



Risk parity performance attribution and scenario analysis: an update

- We revisit the relative performance of equity bond risk parity portfolios over equally weighted allocations by attributing it to diversification and reallocation effects. The diversification effect reflects the benefits of efficient risk diversification while the reallocation effect captures differences in historical risk-adjusted asset returns, which is unintended and is period-specific.
- We consider a case study of US equity bond portfolios and find that, unlike in the previous 24 years, risk parity has outperformed an equally-weighted allocation only marginally over the last four years. While the diversification effect has remained a stable and significant performance contributor, this has been offset by the reallocation effect which turned negative during the period of rising bond yields.
- We formulate return scenarios consistent with the current yield environment and discuss their implications for the future performance of risk parity portfolios.

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Introduction

Risk parity (RP) multi-asset portfolios have become increasingly popular with investors. Indeed, RP portfolios have often performed well compared to conventional alternatives¹ across various multi-asset universes in the last two decades.

In *What Makes Risk Parity Work? A Performance Attribution Approach*, we explained that the relative performance of RP portfolios over alternative allocations can be decomposed into two effects: diversification and reallocation.

The diversification effect is intentional and reflects the better balance of risk across portfolio assets. This higher risk diversification is the main reason for investors to adopt RP.

The reallocation effect is unintended and occurs due to the underlying asset classes having different risk-adjusted returns. The reallocation effect has been positive over recent decades because RP portfolios typically over weights less volatile assets, which often had higher information ratios than more volatile ones.

In the example of a US equity-bond portfolio, we found that diversification and reallocation effects equally contributed to the outperformance of the RP portfolio over an equally-weighted (EW) allocation from 1991 to 2014. The reallocation effect was positive and very significant due to the higher risk-adjusted returns of bonds in the past few decades, which was helped by a downward trend in yields. In *Implications of Rising Rates for Treasury and Risk-Parity Portfolios*, we identified rates and equity scenarios under which the RP portfolio underperforms the EW equity-bond portfolio.

In this report, we update the performance attribution analysis of RP equity-bond portfolios for the past four years ending in December 2018. We quantify diversification and reallocation effects and find that the reallocation effect has been significantly negative in the recent environment of rising bond yields.

We show that, as a result of the drag from the reallocation effect, and consistent with our analysis in 2015, the RP and the conventional EW equity-bond portfolios performed similarly in the past four years. We then perform scenario analysis of RP equity-bond portfolios as of 31 December 2018.

Revisiting performance attribution of risk parity portfolios

We consider a US equity-bond allocation to analyse the recent performance of risk parity portfolios. The Bloomberg Barclays US Aggregate and S&P 500 indices are the respective proxies for bonds and stocks.

Equally-weighted (EW) equity-bond allocation is used as a conventional benchmark relative to which we measure the performance of the RP allocation. The RP portfolio allocates risk equally between stocks and bonds which, in this case, means weights are proportional to inverse volatilities of historical returns. Using long-term volatilities² of equity and bond indices, we find that the RP portfolio allocates 20% to equities and 80% to bonds.

Figure 1 reports performance statistics for the equity and bond indices, as well as for the EW and RP portfolios. While equities had a higher average return than bonds (7.42%/yr vs. 2.69%/yr in excess over 1M Libor), bonds had a much lower volatility and, as a result,

¹ For example, in a simple case of US equity-bond portfolio, risk parity has outperformed the conventional 50/50 allocation in the long historical sample as shown later.

² Long-term volatilities are estimated from monthly index returns in the period between January 1991 and December 2018.

outperformed stocks in risk-adjusted terms. Indeed, Sharpe ratios of the US Aggregate and S&P 500 indices were 0.77 and 0.53, respectively.

As a result of the larger volatility of the equity market, 93% of the risk of the EW equity-bond portfolio is attributed to equities. The RP portfolio, on the other hand, distributes risk equally across the underlying assets, which results in 20/80 allocation between stocks and bonds.

FIGURE 1

Performance statistics of equity-bond allocations

From January 1991 to December 2018	S&P 500	US Aggregate	Equally Weighted (EW)	Risk Parity (RP)	Leveraged RP (LRP)
Avg. Return Over 1M Libor, %/yr	7.42	2.69	5.05	3.64	6.55
Volatility, %/yr	14.09	3.51	7.35	4.08	7.35
Sharpe Ratio	0.53	0.77	0.69	0.89	0.89
Maximum Drawdown, %	57.54	8.22	29.87	12.09	21.13
Equity/Bond Weights, %	-	-	50/50	20/80	36/144
Risk Contribution, %	-	-	93/7	50/50	50/50

Source: Bloomberg, Barclays

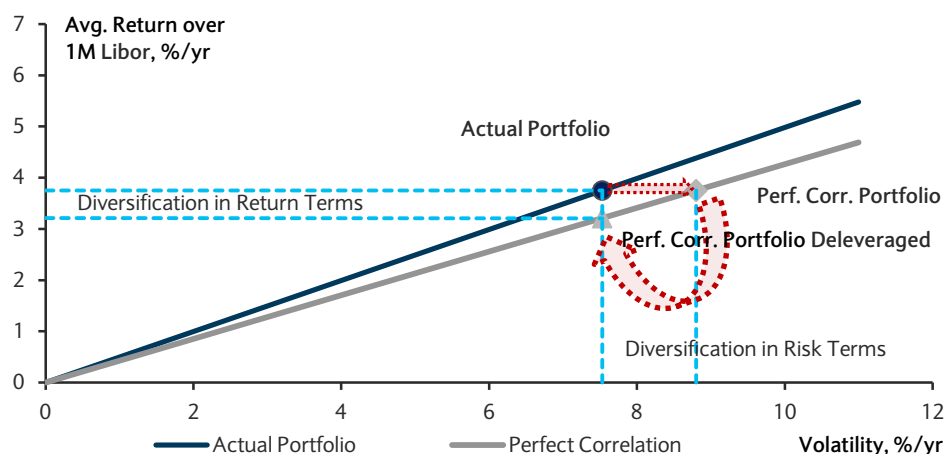
The RP portfolio has a lower average return and risk than the EW portfolio because of its lower allocation to stocks. Its risk-adjusted return (Sharpe ratio), however, is higher than that of the EW portfolio. The volatility of RP portfolio is 1.8x smaller than that of the EW allocation, but investors can use leverage to obtain the same level of return volatility so that average returns of the two portfolios are directly comparable. We therefore leverage the RP to match volatility of the EW allocation³. The resulting leveraged RP (LRP) portfolio is reported in the rightmost column of Figure 1.

The respective equity and bond positions of the LRP allocation become 36% and 144%. Leveraging the RP portfolio increases average return and volatility but leaves the Sharpe ratio unchanged. Despite the fact that volatilities of the LRP and EW portfolios are identical by design, the maximum drawdown of the LRP portfolio is significantly lower than that of EW: 21.13% vs. 29.87%.

The difference in average returns between LRP and EW portfolios (the performance gap) can be decomposed into diversification and reallocation effects. The diversification effect measures the return contribution from a more efficient risk allocation between stocks and bonds. It can be quantified by measuring the reduction in portfolio volatility due to imperfect correlations between asset returns. For each allocation scheme, we compare the realised portfolio volatility to the volatility of the same portfolio under the assumption of perfect correlation between the two underlying assets. As illustrated in Figure 2, this difference in volatility can be expressed in terms of average return when the perfectly correlated portfolio is deleveraged along the risk/return line to match the volatility of the actual portfolio. The diversification effect is then obtained by comparing diversification gains in the LRP and EW portfolio.

³ We assume 1-M LIBOR as the funding rate.

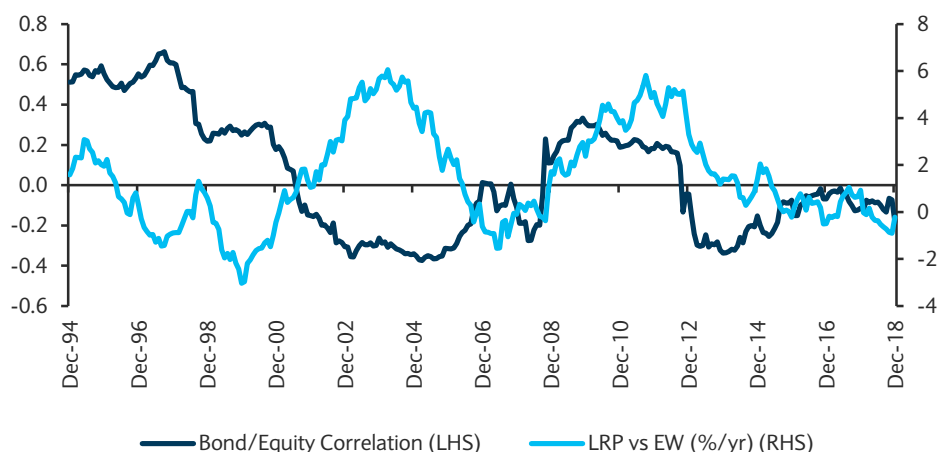
FIGURE 2
Measuring portfolio diversification effect in risk and return terms



Source: Barclays Research

Because RP allocates risk more evenly across the two asset classes, the diversification effect increases as the equity-bond correlation decreases. However, the overall relative performance of the LRP over EW portfolios does not necessarily go hand in hand with bond-equity correlation. As shown in Figure 3, the LRP portfolio performance relative to the EW allocation was not always closely linked to correlation regimes.

FIGURE 3
48-month rolling outperformance of LRP over EW portfolios versus bond-equity correlations



Source: Bloomberg, Barclays Research

Following the 2008 financial crisis, the LRP portfolio outperformed the EW portfolio while correlations remained relatively high. From 2013 onwards, the relative performance steadily declined despite the fact that bond-equity correlations became negative in that period. Even though the primary objective of RP is to capture the positive contribution from the diversification effect, relative performance can be affected by another factor which we call the reallocation effect. This effect is unintended and can be measured as the difference between observed performance gain and the diversification effect: once performance has been controlled for the diversification effect as shown in Figure 2, the remaining difference in return between LRP and EW portfolios is the reallocation effect. It comes from

under/overweighting of the asset with the highest Sharpe ratio. In our case study, it is positive as bonds experienced a higher Sharpe ratio than equities⁴.

In Figure 4, we report performance statistics and attribution analysis from January 1991 to December 2014 (as published in our original study) and from January 2015 to December 2018 (the most recent four years). Over the first period, LRP outperformed EW by 1.75%/y. Contributions from diversification and reallocation effects to this outperformance are almost identical: 0.89%/y and 0.86%/y respectively. In that earlier period, the reallocation effect is explained by the higher Sharpe ratio of bonds (0.84) relative to that of equities (0.52).

FIGURE 4

Performance attribution of LRP and EW portfolios to diversification and reallocation effects

	January 1991-December 2014				January 2015-December 2018			
	S&P 500	U.S. Agg.	EW	LRP	S&P 500	U.S. Agg.	EW	LRP
Avg. return over 1m Libor, %/yr	7.53	3.01	5.27	7.02	6.73	0.77	3.75	3.80
Volatility, %/yr	14.49	3.60	7.60	7.60	11.59	2.88	5.71	5.71
Sharpe Ratio	0.52	0.84	0.69	0.92	0.58	0.27	0.66	0.66
Leverage				1.8				1.9
Volatility perf. corr.	-	-	9.04	10.35	-	-	7.24	8.94
Performance gap, %/yr	-	-	-	1.75	-	-	-	0.04
Diversification effect, %/yr	-	-	-	0.89	-	-	-	0.72
Reallocation effect, %/yr	-	-	-	0.86	-	-	-	-0.68

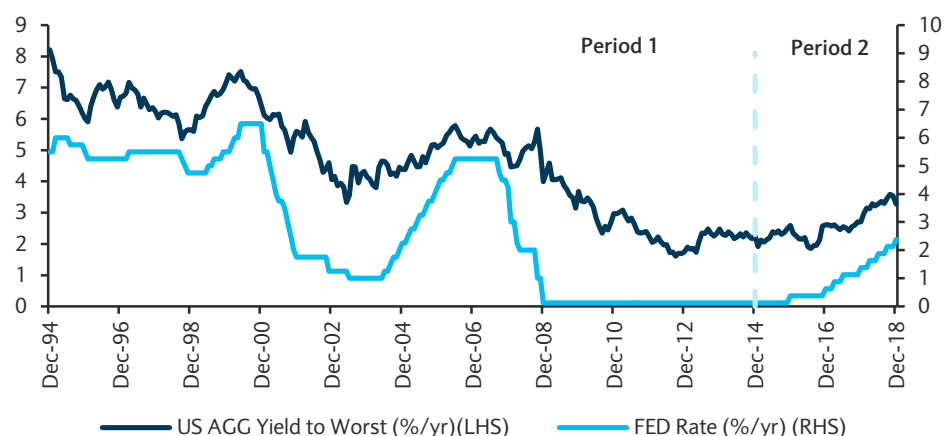
Source: Bloomberg, Barclays Research

In the second period (right panel of Figure 4), the volatility of equities and bonds has reduced significantly and the required leverage to reach the EW portfolio volatility increased from 1.8 to 1.9. Performance attribution also changed significantly compared to the first period. The LRP portfolio outperformed the EW allocation only marginally. The diversification effect remained positive and significant at 0.72%/y. However, the reallocation effect was large and negative: -0.68%/y and almost completely offset the positive diversification effect.

The relatively poor risk-adjusted performance of bonds in the past four years resulted from the recent upward trend in yield of the US Aggregate index, as illustrated in Figure 5. The realised excess return of the bond index over one month Libor was only 0.77%/y, so that equities outperformed bonds in risk-adjusted terms with a Sharpe ratio of 0.58 versus 0.27 for the US Aggregate Index in the past four years.

⁴ An analytical definition of diversification and reallocation effects is available in *What Makes Risk Parity Work? A Performance Attribution Approach*, Barclays Research, January 2015

FIGURE 5
Evolution of the FED rate and yield of US Aggregate Index



Source: Bloomberg

The reallocation effect is specific to the time period considered and fluctuates as a function of relative returns of bonds and equities. To illustrate this, we report in Figure 6 the reallocation effect under different equity/bond return scenarios while keeping volatilities and correlation unchanged. The reallocation effect decreases with equity returns and increases with bond returns since the LRP portfolio allocates less weight to equities. It is also much more sensitive to changes in bond returns than in equity returns because the LRP portfolio overweighs bonds and underweighs equities relative to the EW allocation.

FIGURE 6
Reallocation effect between LRP and EW portfolios under various equity and bond return scenarios

Equity return in excess of 1M Libor (%/yr)	Bond return in excess of 1M Libor (%/yr)										
	-5.00	-3.00	-2.00	-1.00	-0.50	0.00	0.50	1.00	2.00	3.00	5.00
-10.00	-1.89	-0.39	0.36	1.12	1.49	1.87	2.25	2.62	3.37	4.13	5.63
-5.00	-2.83	-1.32	-0.57	0.18	0.56	0.93	1.31	1.69	2.44	3.19	4.70
0.00	-3.76	-2.26	-1.50	-0.75	-0.38	0.00	0.38	0.75	1.50	2.26	3.76
5.00	-4.70	-3.19	-2.44	-1.69	-1.31	-0.93	-0.56	-0.18	0.57	1.32	2.83
10.00	-5.63	-4.13	-3.37	-2.62	-2.25	-1.87	-1.49	-1.12	-0.36	0.39	1.89

Source: Bloomberg, Barclays Research

Note: The table above is based on volatilities and correlation of monthly index returns between January 2015 and December 2018

Scenario performance of risk parity portfolios

Taking recent (31 December 2018) market conditions as a starting point, we investigate bond/equity scenarios under which LRP underperforms the EW allocation. We then report breakeven scenarios for which the two portfolios have identical performance.

Figure 7 reports the required breakeven equity returns that make EW and LRP portfolios deliver the same performance under different bond scenarios⁵. The space of equity-bond returns is therefore divided into two areas by the breakeven line. Because the LRP portfolio

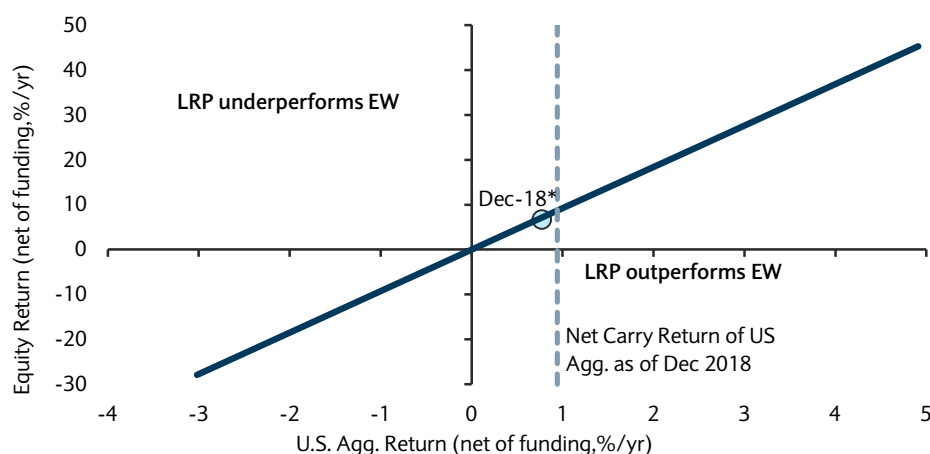
⁵ Volatility and correlation structure is estimated from the period January 2015-December 2018.

shifts allocation from equities to bonds, scenarios above the breakeven line correspond to the LRP performing worse than the EW portfolio.

This figure can be also used to put the recent relative performance of the RP over EW portfolios in perspective. The realised returns of the bond and equity markets in the past four years placed the LRP portfolio marginally below the breakeven line, having outperformed the EW portfolio by only 0.04%/y.

FIGURE 7

Effect of asset returns on the performance of LRP relative to EW portfolios (31 December 2018)



Source: Bloomberg, Barclays Research

Bond return scenarios can also be formulated in terms of yield changes. To compute the bond return implied by a given yield change, we first estimate a bond index return as the sum of the yield carry, roll down, and a parallel shift effects⁶. In this analysis, yield carry is taken as the index average yield-to-worst and roll-down is estimated from the shape of the Treasury yield curve. A parallel upward shift in yields has a negative effect on return, from the index duration exposure, and a positive effect on carry. This secondary effect on carry is very small if the horizon is short but can be significant when estimating bond index returns on a long horizon⁷.

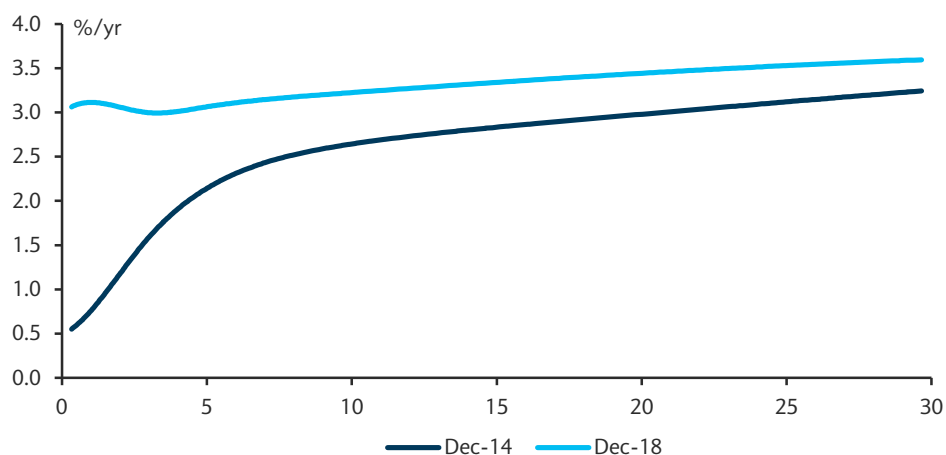
Figure 8 shows that the yield curve shifted upwards and flattened significantly from December 2014 to December 2018. The reduction in slope has the effect of decreasing the projected roll-down return from 0.46%/yr (as of Dec 2014) to 0.17%/yr while the increase in funding rate from 0.17%/yr to 2.50%/yr reduces net carry from 2.54%/yr to 0.94%/yr. These return projections assume that yield curve shape and index structure remain unchanged over time.

⁶ We use the following formula: $Annual\ Index\ Return = y + YCSlope\left(T, T - \frac{1}{12}\right) * \left(D - \frac{1}{12}\right) + \frac{\Delta y}{2} - \Delta y * \left(D - \frac{1}{12}\right)$, where T is the index average life. Because the index is rebalanced monthly, the duration is only adjusted by a one-month shift.

⁷ See *Estimating Bond Index Returns on a Long Horizon*, Barclays Research, May 2018

FIGURE 8

Estimated US Aggregate Index yield curve based on Treasury curve and index OAS at two different points in time



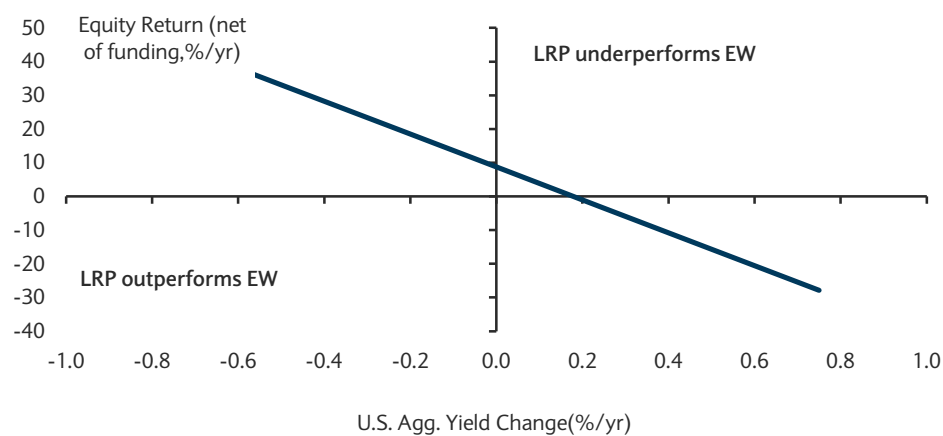
Source: Bloomberg, Barclays Research

The break-even relationship between equity returns and yield changes of the bond index is shown in Figure 9, for a horizon of one year. For parallel shifts in bond yields, positive yield changes translate into a lower bond returns and lower break-even equity returns.

At the end of December 2018, the required break-even equity excess return over cash is of 8.71%/yr under the assumption of an unchanged yield curve. Note that Figure 7 and 9 are equivalent representations of yield changes scenarios. In particular, the unchanged yield scenario in Figure 9 is consistent with a bond index excess return over cash of the order of 0.9%/y, corresponding to the vertical line shown in Figure 7. Assuming risk parameters are well predicted by the volatilities and correlations observed in the period from January 2015 to December 2018, the equity return (in excess of 1M Libor) that makes LRP break even with the EW allocation is now 8.7%/y. If equities were to perform as in the last four years (6.73%/yr over cash) LRP would outperform the EW allocation in that bond scenario.

FIGURE 9

Breakeven between LRP and EW portfolios expressed as equity return vs. yield change of US Aggregate Index, December 2018



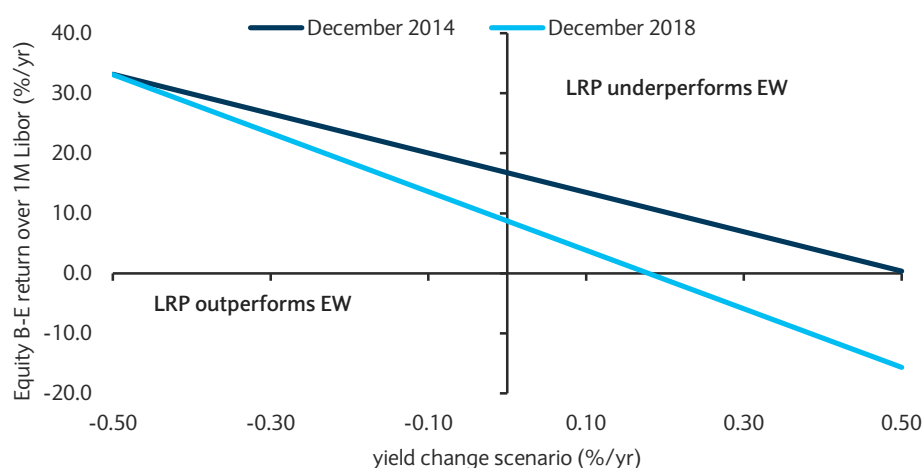
Source: Bloomberg; Barclays Research

In Figure 10, we perform the same analysis⁸ taking December 2014 as a starting point and we compare results with the December 2018 starting point under various yield changes scenarios. Contrasting both break-even lines, it appears that in flat and bearish bond scenarios (bond yields remain unchanged or increase) LRP outperformance over EW allocations require equity returns to be lower than used to be expected in 2014. In effect, under a no yield change scenario, the breakeven equity return is 8.7%/y in December 2018 compared to 16.8%/y in December 2014. Because the December 2018 breakeven line is steeper, projected breakeven equity returns are similar in bond rally scenarios at the two points in time.

On that basis, one could argue that leveraged risk parity is no more likely to outperform equally weighted equity-bond allocation now than was the case in 2014.

FIGURE 10

US Aggregate Index yield change scenarios and implied S&P 500 break-even excess returns over 1M Libor



Source: Bloomberg, Barclays Research

Conclusion

Risk parity performance has been lower, relative to equal weights, in the past four years than in the previous 24 years. While diversification benefits remain, the re-allocation effect has recently been detrimental to strategies that overweight bonds relative to equities.

Scenario analysis helps estimate equity and bond return combinations that make Leveraged Risk Parity (LRP) portfolio break even with Equal Weighted (EW) equity-bond allocations. LRP performance realised in the past four years is in line with scenario projections based on market conditions observed at the end of 2014.

Scenario analysis based on market conditions at the end of 2018 indicate that breakeven equity returns are substantially lower than those projected in December 2014. Therefore, LRP might not be more likely to outperform EW allocations now than was the case in 2014.

⁸ The volatility estimates used to compute the LRP weights in December 2014 are based on the period from January 1991 to December 2014 while the analysis performed in December 2018 is based on the period from January 2015 to December 2018.

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