

# Path-Dependent Risk Measures in Portfolio Optimization

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## Abstract

*Abstract and presentation refer to two interlinked projects. Project 1 is in an advanced stage, project 2 in an early stage. Feedback to both is warmly welcome. Please do not circulate without permission of the authors.*

Project 1: The maximum drawdown (MDD) is the largest cumulative loss from a peak to a following trough within a given period of time. It is one of the most widely used path-dependent risk measures in the fund management industry, and it is often used as additional criterion to assess a portfolio or strategy. However, there is little empirical research on portfolios explicitly optimized for MDD. In this project, MDD is used as objective for portfolio optimization. Based on data for S&P 500 Health Care stocks for the period 2012-2020, an empirical study is performed with 2000 random combinations of assets for different time-windows. For each of these situations, gradient based sequential least squares was used to minimize the in-sample MDD and the in-sample variance, respectively. These optimized portfolios were then analysed for their out-of-sample performance. As expected, the out-of-sample return of MDD-optimized portfolios was higher and the out-of-sample MDD was lower than their minimum-variance (min-var) counterparts. At the same time, however, MDD-optimized portfolios typically outperformed their min-var counterparts by having lower Value-at-Risk and lower Expected Shortfalls for out-of-sample windows up until the end of 2019. These advantages do not prevail for out-of-sample windows in 2020, i.e., after the covid-crisis had begun while portfolios were optimized predominantly on pre-covid data.

Project 2: Popular existing path-dependent risk measures focus on drawdowns starting from a peak. However, some strategies or mechanisms may be defined with reference to the situation at the beginning of the period, not the peak. In project 2, a new path-dependent risk measure is proposed which defines drawdown as the largest drop from start, instead of peak, to trough: the start-to-low drawdown (SLD). First, SLD-properties are analyzed and compared to those of other risk measures. Second, the properties of portfolios optimized for SLD shall be analyzed, including the risk-return trade-off offered. Third, application to the setting of a selected type of investor is envisaged. Possible settings include that of levered investors and capital requirement regulation as known e.g. in the insurance and banking industry, and towards pension funds. Regulation forces action in case of insufficient funding that may follow drawdowns. Such action is usually associated with (opportunity) cost.

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