# Risk Parity[1]

January 2, 2018

"Risk Parity" is an asset allocation solution where asset classes contribute equally to total portfolio risk. Risk Parity portfolios become optimal mean-variance portfolios when leverage is unrestricted and asset classes have identical Sharpe Ratios[2], allowing correlations to drive optimal asset weights.

"Risk Parity" is best described as an asset allocation solution. Its roots lie in the early work[3] of Nobel Laureate William F. Sharpe; was first popularized by Ray Dalio of Bridgewater over a decade ago in his "All Weather" strategy; and more recently has been broadly commercialized by other asset management firms.

Risk Parity and traditional asset allocation portfolios differ in two important ways. First, Risk Parity portfolios use leverage, a feature absent from traditional asset allocation policies of institutional investors.[4] Secondly, Risk Parity assumes equal Sharpe Ratios across asset classes.

Portfolio Leverage

Exhibit 1 below depicts the rationale behind the use of leverage in Risk Parity.

Exhibit 1[5]:

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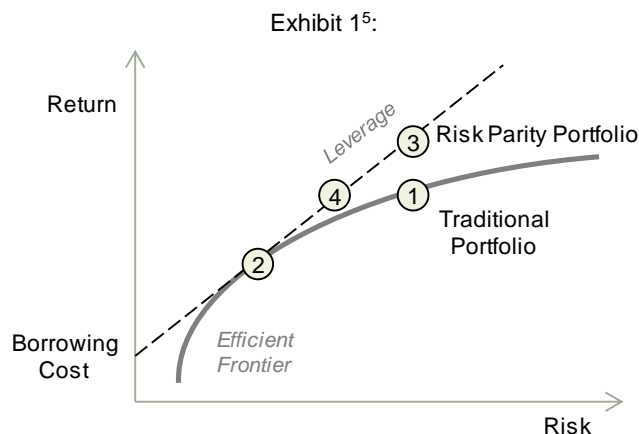
[1] See also Cliffwater Research, "Should Pension Assets Be Leveraged?", August 17, 2014.

[2] Sharpe Ratio equals excess return, defined as total return minus risk-free rate, divided by risk.

[3] See William F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk," *The Journal of Finance*, September 1964.

[4] To our knowledge, fiduciaries to institutional investors have long been reluctant to embrace leverage as part of asset allocation policies either because of the appearance of outsized risk-taking or the potential impact of taxable income through UBTI. Consequently, most asset allocation studies constrain asset weights to avoid leverage.

[5] The chart shown above is provided for illustrative purposes only. The chart is intended to represent the trade-off between risk and return investors make in constructing an optimal portfolio.

Portfolio 1 identifies a traditional institutional portfolio constructed to reside on the "efficient frontier" where leverage is not permitted. Its assets might include stocks, bonds, and alternative investments.

In his groundbreaking early work, Sharpe proposed a better solution to *Portfolio 1*. All investors should invest in the portfolio that has the highest Sharpe Ratio[6] – *Portfolio 2* – and leverage that portfolio up or down to the desired level of risk. He pointed out that an investor in *Portfolio 1* could do better by leveraging *Portfolio 2* to create a higher return *Portfolio 3* at the same level of risk as *Portfolio 1*.[7] Alternatively, the investor could apply less leverage to *Portfolio 2* to reach *Portfolio 4*, which provides the same return as the traditional *Portfolio 1* but at a lower level of risk.

In practice, *Portfolio 2* contains higher allocations to fixed income, notably Treasury bonds, and smaller allocations to equity. Consequently, *Portfolio 2* by itself fails to provide a return and risk that meets investor preferences, such as that found in *Portfolio 1*. Risk Parity portfolios solve this return and risk deficit through leverage to achieve *Portfolio 3*.[8]

Sharpe Ratio Equivalence

Unique to Risk Parity is the presumption that all asset classes have equal Sharpe Ratios. This is a very convenient assumption for two reasons. First, it eliminates the hard work of developing expected return inputs for asset allocation studies.[9] And second, in combination with leverage, it creates a greatly simplified world where only asset class correlations matter in asset allocation.[10]

Risk Parity Optimization Example

Exhibit 2 illustrates a Risk Parity solution for three asset classes: stocks, Treasuries, and credit.

Exhibit 2: Risk Parity Example with Three Asset Classes

		Stocks	Credit	Treasuries	Risk Parity Portfolio
A. Inputs[11]:					
1	Risk *(standard deviation)*	15.0%	11.0%	7.0%	
2	Sharpe Ratio	0.3	0.3	0.3	
3	Excess return *(1 x 2)*	4.5%	3.3%	2.1%	
4	Correlations:				
	Stocks	1.00	0.60	-0.40	
	Credit		1.00	-0.40	
	Treasuries			1.00	
B. Optimization:					
5	Asset level leverage	0%	35%	105%	58%[12]
6	Levered excess return	4.5%	4.5%	4.5%	4.5%
7	Optimal mix *(on net assets)*	42%	42%	73%	158%
8	Optimal mix *(on gross assets)*	27%	27%	46%	100%
9	Risk *(standard deviation)*	15.0%	15.0%	15.0%	8.9%
10	Risk contribution *(% of total)*	33.3%	33.3%	33.3%	100%

Risk Parity

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[6] Also referred to as the portfolio with the highest risk-adjusted return.
[7] Sharpe also pointed out that in a perfect world, all investors would hold the same Portfolio 2 which would represent the market portfolio, the concept underlying index funds and efficient markets.
[8] Leverage can be achieved in several ways, but a common approach is the use of futures contracts.
[9] Return is no longer an independent variable (input) but a linear function of the risk.
[10] Risk is the same because each individual asset class can be levered up or down to the same risk level.
[11] All return, risk and correlation assumptions are meant to represent investor expectations.
[12] Portfolio leverage equals asset leverage multiplied by asset weight, 58% = (0% x 0.27) + (35% x 0.27) + (105% x 0.46).

Section A contains asset class inputs. Risk and correlation inputs in rows 1 and 4, respectively, are illustrative, yet approximate historical levels. Risk Parity supposes equal Sharpe Ratios and we select 0.3 in row 2 as reflective of long term outcomes. Excess return, in row 3, is the product of risk and Sharpe Ratio. Since Sharpe Ratios measure excess return divided by risk, row 3 measures return above the risk-free rate. The Risk Parity portfolio is an unconstrained optimization based upon these inputs, but it is perhaps easier to grasp through a three-step process described in Section B.

The first step is to adjust the risk of the three asset classes to equal levels. This is done by leveraging (or de-leveraging) the asset classes to equal risk values. In our example, we apply leverage in row 5 to credit and Treasuries to achieve the same 15% risk level as equity.[13] In so doing the return for all three asset classes equals 4.5% in row 6, due to their equal Sharpe Ratios. Excess return for the total portfolio will also equal 4.5%, regardless of individual asset weights.

The second step is to solve for the minimum risk portfolio for three asset classes, each having the same 4.5% return, the same 15% risk, but very different correlations. The optimal asset class weights are found in rows 7 and 8, expressed as a percent of net assets and gross assets, respectively.[14]   Row 7 presents the optimized Risk Parity portfolio weights as a percent of net assets. The weights sum to 158% because leverage accounts for an additional 58% of asset exposure, mostly assigned to Treasuries. Row 8 presents the same weights as a percent of gross assets (or gross asset exposure). Almost one-half (46%) of the portfolio is allocated to Treasuries solely due to its negative correlation with the other two asset classes. The equal but lower allocations to equities and credit are explained by their higher correlation with each other and identical correlations with Treasuries.

Row 10 reports the fraction of total portfolio risk contributed by each asset class. In the Risk Parity world of equal asset class Sharpe Ratios, optimization always produces asset weights (rows 7 and 8) that result in each asset class providing the same contribution to overall portfolio risk, as we find in row 10. That is why it is called Risk Parity.

Finally, the third step would be to adjust the Risk Parity leverage to match investor risk preferences. The Risk Parity portfolio in Exhibit 2 has an 8.9% risk level (row 9), roughly comparable to the risk found in actual Risk Parity portfolios over the last several years. However, a Risk Parity portfolio's risk (and return) can be increased (decreased) by altering overall portfolio leverage. The new higher (or lower) risk portfolio would also satisfy Risk Parity conditions of highest Sharpe Ratio and equal portfolio risk contribution by asset classes, but with a potentially better match to investor risk preferences.

Conclusion

Risk Parity is an adaptation of traditional mean-variance optimization under (1) the unrestricted use of leverage, and (2) the restrictive assumption of equality in asset class Sharpe Ratios. Leverage is an investor driven preference rather than an input or optimization issue. Sharpe Ratio equivalence is an assumption that affects key inputs to portfolio optimization and, if mistaken, can result in suboptimal portfolios. For example, concerns exist today that Treasuries are at peak valuation, and that the historical negative correlation between rates and risky asset classes may reverse. If these concerns materialize, Risk Parity portfolios could be negatively impacted.

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[13] The choice of the target risk level for all three asset classes is arbitrary and does not impact the optimal mix on gross assets. Rather, it only impacts the amount of leverage used.

[14] Weights based upon net assets equal total long asset class exposure divided by assets net of borrowing. Weights based upon gross assets equal total long asset class exposure divided by assets, including borrowing.

A New Year tradition among institutional investors is a review of asset allocation policies. Risk Parity is increasingly gaining headlines, potentially as an alternative to the conventional asset allocation study. Our surveys of pension systems show that many are "incubating" externally managed risk parity funds but very few have embraced Risk Parity fully.

This report is intended to present the investment concepts underlying Risk Parity. However, our own asset allocation approach continues to be based upon unique inputs for asset class return and risk derived from asset class fundamentals, following a more traditional approach. Our forthcoming "Cliffwater 2018 Asset Allocation Report" will highlight some of these differences.

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