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Portfolio Strategy

Surplus Targets and Percentile Fans

Investment funds ultimately serve needs, and even if ambiguous, needs represent fundamental liabilities that should impact the fund's allocation.

This paper focuses on the key differences between an asset-only context and a simple surplus model.

"Percentile fans" help to visualize the range of outcomes for various equity beta values. The focus on fund-level betas was based on studies that showed that these beta effects account for over 90% of the volatility in even the most diversified funds.

Liability headwinds depress surplus growth and together with liability volatility lead to challenging risk/reward tradeoffs, especially over longer time horizons.

In an annualized asset-only framework, outcome percentiles compress over time around a stable expected return. In contrast, the surplus measure is never annualized, so that the outcomes widen around more slowly rising expected values.

There is usually one flat percentile line that acts as a "risk floor," dividing risk-constraint thresholds that define maximum betas from target thresholds that call for minimum betas. Risk/target combinations determine a feasible region of beta values, which tend to include the fund-level betas actually seen in practice.

In an asset/liability framework, the outcome distribution is highly dependent on the initial surplus or deficit. High surplus funds enjoy a rising range of outcomes, due to the stronger asset-based tailwinds, while the higher liability headwinds depress a deficit fund's outcomes. A deficit fund with unfortunate outcomes can find itself in a serious downward spiral.

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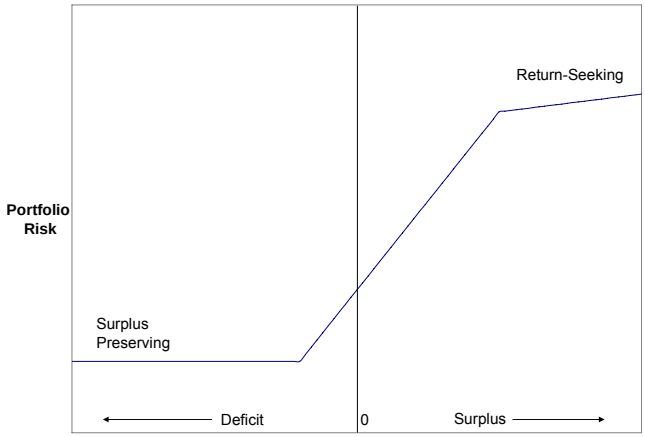
Surplus Targets and Percentile Fans

Fundamental Objectives of Investment Funds
Virtually all investment funds — endowments, foundations, pension funds — have the ultimate objective of servicing some hierarchy of needs, which may or may not be formalized. With pension funds, actuaries and accountants go to considerable effort to calculate one or more specific liability values. However, other fund types view their payout responsibilities more on a year-by-year basis — e.g., foundations have the 5% minimum payout while endowments usually have an annual spending formula. Except for pension funds, the prospective annual payments are rarely extrapolated into future years. Such an extrapolation — whether in terms of a desired target or a bare-minimum payment stream — can always be discounted to provide a current-dollar liability value. The fund's asset value could then be compared with this liability estimate to provide at least a crude gauge of the asset/liability surplus.

A surplus number (if positive) or the deficit (if negative) can provide valuable information regarding the fund's adequacy, the need for additional contributions, the impact of real and nominal interest rates, and the appropriate risk structure for the portfolio.

As demonstrated in the body of this paper, high surplus funds tend to be in a good position to accept greater risks in pursuit of better returns, while deep-deficit funds with high-risk portfolios are seriously vulnerable to ever worsening deficits. On the one hand, a return-seeking fund with an ample surplus can tolerate a reasonable level of risk. On the other hand, one would think that a fund with a deep deficit would try to conserve the remaining assets. Thus, one might expect surplus-sensitive funds to generally adapt their risk-taking along the lines depicted schematically in Exhibit 1. However, a fund's response to a given surplus/deficit value may vary from one extreme to another, depending on the value assigned to higher returns, the willingness to take risks, the availability of exogenous back-up funding, the flexibility in the prospective needs, etc.

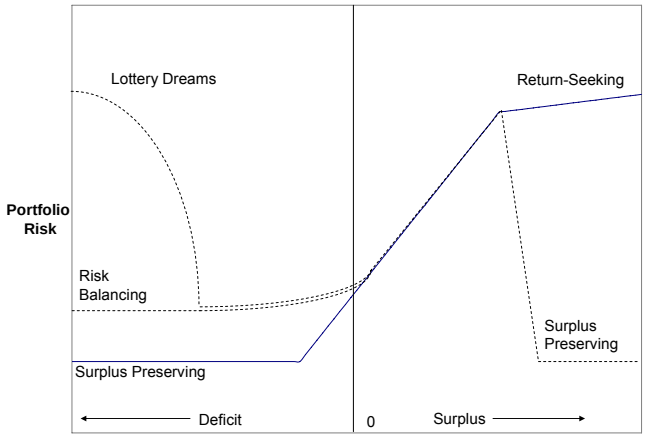
Exhibit 1
Surplus-Sensitive Risk-Taking: Basic Path



Source: Morgan Stanley Research

Moreover, each fund has its own set of values, and their strategies may diverge from that depicted in Exhibit 1 and take on the more complex pathways shown in Exhibit 2. For example, a high-surplus fund may turn away from return-seeking in order to safely preserve a current surplus that it deems comfortably adequate. Similarly, a deep-deficit fund may take a "lottery" path in the belief that a high-risk portfolio represents its only chance of attaining an acceptable funding level.

Exhibit 2
Surplus-Sensitive Risk-Taking: Alternative Pathways



Source: Morgan Stanley Research

And in some deficit situations where the liability risk has a high level of both interest rate risk and liability "noise," the fund might opt for a moderate risk portfolio that balances the overall surplus risk.

The surplus/deficit level should never — by itself — determine a fund's strategy. However, knowledge of the surplus/deficit level can facilitate informed portfolio decisions that relate to the fund's underlying liability. Even a rough estimate of the surplus/deficit can provide valuable insights and help tie the investment process more closely to the ultimate needs that the fund is intended to serve.

The Surplus Model

This paper address one facet of the surplus/deficit problem — the selection of the equity beta exposure. A simple asset and liability model is used to develop a percentile "fan" that characterizes the surplus distribution for each beta value. The surplus' risks and rewards for a given beta level can then be readily visualized. This framework also allows finding the maximum beta value that will satisfy a given risk constraint, as well as the minimum beta required for a reasonable probability of achieving a specified surplus target.

In our previous note [1], the concept of a "percentile fan" was introduced in an asset-only framework to provide a simultaneous view of the prospects of reaching return targets while satisfying prescribed risk limits. We found that a range of feasible beta values was defined by this combination of a maximum beta for risk constraint and a minimum beta for achieving return objectives. This beta range turned out to closely approximate the 0.55-0.65 equity sensitivity of most individual and institutional portfolios — even those with high levels of diversification [2-4].

This Note extends asset-based percentile fans into asset/liability surplus space. The baseline asset model remains as in the earlier paper with a 5% interest rate, a 4% equity return premium and a 16% equity volatility. The assets consist of an equity percentage represented by the beta value. The remainder of the portfolio is invested in bonds with a fixed duration of 5 years. The baseline interest rate volatility is set at 1%.

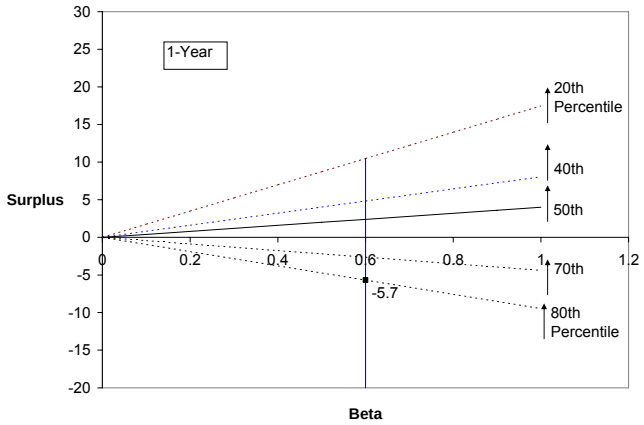
The Liability Effect

The liability is modeled as an accumulating 12-year rolling duration with no payments or outflows. At the outset, the starting assets are assumed to exactly match the liabilities so that the initial surplus is zero.

To emphasize the liability effect, Exhibit 3 departs from the baseline model's 5-year bond duration and assumes that all portfolios are theoretically matched to the 12-year liability duration. By eliminating any interest rate effect, this simplification leads to a fan with straight lines that are analogous to the asset-only case described in our earlier paper. It should be noted that the percentile labeling refers to the probability of surplus values that exceed the indicated percentile value.

Exhibit 3

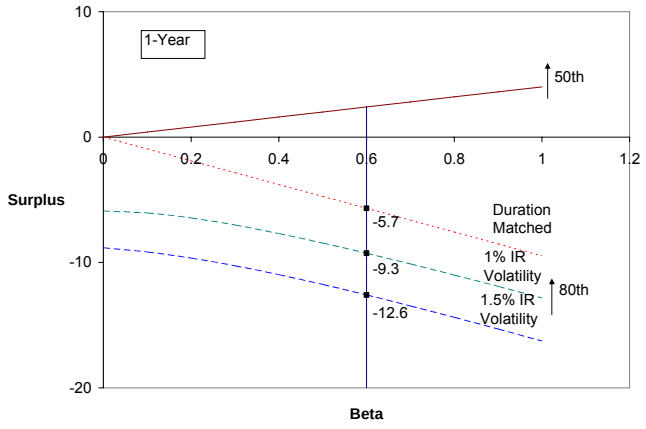
The Percentile "Fan" with Duration of Assets = Duration of Liabilities



Source: Morgan Stanley Research

However, without this duration-match, the liabilities introduce additional volatility that widens the percentile fan. This effect can be seen in Exhibit 4, which shows the 80th percentile curves for three cases: 1) duration-matched as in Exhibit 3, 2) a fixed 5-year bond duration with a 1% interest rate volatility, and 3) a 5-year bond duration with a higher 1.5% interest rate volatility. Any point on these curves can be interpreted as the 80th percentile of the surplus distribution defined by a beta value along the horizontal axis. For example, the highlighted 0.60 beta refers to a portfolio consisting of 60% equity and 40% 5-year duration bonds. As the assumptions progress from the duration-matched to the 1% and 1.5% rate volatility cases, the associated 80th percentile surplus value is seen to decline from -5.7 to -9.3 to -12.6.

Exhibit 4
80th Percentile Curves

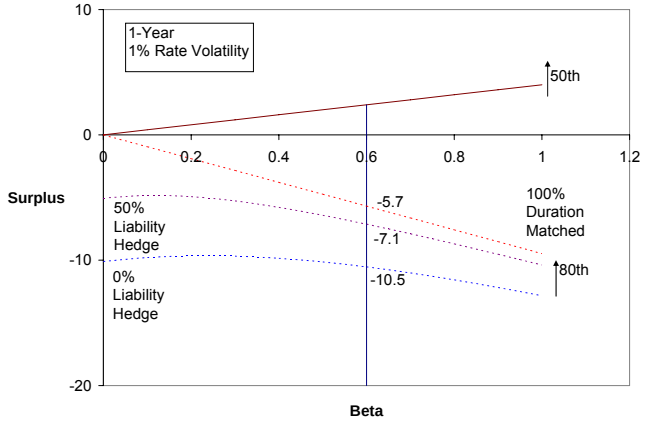


Source: Morgan Stanley Research

Hedging Effects

Exhibit 5 continues the focus on the 80th percentile curves to illustrate the effect of liability hedging. Once again, the straight-line 80th percentile corresponds to the tighter duration-matched distribution displayed in both Exhibits 3 and 4. However, with 0% hedging, the bond duration is set at zero, and the surplus is fully vulnerable to liability fluctuations. The resulting 80th percentile curve then starts at -10 for zero beta and declines with higher beta values. With 50% hedging, the portfolio maintains a 6-year overall fund duration across all beta values, and the 80th percentile curve falls halfway between the two preceding curves.

Exhibit 5
Effects of Liability Hedging



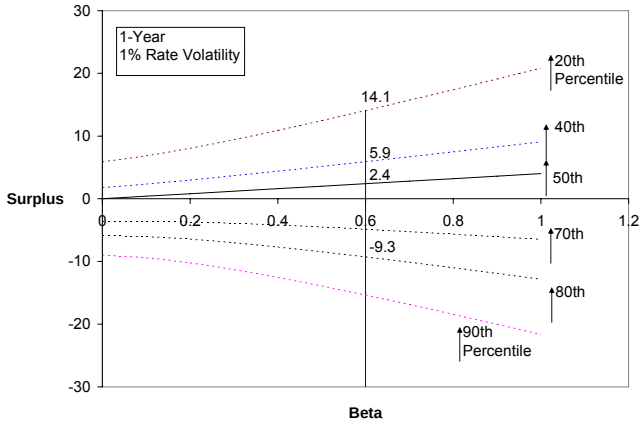
Source: Morgan Stanley Research

Exhibit 5 demonstrates that the liability volatility has a sizable impact even at the lower beta values. Thus, reducing the portfolio beta in an effort to lower surplus volatility will have little effect unless there is also some additional degree of liability hedging. Similarly, liability hedging beyond a certain level will have only a muted surplus effect unless there is a moderation in the portfolio beta. The key point is that reduction in surplus volatility is best achieved through a coordinated process of beta control and liability hedging.

The Surplus Percentile Fan

Exhibit 6 adds percentile curves of 20%, 40%, 70% and 90%. With assets and liabilities both set initially at 100, the expected 1-year surplus for a 0.60 beta portfolio is the difference between 107.4 for the assets (100* (0.6 β*4% + 5%)) and 105 (100*5%) for the liabilities. This 2.4 difference (107.4-105) corresponds to the 0.60 beta point on the 50th percentile line. The fan also indicates that at this 0.6 beta, there is a 20% chance of exceeding a surplus of 14.1 and a 40% chance of exceeding 5.9. On the risk side, the 80th percentile line implies that the 0.6 beta portfolio has a 20% chance of taking the surplus below -9.3.

Exhibit 6
The Surplus Percentile "Fan"



Source: Morgan Stanley Research

In comparing the surplus fan with the asset-only fan from our previous report, several differences are evident. First, because the surplus is the difference between the growth in assets and the growth in liabilities, the 50th percentile line originates at the zero surplus point and then ascends more gradually than in the asset-only case. Thus, at a beta of one, the surplus only grows by the 4% equity risk premium, to a level of 104. On either side of the market line, the percentile curves extend more broadly,

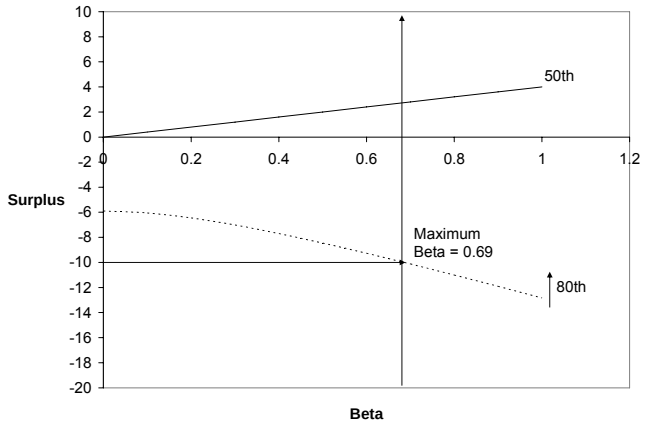
reflecting the greater surplus volatility associated with the liability's interest rate sensitivity.

Surplus Risk Constraints

An investor may want to establish a risk constraint such that the surplus will have a low probability of falling below some specified threshold or, equivalently, will have a high probability of staying above it. For example, in Exhibit 7, the specified surplus limit is set at -10 with an 80% probability. This leads to a maximum beta value of 0.69.

Exhibit 7

Maximum Beta for a -10 Deficit Target with 80% Probability



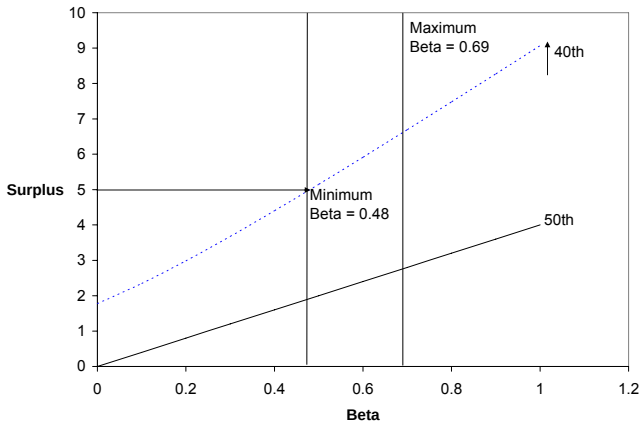
Source: Morgan Stanley Research

A fund may also set a positive target to be achieved with a certain probability. For example, suppose an investor targets a +5 surplus with a probability of at least 40%. In Exhibit 8, the beta must be extended until it reaches the 40th percentile line at a beta of 0.48. Lower portfolio betas would lead to lower probabilities of achieving the +5 surplus target.

Because of the way that we have identified the percentiles, the higher percentile curves define the risk constraints. Combining the results from Exhibits 7 and 8 creates a feasible beta range of 0.48-0.69. This beta regime covers the 0.55-0.65 beta range seen in most US institutional portfolios.

Exhibit 8

Minimum Beta for a +5 Surplus Target with 40% Probability



Source: Morgan Stanley Research

The "Risk-Floor"

One interesting result from our previous asset-only report was that the horizontal 60th percentile line stayed constant at 5%, regardless of the portfolio beta. This flat line implied that all equity percentages had the same 60% probability of exceeding the 5% risk-free rate over a one-year period.

A more general interpretation might be that this 60th percentile formed a "risk floor" in the sense that all beta allocations provide the same risk of penetrating this 5% floor level. Thus, suppose a threshold was defined solely in terms of having no more than a 40% chance of declining below this 5% risk-free rate in the asset-only example. If this 60th percentile floor were the only risk constraint, then all beta values would satisfy this constraint. In such an admittedly curious situation, the fund could press forward to the highest possible beta in order to maximize the expected return. However, such an approach would be ill advised, since having such an artificial shortfall threshold, especially one with a high 40% level of penetration, ignores the potential damage from all the lower-probability "tail" events. Indeed, such "below-the-threshold" tail events present one limitation of any single-level shortfall analysis. Ideally, any comprehensive risk control approach should somehow incorporate the entire risk region of the return distribution.

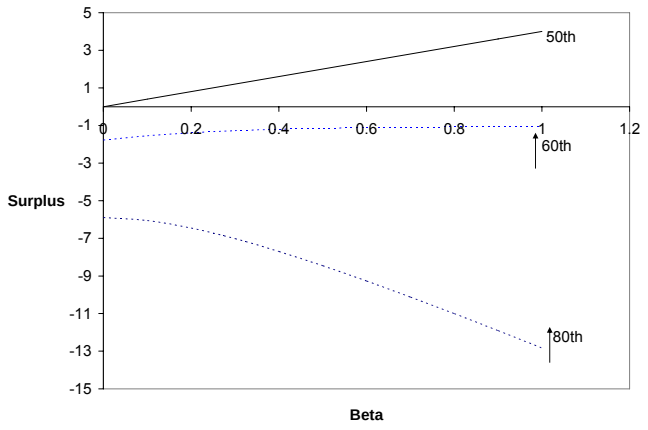
The virtue of a shortfall approach lies in its simplicity, its easy visualization in various return/risk spaces, and its minimal assumptions about the detailed form of the distribution. In many cases where a risk threshold is stringently defined in terms of a sufficiently low penetration probability, the shortfall

approach can provide risk limits that are pragmatically satisfactory.

In the surplus case, one also finds percentile "risk floors," but they differ in being located at lower threshold levels. For example, in Exhibit 9, the 60th percentile curve for the surplus is plotted. The line is not straight but stays in a narrow range around -1.5 as the beta value is increased. At a zero beta, the unhedged portion of the liability carries a volatility that pushes the 60th percentile surplus down to -1.8. As the beta gets larger, the increasing volatility is offset by the growing equity return, so that as in the asset-only case, the 60th probability curve is approximately flat, although at this slightly lower level. Consequently, this 60% percentile again acts as a (somewhat rougher) risk floor, implying that the year-end surplus has a 60% probability of exceeding -1.5 regardless of the asset's beta value. Put another way, every portfolio mix of equity and bonds will have the same 60% probability of having the one-year surplus above -1.5.

At the same time, Exhibit 9 also shows that the 80th percentile curve declines quite dramatically with higher beta values. And, as discussed in the preceding section, this descending curve, when taken as a shortfall probability, implies that there will be some maximum beta value that acts as a risk limit (e.g., Exhibit 7).

Exhibit 9
The "Risk Floor"



Source: Morgan Stanley Research

The risk floor helps determine the location of maximum and minimum beta levels. Any percentile with a higher upside probability will always descend starting from some threshold below the risk floor. This same principle applies to setting return targets having a specified minimum probability: The relevant percentile curves will be ascending ones that have higher thresholds and lower probabilities than the risk floor. These rising percentile curves will then determine a minimum beta needed to achieve the target surplus with the required probability.

Thus, the risk floor and its characteristic probability can be viewed as a dividing line between the conditions that establish maximum-beta risk constraints and those that set minimum beta levels for achieving positive targets.

Multi-Year Horizons

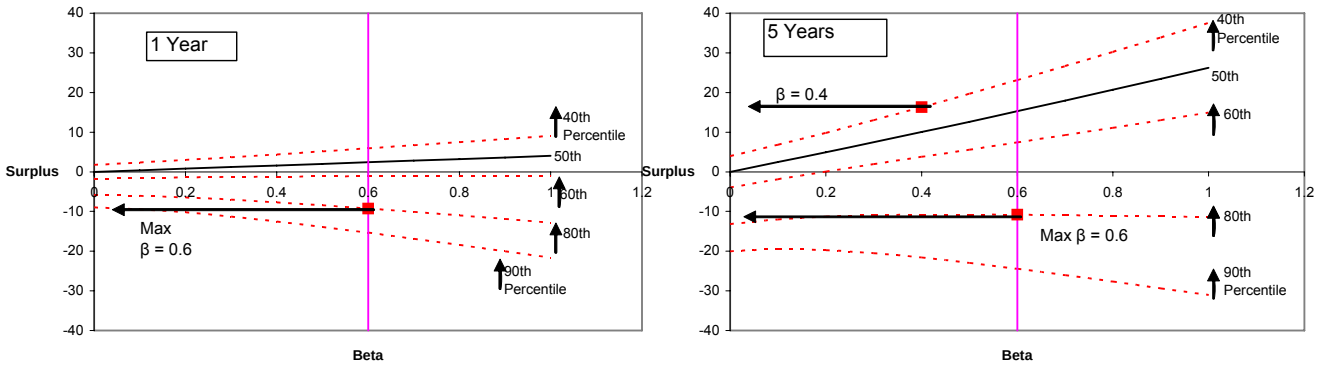
The analysis thus far has focused on a one-year time horizon. However, percentile lines can also be useful when looking at multi-year periods. Exhibit 10 plots percentile fans for 1 and 5 year periods. In our previous report, we examined the asset-only percentile fans in terms of annualized returns. In that case, as one moves from 1 year to 5 years the percentile fan compresses around an approximately constant market line. This pattern resulted from the annualization of returns that is a standard form of analysis in asset-only space. In contrast, the surplus measures in Exhibit 10 are not annualized. Thus, as the horizon progress from 1 year to 5 years, the 50th percentile increases in slope while the percentile fan actually widens further.

There are several points of interest in Exhibit 10's 5-year fan. It is now the relatively flat 80th percentile line that acts as a risk floor, implying that there is a sizable 20% probability that the surplus will drop below -11 after 5 years regardless of what equity/bond ratio is chosen.

The 80th and 90th percentile curves fall significantly as the time period extends from 1 to 5 years. For example, the 0-beta portfolio has a 90th percentile line that implies a 10% probability of falling below -10 in one-year, but drops to -20 after 5 years.

At a beta of 0.6, there would be a 10% probability of the surplus ending up below -25 after 5 years. On the more optimistic side, this same 0.6 beta would provide a 5-year surplus of+23 with 40% probability.

Exhibit 10
Horizon Effects in Surplus/Beta Space: Initial Zero-Surplus



Source: Morgan Stanley Research

Surplus and Deficit Scenarios

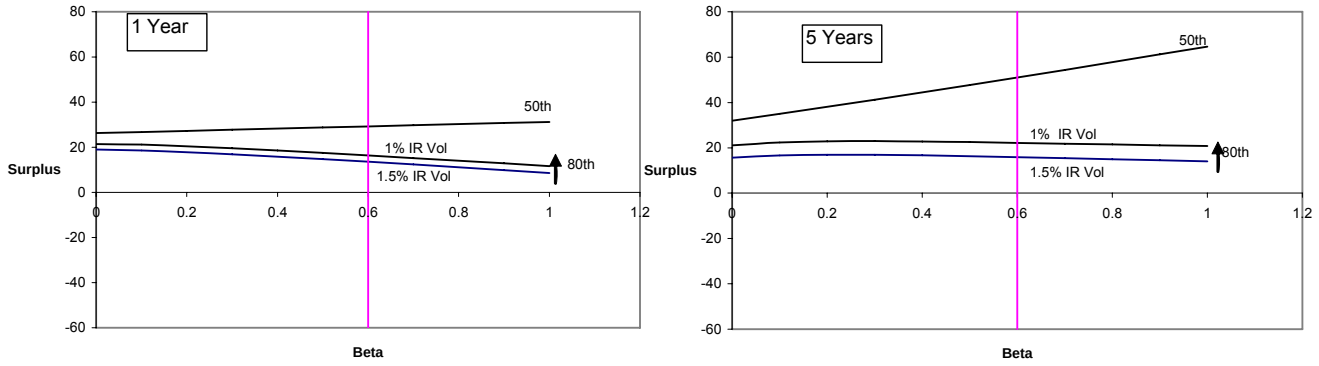
Until this point, all examples have been based on a starting surplus of zero, i.e., with asset value equaling the liability at the outset. Exhibits 11 and 12 now focus on initial surplus values of +25 and -25, respectively. Each graph depicts three percentile curves: 1) the 50th percentile market line, 2) an 80th percentile using our baseline interest rate volatility of 1%, and 3) an 80th percentile with the more sizable rate volatility of 1.5%.

In Exhibit 11, the starting assets amount to 125% of the liabilities. With the larger asset size, the equity premium becomes more significant, lifting the market line above the level seen earlier for the zero-surplus case (Exhibit 10). This uplift is particularly notable in the 5-year panel on the right. For example, for a 0.6 beta portfolio, the 50th percentile surplus increases by 26 points, from 25 to 51! At the same time, the 80th percentile line is again virtually flat. Even for the higher 1.50% rate volatility, the 80th percentile line suggests that there is only a 20% chance of the surplus falling below 15. Thus, a positive surplus can be seen to accommodate significant risk-taking.

In contrast, Exhibit 12's case of a -25 starting deficit represents a more sober situation. Because the liabilities overshadow the asset size and its equity premium, the surplus value barely increases even for the higher beta portfolios. A 0.6 beta would only provide an additional 5 points after 5 years. This low market line drags the entire percentile fan lower. Thus, after 5 years, both 80th percentile lines are virtually flat, but at very severe deficit levels. It should be noted that because the liabilities are so much larger than the assets, the gap between the two 80th percentile lines is considerably greater in Exhibit 12's deficit situation than in Exhibit 11's positive surplus case. It is striking to see how a large starting deficit creates significant prospects of an ever-worsening deficit situation. For example, for the 1.5% rate volatility, after 5 years, there is a 20% chance of a -30 point decline that could take the deficit down from a starting value of -25 to -53!

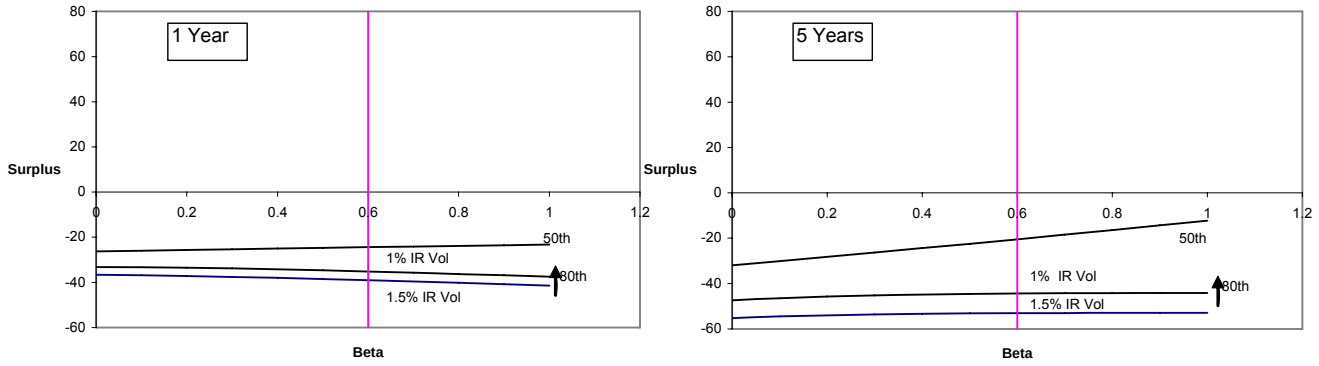
Baring an extraordinary positive movement in asset returns and/or interest rates, the only escape from such a severe deficit situation would be a capital infusion or a ratcheting down of the liability requirement.

Exhibit 11
Initial +25 Surplus



Source: Morgan Stanley Research

Exhibit 12
Initial -25 Deficit



Source: Morgan Stanley Research

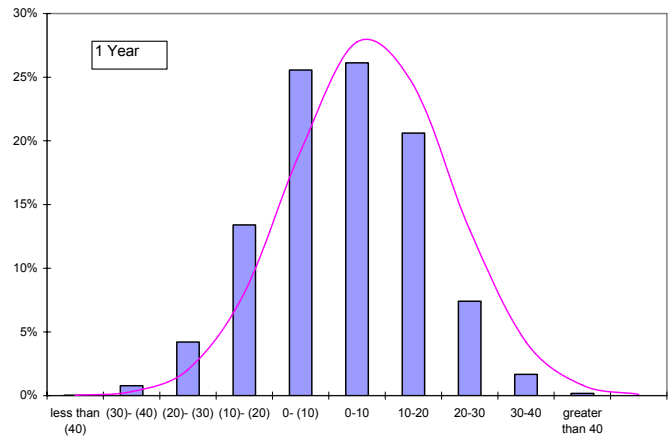
Simulation Results

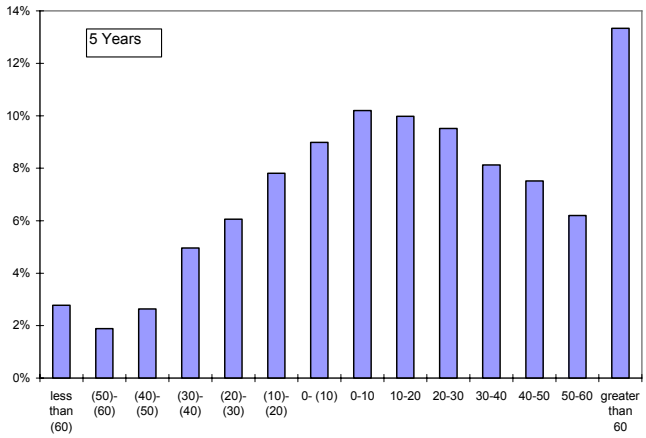
The preceding 5-year graphs were developed on an analytic basis using a standard √N projection for the surplus volatilities. This analysis provides only approximate results for longer time periods, especially for a surplus situation with low mean returns, compounding, and complex rebalancing across both assets and liabilities.

In order to test our analytic results, a more refined simulation was run for the 0-surplus case with a 0.6 beta. Exhibit 13 presents the histograms for the 1-year and 5-year simulations. From our analytic model, over one year, the expected surplus is 2.40 with a volatility of 13.86. Exhibit 13's simulation (with 3000 iterations) results in an expected surplus of 2.20 and volatility of 13.54. The 80th percentile for the simulation comes in at -9.15 versus -9.27 for the analytic approach. In Exhibit 13, the idealized normal distribution is superimposed on the one-year simulation results. These two approaches appear close enough for the one-year horizon.

Moving to 5 years, the analytic framework yielded a mean surplus of 15.27 while the simulation generated a slightly different 15.56. However, the simulation generated a skewed (lognormal-like) distribution that differs significantly from the symmetric probability distribution used in our analysis. This skew and the larger tails would exacerbate the widening of the 5-year percentile fan.

Exhibit 13
Simulation Results





Source: Morgan Stanley Research

Thus, the analytic results support the general thrust of the findings. However, a more granular examination of the longer horizon outcomes clearly calls for a detailed simulation study.

Our surplus model is based upon a liability value that accumulates and fluctuates with the interest rate. The liability duration rolls forward at a constant 12-year level. There are no payments or inflows. This simple model is implicitly based upon a deferred annual payment stream that is independent of the asset value. More complex liability models would obviously lead to different surplus fans, some of which might have considerably more downside vulnerability.

For example, a spending policy that generates payouts as an asset value percentage could entail more severe downside risks over time. These more complex situations could be readily explored through a properly designed Monte Carlo simulation.

Conclusions

1) For a zero-surplus fund, the asset and liability interest rate accumulation offset each other, so that the surplus growth is just the beta times the equity risk premium.

2) A positive surplus fund enjoys an "asset headwind" from the larger ratio of assets whose earnings generally exceed the liability's cost. Similarly, a deficit fund faces a "liability headwind" from the greater liabilities.

3) Over longer horizons, the expected surplus rises year by year, unlike the expected annualized return line that remains essentially invariant in asset-only space.

4) Over longer horizons, the surplus percentile fan widens around the ever higher expected surplus line. In contrast, in the annualized asset-only framework, the percentile fan compresses around the expected return line.

5) Over the 5-year horizon, the 80th percentile acts as a "risk floor," defining a downside threshold that has a 20% probability of being penetrated by any and all equity/bond mixtures.

6) The risk floor also divides the percentile fan into 1) descending curves that can serve as risk thresholds that set maximum betas, and 2) ascending curves that can help specify the minimum beta for positive target levels.

7) The risk floor's threshold is highly sensitive to the initial surplus, ranging from -11 for an initial zero-surplus (Exhibit 10), to +22 for a +25 initial surplus (Exhibit 11) and to -44 for a -25 initial deficit (Exhibit 12).

8) These thresholds were based on a random walk of interest rates with a 1% annual volatility. For a higher 1.5% interest rate volatility, the 80th percentile still acts as a 5-year risk floor, but at a lower threshold. This threshold is materially lower in the deficit case, where

the 20% probability 5-year 80th percentile drops to -53! (Exhibit 12).

References

1) Leibowitz, Martin L. and Anthony Bova. "Return Targets and Percentile Fans." *Portfolio Strategy Note*, May 13, 2009
2) Leibowitz, Martin L. and Anthony Bova. "Allocation Betas." *Financial Analysts Journal*, July/August 2005
3) Leibowitz, Martin L. and Anthony Bova. "Gathering Implicit Alphas in a Beta World." *Journal of Portfolio Management*, Spring 2007
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Global Stock Ratings Distribution

(as of May 31, 2009)

For disclosure purposes only (in accordance with NASD and NYSE requirements), we include the category headings of Buy, Hold, and Sell alongside our ratings of Overweight, Equal-weight, Not-Rated and Underweight. Morgan Stanley does not assign ratings of Buy, Hold or Sell to the stocks we cover. Overweight, Equal-weight, Not-Rated and Underweight are not the equivalent of buy, hold, and sell but represent recommended relative weightings (see definitions below). To satisfy regulatory requirements, we correspond Overweight, our most positive stock rating, with a buy recommendation; we correspond Equal-weight and Not-Rated to hold and Underweight to sell recommendations, respectively.

	Coverage Universe		Investment Banking Clients (IBC)		
Stock Rating Category	Count	% of Total	Count	% of Total IBC	% of Rating Category
Overweight/Buy	**690**	**31%**	**214**	**35%**	**31%**
Equal-weight/Hold	**1022**	**45%**	**288**	**47%**	**28%**
Not-Rated/Hold	**32**	**1%**	**7**	**1%**	**22%**
Underweight/Sell	**510**	**23%**	**99**	**16%**	**19%**
Total	**2,254**		**608**		

Data include common stock and ADRs currently assigned ratings. An investor's decision to buy or sell a stock should depend on individual circumstances (such as the investor's existing holdings) and other considerations. Investment Banking Clients are companies from whom Morgan Stanley or an affiliate received investment banking compensation in the last 12 months.

Analyst Stock Ratings

Overweight (O). The stock's total return is expected to exceed the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.
Equal-weight (E). The stock's total return is expected to be in line with the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.
Not-Rated (NR). Currently the analyst does not have adequate conviction about the stock's total return relative to the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.
Underweight (U). The stock's total return is expected to be below the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.
Unless otherwise specified, the time frame for price targets included in Morgan Stanley Research is 12 to 18 months.

Analyst Industry Views

Attractive (A): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be attractive vs. the relevant broad market benchmark, as indicated below.
In-Line (I): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be in line with the relevant broad market benchmark, as indicated below.
Cautious (C): The analyst views the performance of his or her industry coverage universe over the next 12-18 months with caution vs. the relevant broad market benchmark, as indicated below.
Benchmarks for each region are as follows: North America - S&P 500; Latin America - relevant MSCI country index or MSCI Latin America Index; Europe - MSCI Europe; Japan - TOPIX; Asia - relevant MSCI country index.

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