Liability-Relative Optimization:
Focusing on True Risk

The investment management process traditionally has focused on the risk and return characteristics of investors' assets. In many cases, the asset-centric approach may not be ideal because the purpose of most asset portfolios is to fund a specified future cash flow stream—a liability. Optimal solutions should consider investors' total financial situation by focusing on the risk and return characteristics of the investor's net portfolio, which contains both assets and liabilities. After all, it is the investor's total financial health that matters; not the risk and return of the assets in isolation. The true risk for the portfolio is not the standard deviation of the assets or the performance of the assets relative to that of peers; the true risk is not being able to fund the future liability.

Liability-relative optimization, or surplus optimization, is not a new concept. Some of the biggest names in finance including Jack Treynor, Martin Leibowitz, John Mulvey, Roger Ibbotson, Edwin Elton, and Martin Gruber have worked on this methodology at one time or another. The creators of Modern Portfolio Theory, like Bill Sharpe, have contributed tools and techniques to create optimal strategic asset allocation while considering both assets and liabilities. Following a perfect storm in the early 2000s that saw the funding status of many plans plummet, pension plan sponsors rediscovered the need for liability-driven investments (LDI). Today, the use of LDI techniques is quickly spreading beyond traditional users to those designing target maturity and retirement income strategies.

Liability-based approaches have typically applied within a defined pension context where there is a legal liability, but they are relevant for everyone with a portfolio of assets that exists to fund a liability. This includes individual investors funding their future retirement income, foundations and endowments seeking to preserve real purchasing power, or insurance companies managing pay-outs in conjunction with a pool of assets.

The historical approach to asset-liability modeling has actually been asset-only mean-variance optimization followed by a series of Monte Carlo simulations. The resulting return, wealth, and income distributions are then analyzed. This is an inferior tactic because asset-only optimization fails to consider the liability and focuses on the wrong definition of risk. The true risk is that of a mismatch between the assets and the liabilities preventing the portfolio from paying for the liability.

Conceptually, liability-relative optimization is an extension of the traditional Markowitz asset-only approach to determining an optimal asset allocation in which the mean-variance optimizer is constrained to hold an asset class (or combination of asset classes) representing the liability short. Liabilities are typically modeled as a combination of TIPS, long-term nominal bonds, and perhaps a small allocation to equities or real estate. The liability model attempts to capture the systematic characteristics of the liabilities.

Institutional investors are now anxiously adopting these techniques. Robust tools are available for building portfolios that exist to pay for liabilities. Liability-relative optimization helps redefine risk around what truly matters, maximizing the health of an investor's total portfolio and taking advantage of a natural hedge that may exist between the portfolio's assets and the systematic risk factors that influence the value of liabilities. Investment professionals have the opportunity to make conscious decisions to find risk-return balances for the entire portfolio when building optimal asset allocation strategies.

References

Waring, M. Barton. 2004. Liability-relative investing: Be dual duration matched and on the surplus efficient frontier. *The Journal of Portfolio Management* (Summer). Reprinted in *Investment Insights* volume 8 issue 1.

Waring, M. Barton. 2004. Liability-relative investing: Surplus optimization with beta, alpha, and an economic view of the liability. *The Journal of Portfolio Management* (Summer). Reprinted in *Investment Insights* volume 8 issue 2.

Case Study

Construction of a Liability Model using Surplus Optimization in Morningstar® EnCorr®

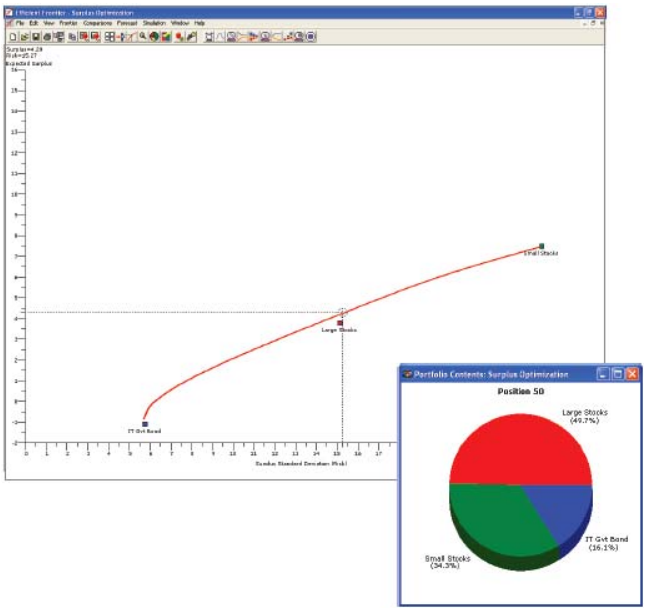
Liabilities are typically a series of outgoing payments. The systematic characteristics of liabilities vary. In most cases, the cash flow series is expected to last for a significant period of time. In this sample case, we will use the LT Gvt Bond to represent our liability. However, EnCorr allows practitioners to choose any assets, or combination of assets, to model the systematic characteristics of the liabilities.

When running an optimization case that includes liabilities, EnCorr generates an "expected surplus," which is a forecast of future net worth. The expected surplus is the excess of the asset return over the liability return, expressed as a percentage of the initial value of the fund's assets. This current relative value is defined as:

Current Relative Value = Liabilities / Assets, where,

If the current relative value > 100, then the portfolio fund is underfunded;
If the current relative value < 100, then the portfolio fund is overfunded;
If the current relative value = 100, then the portfolio fund is fully funded.

Figure 1. Surplus Optimization



Ultimately, the better a plan's funding is, the smaller the effect of liabilities on the asset allocation and the lower the impact of a switch from an asset-only to a full surplus optimization.[1] EnCorr also produces a "surplus standard deviation," which mathematically is the square root of the surplus variance.

In this sample case, we will use the **Xsample.inp** file from EnCorr Optimizer Inputs to build the case.

Instructions

- Open EnCorr Optimizer
- Click on **File**, **Inputs** from the Main Optimizer window
- Select **Xsample.imp** from CaseFile folder
- Select the following asset classes from the available assets as your Select Assets: **Large Stocks**, **Small Stocks**, **IT Govt Bond**, and **30 Day TBill**
- Select the LT **Gvt Bond** as your Liability

We will assume a fully funded pension fund. (The EnCorr Optimizer also enables you to run a surplus optimization on funds that are overfunded or underfunded.)

To assign a current relative value for your liability, which is represented by the LT Gvt Bond due to its long-term nature (20 years in this case):

Instructions

- Go to the **Inputs** tab
- Select the Liabilities subtab and enter the **Current Relative Value** of 100
- Click the **Optimize** button

The Efficient Frontier and the other linked windows appear. In the Efficient Frontier window, the periscope is on "Position 50" on the frontier line. By including the portfolio liability into the optimization process, the portfolios generated along the efficient frontier from the surplus optimization (Figure 1) are constrained to hold the liability short. This calculates more realistic portfolio risk-return expectations then from an asset-only optimization (Figure 2).

The Portfolio Statistics window displays the portfolio data (asset weights, expected surplus, surplus standard deviation, asset expected return, and asset standard deviation, etc.) for the portfolio at "Position 50" (Figure 3).

Notice that the Expected Surplus and the Surplus Standard Deviation are 4.3% and 15.3%, respectively. Recall from the **Inputs**, **Liabilities** subtab that the return for the liability, LT Gvt Bond is 8.35%.

[1] Sharpe, William and Tint, Liabilities—A New Approach, *The Journal of Portfolio Management*.

Figure 2. Asset-Only Optimization

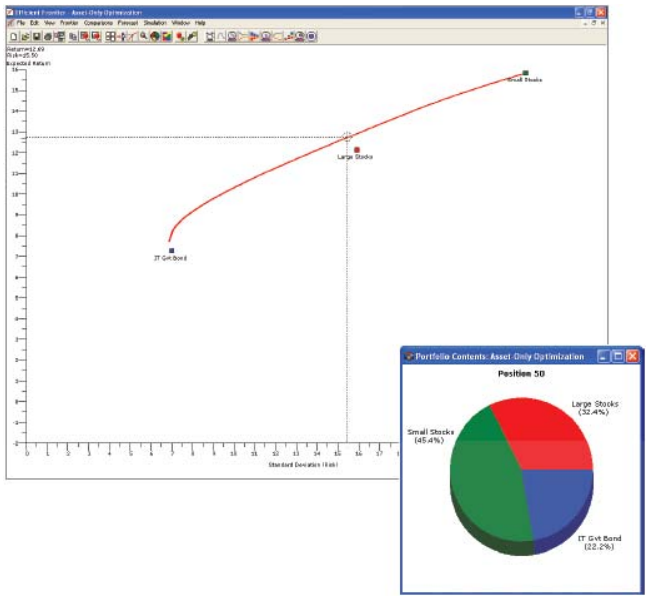
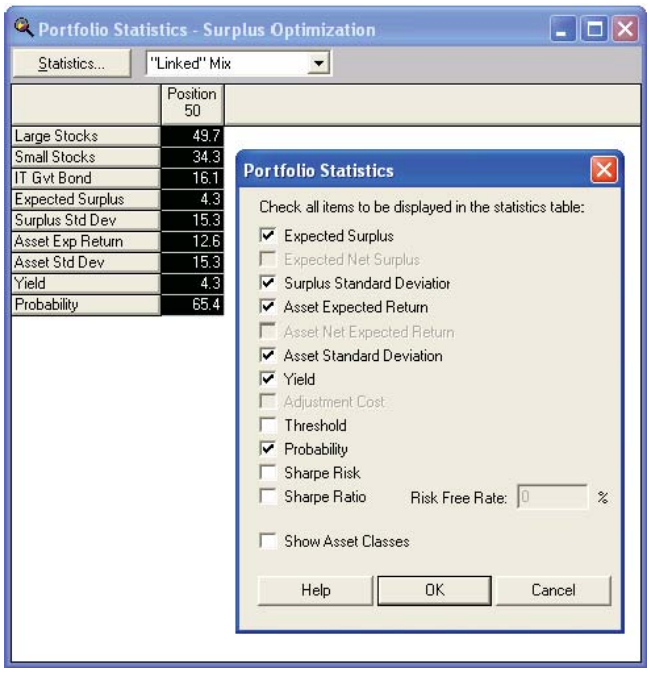


Figure 3. Portfolio Statistics Window



Assume that the fund's assets are $25,000,000. Since the current relative value is 100, the liability obligation will have a present value of $25,000,000. Today, the fund's net worth is 0 (assets minus liabilities), but given the Expected Surplus of 4.3%, you can calculate next year's net worth. Since the expected surplus is a forecast of future net worth, next year's expected net worth is $1,075,000. We arrive at this figure by multiplying this year's assets by the Expected Surplus, or: $25,000,000×4.3%=$1,075,000.

Also, we can forecast next year's total assets (not accounting for the liability obligation) and the present value of the liability a year from now. The forecasted total assets a year from now are this year's assets multiplied by 1+ E(Ra), the asset expected return for a given point on the efficient frontier line, or: $25,000,000×(1+12.6%) = $28,150,000.

The forecasted present value of the liability a year from now is simply this year's present value of the liability obligation multiplied by 1+ E(Rl), the return on liabilities, or: $25,000,000×(1+ 8.35%) = $27,087,500.

We can also simulate returns and wealth percentiles charts and graphs when using surplus optimization.

Instructions

- Click on **Simulation**, **Simulation Setup** from menu options
- Click the **Select** subtab and choose the series to simulate
- Choose the **Settings** subtab and enter 25,000,000 as the Initial Wealth
- Check box next to **Liability-adjust returns and wealth values**
- Click the **Run Simulation** button

A regular portfolio and a surplus portfolio will appear for each selected portfolio in the **Simulation Setup**. Also, for each cash flow scenario a simulated liability portfolio and other linked windows will appear.

The liability portfolio functions just as they do with an asset-only portfolio mix. The initial value for the liability portfolio is the initial value specified in the **Simulation Setup** multiplied by the sum of the current relative values of the liabilities. In this case, the initial value for the simulation is $25,000,000 and the liability (LT Gvt Bond) has a relative value of 100%. The liability portfolio will have an initial value of: $25,000,000×(1.0+ 0) =$25,000,000.

All graphs and tables that are normally available for simulated asset portfolios are available for the liability portfolio.

The surplus portfolio is created by taking the wealth value of the asset mix for each simulation and subtracting the wealth value of the liability for the simulation. Since this can lead to negative wealth values for the surplus portfolio, it is not possible to generate return numbers for the surplus portfolio. Some of the graphs and tables under the simulated portfolio may not be available.

