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PENSION LIABILITIES AND RISK PARITY

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Pension Liabilities and Risk Parity

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For quite some time, pension funds, both public and corporate, have not been happy places to be. However, to quote the Russian novelist Leo Tolstoy, “Happy families are all alike; every unhappy family is unhappy in its own way.”

Although there are many differences between U.S. public pensions and U.S. corporate pensions in terms of actuarial assumptions and accounting standards, the most significant is probably the way each determines the present value of future liabilities. For public pensions, the discount rate for future liabilities is based on the expected return of the pension assets. Typically, this is assumed to be between 7% and 8%. The assumption is that, over time, the assets could earn those rates of return by investing in strategies that often rely heavily on equity risk premiums. The argument for this approach is weak at best, even though it is compliant with government accounting standards. The drawback of this approach is now clear, given that the equity market has underperformed in the last decade—while pension liabilities remain largely unchanged. As a result, most public pensions are now severely underfunded (Novy-Marx and Rauh [2009]).

In contrast, the Pension Protection Act of 2006 requires corporate pension plan sponsors to evaluate pension liabilities more accurately with high-quality corporate bond yields rather than the expected return on plan assets. This lower discount rate leads to a higher and

more realistic estimate of the present value of liabilities, thus forcing corporations to either increase pension contributions, seek liability-matching investment strategies, or both. These efforts have helped corporate pensions better cope with the perfect storm of declining interest rates and low equity returns. Although most corporate pension plans are also underfunded, corporate pensions are in better shape than their public counterparts.¹

Reducing the funding gap remains a daunting challenge for plan sponsors. In the current environment of low interest rates (a result of the global financial crisis and the subsequent subpar economic recovery and ongoing sovereign debt crisis), public pensions couldn't possibly afford to bring the discount rate closer to reality, and corporate pensions are reluctant to fully embrace liability-matching investment strategies. To many, a continuing booming equity market, absent the unpalatable options of increasing contributions or reducing benefits, appears to be the only chance to get out of the current predicament. Or so it seems. But what if equity and equity-like assets underperform again as the global economic recovery falters?

To find appropriate solutions, it helps to find the sources of the problems. In this article, I highlight the different challenges facing public and corporate pensions and propose different solutions to match pension liabilities. In both cases, a risk parity approach

can be an effective investment strategy in either an asset-only or an asset-liability management framework. I first give a brief review of risk parity strategies, and then present risk parity solutions for both public and corporate pensions.

RISK PARITY STRATEGIES: MAXIMIZING RISK-ADJUSTED RETURNS

Traditional 60/40 asset allocation portfolios are not truly diversified; they have unbalanced allocations to high-risk and, often, equity-risk or growth-risk assets. As a result, their returns hinge upon strong economic growth and strong equity markets, and under-diversification leads to low risk-adjusted returns. Risk parity is a new way to construct asset allocation portfolios, based on the principle of risk diversification. This methodology achieves both higher risk-adjusted returns as well as higher total returns (Qian [2005] and [2006]). Qualitatively, risk parity balances the risk allocation to different return premiums, such as the equity risk premium and interest rate term premium. From a quantitative perspective, risk parity portfolios achieve high Sharpe ratio, or risk-adjusted return, when their risk allocations align with long-term expected Sharpe ratios of different asset classes. Another benefit of risk parity strategies is the ability to achieve specific portfolio risk and return targets by leveraging the entire portfolio with appropriate portfolio construction and implementation.

The economic benefits of risk parity strategies include: stable returns over time, robustness to different economic regimes, and significant downside protection during financial crises. These features make risk parity an appealing strategy for pension funds.

PUBLIC PENSIONS: MATCHING RETURN TARGETS WITH MINIMUM RISK

Although the actuarial practice of using projected rates of return on assets, rather than market-based interest rates, as the discount rate for future liabilities is questionable it is hard to see plan sponsors changing the practice any time soon. So within the current sub-optimal framework, the challenge is to find investment strategies that *achieve the expected return target for the least amount of risk*.

In essence, the liability is now being “modeled” as a risk-free investment with the targeted return. Given the

fact that no such investment exists and, thus, it cannot be hedged, the next best thing is to find investments that meet the same return (possibly a little higher to ensure an higher probability of meeting the objective) with minimum volatility (i.e., investments with highest Sharpe ratio).

Risk parity strategies that balance risk contributions of different assets and/or different uncorrelated return premiums represent a suitable solution. Due to proper risk diversification, the long-term Sharpe ratio of risk parity portfolios is higher than those of traditional asset allocation portfolios. In addition, since risk parity portfolios are less sensitive to different macroeconomic environments, their returns are more robust over market cycles. In contrast, volatile return patterns embedded in portfolios concentrated in equity risk inevitably lead to volatility in the plan’s funding status over time, even with multi-year smoothing. Large swings in the plan’s funding status expose plan sponsors to political and legislative risks as well as investment risks. Risk parity can help mitigate these risks by providing more stable returns under different market environments.

I shall use a simple stock/bond example throughout the article to illustrate how risk parity portfolios can reduce these risks. Keep in mind that risk parity strategies with more asset classes such as real assets can be more efficient and robust than the simple cases used here for illustrative purposes. Given the level of current interest rates and volatilities of risky assets, I assume a return of 2% and a risk of 5% for high-quality bonds, and a return of 8% and a risk of 20% for stocks. I also assume a correlation of 0.1 between the two asset classes. Those assumptions would imply an equal Sharpe ratio of 0.4 for both asset classes, which is not inconsistent with long-term averages. Given these low expected returns, partly due to the current risk-free rate of 0% in the U.S., one can only realistically target a rate of return that is lower than the 7%–8% range with just these two asset classes. I set it at 6.5%.

As shown in Exhibit 1, to achieve the 6.5% return target, the traditional asset allocation would hold 75% of the plan assets in stocks and the remaining 25% in bonds. The annualized risk of this 75/25 portfolio is 15.2%, resulting in a Sharpe ratio of 0.43. On the other hand, the risk parity portfolio can achieve the same 6.5% return by allocating 41% to stocks and 164% to bonds (4:1 ratio of bonds versus stocks). Even though it is leveraged at 205%, the portfolio risk is lower, at 12.1%, and

EXHIBIT 1

Two Asset Allocation Portfolios with the Same Expected Return at 6.5%

	Traditional	Risk Parity
Stocks	75%	41%
Bonds	25%	164%
Expected Return	6.5%	6.5%
Volatility	15.2%	12.1%
Sharpe Ratio	0.43	0.54

the Sharpe ratio increases to 0.54. Under these assumptions, the risk parity portfolio dominates the traditional 75/25 portfolio.

As shown in Exhibit 2, the lower volatility of risk parity results in a narrower return distribution around the mean. Over time, its deviation from the 6.5% target

will be smaller than that of the traditional asset allocation portfolio.² Thus, risk parity can help public pension plans achieve their targeted returns with lower risk, resulting in a more consistent plan funding status.

One of the benefits of lower volatility is a lower shortfall probability of portfolio returns versus a minimum return target. This is appealing not only to public pension funds, but to foundations and endowments that might have a minimum spending rate. When the expected return is above the minimum target, the lower volatility means the lower shortfall probability.

In addition, the shortfall probability falls faster with investment horizon for a low-risk portfolio, in our case, the risk parity portfolio. Exhibit 3 displays the shortfall probabilities of two portfolios versus a rate of 5% a year over time horizons from five to 30 years. As the

EXHIBIT 2

The Return Distribution of Two Portfolios

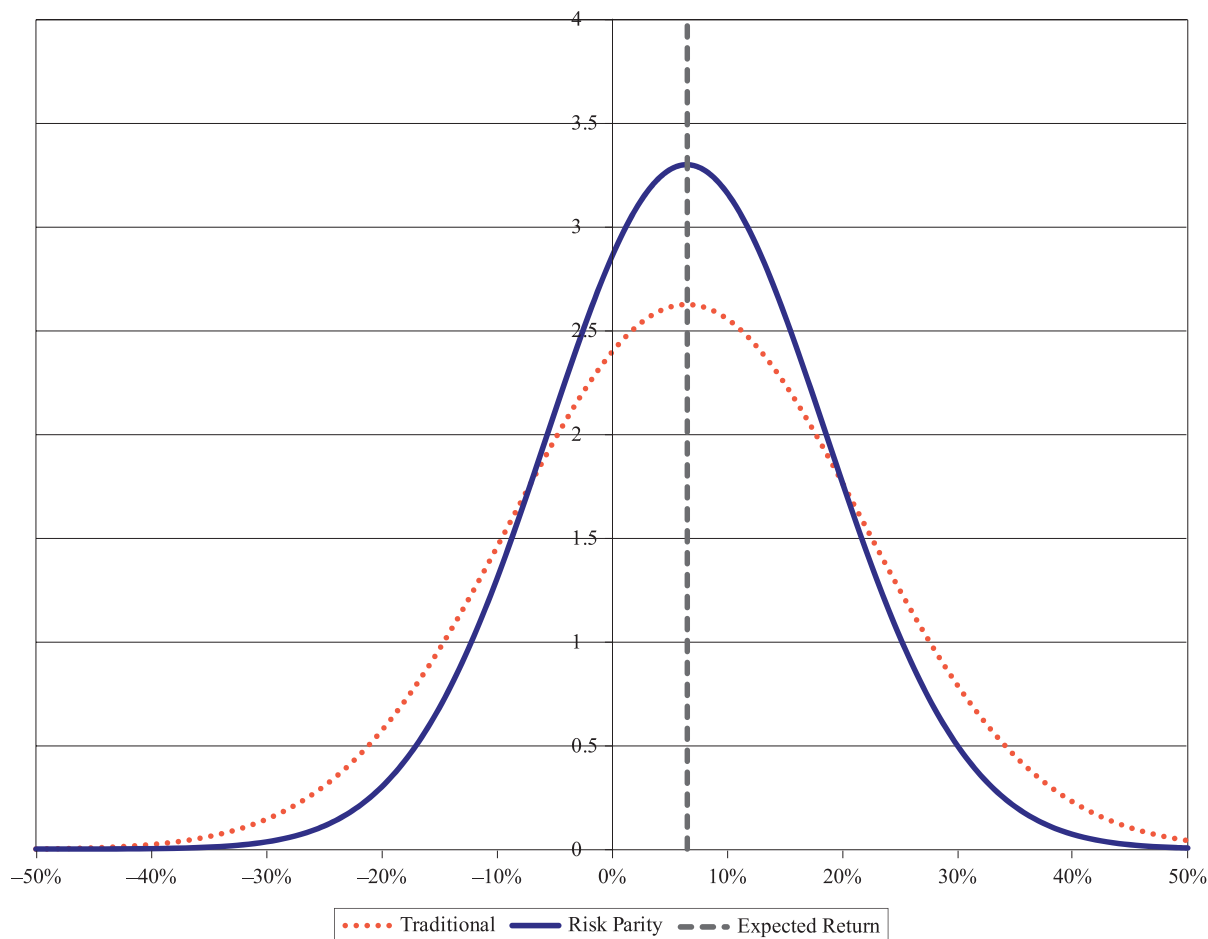


EXHIBIT 3

Shortfall Probabilities of Two Portfolios Relative to 5% over Different Time Horizons

	Risk Parity	75/25
5 Year	42.7%	46.4%
10 Year	40.8%	45.7%
15 Year	38.9%	45.1%
20 Year	38.0%	44.8%
25 Year	37.0%	44.4%
30 Year	35.6%	44.0%

horizon lengthens, the shortfall probability of the risk parity portfolio declines steadily from 42.7% to 35.6%, while the shortfall probability of the 75/25 portfolio remains almost stagnant, changing only slightly from 46.4% to 44%.

CORPORATE PENSIONS: RISK PARITY IN AN ASSET-LIABILITY FRAMEWORK

Because the discount rate that is applied to corporate pension liabilities adjusts with changes in high-grade corporate bond yields, corporate pension liabilities are, to a large extent, marked to market. These changes in the present value of the liabilities would flow through to the corporate income statement, and as a result create demand for liability-driven investment (LDI) strategies to help manage income stability.

A cursory look would indicate that risk parity is also a better fit for LDI strategies than traditional asset allocation approaches because it has significant exposure to interest rate duration—a natural hedge for corporate pension liabilities. While this statement is certainly true, it represents an incomplete picture. For corporate pensions, the objective is to minimize the surplus (asset minus liability) risk. If we assign a portion of the fixed income exposure in the risk parity portfolio to match the liabilities, then the residual portfolio would no longer have risk parity in the surplus risk space.

Within the framework of asset liability management, the optimal investment strategy on the asset side consists of a liability-matching portfolio and a risk asset portfolio (Waring and Whitney [2009]). The liability-matching portfolio is dictated by company-specific, or for that matter, agency-specific liabilities.³ On the other hand, the risk asset portfolio is quite general, and is designed to generate surplus return relative to the liabili-

ties with low surplus risk. These goals are consistent with risk parity strategies; hence we propose *using risk parity for the risk asset portfolio in corporate pension plans*. Therefore, the overall assets of corporate pensions can be invested in some combination of liability-matching portfolios and risk parity portfolios as well as other return-generating strategies.

To illustrate this point, I use a corporate bond portfolio as the liability benchmark for corporate pension funds and combine it with the risk parity portfolios discussed in the previous section. For the moment, I assume the plan is fully funded at 100%. Because a risk parity portfolio is scalable in terms of its risk/return and leverage, we denote the unlevered risk parity portfolio with 20% in stocks and 80% in fixed income as RP1. Then RP1/2 would be 10% in stocks and 40% in fixed income.

Exhibit 4 presents three cases of the total portfolio including both the liability-matching portfolio in 100% corporate bonds with a risk parity portfolio. Case A, labeled RP0, is the fully matched portfolio with a 0% investment in risk parity—hence, it has no surplus risk. Case B has RP1/2, 50% of the unlevered risk parity, and Case C has RP1, the unlevered risk parity. The expected surplus return and risk are from the risk parity portfolios and are scaled by the percentage of investment in risk parity.

Regarding these scenarios, first, I have assumed that a perfect liability-matching portfolio can be found. While this might not be possible in reality, one should nevertheless strive to find a matching investment portfolio that minimizes the surplus risk to the liabilities. Ideally, the surplus risk and return of the liability-matching portfolio should be small compared to the risk and return generated by the risk asset portfolio.

Second, for a fully funded plan, case A, with just the liability-matching portfolio, has zero surplus risk and is optimal. However, if a plan sponsor is ever in such an envious position now or in the future and is willing to take on some surplus risk, spending that risk budget on risk parity as proposed in cases B and C is better than splurging on either stocks or bonds.

Third, for recommendations B and C, the total portfolio may feel tilted toward bonds, violating the risk parity principle. This is not the case, since one needs to separate the liability-matching bond allocation from the risk parity portfolio, which now follows the risk parity principle in the surplus risk space under the framework of asset-liability management.

EXHIBIT 4

Example of Corporate Pension Portfolios Using Liability-Matching Asset Portfolio and Risk Parity

	A	B	C
	Portfolio with RP_0	Portfolio with $RP_{1/2}$	Portfolio with RP_1
Corporate Bonds	100%	100%	100%
Stocks	0%	10%	20%
Bonds	0%	40%	80%
Surplus Return	0%	1.6%	3.2%
Surplus Risk	0%	3%	5.9%
Leverage	100%	150%	200%

Fourth, portfolio implementation of case B and C requires leverage. Leverage can be added in both the liability-matching portfolio and the risk parity portfolio through a combination of futures and swaps.

Lastly, there is a strong argument against allocating too much equity risk in the risk asset portfolio, which seems to be the prevailing practice in the industry. Equity risk is highly correlated with growth risk in the economy in general and with the health of the corporate sector in particular. If economic growth weakens, the fundamentals of most corporations will likely deteriorate. This creates a compounding problem for equity-concentrated pension plans (i.e., the pension plan and the corporate sponsor's fundamentals would worsen at the same time). If the equity investment losses adversely impact the plan's funding status, the corporation could be forced to increase contributions at a time of poor corporate health. If one follows this diversification argument to its logical conclusion, it is probably sensible to tilt the risk asset portfolio toward investments that are counter cyclical, such as high-quality bonds. Of course, a detailed analysis and recommendation requires a holistic evaluation of a company's business operation combined with its pension assets.

Underfunded Corporate Pensions

Given that most corporate pension plans remain underfunded, it is important to ask how the proposed portfolios in Exhibit 4 change in response to funding status. Can we still implement a liability-matching portfolio for an underfunded pension plan? Do we necessarily have to take on more equity risk to close the funding gap?

Surprisingly, we need not make many changes to the portfolios if we adhere to the asset-liability framework. The only change required is to increase the leverage of the liability-matching portfolio. Let's use a concrete example and suppose the plan is 80% funded. In other words, the asset-liability ratio is 80%, or reciprocally, the liability-asset ratio is 125%. To minimize the surplus risk down to zero (i.e., to match the asset exposure to the liabilities), the asset portfolio exposure needs to be levered to 125% of the underlying assets. Levering the asset portfolio covers the funding gap, but the surplus return is surely negative, due to the financing cost of leveraging. Assuming the leveraging cost is 1%, the surplus return will be -25 basis points if there is no other investment in the plan.

This investment strategy, labeled D in Exhibit 5, has no surplus risk, but it is destined to remain underfunded forever, because the asset return is always lower than that of the liabilities.⁴ In this example, the leverage ratio on assets is 125% to compensate for the underfunded status of the plan, and this is denoted by cash position of -25%. This strategy could be a suitable solution if the plan sponsor makes additional contributions to close the funding gap and moves the plan to match liabilities.

As shown in Exhibit 5, similar adjustments are made to the other two investment proposals, E and F, which combine the levered liability-matching portfolio with the risk parity portfolios of two different scales. The surplus returns are reduced by the financing costs, the surplus risks remain the same, and the leverage ratios of the total portfolios increase by 25%. The additional row shows the implied surplus Sharpe ratio. The low-tracking portfolio has an implied Sharpe ratio of 0.46, and the high-tracking portfolio has a Sharpe ratio of 0.50.

Some readers might question the wisdom of leveraging underfunded assets to match liabilities to eliminate the surplus risk. There are three reasons to do so. First, the current costs of leveraging are actually quite low. The financing cost depends on the prevailing interest rates and credit qualities of borrowers. At today's low interest rates, often cited as the reason against liability-matching schemes, the short-term financing costs of matching liabilities are even lower. For example, U.S. Treasury bill rates are close to zero. Of course, short-term interest rates could rise in the future. But the point is that in today's low interest-rate environment, the financing cost is not a reason against leverage-based liability-matching. One may ask—if not now, when?

EXHIBIT 5

Example of Corporate Pension Portfolios with 80% Funding Ratio Using Liability-Matching Asset Portfolio and Risk Parity

	D	E	F	G
	Portfolio with RP_0	Portfolio with $RP_{1,2}$	Portfolio with RP_1	Traditional 60/40
Corporate Bonds	125%	125%	125%	0%
Cash	-25%	-25%	-25%	0%
Stocks	0%	10%	20%	60%
Bonds	0%	40%	80%	40%
Surplus Return	-0.25%	1.35%	2.95%	2.85%
Surplus Risk	0%	3%	5.9%	12.3%
Surplus Sharpe	-	0.46	0.50	0.23
Leverage	125%	175%	225%	100%

The second point is that some plan sponsors have always been leveraging the plans by issuing pension-obligation or corporate bonds and investing the proceeds along with the pension assets. This form of leverage using long-term financing is not that different from leverage using financial instruments with short-term financing. Of course, one can debate the pros and cons of short-term versus long-term financing, but leverage is leverage. And it is noted that pension funds have invested in many strategies that employ a high degree of leverage, such as private equity, real estate, and hedge funds. One difference is that the leverage in these strategies is often implicit or hidden within a fund structure (Qian [2011]). And more importantly, their leverage is applied to risk dimensions that share the same growth characteristics as equity risk.

Lastly, this approach is akin to the tax arbitrage that Fischer Black first proposed for corporate pension funds as early as 1976.⁵ These forms of leveraging are prudent because they are used for the purpose of liability-matching. Issuing pension-obligation bonds and then investing the proceeds in risky assets such as public equity, private equity, real estate, and hedge funds is an entirely different story with a potentially dubious ending.

With explicit assumptions of surplus return and risk, one can estimate how long it would take for such investment strategies to return the plan to fully funded status. For a plan that is 80% funded, with 1.35% excess return in case E, it would take 16 to 18 years on average. In case F, the excess return of 2.95% would shorten the average time to seven to eight years. The latter case might seem to be the quicker fix, but the uncertainty

would be much greater, due to higher surplus risks.

How do these investment strategies compare to a traditional 60/40 portfolio, strategy G in Exhibit 5? Relative to the liability benchmark of 125% corporate bonds, the 60/40 portfolio takes an active weight of 60% in equity and -85% in bonds. For a simple calculation, assume that the bonds in the asset portfolio are the same as the bonds in the liability benchmark. This would result in an expected surplus return of 2.85% and surplus risk of 12.3%. This risk is twice as high as that of case C, and as a result the surplus Sharpe ratio is only 0.23.

Exhibit 6 plots the surplus risk and return of the seven investments proposed in Exhibits 4 and 5. Strategies A, B, and C are for a fully funded plan and strategies D, E, F, and G are for the unfunded plan. It points to the fact that the traditional 60/40 portfolios are very inefficient as a LDI strategy.

One has to admit that it is extremely rare that active investment strategies would intentionally take on active risks as high as 12.3%. But this is exactly the case with 60/40 portfolios relative to a liability benchmark. The hope of such a strategy is that the risky assets would outrun the liability in the long run. But as we all know too well but sometimes forget, the hare does not always win the race against the tortoise.

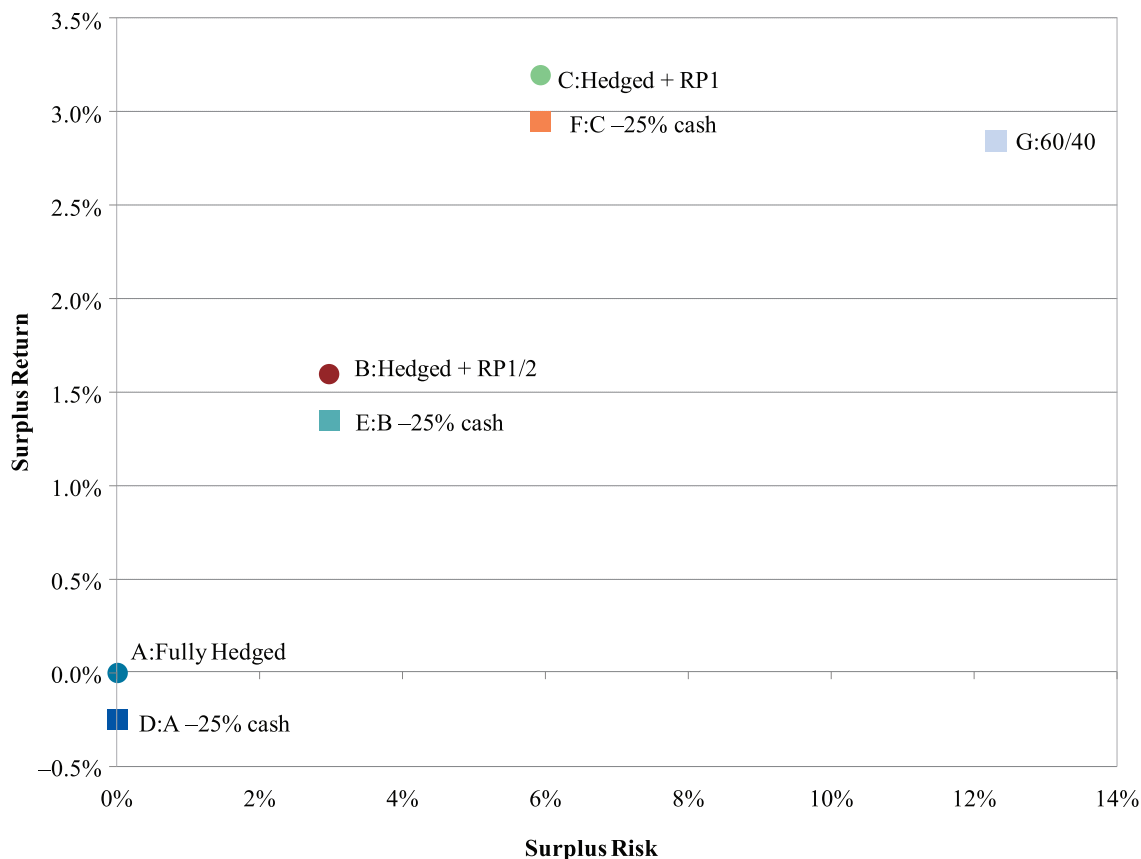
De-risking with Risk Parity

Increasingly, many corporate plan sponsors have recognized that traditional asset allocation portfolios are poorly suited to hedge pension liabilities. The mismatch results in a significant amount of surplus risk, and many plan managers now are taking steps to de-risk. But how to de-risk, while still preserving positive surplus returns necessary to close the funding gap, deserves a careful analysis.

One simple approach is to increase the plan's allocation to fixed income and decrease the allocation to risky assets such as equities. Since the liabilities are all fixed income, the asset shift to more fixed income will reduce surplus risk. This approach, which I call traditional de-risking, incrementally reduces equity in a 60/40

EXHIBIT 6

Surplus Risk and Expected Surplus Return of Investment Strategies against a Liability Benchmark



portfolio and at the extreme makes the asset portfolio 100% fixed income.

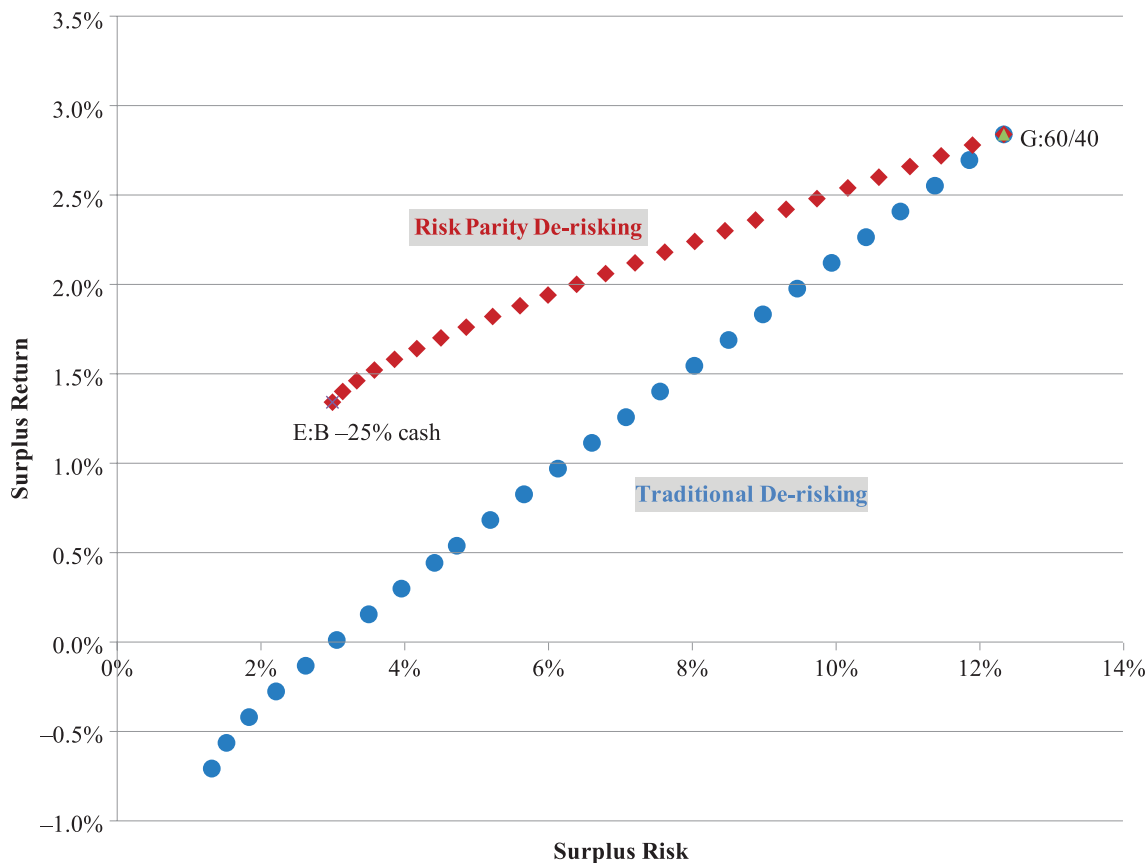
The dotted-path in Exhibit 7 shows the expected surplus return and risk of this approach for an 80% funded plan. The point labeled “G” is the 60/40 portfolio seen in Exhibit 6. As we decrease the equity allocation and increase fixed income by the same amount, both risk and return decline. For instance, when the plan asset is 20/80, or 20% in equity and 80% in bonds, the surplus risk is reduced to 4.4% while the surplus return is reduced to 0.45%. It is apparent that the traditional approach to de-risking will have a significant negative impact on the expected surplus return. When the asset portfolio is 100% fixed income, the surplus risk is reduced to 1.25% and the surplus return becomes -75 bps. Since the plan is 80% funded, moving to 100% fixed income that has similar characteristics as the liabilities is not a winning proposition.

An alternative approach, which I call “risk parity de-risking,” offers better expected surplus returns while also reducing surplus risk. Marked as the diamond path in Exhibit 7, the beginning portfolio is still 60/40 but we choose portfolio E, the liability-matching portfolio plus RP1/2 (see Exhibit 5 and 6) as the target portfolio. As we reduce weight in portfolio G and increase weight in portfolio E, risk parity de-risking lowers the surplus risk while maintaining a higher level of surplus return.

The benefit of risk parity de-risking is rather significant. How is this possible? From a Sharpe ratio perspective, for an underfunded plan, traditional de-risking actually reduces the overall Sharpe ratio, since a greater fixed income allocation in the asset mix just “locks in” the negative surplus return relative to the liability benchmark. In contrast, risk parity de-risking increases the Sharpe ratio by moving closer to liability-

EXHIBIT 7

Risk and Return Paths of Two De-risking Approaches: Traditional and Risk Parity



matching and increasing the risk-adjusted returns of the risk asset portfolio.

CONCLUSION

Many pensions are underfunded. It is a challenge to devise investment strategies that could return them to health over time while also protecting against further deterioration. In the current regulatory environment, public pensions and corporate pensions are treated differently and, as a result, they may warrant different investment approaches. For the public pension, the approach should be to invest in strategies that meet the required return with the least amount of risk. For corporate pension plans the approach should be to invest in liability-matching portfolios plus risk asset portfolios with an optimal surplus Sharpe ratio.

In this article, I outline ways that plan sponsors can use risk parity strategies to achieve these investment objectives. For public pension funds, risk parity can provide the targeted return on assets with lower risk, thus reducing the volatility in its funding status. For corporate pension funds, risk parity can be deployed in the risk asset portfolios that are separated from the liability-matching portfolios. At its core, risk parity is an approach to allocate risk efficiently and to deliver stable returns. Whether we consider the absolute risk for public pensions or surplus risk for corporate pensions, risk parity provides a way to generate efficient risk-adjusted returns and create the long-term wealth required to meet future pension obligations.

Traditional 60/40 portfolios are ill-suited for corporate pension plans because the surplus risk relative to liabilities is extremely high. Traditional de-risking

approaches lower the surplus risk but incur a significant reduction in surplus return. The alternative risk parity de-risking suggested in this article can help corporate pensions maintain a high level of surplus return while reducing surplus risk. In addition, this strategy moves pension plans closer to a liability-matching framework, which corporations would ultimately adopt.

ENDNOTES

The author thanks Bryan Belton, Michael Campbell, and Tim McCusker for helpful discussions on the topic and comments on the article.

¹According to *Pension & Investments* (April 30, 2012, p. 1), the average funding ratio of the 100 largest U.S. corporate pension plans stood at 81.6% in 2011.

²For simplicity, the graph uses normal distributions for both portfolios. In reality, equity returns have significant left tail risk. With lower allocation to equities, a risk parity portfolio also reduces the left tail risk.

³These could be pension funds, but also insurance companies or any other entities with future liabilities.

⁴The funding ratio could actually increase while the difference grows because both the numerator and the denominator get larger.

⁵For liability-matching as well as tax arbitrage, Fischer Black [1980] proposed investing all proceeds from bond issuance in a diversified portfolio of corporate bonds with similar risk characteristics to that of the issuing corporation. In other words, zero surplus risk but positive surplus return.

REFERENCES

Black, F. "The Tax Consequences of Long-Run Pension Policy." *Financial Analysts Journal*, Vol. 36, No. 4 (July/August 1980), pp. 21-28.

Novy-Marx, R., and J.D. Rauh. "The Liabilities and Risks of State-Sponsored Pension Plans." *Journal of Economic Perspectives*, Vol. 23, No. 4 (Fall 2009), pp. 191-210.

Qian, E. "Risk Parity Portfolios: The Original." Research Paper, PanAgora, 2005.

———. "On the Financial Interpretation of Risk Contribution: Risk Budgets Do Add Up." *Journal of Investment Management*, Vol. 4, No. 4 (2006), pp. 1-11.

———. "Risk Parity and Diversification." *The Journal of Investing*, Vol. 20, No. 1 (Spring 2011), pp. 119-127.

———. "Who is Afraid of Leverage?" *Investment Insights*, Pan-Agora, 2012.

Waring, B., and D. Whitney. "An Asset-Liability Version of the Capital Asset Pricing Model with a Multi-Period Two-Fund Theorem." *The Journal of Portfolio Management*, Vol. 35, No. 4 (2009), pp. 111-130.

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