Market Insight:
Analyzing Hedges for Liability-Driven Investors

Lisa R. Goldberg and Sang-Hoon Kim

March 2012

Abstract:

Managing surplus risk enables pension plans and endowments to align their asset allocations with their future obligations. BarraOne's Correlation Risk Decomposition enables investors to identify the drivers of surplus risk, and to analyze the potentially subtle impact of specific hedges. In this case study, a term structure hedge using an interest rate swap substantially lowers surplus risk as expected. However, a credit hedge using a default swap elevates surplus risk.

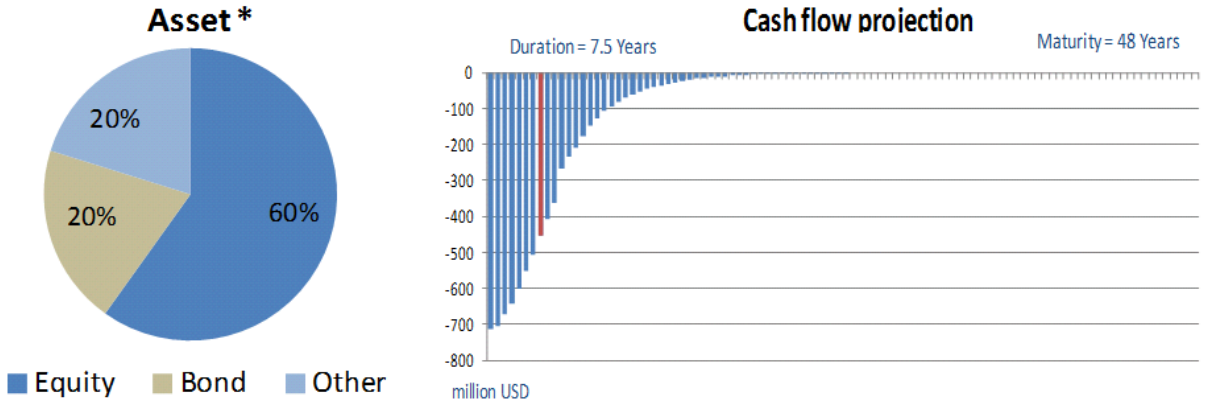
Introduction: The LDI Surplus Risk

Investors such as pension plans and endowments, who are responsible for a stream of future financial obligations, may practice Liability-Driven Investing (LDI) to account for liabilities in asset allocation. An important element of LDI is surplus risk, meaning the measure of the variability in return to a portfolio that is long assets and short liabilities. The analysis of surplus risk provides insight into a fund's financial health, and it can help to gauge the likelihood that the funding ratio of assets to liabilities might stray from target.

How We Analyze the Surplus Risk

Figure 1 displays the assets and liabilities of a typical US pension plan with the asset allocation roughly 60 percent equity, 20 percent bonds, and 20 percent alternative assets.[1] The liability is modeled as a stream of cashflows.[2] To determine the present value of the liabilities, we follow the Financial Accounting Standards Board (FASB) guidelines, which mandate that a Corporate US Pension Plan estimate the present value of its liabilities by discounting with a double-A industrial curve. By endowing the liabilities with a relatively high present value, this discounting scheme encourages a relatively conservative approach to asset allocation,[3] and it imparts an element of credit risk to the surplus. In August 2011, the liabilities had a maturity of 48 years and an effective duration of 7.5 years.

Figure 1: Asset allocation and liability stream for a US pension plan as of August 31, 2011. Source: BarraOne.



[1] In this context, alternatives are private market assets proxied through public equity and fixed income indices.

[2] The liability discounting curve is set to Moody's Aa2 Industrial. With respect to this curve, liabilities have a 7.5 year duration.

[3] By contrast, Governmental Account Standards Board (GASB) regulations mandate that public US pension plans discount liabilities by a flat rate equal to their estimates of expected return on assets.

The risk profile of the plan's assets and surplus is shown in the "Unhedged" columns in Figure 2. The (annualized) volatility of asset return is 16.6 percent per year, while the volatility of surplus return is 18.5 percent. Note that the surplus has a much higher allocation to term structure and spread due to the bond-like characteristics of the liability. Most of the spread risk arises from the discounting curve.[4]

Figure 2: Risk decomposition of the surplus to a US pension plan as of August 31, 2011. Hedging interest rate risk lowers surplus risk, while hedging credit risk increases surplus risk. Source: BarraOne.

	Unhedged		Interest Rate Swap		Interest Rate Swap & CDS	
Risk Source	*Asset Risk*	*Surplus Risk*	*Asset Risk*	*Surplus Risk*	*Asset Risk*	*Surplus Risk*
Total Risk	**16.6**	**18.5**	**16.0**	**15.9**	**17.1**	**16.7**
Local Market	15.9	18.0	15.2	15.3	16.3	16.1
Common Factor	15.8	17.9	15.2	15.1	16.2	15.9
Industry	15.7	15.7	15.6	15.6	15.6	15.6
Style	0.4	0.4	0.4	0.4	0.4	0.4
Term Structure	0.8	7.2	6.0	2.6	6.0	2.5
Spread	0.3	3.3	2.1	4.1	2.1	1.7
Selection	0.6	2.2	0.6	2.2	1.4	2.5
Currency Risk	1.8	1.8	1.8	1.8	1.8	1.8

The fund can substantially neutralize its exposure to fluctuations in the term structure by entering into an interest rate swap. As noted in Winkelmann, et al (2007):

> In the US market, benchmark swap indices are available between 1 and 50 years of maturity, providing good yield curve sensitivity matching. Similarly, these indices are available between 1 and 50 years in the UK. Since swaps are synthetic instruments, they are not subject to `specials` or supply constraints. Consequently, they can provide a capital-efficient way to manage an interest rate hedge.

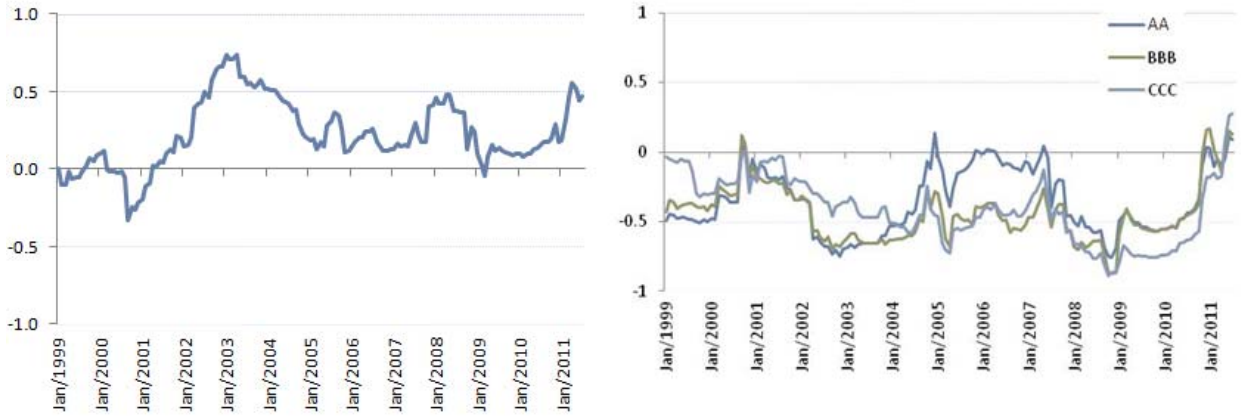
The two columns labeled "Interest Rate Swap" in Figure 2 show the forecast risk of the plan's assets and surplus after the introduction of an interest rate swap. Term structure risk in the surplus is decreased to 2.6 percent from 7.2 percent, and the overall surplus risk is decreased to 15.9 percent from 18.5 percent.

[4] The present value of the assets is taken as the base value in this analysis.

Similarly, credit default swaps provide a natural hedge to the surplus spread risk. The two columns labeled "Interest Rate Swap & CDS" show the risk for the plan's assets after the additional introduction of a credit default swap. As expected, the spread risk is decreased to 1.7 percent from 4.1 percent. Surprisingly, the surplus risk has increased from 15.9 percent to 16.7 percent.

Why does the credit hedge increase the surplus risk? An indication is in Figure 3, which shows a time series of correlations between equities and interest rates in the first panel and between equities and credit spreads in the second panel. Recently, equities and interest rates have tended to be positively correlated, so that a position in the interest rate swaps that receives a fixed rate hedges the term structure risk in the liabilities and mitigates some of the equity risk, too. By contrast, equities and credit spread have tended to be negatively correlated, so that a position selling protection in credit default swaps hedges the spread risk and exacerbates the equity risk.

Figure 3: Left panel: Correlation between US Large Cap Equity and 10-Year Treasury Rate. Right Panel: Correlation between US Large Cap Equity and Credit Spreads. Estimates are based on a rolling 24-month window.
Source: BarraOne.



The decompositions in Figure 2 do not indicate the impact that hedging a particular risk factor or asset class will have on surplus risk. However, there is an alternative decomposition that makes the impact transparent. As shown in Menchero and Davis (2011), it is possible to deconstruct risk in a way that immediately highlights the implications of a hedge on surplus risk. The central element is a correlation risk decomposition,[5] which expresses surplus risk as an exact sum of contributions from components of the portfolio. The first step toward correlation risk decomposition is to express risk as an exact sum of contributions corresponding to risk drivers in a portfolio:

$$\sigma = RC_{equity} + RC_{term\ structure} + RC_{spread} + \ldots$$

In a second step, we express the risk contribution as a product of three terms: the surplus exposure to the risk driver, the standalone risk of the driver, and the correlation of the driver with surplus return. For example:

$$RC_{spread} = X_{spread}\sigma_{spread}\rho_{spread}.$$

In Figure 2, the surplus risk shown for each risk driver is the product of the first two terms in the risk contribution. For example, the 3.3 percent spread contribution to unhedged surplus risk is a product of surplus exposure to spread, X_{spread} with the standalone spread risk σ_{spread}. Missing from the chart is the correlation of spreads with surplus return ρ_{spread}. It is that correlation that indicates the directional impact of a hedge on surplus risk.

Figure 4 shows the BarraOne correlation risk decomposition of surplus risk. The columns labeled "Surplus Risk" in Figures 2 and 4 are identical. Each entry corresponds to a risk driver, and it is the product of the driver's surplus risk exposure with its standalone risk. Each entry in the column labeled "Surplus Correlation" in Figure 4 indicates the directional impact that a hedge will have on surplus risk. For example, the correlation of term structure return with surplus return is 0.6. This means that a small term structure risk hedge will decrease surplus risk. In contrast, the correlation of spread return with surplus return is -0.39. This means that a small spread risk hedge will increase surplus risk. Entries in the "Surplus Risk Contribution" column in Figure 4 are products of Surplus Risk and Surplus Correlation. Notably, risk contributions are additive. The Total Risk Contribution, 18.5 percent, is the sum of Local Market Risk Contribution, 17.9 percent, and the Currency Risk Contribution, 0.5 percent. In turn, the Local Market Risk Contribution, 17.9 percent, is the sum of the Common Factor Risk Contribution, 17.7 percent, and the Selection Risk Contribution, 0.3 percent.

[5] "X-Sigma-Rho Decomposition" is another name for a "Correlated Risk Decomposition."

Figure 4: Correlated risk decomposition of the surplus to a US pension plan as of August 31, 2011. The impact of a hedge on surplus risk can be determined immediately from the sign of the correlation. Source: BarraOne.

	Unhedged		
Risk Source	*Surplus Risk*	*Surplus Correlation*	*Surplus Risk Contribution*
Total Risk	**18.5**	**1.00**	**18.5**
Local Market	18.0	1.00	17.9
Common Factor	17.9	0.99	17.7
Industry	15.7	0.92	14.5
Style	0.4	0.50	0.2
Term Structure	7.2	**0.60**	**4.3**
Spread	3.3	**-0.39**	**-1.3**
Selection	2.2	0.12	0.3
Currency Risk	1.8	0.31	0.5

Conclusion

Liability-Driven Investing is important for any institution that is responsible for paying a fixed stream of benefits. A key element of this paradigm is the risk of the surplus, which is the portfolio that is long assets and short liabilities. Surplus risk is the variability in the return to this long-short portfolio. The correlations between a risk factor and the surplus return is a guide to how a hedging strategy will impact surplus risk. In the example illustrated above, equity and term structure return are positively correlated with surplus return. This means that small equity and term structure hedges will decrease surplus risk. In contrast, spreads are negatively correlated with surplus, meaning that a small spread hedge increases surplus risk. Liability-driven investors can effectively manage their portfolios through the use of a correlation risk decomposition that illuminates the impact of candidate hedges on surplus risk.

References

Menchero, Jose and Benjamin Davis, 2011, "Risk Contribution is Exposure Times Volatility Times Correlation: Decomposing Risk Using the X-Sigma-Rho Formula," *The Journal of Portfolio Management*, 37(1), pages 97-106.

Winkelmann, Kurt, Scott McDermott, Alain Kerneis and Yevgenia Zemlyakova, "Liability-Driven Investment Policy: Structuring the Hedging Portfolio," 2007, Goldman Sachs Asset Management Strategic Research.

Client Service Information is Available 24 Hours a Day

clientservice@msci.com

Americas

Americas	1.888.588.4567 (toll free)
Atlanta	+ 1.404.551.3212
Boston	+ 1.617.532.0920
Chicago	+ 1.312.675.0545
Montreal	+ 1.514.847.7506
Monterrey	+ 52.81.1253.4020
New York	+ 1.212.804.3901
San Francisco	+ 1.415.836.8800
Sao Paulo	+ 55.11.3706.1360
Stamford	+1.203.325.5630
Toronto	+ 1.416.628.1007

Europe, Middle East & Africa

Amsterdam	+ 31.20.462.1382
Cape Town	+ 27.21.673.0100
Frankfurt	+ 49.69.133.859.00
Geneva	+ 41.22.817.9777
London	+ 44.20.7618.2222
Madrid	+ 34.91.700.7275
Milan	+ 39.02.5849.0415
Paris	0800.91.59.17 (toll free)
Zurich	+ 41.44.220.9300

Asia Pacific

China North	10800.852.1032 (toll free)
China South	10800.152.1032 (toll free)
Hong Kong	+ 852.2844.9333
Seoul	+827.0768.88984
Singapore	800.852.3749 (toll free)
Sydney	+ 61.2.9033.9333
Tokyo	+ 81.3.5226.8222

Notice and Disclaimer

About MSCI

MSCI Inc. is a leading provider of investment decision support tools to investors globally, including asset managers, banks, hedge funds and pension funds. MSCI products and services include indices, portfolio risk and performance analytics, and governance tools.

The company's flagship product offerings are: the MSCI indices with approximately USD 7 trillion estimated to be benchmarked to them on a worldwide basis[1]; Barra multi-asset class factor models, portfolio risk and performance analytics; RiskMetrics multi-asset class market and credit risk analytics; MSCI ESG (environmental, social and governance) Research screening, analysis and ratings; ISS governance research and outsourced proxy voting and reporting services; FEA valuation models and risk management software for the energy and commodities markets; and CFRA forensic accounting risk research, legal/regulatory risk assessment, and due-diligence. MSCI is headquartered in New York, with research and commercial offices around the world.

[1] *As of June 30, 2011, based on eVestment, Lipper and Bloomberg data.*