4.14
Maximum Drawdown	12.4%	33.4%	29.5%	38.6%	41.5%
Drawdown/Volatility	2.69	4.43	2.94	7.70	7.08
Post-crisis: Mar 2009 - April 2014					
Annualized Excess Return	8.3%	7.3%	4.7%	1.3%	9.6%
Annualized Volatility	8.6%	8.4%	10.9%	14.5%	13.1%
Sharpe ratio	0.97	0.88	0.43	0.09	0.73
Maximum Drawdown	11.0%	15.6%	18.0%	30.2%	26.3%
Drawdown/Volatility	1.28	1.86	1.65	2.09	2.01

Source: Barclays Research

The Cross-Asset Portfolio

The second stage of constructing a risk balanced portfolio involves assigning weights to each of the asset class portfolio building blocks. The methodology allows managers to generalize the construction process to include risk measures of their choosing in addition to those described here.

Mean-variance optimization (MVO) developed by Markowitz in the 1950s is a much-discussed, but infrequently used, asset allocation methodology. Due to the sensitivity of allocations to inputs, which can result in high turnover, it is met with muted enthusiasm by practitioners. However, despite its practical limitations MVO, remains the well-understood reference point against which investors determine whether or not assets in a portfolio have been optimally allocated. MVO incorporates the forecasted means and covariance between asset returns to maximize a portfolio's expected return for a given amount of expected volatility. For a more complete treatment of MVO portfolio construction techniques, see *Investing with Risk Premia Factors*. Several popular risk-based portfolio construction methodologies can be thought of as being mean-variance optimal under certain assumptions with respect to expected returns, volatilities and correlations. As seen in Figure 5, one necessary condition for a risk parity portfolio to be mean-variance optimal is that the Sharpe ratios of the portfolio's constituents are equal.

FIGURE 5

Portfolio Construction Methods

Portfolio Type	Objective function	Characteristics	Optimality conditions
Equal Notional	Assign equal weights	• Equal notional allocations • Portfolio risk is dominated by high volatility assets	Equal Sharpe ratios, volatilities, and correlations
Equal Volatility	Allocate weights in proportion to the inverse of the volatility	• Volatility is the sole determinant of portfolio weights • Fails to account for the potential diversification benefits of negatively correlated assets	Equal Sharpe ratios and correlations
Maximum Diversification	Achieve the highest Sharpe ratio, using forecasts for volatilities and correlations	• Tends to concentrate weight in the negatively correlated assets • Highly sensitive to correlations and volatilities • High portfolio turnover	Equal Sharpe ratios
Risk Parity	Allocate weights such that total risk contributions from each asset are equal, using forecasts for volatilities and correlations	• Tends to overweight negatively correlated assets • Moderate portfolio turnover • Can be viewed as a combination of the equal volatility portfolio and the maximum diversification portfolio	Equal Sharpe ratios and realized correlations are adjusted relative to forecasted/historical correlations
Risk Budgeting	Allocate total risk contributions proportional to desired risk budgets	• Tends to overweight negatively correlated assets • Moderate portfolio turnover • Can be viewed as a tilt from risk parity	Realized Sharpe ratios are proportional to the risk budgets and realized correlations are adjusted relative to forecasted/historical correlations
MVO	Achieve the highest Sharpe ratio, using forecasts for expected returns, volatilities, and correlations	• Sensitive to changes in covariance matrix and expected returns • High portfolio turnover	

Source: Barclays Research

It is often stated that this "no view" (i.e., equal Sharpe ratio) assumption is itself a rather strong view, with critics arguing it ignores the cyclical, time-varying performance of asset classes or even the possibility that long-run asset class Sharpe ratios are indeed different. However, in the absence of specific views on the future relative performance of asset classes, risk-based portfolio construction is a sensible starting point for systematic asset allocation. Of interest to investors looking to time market exposures is the conditional behavior of asset classes, leaving open the possibility of constructing a tactical portfolio that varies exposure to asset classes. As we show later, investors with views on short-term varying expected returns, whether they are derived from bottom-up fundamental analysis, macroeconomic models or other signals such as value or trend, can modify the equal Sharpe ratio assumption. This is carried out using a simple risk budgeting rule or tilting mechanism to capture expected performance differences between asset classes. In light of the extensive literature on the mechanics of varying MVO portfolios, we simply provide the intuition behind the methodologies. For a more technical treatment on the subject, see *Investing with risk premia factors* and "Risk Parity Portfolios with Risk Factors," Roncalli (2012). Our intention is to provide a tradable implementation flexible enough to accommodate a range of portfolio constraints and objective functions.

Tradable risk-based portfolios

The risk parity portfolio can be thought of as combining elements from the equal volatility weighting and maximum diversification methodologies. Starting from the equal notional portfolio, the equal volatility portfolio introduces risk weighting based on individual asset class volatilities. The maximum diversification portfolio adjusts the equal volatility weights by taking into account correlations. The risk parity methodology weakens the perfect forecast assumption made by the maximum diversification approach. The maximum diversification portfolio assumes complete certainty in the forecasted correlation matrix whereas risk parity assumes correlation estimates are noisy and applies an adjustment.

Portfolio construction techniques can be divided into four categories, each using a different yardstick to define the term "equal exposure." In order of complexity they are: notional exposures, volatility-weights, covariance-based weights and, finally, accounting for volatilities, covariance and expected returns. In practitioner parlance, these correspond to the 60/40 portfolio, the equal volatility portfolio, the maximum diversified (or risk parity) portfolio and the standard mean-variance optimized portfolio.

Because forecasting volatilities and correlations are generally accepted to be easier tasks than predicting returns, we begin by comparing portfolios that allocate solely based on risk. The equal volatility portfolio takes into account individual volatility contributions but ignores correlations. This method may be preferred when the underlying constituents do not display stable correlations, as in the case of signal-based systematic or discretionary alternative beta or alpha strategies. When correlations are relatively stable, equal volatility weighting tends to persistently overweight higher correlated assets relative to methodologies that account for the diversification benefit of lower correlated assets.

The maximum diversification portfolio is the MVO solution under the assumption of equal Sharpe ratios. While compensating for the potential allocation bias caused by the volatility-weighting approach, the perfect-foresight assumption for the correlation matrix can be problematic, especially during inflection points in the economy. Risk parity weakens this perfect foresight correlation assumption. Assuming forecasts are imperfect, risk parity shrinks correlations toward equal correlations to determine allocations. In the face of noisy correlations, risk parity reduces portfolio turnover relative to the maximum diversification approach.

We construct a performance history that spans 10 years of returns (2004-14). While a longer back-test is desirable, we are restricted by data availability in order to ensure full tradability. The performance statistics in Figure 6 highlight the benefits of instrument diversification within asset classes, the improvement in performance by balanced asset class exposures and the noticeable benefit of introducing correlations.

FIGURE 6

Tradable Portfolios (Apr 2003 – Apr 2014)

	60/40 ACWI/Global Agg	Equities/Rates 90% Equity Risk	Equities/Rates Equal Volatility	Equal Volatility	Maximum Diversification	Risk Parity
Full Period (Apr 2003 - Apr 2014)						
Annualized Excess Return	5.0%	5.9%	6.0%	6.5%	7.1%	7.0%
Annualized Volatility	11.0%	7.9%	4.8%	7.5%	5.1%	6.1%
Sharpe ratio	0.45	0.74	1.25	0.86	1.40	1.16
Maximum Drawdown	42.1%	29.3%	13.6%	20.9%	11.6%	15.3%
Drawdown/Volatility	3.82	3.70	2.82	2.80	2.28	2.52
Skewness	-0.73	-0.95	-0.72	-1.17	-0.98	-1.01
Rebalancing Transaction Costs				0.02%	0.15%	0.04%

Source: Barclays Research

- **Instrument diversification**: The 60/40 MSCI ACWI/Barclays Global Aggregate portfolio, commonly regarded as the asset allocation benchmark, realized a Sharpe ratio of 0.45 over the sample period. To measure the effect of diversification within the asset classes, we replicate the 60/40 portfolio using our asset class components (described in the section above) by dividing the risk allocation 90/10 between the equities and rates buckets5. This 90% equity risk portfolio realized a Sharpe ratio of 0.74 over the same period, reflecting the benefit of instrument diversification within the asset classes. While displaying an improvement in risk-adjusted returns, the tail risk profile remained unchanged.

- Asset class risk diversification (equities/rates): The performance of an equal volatility weighted (i.e., risk-balanced) equities/rates portfolio is demonstrably better with a realized Sharpe ratio of 1.25, illustrating the benefits of balanced asset class exposure. The improvement in risk-adjusted returns is accompanied by a reduction in the maximum drawdown to volatility ratio to 2.826.

- Enlarging the asset class universe (commodities, credit and EM): Incorporating the remaining asset classes led to a degradation of performance. Over the past 10 years, market risk has been dominated by the growth factor – sometimes described as "risk-on/off" – and the correlation between equities, commodities, EM FX and credit has been moderate to high. At the same time, the macroeconomic environment led to weak risk-adjusted performance of credit and EM FX. Putting these two observations together, when we apply equal volatility weighting to these assets, we are effectively enlarging the risky asset bucket, but with components that have not performed as strongly as equities. Some investors view the poor performance of EM FX and credit relative to equities as part of the cyclical performance of asset classes whereas others might see it as the evidence to support risk budgeting owing to structurally different (long-run) Sharpe ratios.

[5] The risk profile of the 60/40 portfolio shows an overwhelming dominance of equity risk, a common criticism of this portfolio.

[6] It is worth noting, at the risk of stating the obvious, that some of this improvement in performance was driven by the increased allocation to rates, which performed strongly over the period.

Using the same universe as the cross-asset volatility-weighted basket, we find the introduction of correlations had a noticeable positive impact on performance. Risk-adjusted returns were similar to the equities/rates basket, despite containing what are effectively poorly performing assets during this time period. During a period when a two-state world prevailed for much of the time, the de-emphasis of the correlation matrix in the risk parity approach contributed to underperformance versus the maximum diversification approach.

To provide the context of a longer history, we expanded the back-test to 1975. The intention is to test these portfolio construction methodologies during different parts of the economic cycle when asset class correlations displayed a greater degree of variation. While we had a limited number of instruments given the length of the sample period, the analysis revealed the risk parity approach to be a robust methodology.

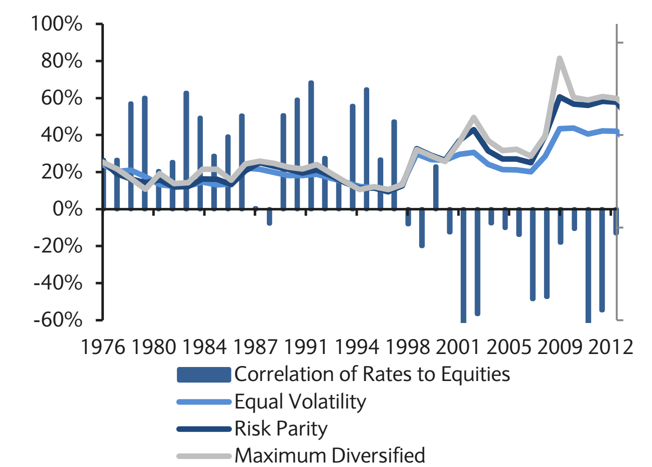
A (nearly) four decade-long history

We evaluate portfolio construction techniques on US assets over a nearly four decade-long period. The long history captures multiple economic cycles, major events such as the Oil Crisis and subsequent inflationary period, the Gulf wars and Asian Financial Crisis and changing asset class correlations. We put the results over the past decade in historical context as we assess the robustness of the different risk weighting methodologies. The data limitation restricts this long-term analysis to four broad-based US asset class indices across equities, interest rates, commodities and credit. The respective constituents are the Russell 1000, the Barclays US Treasury Index, the S&P GSCI, and the Barclays US Credit Corporate Excess Return Index. Discussed later in greater detail, the sensitivity of changing correlations on allocation weights is central to the difference between construction methodologies. In contrast to the relatively stable correlations over the recent past, Figure 7 and Figure 8 illustrate both the time varying nature of correlations and their role in determining asset class allocations over the extended history.

All five portfolios displayed attractive risk-adjusted performance over the full sample period, with Sharpe ratios ranging from 0.50 to 0.69. We leave the discussion on risk budgeting to the next section, simply observing that dynamic risk-allocation does enhance the portfolio return characteristics. The full performance statistics can be found in Figure 9. The findings in brief are:

FIGURE 7

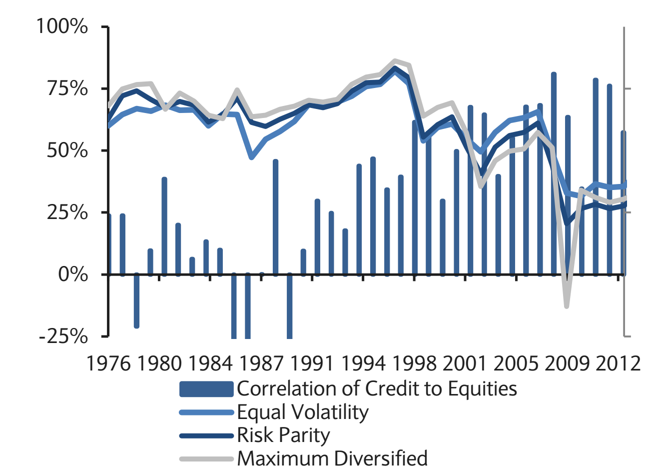
US Rates Weights and Rolling Correlation of US Rates to US Equities



Source: Barclays Research

FIGURE 8

US Credit Weights and Rolling Correlation of US Credit to US Equities



Source: Barclays Research

- While the equal volatility and maximum diversification portfolios had similar risk-adjusted returns and drawdown to volatility ratios, the skewness of returns was worse for the maximum diversification portfolio (-1.75 versus -1.28). This illustrates the potential issue with methodologies highly sensitive to the correlation matrix.
- For correlation-based portfolios, weakening the exact forecast assumption tends to improve performance. Comparing the risk parity versus the maximum diversification portfolio, the Sharpe ratio rose from 0.50 to 0.65, the maximum drawdown to volatility and skewness declined from 4.75 to 3.99 and the negative skewness fell in magnitude from -1.75 to -0.96.

FIGURE 9

Performance Statistics (Dec 1975 – Apr 2014)

	60/40	Equal Volatility	Maximum Diversification	Risk Parity	Risk Budgeting (12M Trend)
Full Period (Dec 1975 - Apr 2014)					
Annualized Excess Return	5.1%	1.9%	1.4%	1.8%	2.3%
Annualized Volatility	9.6%	3.3%	2.7%	2.8%	3.3%
Sharpe ratio	0.53	0.59	0.50	0.65	0.69
Maximum Drawdown	32.1%	16.4%	13.0%	11.1%	10.4%
Drawdown/Volatility	3.33	5.01	4.75	3.99	3.18
Skewness	-0.44	-1.28	-1.75	-0.96	-0.93
Turnover in Weights: Average Annual	0%	26%	48%	30%	165%
Transaction Cost Estimate (Annual)	0.00%	0.03%	0.05%	0.03%	0.17%
1st Decade (1975 - 1983)					
Annualized Excess Return	3.5%	1.0%	0.6%	1.0%	2.3%
Annualized Volatility	10.8%	3.4%	3.0%	3.2%	4.1%
Sharpe ratio	0.32	0.29	0.21	0.33	0.56
2nd Decade (1984 -1993)					
Annualized Excess Return	6.2%	2.6%	1.7%	2.1%	2.0%
Annualized Volatility	10.3%	2.4%	1.6%	1.9%	2.2%
Sharpe ratio	0.60	1.07	1.08	1.09	0.91
3rd Decade (1994 - 2003)					
Annualized Excess Return	4.8%	1.5%	1.2%	1.5%	2.3%
Annualized Volatility	9.5%	2.5%	2.1%	2.3%	2.8%
Sharpe ratio	0.50	0.59	0.54	0.64	0.83
4th Decade (2004 - 2014)					
Annualized Excess Return	5.6%	2.2%	1.6%	2.3%	2.3%
Annualized Volatility	8.5%	4.4%	3.8%	3.5%	3.8%
Sharpe ratio	0.66	0.52	0.43	0.65	0.60
Correlation with Asset Classes					
US IG Credit Spreads	28%	59%	45%	52%	-1%
US Rates	31%	28%	44%	39%	-5%
US Equities	98%	70%	43%	59%	30%
Commodities	16%	56%	45%	50%	8%

Source: Barclays Research

The performance statistics in Figure 9 are gross of trading costs. Given our focus on tradable solutions, we look at annual turnover as an indication for costs. Portfolio turnover is measured as the annual change in target portfolio weights due to the monthly rebalancing. By this definition, the 60/40 portfolio incurs no turnover. The equal volatility-weighted and risk parity portfolios incurred 26% and 30% annual turnover, respectively (with monthly rebalancing) while the maximum diversification had a turnover of 48%. While trading cost is an increasing function of turnover, as we see in Figure 9, the absolute cost imposed by the turnover does not materially affect risk-adjusted returns.

The key difference between the maximum diversification and risk parity portfolios is the correlation matrix. In the case of the former, we assume perfect foresight while the latter assumes correlations are noisy and makes an adjustment, which can be thought of as shrinking correlations toward equal. By adopting the risk parity approach, the total risk contributions of negatively correlated assets is truncated relative to the maximum diversification portfolio. While differences in performance statistics over this sample period are not decisive, lower portfolio turnover, more intuitive portfolio weights and robust allocations in the face of market uncertainty leads us to focus on risk parity as our default (equal) risk-based portfolio construction methodology.

Accounting for Varying Expected Returns

So far we have discussed portfolio construction methodologies that do not require precise estimates of assets' expected returns. Thus, the responsibility of the portfolio manager was restricted to selecting assets with broadly similar (and positive) Sharpe ratios. We argued that the difficulty of correctly forecasting expected returns as well as the significant sensitivity of portfolio allocations to return estimates suggest that managers of average skill are better off avoiding estimating expected returns altogether. However, skilled analysts who can produce more informed estimates of short-term asset performance will naturally want to incorporate them into the portfolio construction process.

The simplest way to do that within a risk-based framework is to "tilt" the risk-based allocation to favor assets that are expected to outperform and to reduce, or eliminate, exposure to assets that are expected to underperform. A topical case in point is interest rate exposure. Due to the relatively low volatility of interest rates and their negative correlation to other asset classes, interest rates demand significant notional allocations in risk-based portfolios. However, in the current investment climate many investors are reluctant to take on rates exposure given a number of concerns: interest rates are at historical lows, quantitative easing (QE) is being scaled back, economic growth is picking up and the potential of rising inflation is ever present. Yet, interest rates remain the only asset class that provide diversification during a potential market crisis that can be triggered by shocks to global economic growth. The key question then is how a manager should attempt to balance the negative expectations about rates returns versus their positive role as a portfolio hedge.

Risk budgeting is a straightforward extension of risk parity that allows managers to account for the risk properties of asset classes while expressing views on their future performance. Risk budgeting asks managers to tilt the "risk budget" allocated to each asset class rather than their notional allocation. Instead of the equal risk budgets prescribed by risk parity, risk budgets are allocated according to the returns expectations of each asset class. In this case, the risk properties of the asset class will influence the notional weight allocated to it. Consider the example of interest rates again. Managers expecting negative rates returns may be tempted to completely eliminate rates exposure leaving their portfolios vulnerable to a market downturn. In contrast, in a risk budgeting framework an allocation of a zero risk budget to rates will still result in a significant presence of rates in the portfolio due to the diversification they offer.

In the rest of this section, we analyze the role of interest rates in cross-asset portfolios and show how the risk budgeting methodology translates risk budget tilting onto notional tilting. We then discuss how risk budgeting can be combined with a systematic rule for predicting returns and back-test a trend-based strategy. Given the difficulty in predicting returns one would not expect a significant improvement over risk parity. However, we show that trend-based strategies have the potential to protect the portfolio from large losses during bear markets and their incorporation into the risk-based portfolio construction framework should be strongly considered.

A closer examination of rates

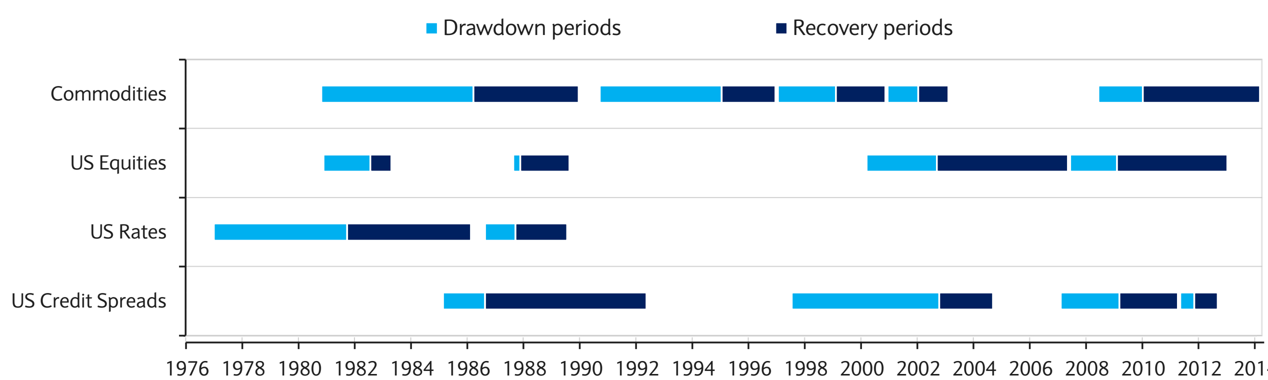
Many investors believe the next structural shift in economic regimes will herald a change not only in asset class returns, but also potentially in the correlations between asset classes. Their primary concern is that rates and equities will begin to display a positive correlation, leading to a breakdown in the diversification benefit within risk parity portfolios. We discuss the long-run performance of rates and with the aid of a scenario-based study, we examine the expected performance of a rates basket in the event of three possible scenarios. The intention is to provide investors with a historical perspective and a likely path of rates returns in the event of three possible scenarios.

Diversification properties

It is useful to study the behavior of rates over a longer history given the near-monotonic fall in the level over the past 30 years. Since the 1990s, rates have been the diversifier within cross-asset class portfolios. Prior to that, credit filled this role. Figures 7 and 8 illustrate the correlations versus equities and the corresponding allocations within the risk parity framework. As Figure 10 illustrates, during a period when two asset classes are negatively correlated they naturally tend not to suffer concurrent drawdowns. During the high inflation period of 1980-1981, credit was the diversifier. During the 2001 and 2008 market crises, rates exposure provided the diversification, as they continue to do today.

FIGURE 10

Significant Drawdowns of Rates, Equities, Commodities, and Credit Long-Only Strategies



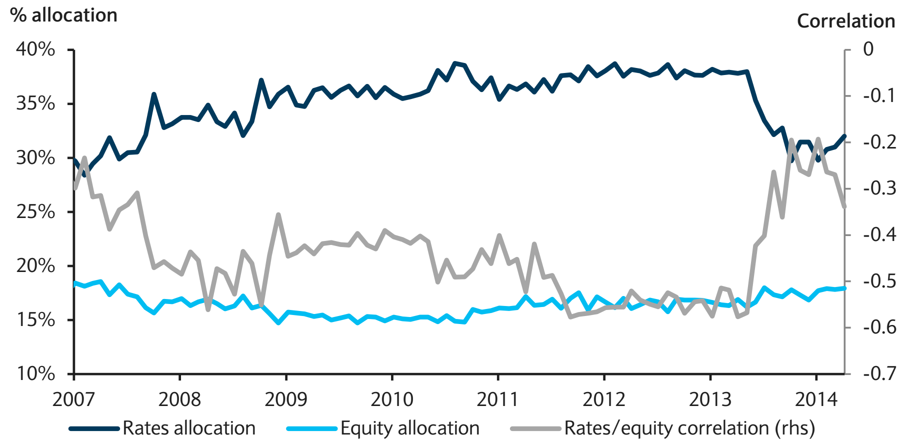
Source: Barclays Research

Changing correlations

The scaling-back of QE is an event that causes trepidation for investors holding long-only rates exposure. One way to address the impact of rates on the risk parity portfolio is to look at the effect of correlations on rates and equity allocations. From Q2 13, the allocation to rates has declined from 38% to 32% on the back of rising correlations (from -0.6 to -0.2). This suggests that, assuming relative asset class volatilities remain constant, a negative shock to interest rates today should have a less adverse effect on the risk parity portfolio than any time since 2007, when correlations and allocations were last at this level. Furthermore, the allocation to rates would continue to decline if correlations continued to increase.

FIGURE 11

Risk parity allocations: The role of correlations (2007 - 2014)



Source: Barclays Research

Harvesting carry and accounting for expectations

In a rising interest rates environment investors will not necessarily realize losses as long as the rise in rates is consistent with what has already been projected and priced in by the market. To illustrate this point, we consider an investment in the 10y Treasury note. As of the beginning of June 2014, the forward rates implied by the yield curve imply a rise of about 40bp for the 10y rate over one year, from 2.46% to 2.85%. In this scenario the negative price return is offset by the significant carry earned (approximately 250bp at the 10y point in June 2014) to provide an approximately flat return. Investors can employ scenario analysis to quantify the effect of the evolution of the yield curve over a period of time.

Using the Barclays POINT® portfolio analysis system, we ran three scenarios over a two-year period.

1. Rates rise along the implied forward path.
2. Rates remain unchanged for a year and then rise according to the implied forwards. In this scenario the 10y rate rises from 2.46% to 2.85% in the second year.
3. The curve remains unchanged for the first year and then moves up 100bp over the course of the second year, which is beyond what is currently implied. We use a 100bp parallel shift of the entire curve, meaning that the 10y rate ends up at 3.46% at the end of the second year.

Figure 12 tabulates the results. As expected, the first scenario shows an excess (of cash) return close to zero whereas the second and third scenarios show positive returns during the first year. During the second year, excess returns are close to zero for the second scenario and -4.14% for the third scenario, resulting in a negative performance of -0.98% for the two-year period.

FIGURE 12

Scenario Analysis Returns: 10y Treasury Note

	Year 1	Year 2
Scenario 1: Roll on Forwards		
Coupon Return	2.68%	2.60%
Price Return	-2.60%	-1.96%
Total Return	0.08%	0.64%
Cash Return	0.26%	0.72%
Excess Return	-0.18%	-0.08%
Scenario 2: Hold curve constant 1 year + Roll on implied forward curve over 1 year		
Coupon Return	2.68%	2.60%
Price Return	0.83%	-2.53%
Total Return	3.51%	0.07%
Cash Return	0.23%	0.26%
Excess Return	3.28%	-0.19%
Scenario 3: Hold curve constant 1 year + Parallel shift up of 100 bps over 1 year		
Coupon Return	2.68%	2.60%
Price Return	0.83%	-5.97%
Total Return	3.51%	-3.37%
Cash Return	0.23%	0.77%
Excess Return	3.28%	-4.14%

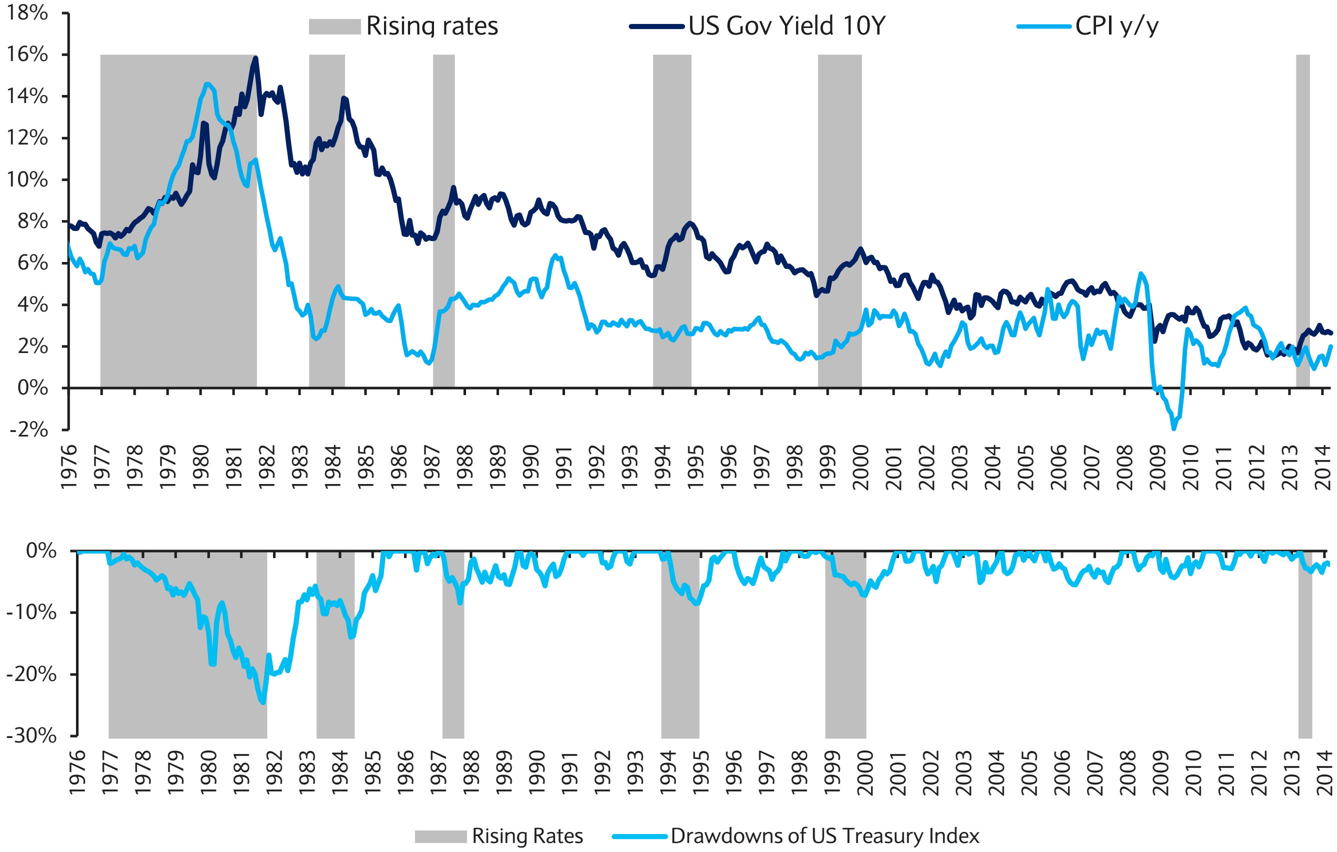
Source: Barclays Research

Inflation

In Figure 13 we display the evolution of the 10y Treasury rate along with the CPI index since 1976, and highlight episodes of rising rates along with drawdowns of the US Treasury Index. We identify six periods of sustained rising rates and show that in all cases the Treasury index suffered drawdowns (i.e., the magnitude of the rates rise was never fully anticipated by the forward curve). Almost all rising rates episodes coincided with rising CPI, presumably driving inflation expectations higher. The notable exceptions are the 1994 and 2013 episodes. Indeed, most investors use the 1994 episode to model likely scenarios for the future.

In summary, there are three significant aspects that investors should keep in mind about interest rate exposures in risk parity portfolios. First, increasing correlations between interest rates and other asset classes will lead risk parity methodologies to dynamically decrease the notional weight allocated to interest rates. Second, investors expecting an increase in interest rates need to balance the benefit of the rich carry available in a steep yield curve with the losses suffered when rates rise. Investors need to carefully consider how their views might be different, in magnitude and timing, from what is already priced in. Finally, investors that look to historical episodes of rising rates as a source of information to form their own views on the future performance of the asset class should acknowledge that there are very few “similar” instances of the current scenario: namely, a period when interest rates are almost certainly expected to rise, but high inflation is not a great concern.

FIGURE 13
Rising Rates Environments and Drawdowns of US Treasury Index



Source: Barclays Research

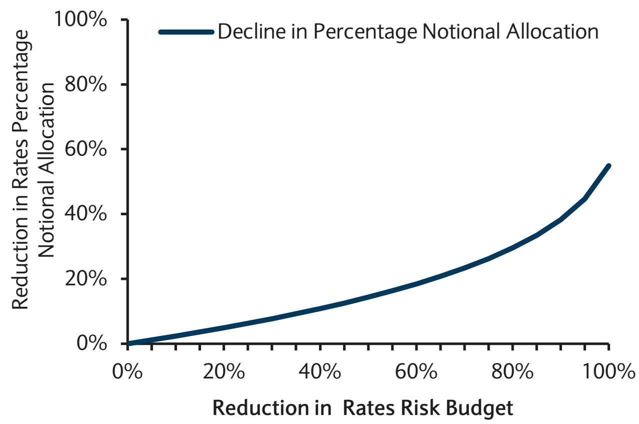
Risk Budgeting

In this section, we discuss risk budgeting as a mechanism to translate views into notional tilts. Using the risk parity portfolio created in the section above, we show two illustrations of the impact of lowering risk budgets: on rates (Figure 14) and on equities (Figure 15). As expected, a negative view that results in a lower risk budget on a diversifying asset would have a smaller impact on the portfolio than a negative view on an asset that is "similar" (i.e., has positive correlations) to other assets in the portfolio.

While the effect on equities is almost linear, that on rates is significantly less pronounced, especially for small reductions in the risk budget. A 50% reduction in the risk budget results in a 50% notional reduction for equities, but only in a 15% reduction for rates. Even with a zero risk budget, rates gets allocated approximately half of the weight compared with its original risk parity risk budget. One may wonder what happens when the risk budget turns negative. In general, the risk budgeting method becomes highly non-linear with negative risk budgets and the results become unstable and unintuitive. For this reason, we recommend always keeping risk budgets non-negative.

FIGURE 14

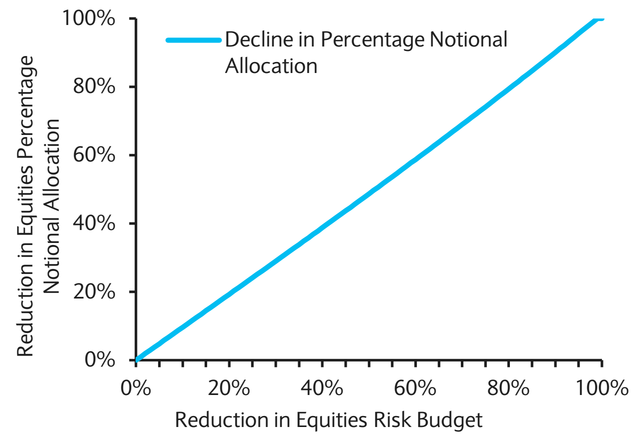
Risk Budgeting: Reducing the Rates Risk Budget



Source: Barclays Research

FIGURE 15

Risk Budgeting: Reducing the Equities Risk Budget



Source: Barclays Research

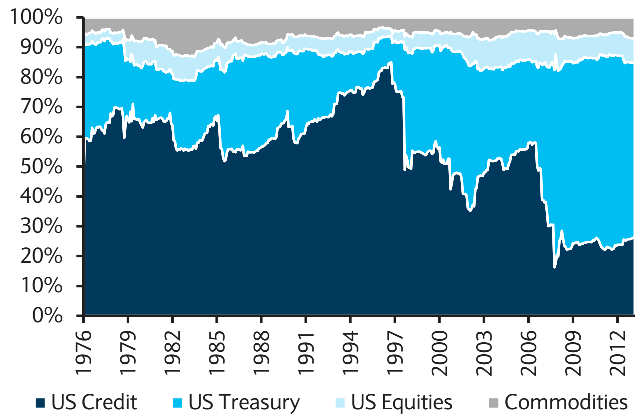
Allocating risk budgets

To understand better the properties of risk budgeting, we establish a simple risk budgeting rule and create a historical back-test. Our rule favors assets that are trending positively and penalizes assets that are trending negatively. In particular, we allocate risk budgets proportional to historical trailing 12-month Sharpe ratios, when positive. This is tantamount to a trend signal using a Sharpe ratio measure instead of price. To avoid negative risk budgets, we map negative Sharpe ratios on to small positive risk budgets using an intuitive transformation that maintains ranking of assets according to their Sharpe ratios.

In Figure 9 we reported the performance of the trend-based risk-budgeting portfolio alongside other portfolio construction methodologies. The risk budgeting portfolio had a Sharpe ratio that was marginally higher than that of the risk parity portfolio (0.69 versus 0.65), but had significantly higher turnover. While risk budgeting did not materially change the risk-adjusted performance relative to the risk parity portfolio, it did improve the portfolio's drawdown profile by allocating away from asset classes experiencing sustained losses.

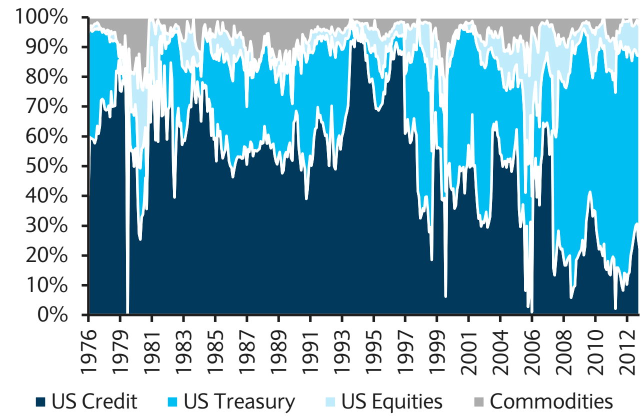
This simple example illustrates the potential of employing the risk budgeting methodology with well-established alternative risk premia signals such as trend, carry and value to systematically tilt risk parity portfolios. This type of risk premia signal-based tilting is equivalent to adding alternative risk premia related to these signals as an overlay to a traditional beta portfolio to create an "enhanced beta" portfolio. In the following section we will discuss alternative ways to achieve that combination.

FIGURE 16
Risk Parity Weights



Source: Barclays Research

FIGURE 17
Risk Budgeting Weights (12M Trend Signal)



Source: Barclays Research

Risk budgeting at the instrument level

Earlier we applied risk budgeting at the asset class level. Continuing with the theme of the previous section, we consider the impact of applying trend-based risk budgeting at the instrument level as well. Indeed, in an earlier paper, *Diversified Trend Following* (Ghia 2014), we argue that trend strategies can have more of an effect when applied at an instrument rather than at an asset class level. To incorporate trend signals at the instrument level within a risk budgeting framework, we discuss two similar yet operationally different approaches.

The first approach adjusts volatility budgets within an asset class according to an instrument-level trend signal that is consistent with the methodology developed in the paper *Diversified Trend Following*. Instruments are accordingly assigned either a full, half or zero volatility budget[7]. We find that the resulting trend-adjusted asset class portfolios have similar Sharpe ratios to their simple long-only equivalents. The tail risk mitigation properties of trend-based signals are reaffirmed in the form of a lower drawdown and a less negative skew. These trend-adjusted asset class building blocks can be combined using equal notional weights in a portfolio we label Equal Vol + Trend. This portfolio is more nuanced than it seems, however. As a consequence of how volatility budgets are allocated, asset classes with negative or no trend will have a lower realized volatility than predominantly positively trending asset classes; thus, risk-weighting (as opposed to equal-notional weighting) these asset classes would overweight the less desirable (from a trend perspective) asset classes. Finally, the methodology does not account for correlations as the introduction of the trend-based portfolio construction makes its estimation significantly more complicated than that of the simple long-only asset class portfolios.

To avoid potential model complexity, especially when its contribution to generating a robust portfolio is unclear, we explore a second, more straightforward methodology. Using the identical universe of constituents and signals, we construct a standalone long/neutral/short trend strategy and then combine it with our standard risk parity portfolio. In this implementation, that we call Risk Parity + Trend, we use equal notional weights and report the results in Figure 18. We observe that this methodology produces very similar results with the Equal Vol + Trend methodology. At the same time, the simplicity of its construction allows users to address portfolio construction choices separately for the risk parity portfolio and the signal-based overlay and decide in what proportions to mix the two.

[7] Because we do not account for correlations when we construct asset class building blocks, we use the term "volatility budget" rather than risk budget in this specific context to avoid confusion.

FIGURE 18

Risk Parity with Trend Performance (2003 – 2014)

	60/40	Risk Parity	Equal Vol + Trend	Risk Parity + Trend
Full Period (Apr 2003 - Apr 2014)				
Annualized Excess Return	5.0%	7.0%	5.2%	5.4%
Annualized Volatility	11.0%	6.1%	4.5%	4.0%
Sharpe ratio	0.45	1.16	1.17	1.37
Maximum Drawdown	42.1%	15.3%	5.6%	5.5%
Drawdown/Volatility	3.82	2.52	1.25	1.38
Skewness	-0.73	-1.01	-0.22	-0.17
Pre-crisis: April 2003 - May 2007				
Annualized Excess Return	8.2%	12.0%	8.9%	7.9%
Annualized Volatility	5.5%	5.4%	4.7%	4.3%
Sharpe ratio	1.50	2.21	1.90	1.83
Maximum Drawdown	0.07	0.06	0.06	0.05
Drawdown/Volatility	1.29	1.13	1.18	1.19
Crisis: May 2007 - Mar 2009				
Annualized Excess Return	-19.2%	-3.7%	0.6%	2.8%
Annualized Volatility	7.1%	3.5%	5.9%	12.6%
Sharpe ratio	-2.70	-1.05	0.11	0.22
Maximum Drawdown	0.04	0.15	0.06	0.04
Drawdown/Volatility	0.58	4.32	0.96	0.33
Post-crisis: Mar 2009 - April 2014				
Annualized Excess Return	12.7%	7.3%	4.1%	4.4%
Annualized Volatility	11.6%	5.8%	4.4%	3.7%
Sharpe ratio	1.10	1.25	0.92	1.17
Maximum Drawdown	0.15	0.09	0.06	0.05
Drawdown/Volatility	1.31	1.56	1.26	1.46

Source: Barclays Research

Conclusion

The wide-ranging discussion has covered some of the more popular approaches to portfolio construction. Using a longer-term study, we put the recent past into a broader historical context while developing a system that allows investors the flexibility to both define their own risk-based allocation mechanism and to introduce views-based forecasts. The importance of tail risk management has become increasingly evident, especially in light of the crisis of 2008. Traditional risk parity investing does not explicitly account for tail risk, instead relying on correlation and volatility measures to manage asset class exposures. Rather than exploring an in-depth discussion on incorporating tail risk management into a risk parity framework, we illustrate how trend-based tilting has been very effective at limiting large drawdowns during the past decade. Signal or views-based tilting of risk-based portfolios can be a very effective tool to incorporate additional risk premia in risk parity portfolios, and allows managers to differentiate themselves while maintaining the discipline of risk balancing. As always, the marginal benefits of complexity versus difficulty of interpretation and operational risk must be carefully evaluated. Simpler solutions delivering similar results might be available and should be preferred.

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Analyst Certification

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