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Risk Parity Portfolios:

Efficient Portfolios Through True Diversification

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Summary

Risk Parity Portfolios are a family of efficient beta portfolios that allocate market risk equally across asset classes, including stocks, bonds, and commodities. The investment approach for Risk Parity Portfolios is different than traditional asset allocation; it delivers true diversification that limits the impact of losses of individual components to the overall portfolios. Using this approach, Risk Parity Portfolios are expected to generate superior return for a given level of targeted risk. In addition, Risk Parity Portfolios can be combined with alpha sources such as tactical asset allocation and security selection to achieve even higher total return objectives.[1]

Eggs in one basket

One well-understood and seemingly well-heeded investment axiom on investing is: Don't put all your eggs in one basket. So, if you were advised to place over 90% of your eggs in one basket, would you think that is sufficient diversification? Apparently, many investors, those who invest in a balanced portfolio of 60% stocks and 40% bonds, do, even though a 60/40 portfolio does not offer true risk diversification.

How can this be true? The answer is: Size matters — the stock "eggs" are about nine times as big as the bond "eggs." Assume stock and bond returns have an annual standard deviation of 15% and 5%, respectively. Then, in terms of variance, stocks are nine times riskier than bonds. We shall explain below why the variance and covariance are the correct measures to use in analyzing portfolio risks. For now, imagine we have six stock "eggs" of size 9 and four bond "eggs" of size 1 in two separate baskets. In total, we have an equivalent of 58 (i.e., 6 x 9 + 4) "eggs," of which 54 are from stocks. Fifty-four out of 58 is about 93%.

While our egg analogy might appear simplistic,[2] it is not far from reality. For example, from 1983 to 2004, the excess return of the Russell 1000 Index had an annualized volatility of 15.1% and the Lehman Aggregate Bond Index had an annualized volatility of 4.6%, while the correlation between the two was 0.2.[3] Based on these inputs, stocks contributed 93% of risk and bonds contributed the remaining 7% for a 60/40 portfolio. The message is clear — while a 60/40 portfolio might appear balanced in terms of capital allocation, it is highly concentrated from the perspective of risk allocation.[4]

From risk contribution to loss contribution

Why should investors care about risk contribution? Our research shows the risk contribution is a very accurate indicator of loss contribution.[5] Risk might seem only an abstract concept until a loss occurs. When that happens, managers and clients alike always want to know what contributed to the loss. Going back to our previous example of a 60/40 portfolio, the table below displays the average contribution to losses with three different thresholds.

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[1] No assurance can be given that the investment objective will be achieved or that an investor will receive a return of all or part of his or her initial investment. As with any investment, there is a potential for profit as well as the possibility of loss.

[2] It neglected any correlation between the stocks and bonds, and it did not square the weights.

[3] "Returns" in this article are excess returns, i.e., the returns of the assets minus 90-day T-bills.

[4] Another telltale sign of the stocks' dominance is the correlation between the return of the 60/40 portfolio and the Russell 1000 Index return. For the period considered, it is above 0.98.

[5] Qian, Edward E. "On the Financial Interpretation of Risk Contribution: Risk Budgets Do Add Up," The Journal of Investment Management, Fourth Quarter 2006.

TABLE 1: AVERAGE LOSS CONTRIBUTION FOR THE 60/40 PORTFOLIO BASED ON THE RUSSELL 1000 AND LEHMAN AGGREGATE BOND INDICES: 1983–2004

Loss>	Stocks	Bonds	N
2%	95.6%	4.4%	44
3%	100.1%	–0.1%	25
4%	101.9%	–1.9%	14

Source: PanAgora.

For losses above 2%, stocks, on average, contributed 96% of the losses. This is very close to the risk contribution of 93% we calculated earlier. For losses greater than 3% or 4%, the contributions from stocks are higher, above 100%. Although the data in this table is influenced by sampling error (N is the number of monthly returns for a given threshold) and higher tail risks from stocks, it provides empirical evidence for the economic interpretation of risk contribution; it approximates the expected loss contribution from underlying components of the portfolio. This is true when we use variances and covariances to calculate risk contribution.

Risk Parity Portfolios

It can now be understood why a 60/40 portfolio is not a well-diversified portfolio. When a loss of decent size occurs, over 90% is attributable to the stocks. To put it differently, the diversification effect of bonds is insignificant in a 60/40 portfolio. Conversely, this would imply that any large loss in stocks will result in a loss of similar size for the whole portfolio. This is hardly diversification.

How can we use these insights to design a portfolio that limits the impact of large losses from individual components? This can be accomplished if we make sure the expected loss contribution is the same for all components. The concept of risk contribution and its economic interpretation thus leads us to the development of Risk Parity Portfolios that allocate risk equally among asset classes.

TABLE 2: RETURN CHARACTERISTICS OF INDICES AND PORTFOLIOS: 1983–2004

	Russell 1000	Lehman Agg	60/40	Parity	Parity (L)
Average	8.3%	3.7%	6.4%	4.7%	8.4%
Standard deviation	15.1%	4.6%	9.6%	5.4%	9.6%
Sharpe ratio	0.55	0.80	0.67	0.87	0.87

Source: PanAgora.

While Risk Parity Portfolios can utilize many asset classes,[6] it helps to illustrate their potential benefits using the stock/bond example. For a fully invested portfolio, an allocation of 23% in the Russell 1000 Index and 77% in the Lehman Aggregate Bond Index would have equal risk contribution from stocks and bonds. Table 2 shows some of the return characteristics of this Risk Parity Portfolio and a leveraged version denoted by (L), along with those for the underlying indices as well as for the 60/40 portfolio, all measured by excess return over three-month Treasury bills. As the data show, the Russell 1000 had the highest average return at 8.3%, but also a much higher standard deviation. And, as a result, it has the lowest return-risk, or Sharpe ratio, at 0.55. The bond index had lower average return as well as a lower standard deviation, and its Sharpe ratio, at 0.80, is better. For the 60/40 portfolio, both the average return and the standard deviation are between those of stocks and bonds. More importantly, its Sharpe ratio, at 0.67, is lower than that of bonds, which is an indication of poor diversification: The overall portfolio's Sharpe ratio is lower than one of its components.

In contrast, the Risk Parity Portfolio's Sharpe ratio of 0.87 is higher than those of stocks and bonds, representing the benefits of true diversification. Note that the Risk Parity Portfolio's Sharpe ratio is substantially higher than that of

[6] They include eight asset classes: U.S. large-cap equity, U.S. small-cap equity, international equity, emerging-market equity, government bonds, corporate bonds, TIPS, and commodities.

the 60/40 portfolio.[7] For a fair comparison of average returns, the leveraged version is adjusted so that it has the same level of risk as the 60/40 portfolio. We shall have more to say on the subject of leverage later. What about the loss contribution of the various components of the Risk Parity Portfolio? Table 3 shows that for a loss of 2% or more, stocks contributed 48% and bonds 52%; for a loss of 3% or more, stocks contributed 45% and bonds 55%. These numbers are close to parity, given the limited numbers of sample points.

TABLE 3: AVERAGE LOSS CONTRIBUTION OF THE PARITY PORTFOLIO

Loss>	Stocks	Bonds	N
2%	48.4%	51.6%	17
3%	45.4%	54.6%	6

Source: PanAgora.

The "optimality" of Risk Parity Portfolios

In contrast to the investment approach of most traditional asset allocation portfolios, which typically involves forecasting long-term asset return and employing mean-variance optimization, Risk Parity Portfolios are based purely on risk diversification. The question remains: Why should risk diversification, especially parity risk contribution, lead to efficient portfolios?

The reason is that Risk Parity Portfolios are actually mean-variance optimal if the underlying components have equal Sharpe ratios and their returns are uncorrelated. Are these realistic assumptions? First, equal Sharpe ratios imply that the expected return is proportional to the risk for each asset class. This is theoretically appealing because it means that assets are priced by their risk. In practice, we can derive the implied return of an asset class from its Sharpe ratio and assess whether the implied return is realistic. For instance, if we assume a Sharpe ratio of 0.3, then the implied excess returns (over a risk-free rate) would be 4.5% for stocks and 1.5% for bonds. Second, the actual correlation between stocks and bonds, while not zero, is quite low. These considerations lead us to believe that the Risk Parity Portfolios are efficient, not only in terms of allocating risk, but also in the classical mean-variance sense under the assumption we just tested.

Risk Parity Portfolios have additional benefits. First, each asset is guaranteed to have a non-zero weight in the portfolios. Second, the weights are influenced by asset return correlations in a desirable way: Assets that have exhibited higher correlations with other asset classes will have a lower weight and those that have exhibited a lower correlation with other asset classes will have a higher weight. Commodities, for instance, would have a significant weight due to its low correlations with both stocks and bonds.

Targeting risk/return level with appropriate leverage

While the Risk Parity Portfolio in Table 2 has a high Sharpe ratio, the unleveraged version has lower return than the 60/40 portfolio due to much lower risk. An investor may not be able to achieve his or her return objective simply by creating a portfolio with a high Sharpe ratio. One solution is the use of leverage to achieve higher levels of return. For instance, the leveraged Risk Parity Portfolio in Table 2 has a leverage ratio of 1.8:1. Table 4 shows one additional leveraged Risk Parity Portfolio, whose risk level is the same as that of stocks. It outperformed the Russell 1000 by close to 5% per year with a leverage ratio of 2.8:1, and the second portfolio outperformed the 60/40 portfolio by 2% per year with a leverage ratio of 1.8:1.

TABLE 4: COMPARISON BETWEEN PARITY PORTFOLIOS WITH THE STOCK INDEX AND THE 60/40 PORTFOLIO

	Russell 1000	Parity (L)	60/40	Parity (L)
Average	8.3%	13.2%	6.4%	8.4%
Standard deviation	15.1%	15.1%	9.6%	9.6%
Sharpe ratio	0.55	0.87	0.67	0.87

Source: PanAgora.

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[7] One way to interpret the Sharpe ratio is the return in percentage points for every 1% of risk taken. For example, for every 1% of risk taken, the 60/40 portfolio returns 0.67% while the parity portfolio returns 0.87% per annum.

Many investors have grown to accept the fact that some degree of leverage is necessary and beneficial in investing. For example, investing in common stocks has inherited leverage since companies issue debts to grow their business. And, many hedge fund strategies employ leverage to enhance returns while controlling risks. In the case of Risk Parity Portfolios, leverage is necessary and relatively easy to implement with futures when the risk level is above 5%. While use of leverage entails some short-term risk, our analysis shows that it is appropriate and reasonably safe to employ leverage in the Risk Parity Portfolios over the long run. Since bonds have much lower risk than stocks, the Risk Parity Portfolios leverage bonds such that they would have the same risk contribution as stocks. As a result, the leveraged version of the Risk Parity Portfolio maintains the high Sharpe ratio but also has higher returns.

Using the Risk Parity Portfolios

Risk Parity Portfolios can be used as stand-alone beta products. They can also be combined with alpha strategies to further increase returns. As a beta strategy, Risk Parity Portfolios can be used in the following three ways:

- An unleveraged version with 4%–5% risk, similar to that of the Lehman Aggregate Bond Index
- A leveraged version with a leverage ratio of about 2:1 and a risk target of around 8%–10%, similar to that of domestic or global balanced portfolios
- A global macro strategy with 16%–20% risk and leverage of 4:1, similar to that of a typical hedge fund

Our backtests[8] show that the Risk Parity Portfolios had a Sharpe ratio of 1.1 over the period from 1983 to 2004, translating to excess returns of 4.5%, 11.3%, and 22.6%, respectively, for the three strategies.

We believe that the Risk Parity Portfolios are well suited to the needs of institutional investors today. Given the current challenge posed by relatively low returns from most asset classes, investors must seek better alpha sources as well as extract higher return from their existing market exposure. For many investors, the beta risk actually represents the majority of their total risk budget. The Risk Parity Portfolios provide a more efficient alternative to traditional asset allocation: They limit the risk of overexposure to any individual asset class, while simultaneously providing ample exposure to all of them. With Risk Parity Portfolios, investors can reap the benefits of true diversification: Their eggs are placed evenly and safely in many baskets.

Important disclosure information:
The unmanaged indicies below do not reflect fees and expenses and are not available for direct investment.

The benchmark for this Composite is composed of 60% of the MSCI World Index and 40% of the Citigroup World Bond Index. The 60% MSCI World and 40% Citigroup WGBI is a blended benchmark. The MSCI World Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets. As of June 2007, the MSCI World Index consisted of 23 developed market country indices. The Citigroup World Government Bond Index (WGBI) includes the 23 government bond markets of Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Malaysia, the Netherlands, Norway, Poland, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States. Benchmarks are generally taken from published sources and may have different calculation methodologies, pricing times, and foreign exchange sources than the Composite. The effect of those differences is deemed to be immaterial. The securities holdings of the Composite may differ materially from those of the index used for comparative purposes. Indexes are unmanaged and do not incur expenses. You cannot invest directly in an index.

The Russell 1000® Index measures the performance of the 1,000 largest securities in the Russell 3000 Index.

The Russell 1000® Growth Index measures the performance of the Russell 1000 securities with higher price-to-book ratio and higher forecasted growth values.

The Russell 1000® Value Index includes the Russell 1000 securities with lower price-to-book ratios and lower forecasted growth values.

The Lehman Brothers Aggregate Bond Index is an unmanaged, market-value weighted index used as a general measure of U.S. fixed income securities. The index comprises approximately 6,000 publicly traded bonds including U.S. Government, mortgage-backed, corporate, and yankee bonds with an approximate average maturity of 10 years.

The backtested results are shown for illustrative purposes only and do not represent actual trading or impact of material economic and market factors on PanAgora's decision-making process for an actual PanAgora Client account. Performance results were prepared with the benefit of hindsight and are for illustrative purposes only.

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