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Smoothed safety first and the holding of assets

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1. Introduction and motivation

Solving the portfolio-selection problem has been an important focus of research in finance during the past half century, with numerous strategies having been proposed. Some particularly popular and useful methods have emerged, most notably mean-variance rules and expected utility functions. A competing family of methods involves rules that minimize, in various ways, the probability of realizing a portfolio return below some predetermined benchmark (or target) level of return. Rules derived from this objective are often referred to as *shortfall methods*.

Perhaps the earliest and most celebrated of these shortfall methods is the Safety First (SF) principle of Roy (1952), revisited by Hanssmann (1968) and many others. The semi-variance methods of Markowitz (1970) and the lower partial-moment methods of Bawa (1976,1978) likewise build on the notion of minimizing the chance of realizing a return below some predetermined benchmark. Related to these approaches is the Sortino ratio (see, for example, Sortino and Price 1994) which is a version of the Sharpe ratio (SR) (see, for example, Sharpe 1994) that penalizes only downside risk. Others, such as Cheng (2001), have demonstrated the usefulness of downside-risk methods in real-estate

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†Haley and Whiteman (2008) developed a closely-related rule called Generalized Safety First (GSF). When net asset returns are independent and identically-distributed (IID), GSF is equivalent to Stutzer's (2000) PPI; when the logarithm of gross asset returns is IID, GSF is equivalent to Stutzer's (2003) Decay Rate Maximizing Portfolio. Net IID returns are used below, so in this context, PPI and GSF are interchangeable terms, but the analysis can be extended to the logarithm of gross returns if desired. The interested reader is referred to these papers for complete descriptions of these methods.

‡In fact, Markowitz (1999) has referred to Roy's shortfall-based SF rule as a ‘tremendous contribution’ and wrote (p. 5): ‘On the basis of Markowitz (1952), I am often called the father of modern portfolio theory (MPT), but Roy (1952) can claim an equal share of this honour.’

§The wealth exhaustion constraint, , is implied, but suppressed for notational parsimony throughout the remainder of the paper. Also, short positions are permitted, but all the analysis done here can be adapted to the case of no shorting if desired.

†In the presence of effective pruning strategies, this solution method is tractable for small N in the no-shorting case, but if shorting is permitted the problem becomes extremely computationally intensive, even for small N.

†We experimented with other sigmoid and sigmoid-like functions (such as Extreme Types I and II as well as the logistic, among others). We studied them using simulation methods and via Taylor-series expansions. The latter were particularly helpful in determining how different methods value even- and odd-order moments of the return distribution. After all these various background experiments, the most viable was the Extreme Type I. Of course, an infinite number of sigmoid or sigmoid-like functions exist from which we could select a smoothing function. Perhaps other good choices will be uncovered by future research.

†Note that the smoothing function is only a device used to compute the optimal linear combination w; it is not a distributional assumption concerning the portfolio returns. The shape of the portfolio return distribution follows from the properties of the joint distribution of asset returns.

‡Even if underflows do not occur, values on the order of 10^{-65} will contain substantial rounding error, and this can undermine the reliability of optimization algorithms.

†Stutzer (2000, 2003) emphasized another endogenous utility approach. In the former paper, he drew a connection to the familiar negative exponential utility model, and in the latter paper he described an endogenous version of an expected utility function similar to standard power utility.

‡This is true more generally as well.

†We used the MATLAB™ optimization routine `fminunc`, using a quasi-Newton method with a line search subroutine and numerical derivatives. If the reader has a strong preference for analytic first and second derivatives, then they can be derived, but they are cumbersome to manage and return similar results when used in the optimization process. Of course, `fmincon` could be used as well.

†This last finding is not surprising: preference for positively skewed portfolio return distributions (and, thus, an aversion to negatively skewed portfolio return distributions) is a prominent feature of the PPI method; see Stutzer (2000).

‡In this instance, we used MATLAB™'s `fmincon` routine, though the older `constr` routine also works.

†Similar results were obtained using other reasonable values for d and .