Advanced Portfolio Management

January 2008

A Brief Description of Shortfall Risk

A HEDGE FUND PORTFOLIO CONSTRUCTION TOOL

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Advanced Portfolio Management

A BRIEF DESCRIPTION OF SHORTFALL RISK

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Shortfall risk An intuitive description

Shortfall risk is the risk of not achieving a pre-specified minimal acceptable return. In the case when the shortfall threshold is set to zero, this is the risk of making a loss.

It allows the portfolio manager to manage risk in a world of non-linear, non-normally distributed returns – the kind of return distributions which characterize many hedge fund strategies. Unlike standard deviation and VaR, shortfall risk is not dependent on the assumption of a normal distribution of returns. It can be ideally coupled with return distributions generated by a non-linear Monte Carlo process specifically designed to capture the potential for tail risks that exist in many hedge fund strategies.

As a portfolio construction tool, shortfall risk optimization considers the *entire* distribution of expected returns and thereby considers all potential risk, not just the statistical shorthand of risk captured by standard deviation or VaR.

Hedge fund portfolio construction can employ shortfall risk as a tool through four basic steps:

First, a non-linear Monte Carlo simulation of each manager's forward-looking expected return distributions is generated;

Second, basic exposure and concentration constraints are set;

Third, a shortfall risk optimization program is run to seek the optimal combination of manager distributions which minimizes the geometric space of the total portfolio distribution that falls below the shortfall threshold;

Fourth, optimization results and marginal contributions to portfolio risk are studied and then the shortfall risk optimization is re-run multiple times with changing constraints until the essential allocations of the target portfolio emerge.

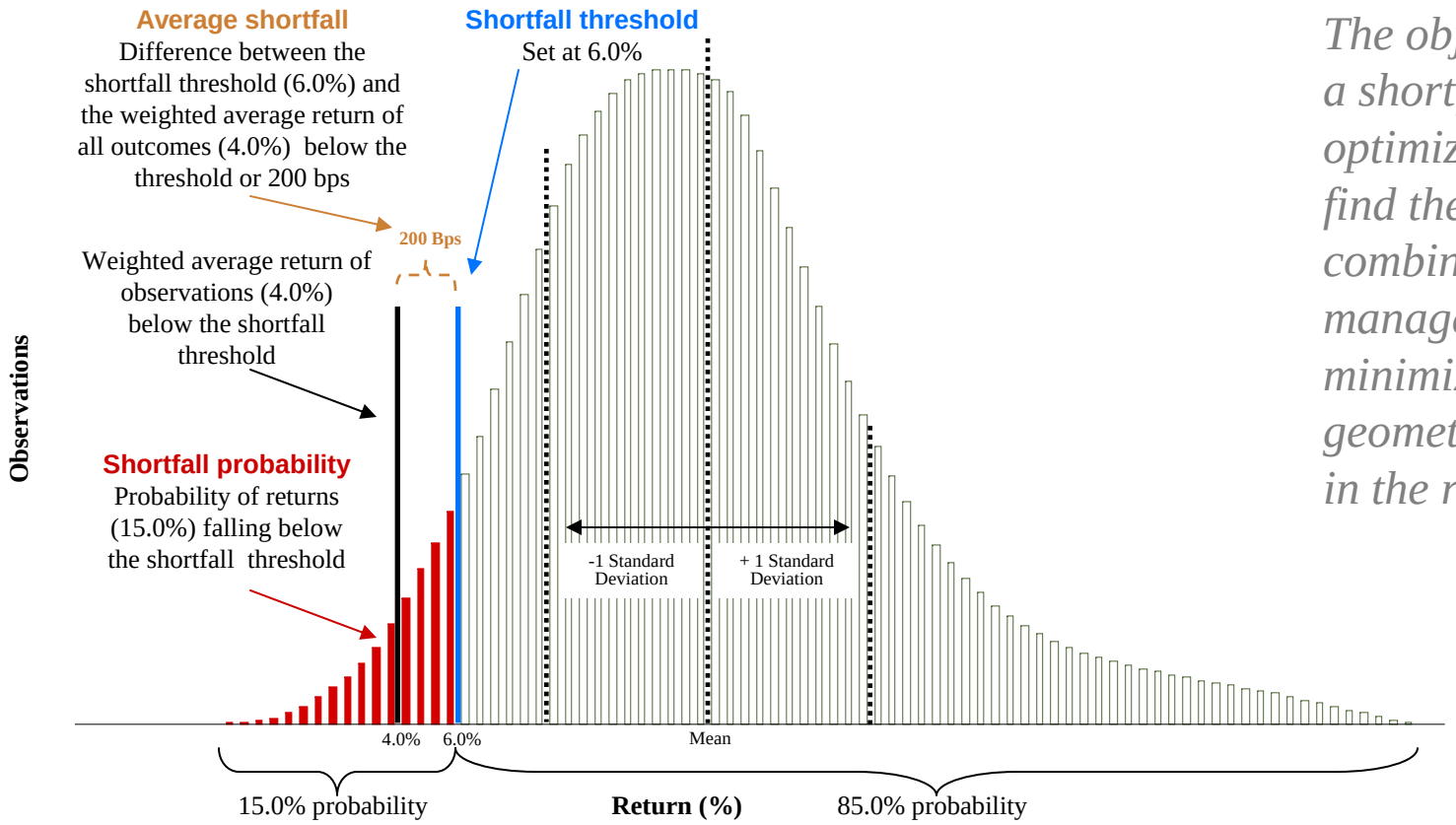
Shortfall risk is the risk of **not** *achieving your minimum return threshold*

Shortfall risk A mathematical definition

Shortfall risk	Shortfall risk measures the probability *and* the magnitude of potential portfolio returns that fall below a predetermined return threshold.
Shortfall threshold	In measuring shortfall risk, a shortfall return threshold is first specified. This threshold determines risk tolerance and segments a 'tail' in the distribution of expected returns. The threshold is also referred to as the minimum acceptable return.
Shortfall probability	Measures the percentage of observations falling below the shortfall threshold.
Average shortfall	The difference between the shortfall threshold and the weighted-average return of all outcomes that fall below the threshold.
Shortfall risk	**= (shortfall probability) x (average shortfall)**

*Shortfall risk can be thought of as an option price that represents the expected value of risk – it combines both the probability of the risk **and** the expected magnitude of the risk in one number*

Shortfall risk A graphic example



The objective of a shortfall risk optimization is to find the combination of managers which minimizes the geometric space in the red tail

Shortfall risk A comparison of risk/return measures

	Definition	Advantages	Disadvantages
Mean-variance	Traditional measure of expected risk and return. Quantifies dispersion around the mean return in traditional statistical terms. Return equals mean of distribution. Risk equals sigma of distribution.	Widely accepted by both academics and practitioners. Long research pedigree. Easy to model using traditional statistical techniques. Utilized as portfolio optimization tool.	Fails to distinguish good from bad outcomes. Difficult to incorporate risk tolerance. Mean return is unrelated to a priori investment objectives. Works best with normal distributions.
VaR	Uses historical variance to calculate potential downside. Takes a current mark-to-market and calculates potential loss based on probabilistic confidence intervals.	Focus on negative tail of return distribution. Widely accepted risk management metric. Applied properly, measures potential downside exposure.	Does not capture specificity of risk. Does not capture non-normal risk. Does not serve as an optimization objective. Fails to incorporate risk tolerance.
Shortfall risk	Simple product of shortfall probability and the weighted average shortfall. Requires a statement of risk tolerance (shortfall threshold).	Two dimensional characterization of distribution tail. Works with non-normal distributions. Optimization is performed relative to an absolute return threshold (risk tolerance).	Requires computationally intense statistical methods.

While mean-variance and VaR are useful risk/return metrics, they have substantial shortcomings which are addressed by shortfall risk

Shortfall risk A numerical example

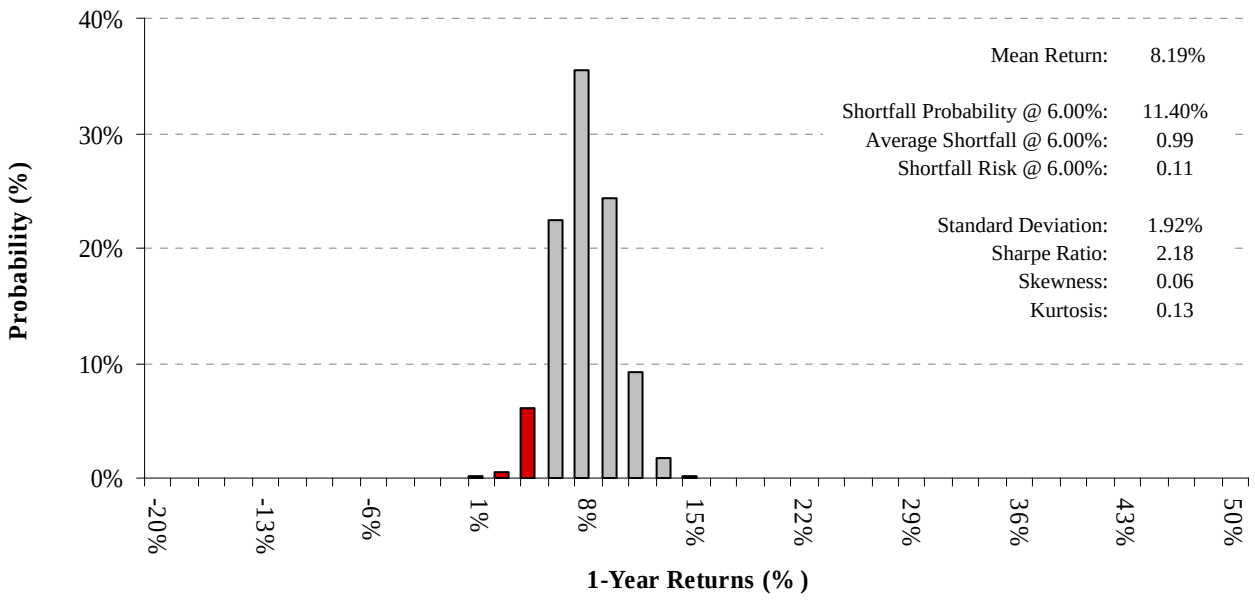
	MV1	SFR1	SFR2	SFR3	MV2
Expected Return:	8.19%	8.98%	9.61%	10.24%	10.88%
Shortfall Probability @ 6.00%:	11.40%	6.90%	6.80%	8.70%	14.30%
Average Shortfall @ 6.00%:	0.99	1.04	1.41	1.85	2.87
Shortfall Risk @ 6.00%:	0.11	0.07	0.10	0.16	0.41
Standard Deviation:	1.92%	2.11%	2.57%	3.34%	4.99%
Sharpe Ratio:	2.18	2.36	2.18	1.87	1.38
Skewness:	0.06	0.03	-0.02	-0.05	-0.01
Kurtosis:	0.13	0.14	0.27	0.37	0.51

Three shortfall optimized portfolios illustrate risk and return trade-offs; mean-variance optimized portfolios create boundaries for evaluating trade-offs

MV = Mean Variance

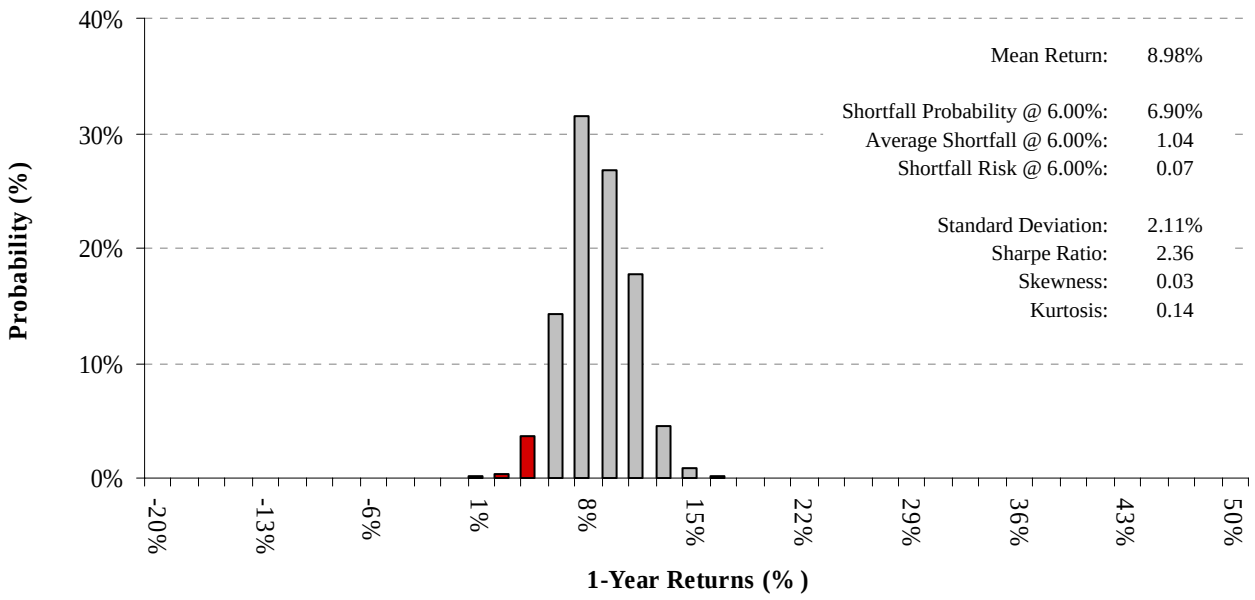
SFR = Shortfall Risk

Comparing portfolio distributions Optimization results MV1



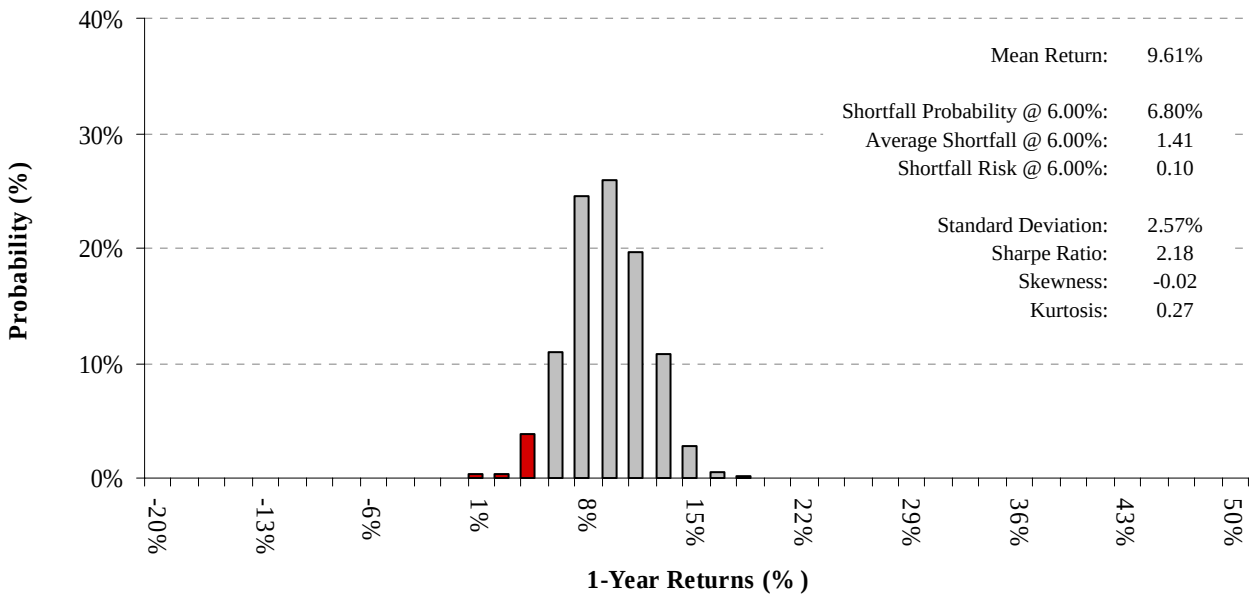
The minimum risk mean-variance optimized portfolio exhibits low standard deviation but high shortfall risk

Comparing portfolio distributions Optimization results SFR1



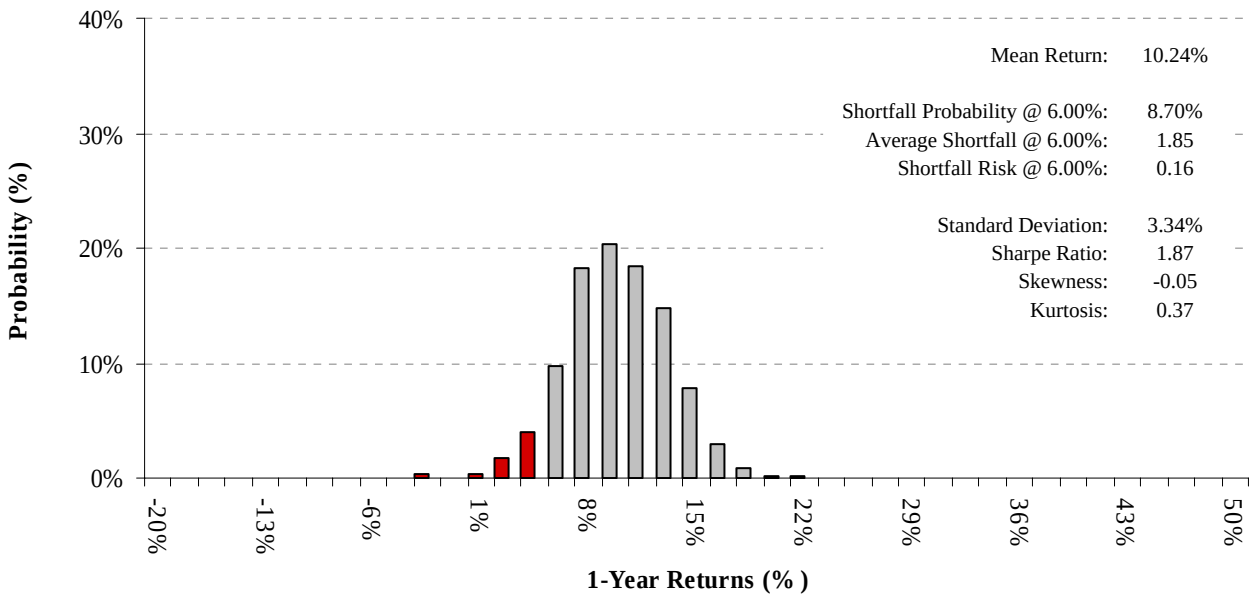
The first shortfall risk optimization (SFR1) exhibits slightly greater standard deviation than MV1, but less shortfall risk and 79 basis points of incremental return

Comparing portfolio distributions Optimization results SFR2



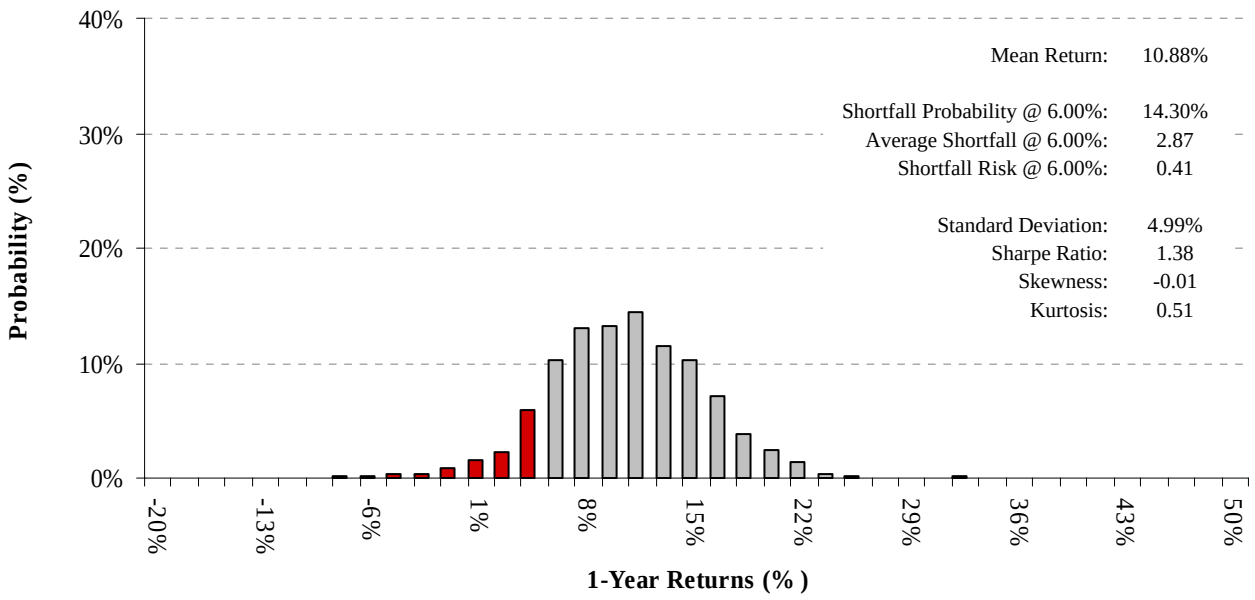
The second shortfall risk optimization (SFR2) has shortfall risk similar to MV1, but 142 basis points of incremental return

Comparing portfolio distributions Optimization results SFR3



The third shortfall risk optimization (SFR3) captures 94% of the return in the MV2 maximum return portfolio, but has only 40% of the shortfall risk

Comparing portfolio distributions Optimization results MV2



The second mean-variance optimization (MV2) is the otherwise unconstrained maximum return portfolio available within the investment universe

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