Beyond Risk Parity

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Abstract

Risk parity is an approach to portfolio construction that focuses on the balance of risks within a portfolio. In this article, the author explores the benefits and shortcomings of the traditional way risk parity is implemented and suggests extensions using a risk-factor based approach.

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Three important aspects of robust portfolio construction have rapidly gained traction as a consequence of the global financial crisis and its aftermath:

1. Broad allocation decisions can be more important for long-term portfolio success than security selection.
2. Efficient implementation of asset allocation requires a forward-looking risk policy that captures changes in the behavior of asset classes.
3. Extreme portfolio risks need to be actively identified and managed by both direct and indirect means.

While a crisis was required to bring these conceptual underpinnings of asset allocation to the forefront yet again, they are critical for portfolio construction in all regimes. Indeed, they should be thought of as building blocks for robust portfolios in all seasons. Once this is accepted, risk parity (which is just one component of sound risk management principles) becomes a natural component of asset allocation—albeit not the only or necessarily dominant one.

The basic idea behind risk parity is simple: Each portfolio “position” should be sized in order to match the “risk contribution” from all assets in the context of achieving a target return at the portfolio level. Put another way, risk equalization rather than the more usual “position” return forecasts is what drives portfolio construction. This is not simply a theoretical point: Return forecasting is hard to do, and typical optimal frontiers derived from returns-based asset allocation are extremely sensitive to the return assumptions.

To practically implement a risk-based approach, one thus has to be able to achieve three objectives:

1. accurate estimates of the risks and correlations of various candidate assets on a forward-looking basis
2. the ability to lever up the less-risky sources of return, and
3. the ability to prospectively manage risk, especially severe tail risks. Note that returns become inputs that determine how much leverage to take to reach an overall portfolio return target.

Let us explore each of these items in turn.

Although risk parity as traditionally implemented attempts to equalize risk across assets, we think that a more robust approach is to allocate instead to "risk factors" embedded inside the assets. For instance, fixed income assets can be best understood by addressing their key risk factors, such as duration risk, yield curve risk, spread duration risk, and convexity risks. These risk factors can be measured for all types of assets, and approaching the risk estimation exercise from this simplifying perspective allows one to compare the risks of assets against each other. Assets are simply carriers of risk factor exposures in various mixes. Ignoring the risk factor content and fixating on assets themselves can result in opacity and tail risks, as we dis- cuss later. Macroeconomics-based forecasting of risks that allows for structural changes, the impact of government intervention, and global economic rebalancing are all easily approached in the risk factor approach, but they are obscured in traditional asset allocation. For instance, rising inflation is negative for the duration risk factor. To create a portfolio that is robust to rising inflation would require reducing duration risk. This could mean that in the fixed income portion of the portfolio the investor moves from longer maturity securities to shorter ones. The exercise is much harder if one only looks at assets, because each asset is a complex package of exposures to many different risk factors.

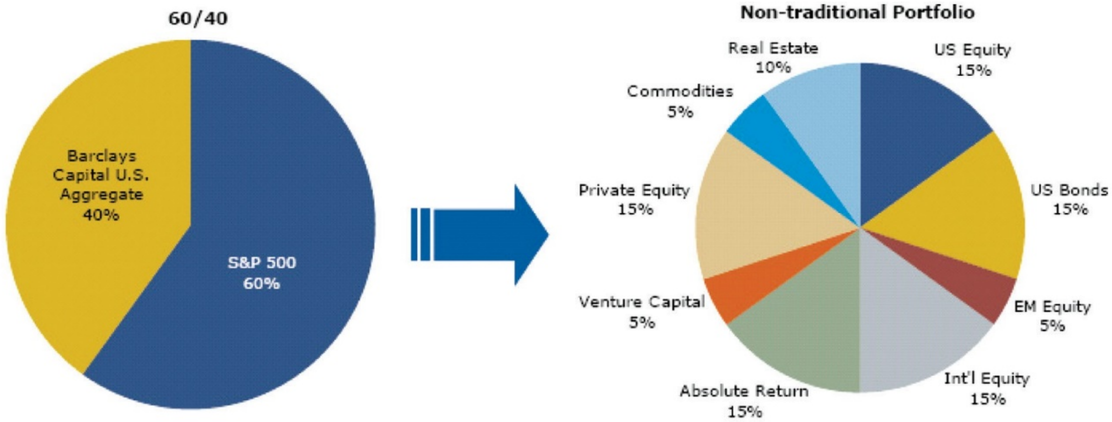
By using forward-looking risk factors, we also reduce hindsight bias and the risk of concentration in assets that are not likely to repeat their past performance. For instance, a typical risk parity portfolio of stocks and bonds would appear to require a large allocation to bonds in the current environment (since bonds have been less risky than stocks), but this could be a mistake since rates are much lower now than they were only a couple of years ago. We can trace this lower prospective performance to the duration risk factor exposure of a fixed income security. At a yield of 50 basis points, a two-year note could barely appreciate a percent in price terms even if rates were to fall to zero. A levered position in short-term government bonds to achieve risk parity could thus be exposed to significant fat-tail risks from rising rates.

Focusing on risk factors allows investors to look at prospective risks and returns to a position, which historical asset performance cannot. As a matter of fact, the newly relevant zero bound on short-term nominal rates makes much of the backward-looking empirical results on the benefits of asset-based risk reduction irrelevant. If one thinks of short-term risk-free rates as an option with risk-mitigating characteristics, this option is currently priced at very expensive levels.

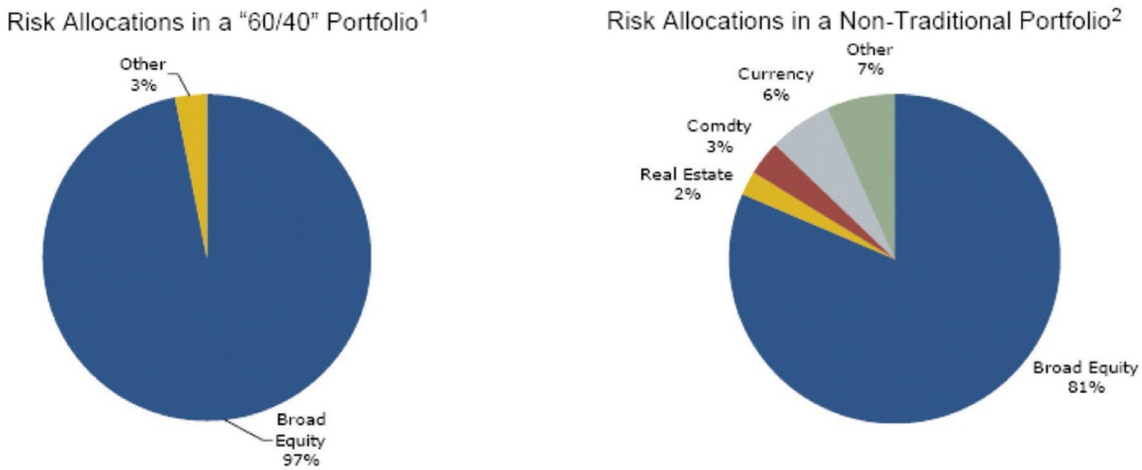
Exhibit 1

A 60/40 Portfolio vs. an Endowment-Style "Diversified" Portfolio

A. Typical allocation



B. Risk decomposition



C. Tail-risk profile based on statistical bootstrap

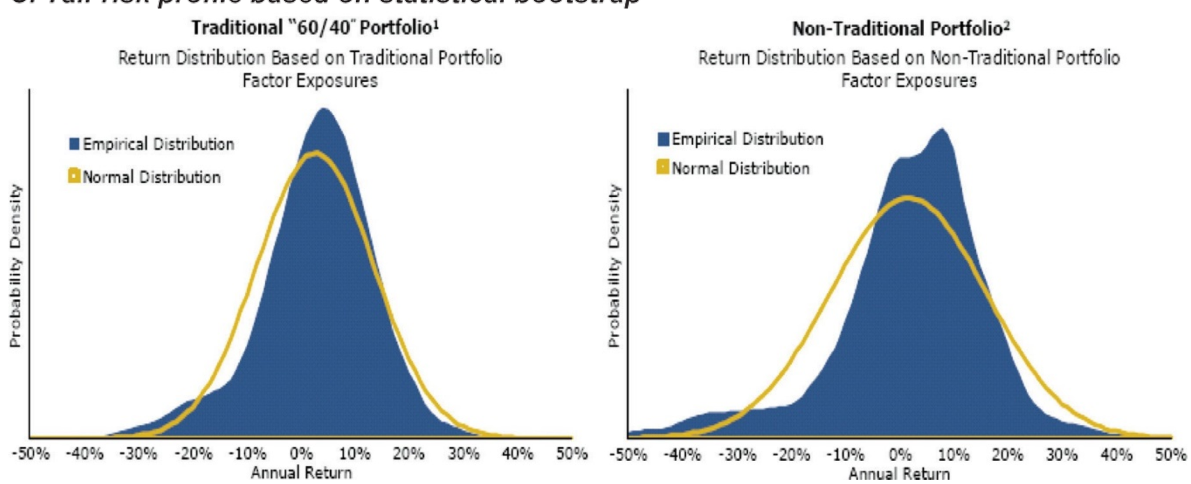


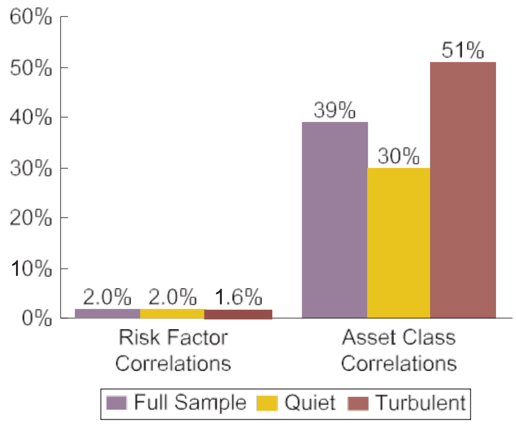
Exhibit 2

Proportion of Variance Explained by Principal Components of Major Asset Class Indices

Eigenvalues: (Sum = 40, Average = 1)				Cumulative Value	Cumulative Proportion
Number	Value	Difference	Proportion		
1	12.72313	6.112347	0.3181	12.72313	0.3181
2	6.610786	3.785894	0.1653	19.33392	0.4833
3	2.824892	0.53839	0.0706	22.15881	0.554
4	2.286502	0.122255	0.0572	24.44531	0.6111
5	2.164248	0.549093	0.0541	26.60956	0.6652
6	1.615155	0.071287	0.0404	28.22472	0.7056
7	1.543868	0.243724	0.0386	29.76858	0.7442
8	1.300144	0.190894	0.0325	31.06873	0.7767

Exhibit 3

Average Cross-Correlations, March 1994–December 2009



Notes: Hypothetical example for illustrative purposes only.

- *Positive (Negative) Size factor weight implies large (small) cap bias.*
- *Positive (Negative) Value factor weight implies value (growth) bias.*
- *Spread Duration factors are measured against Treasuries.*
- *Base currency is U.S. dollar.*
- *Selected dates are the dates for which multivariate distance was higher than the tolerance 15% threshold. Source: Windham Portfolio Advisor.*
- *Asset class regimes were determined using asset class returns but cor- respond closely to the risk factor regimes.*
- *Asset classes: U.S. Equities Small Cap (MSCI US Small Cap 1750); U.S. Equities Large Cap (MSCI US Large Cap 300); Emerging Markets Equities (MSCI EM); Global Equities (MSCI World ex-US); Bonds (BarCap U.S. Aggregate Index); Real Estate (DJ U.S. Select REIT Index); Commodities (S&P GSCI Index). Source: Windham Portfolio Advisor.*
- *Risk Factors: Equity, Size, Value, Momentum, Duration, 2-10 Slope, 10-30 Slope, EM Spread, Mortgage Spread, Corp Spread, Swap Spread, Real Estate, Commodity. Sources: All data from DataStream except for Size, Value, and Momentum from Barra.*
- *The 15% threshold for turbulence can be adjusted to a number greater than 15% to include a broader dataset or lower to focus on more stressed periods. We use 15% to include enough data points while still focusing on highly unusual markets.*

Source: Page and Taborsky [2010].

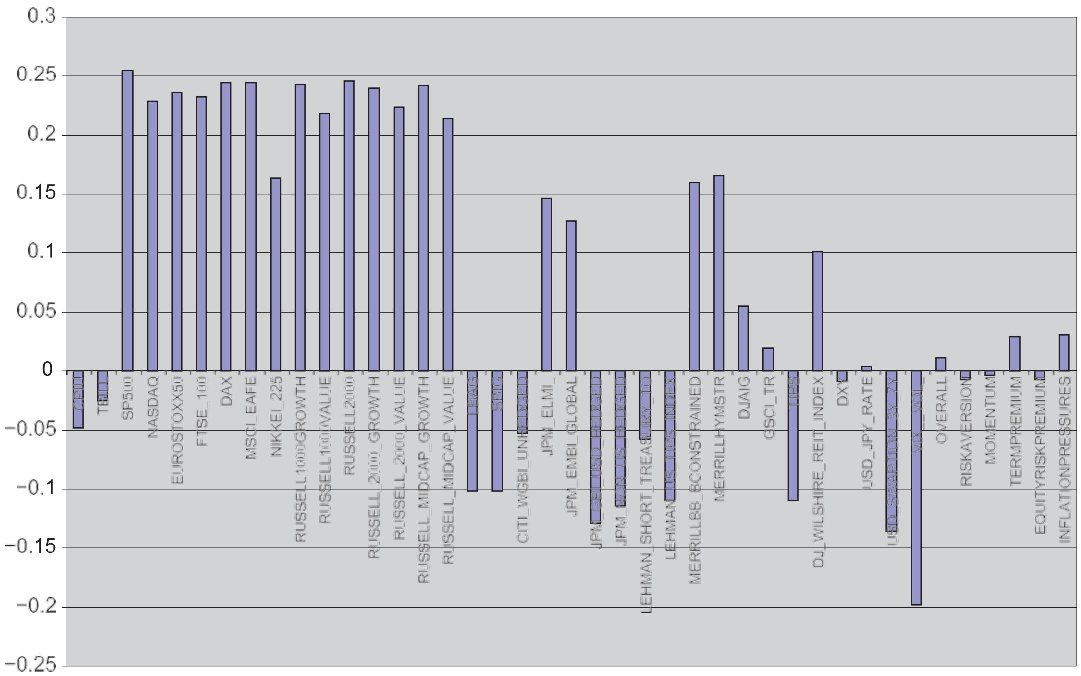
There is one final gain from the risk-factor-based approach. It is well known that typical asset allocation portfolios (such as a 60/40 mix), have over two-thirds of their risk driven by the equity market. What is surprising is that even "diversified" portfolios, such as the one displayed in Exhibit 1, show similar risk allocation (the risk decomposition of the two portfolios is shown in Exhibit 1, Panel B). Indeed, as mentioned before, the dominance of equity factor risk rises sharply in crisis periods and has been an important motivator behind risk parity. The reason behind this is the larger volatility of the equity component, as well as the dependence on the equity risk factor in other portions of the portfolio. For instance, most spread products such as corporate bonds have a significant beta to the equity market. A broadly diversified corporate bond index portfolio thus has exposure to the equity market, and simply using historical estimates of risk from index returns is likely to further understate the risk contribution to the equity risk factor from such an asset allocation. The recent crisis revealed that not only was diversification by looking at cosmetic asset allocation as opposed to risk factor allocation not successful in reducing risk by diversification, it also resulted in an increase in risk as "diversifying" assets became more correlated. As Exhibit 1, Panel C, demonstrates, the tail risks (i.e., the possibility of large negative drawdowns) are actually of the same magnitude, or even larger, in the "cosmetically" diversified portfolio.

The risk factor approach to asset allocation not only allows a clear look into the sources of risk, it simplifies the allocation problem significantly by setting the scale of various exposures in a clear way. For instance, if we forecast an equity factor volatility of 20% (current level of the VIX), then a 0.60 equity beta translates to a 12% volatility contribution and expected one-year maximum drawdown of approximately 15%, even under the assumption of normal distributions (Magdon-Ismail and Atiya [2004]) and zero drift. Over a longer holding horizon, the expected maximum drawdown is higher, for instance even with an annual drift of 10%, 20% volatility translates into a five-year expected maximum drawdown approaching 30%. When expected returns are negative, as in many overvalued securities, the expected maximum drawdown can rise significantly. By focusing on the risk and hence drawdown characteristics of the whole portfolio, the factor approach allows investors to directly (via beta rebalancing) and indirectly (via options) control exposures and hence drawdowns.

Exhibit 4

Example of Factor Decomposition of Asset Returns

A. Loadings of market indices on Factor 1 that can be identified with equity risk



B. Loadings of market indices on Factor 2 that can be identified with bond risk

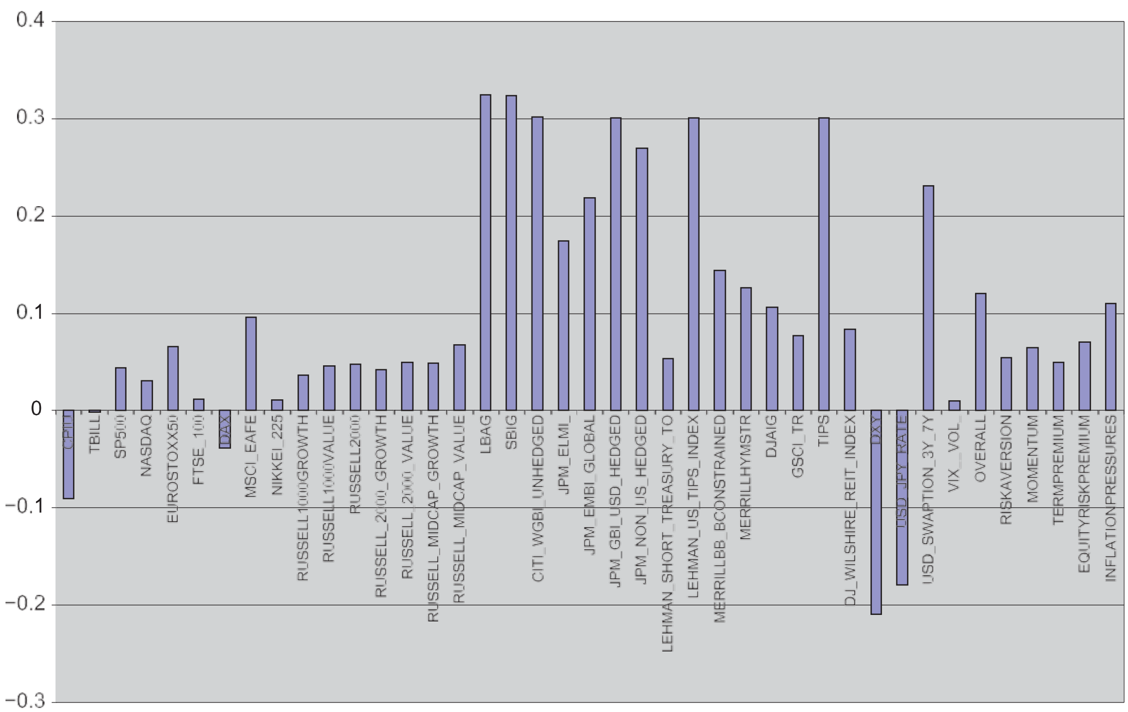
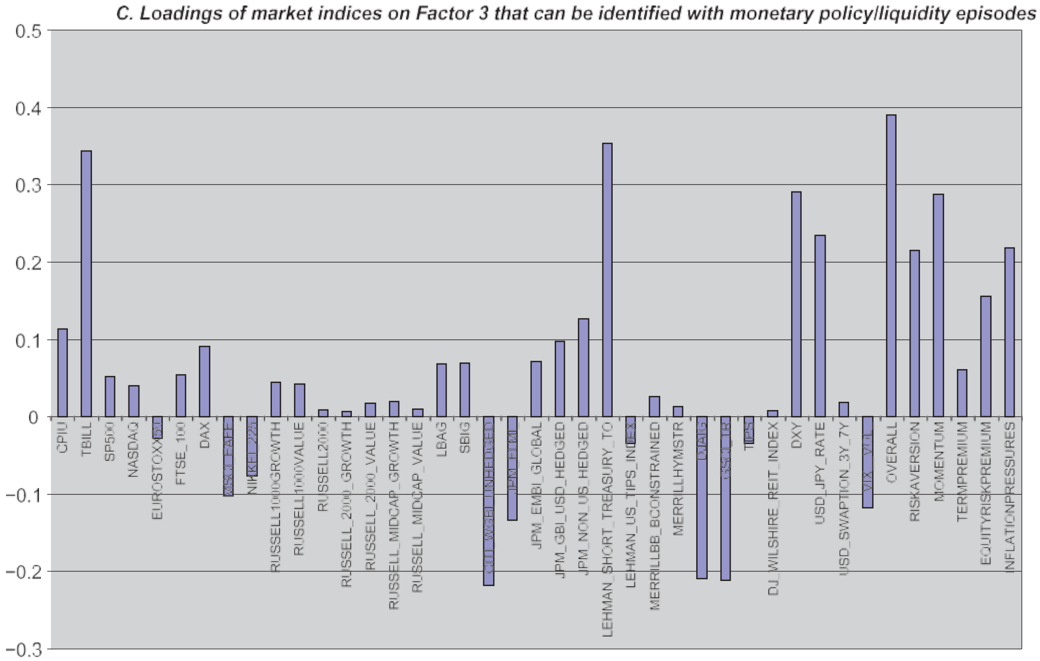


Exhibit 4 (*continued*)

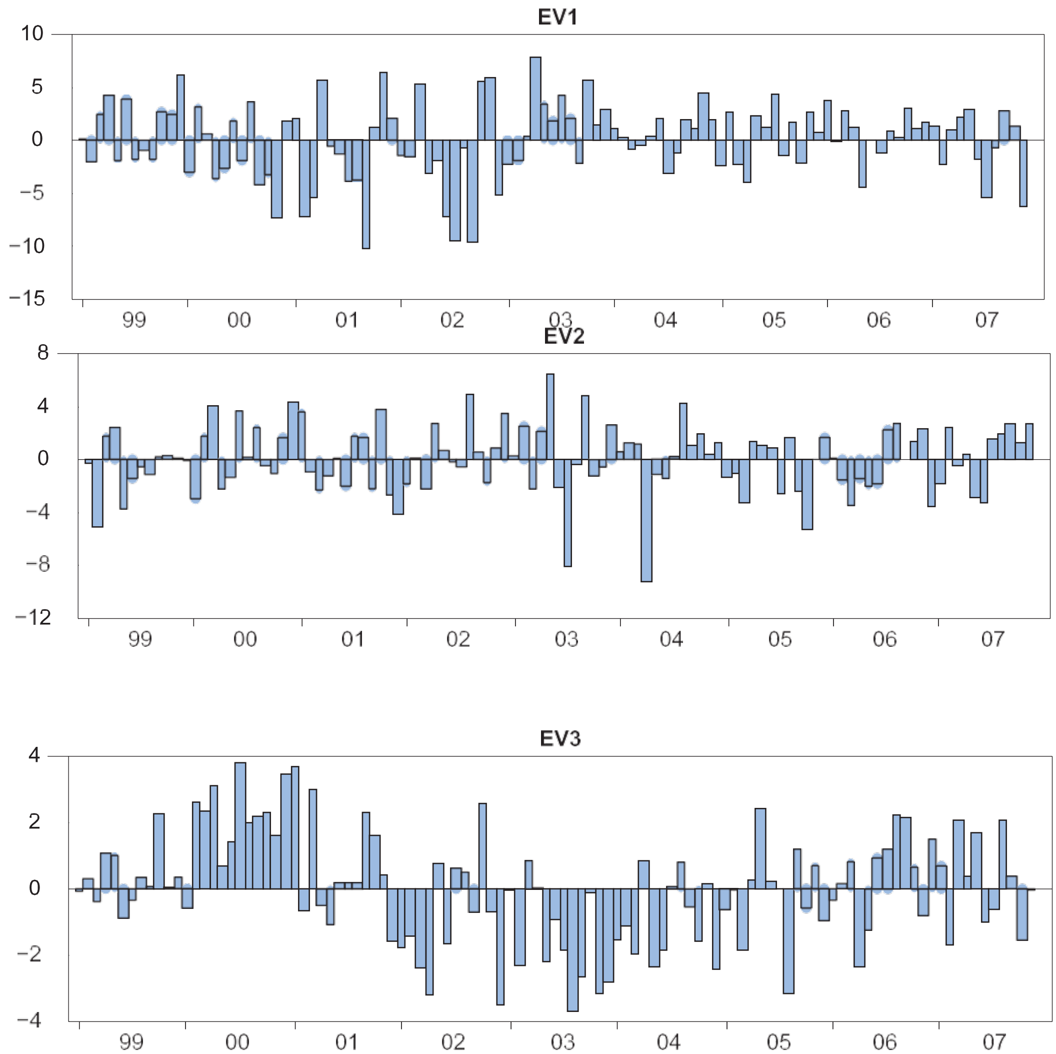


Even though we do not think that much faith should be placed in backward-looking analyses, statistical exploration of the factor structure of asset returns shows that four or five risk factors saturate almost 70% of the movement of almost all liquid assets over the last five decades for which we have reasonable data. In Exhibit 2, we show the proportion of variance explained by the major principal components of returns of popular asset indices. Furthermore, the factors themselves can be identified with equity risk, bond (or duration risk), liquidity, momentum, and currency exposures.

It has also been documented by others (see Exhibit 3, reproduced from Page and Taborsky [2010]) that correlations between key risk factors are low and stable in normal and crisis or turbulent periods. Over the same history, correlations between many major asset classes are much higher and variable; see Exhibit 4. This interesting observation can be traced to the fact that many risky assets are dominated by exposure to equity and liquidity risk factors. In periods of illiquidity, many of them end up looking highly correlated due to the liquidity risk factor simultaneously influencing them. Thus diversification based on risk factors is indeed a more robust approach to managing portfolio risks. As shown in Exhibit 5, the factor returns themselves have also been mean reverting, allowing one to increase exposures when the factor risk premia are high and decrease them when the factor risk premia are low. The long-term stability and mean-reversion characteristics of risk factors are related to the time variation of risk premia and allow the investor to tilt portfolios in directions where the compensation for the risk premia is appropriately priced.

Exhibit 5

Mean Reversion of Factors Extracted by Statistical Principal Component Analysis



To show how assets are related to the risk factors, in Exhibit 6, we compute the coefficients of regressions of the various asset classes on the factors themselves to identify the key risks.

EXHIBIT 6

Coefficients of Regressions of Various Asset Classes on the Risk Factors

A. S&P 500 loads on Factor 1

Dependent Variable: S&P 500
Method: Least Squares
Date: 01/29/08 Time: 11:31
Sample (adjusted): 1999M01 2007M11
Included observations: 107 after adjustments

	Coefficient	Std. Error	*t*-Statistic	Prob.
C	0.003878	0.001534	2.528518	0.013
EV1	0.0101	0.00043	23.48807	0
EV2	0.001894	0.000597	3.175518	0.002
EV3	0.001908	0.000913	2.091349	0.039
R-squared	0.846073	Mean dependent var		0.003878
Adjusted R-squared	0.841589	S.D. dependent var		0.039862
S.E. of regression	0.015865	Akaike info criterion		−5.4127
Sum squared resid	0.025926	Schwarz criterion		−5.31278
Log likelihood	293.5794	Hannan-Quinn criter.		−5.37219
F-statistic	188.7158	Durbin-Watson stat		2.473486
Prob (F-statistic)	0			

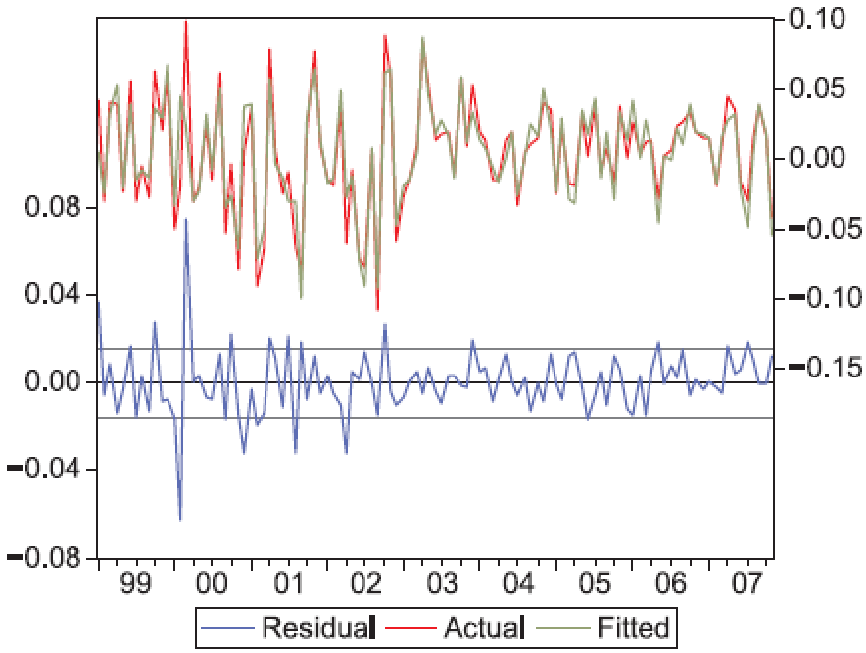


EXHIBIT 6 (*continued*)

B. Barclays Aggregate Bond Index loads on Factor 2

Dependent Variable: LBAG
Method: Least Squares
Date: 01/29/08 Time: 11:34
Sample (adjusted): 1999M01 2007M11
Included observations: 107 after adjustments

	Coefficient	Std. Error	*t*-Statistic	Prob.
C	0.004679	0.000356	13.14515	0
EV1	−0.00105	9.98E-05	−10.4695	0
EV2	0.003427	0.000138	24.75589	0
EV3	0.000178	0.000212	0.838238	0.4038

R-squared	0.875328	Mean dependent var	0.004679
Adjusted R-squared	0.871697	S.D. dependent var	0.010278
S.E. of regression	0.003682	Akaike info criterion	−8.33429
Sum squared resid	0.001396	Schwarz criterion	−8.23437
Log likelihood	449.8844	Hannan-Quinn criter.	−8.29378
F-statistic	241.0556	Durbin-Watson stat	2.104987
Prob (F-statistic)	0		

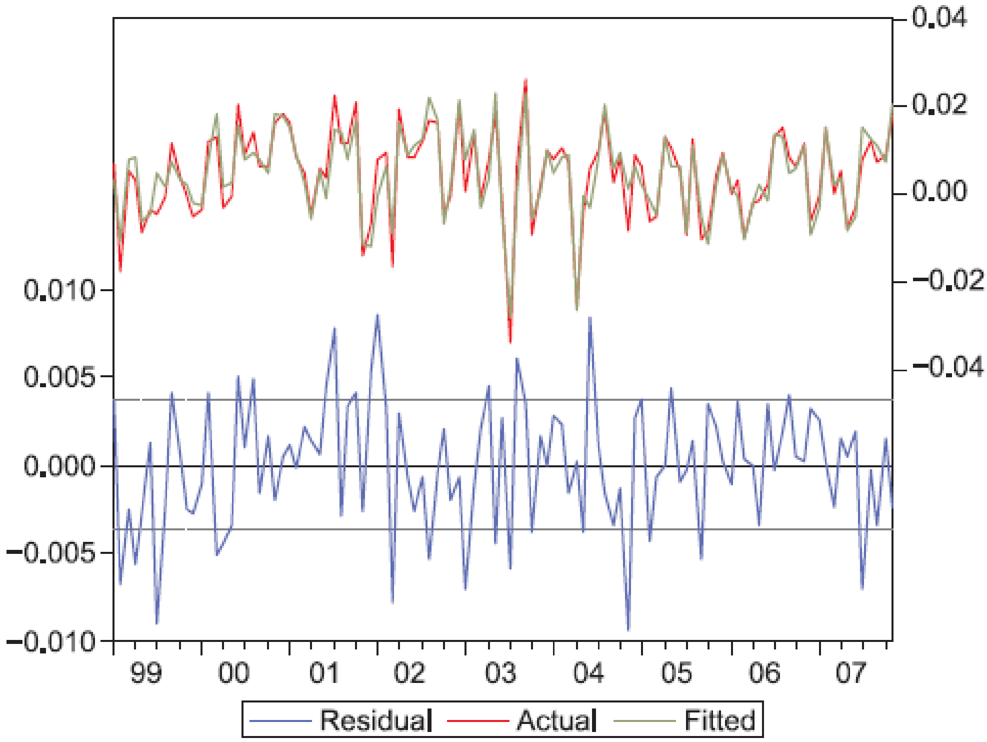


EXHIBIT 6 (*continued*)

C. EMBI Global EM Bond Index loads on both equities and global bond indices

Dependent Variable: JPM_EMBI_GLOBAL
Method: Least Squares
Date: 01/29/08 Time: 11:41
Sample (adjusted): 1999M01 2007M11
Included observations: 107 after adjustments

	Coefficient	Std. Error	*t*-Statistic	Prob.
C	0.01047	0.001722	6.079521	0
EV1	0.003318	0.000483	6.873169	0
EV2	0.00602	0.00067	8.987487	0
EV3	0.000825	0.001025	0.805291	0.4225
R-squared	0.55539	Mean dependent var		0.01047
Adjusted R-squared	0.542441	S.D. dependent var		0.026336
S.E. of regression	0.017814	Akaike info criterion		−5.18094
Sum squared resid	0.032688	Schwarz criterion		−5.08103
Log likelihood	281.1805	Hannan-Quinn criter.		−5.14044
F-statistic	42.88796	Durbin-Watson stat		2.094443
Prob (F-statistic)	0			

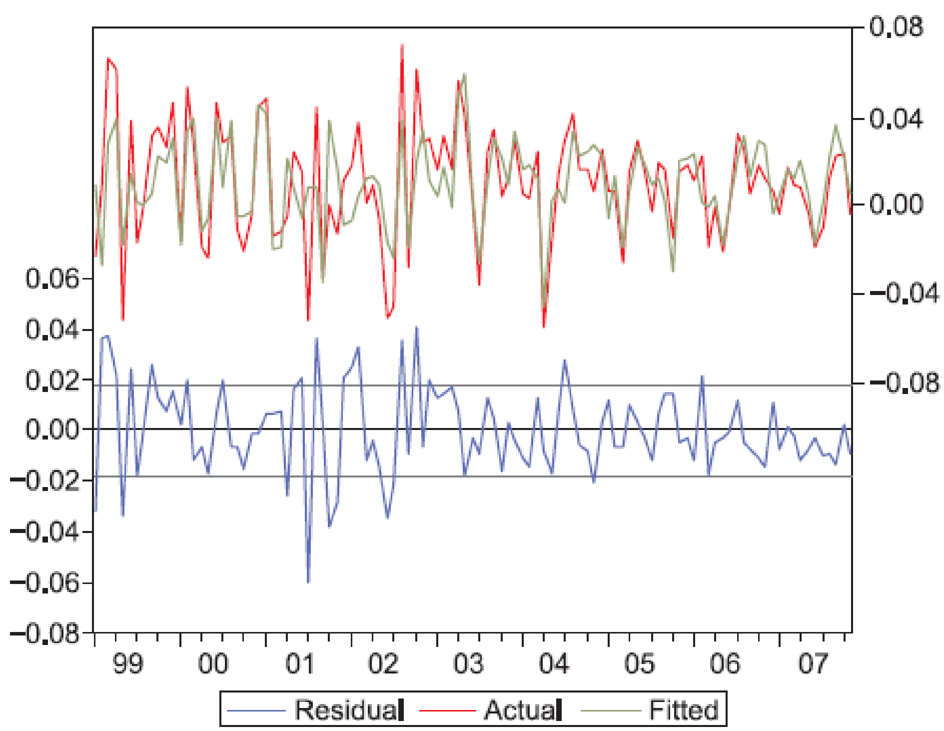
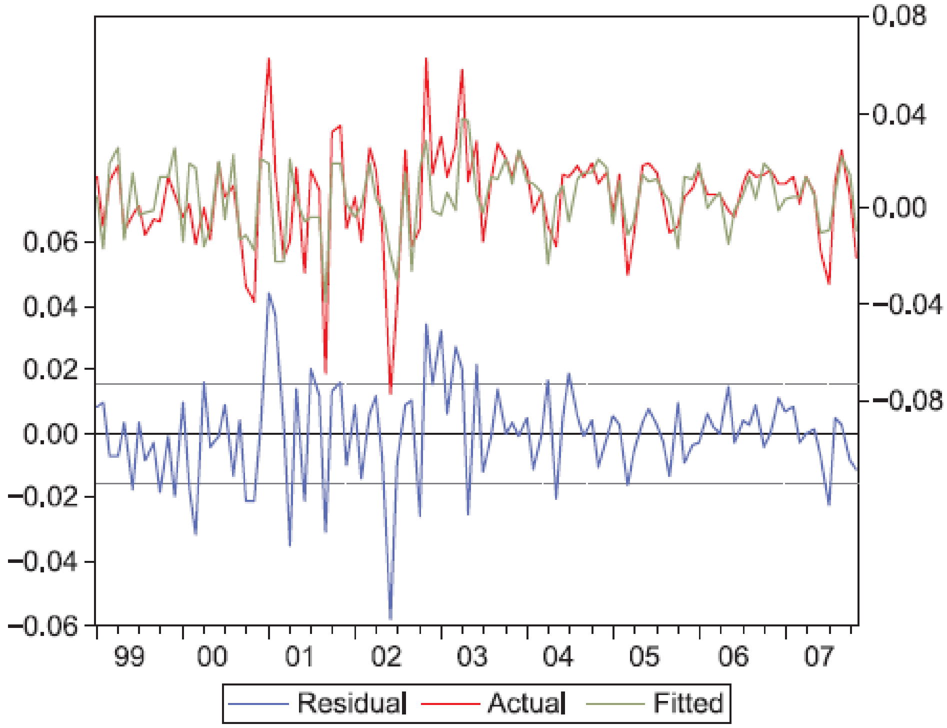


EXHIBIT 6 (*continued*)

D. High-yield index loads predominantly on the first factor (equities) and to a lesser degree on the bond factor

Dependent Variable: MERRILLHYMSTR				
Method: Least Squares				
Date: 01/29/08 Time: 11:50				
Sample (adjusted): 1999M01 2007M11				
Included observations: 107 after adjustments				
	Coefficient	**Std. Error**	***t*-Statistic**	**Prob.**
C	0.004947	0.001502	3.292483	0.0014
EV1	0.003458	0.000421	8.20906	0
EV2	0.002786	0.000584	4.767121	0
EV3	−0.00074	0.000894	−0.8261	0.4107
R-squared	0.468515	Mean dependent var		0.004947
Adjusted R-squared	0.453035	S.D. dependent var		0.021014
S.E. of regression	0.015541	Akaike info criterion		−5.45397
Sum squared resid	0.024878	Schwarz criterion		−5.35405
Log likelihood	295.7874	Hannan-Quinn criter.		−5.41346
F-statistic	30.26551	Durbin-Watson stat		2.013909
Prob (F-statistic)	0			



By observing the most dominant t-statistics and probabilities, we can identify the dominant risk factors. What we find is that the dominant equity and bond factors are present almost everywhere. Panels A and B of Exhibit 6 clearly illustrate that the stock and bond factors are the underlying drivers for the major indices such as the S&P 500 Index and the Barclays Aggregate Bond Index. What is more interesting is that the emerging market bond index (Panel C) and the high-yield bond index (Panel D) are also dominated by the equity factor. This illustrates the source of extra yield and extra risk for those asset classes and, hence, the importance of appropriately accounting for that risk in the asset allocation process. Were one to use the high- yield or emerging market indices as bond proxies, one would severely understate the risk of the portfolio. A risk parity solution that ignores the factor content of these indices by simply referring to them as assets would thus not be as balanced as one would naively think.

One shortcoming of the risk-factor- based approach is that measurement of factor exposures requires sophisticated modeling (e.g., term structure modeling for bonds) as well as the ability to estimate the exposures by performing appropriate stress shocks. However, this can usually be overcome by approaching the problem systematically via identification of the variables, calibration, and identifying reasonable shocks (see, e.g., Bhansali [2003]). Another shortcoming of the factor-based approach is that by construction it ignores idiosyncratic or security-specific contributors to risk and return. Although this shortcoming matters significantly for long/short or arbitrage-type portfolios, it has little impact on the investment decisions for longer-term investors who harvest risk premia from systematic risks.

Implementation of risk parity relies on leverage in order to allow scaling up of risks. It is well known that investors who can lever have the possibility of constructing more-efficient portfolios for delivering the same return than those who cannot lever and are forced to riskier securities to achieve the same returns. Risk parity lies between levering up a fully optimal port- folio (the one with the highest Sharpe ratio on the traditional mean–variance optimal frontier) and no leverage. Thus they behave somewhere in the middle zone between hedge funds and passive investments.

The robust performance of risk parity portfolios in 2008 can be traced to the fact that they held bonds (or the safe duration risk factor) in a levered form. When equities and credit underperformed, the f light to quality to industrial country government bonds, and U.S. Treasuries in particular, compensated by delivering positive performance. It could very well have been a coincidence (perhaps not to be repeated) that the securities that did well in the episode were the ones that happened to be leverage- able. Access to leverage for the lower-risk securities is critical for the performance of risk parity. Other than illiquidity regimes where leverage becomes hard to obtain, we also know from experience that the cost of leverage goes up as more leverage is demanded. Either the funding rates become higher or the initial collateral (haircut) requirements become less favorable.

This non-homogeneous behavior of leverage can impact risk parity portfolios in significant ways. In many currencies, especially in the U.S. and U.K., long-term interest rate swaps have traded through sovereign credit. Some of this was undoubtedly driven by the behavior of investors looking to hedge their liabilities via accumulation of levered long duration instruments. A focus simply on the risk-mitigation characteristics of these instruments without regard to valuation is a recipe for portfolio composition with unbalanced risks. An important corollary to this observation is that implementing risk parity with market indices might embed structural mis-valuation if the indices themselves have been beneficiaries of risk-reduction-driven outperformance.

Many market-cap-weighted indices, both in equities and fixed income, are rearward-facing mirrors. In a world of global rebalancing, we believe that forward-looking bond indices provide the opportunity to provide better risk-adjusted returns. A risk-factor-based approach mitigates the risk of holding expensive securities by quantifying the prospective risks under various economic outcomes in a forward-looking sense. When leverage is not easily available, a risk parity portfolio has only two simple choices: live with the unbalanced risk or accept lower return. There is a more complex choice as well—to obtain leverage through synthetic structured notes. Unfortunately, the complex solution leads to inherent illiquidity and exposure to de-levering episodes, which in itself can lead to an outcome that is even more risky (Bhansali [2007]).

In a world where the outcomes are more dispersed and the tails are fatter (El-Erian and Clarida [2010]), it is essential that portfolio risks are better under- stood and pro-active risk management is employed. Risk parity attempts to manage risk solely by endogenous means. In other words, exposures and asset allocation are scaled up and down based on prospective volatilities. There are a few limitations to this approach. First, market distributions are typically non-normal, especially during periods of stress. So volatility is a very crude metric for risk and for dynamic asset allocation. Second, in periods of stress, transactions costs increase, and it is not usually possible to de-risk or rebalance portfolios easily. Finally, overweighting diversifying securities, such as Treasuries, might end up incurring a large insurance cost and indeed might not turn out to be insurance at all.

We believe that a large portion of the portfolio's tail-risk management should be done via its structure. However, in a world of increased uncertainty and fatter tails, to control for the possibility of severe events, portfolios should employ explicit tail-risk hedging instruments. In the risk factor approach, the exercise of tail-risk mitigation is performed in a holistic manner, by evaluation of the "option cost" of such hedging. By reducing risky factor exposures (e.g., by reducing the equity beta), an investor is also prospectively giving up some upside. If this shadow price of risk reduction is less than the price of explicit protection of the portfolio, then the latter is a more-efficient solution for portfolio construction. As discussed in considerable detail elsewhere (Bhansali [2008, 2010]), to implement this in practice, we analyze the key risk factors of the portfolio, and based on an attachment level (which deter- mines where the hedges start to protect the portfolio) and a low, finite cost, we select a combination of direct and indirect hedges from across asset classes. Active and dynamic tail-risk management is a key component of the risk-based approach to asset allocation. In the presence of leverage, defensive and offensive tail hedging improves the performance of portfolios since it not only allows for more aggressively positioned portfolios, it also allows access to liquidity to increase exposure to risky assets when they have the highest prospective returns. In this sense, we consider tail-risk hedging to be an "offensive risk management" tool. To contrast explicit tail hedging with traditional risk parity, note that tail-risk hedging assumes that investors can tolerate some downside volatility but are really sensitive to substantial drawdown risks. In contrast, traditional risk parity scales the exposures based on volatility and hence selects a portfolio composition that implicitly insures even the smallest fluctuations about the expected portfolio value. We think that by targeting volatility, one might actually be over-insuring the portfolio in a domain of outcomes that are simply noise.

Risk parity is commendable for approaching asset allocation from a risk management perspective. However the devil is in balancing bottom-up details with top-down views. Moving beyond the language of assets and into the domain of risk factors, leverage control, tail-risk management and forward-looking benchmark indices are all essential to making the theory work in practice. The details that matter are the ones that account for the unfolding macroeconomic environment and its influence on security valuation.

ENDNOTE

I would like to thank Mohamed El-Erian for substantial collaboration in the development of ideas relevant to asset allocation and tail hedging and for numerous comments on various drafts of this article. Any remaining errors and omissions are solely mine.

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IMPORTANT DISCLOSURES

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