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A Heuristic Framework for the Bi-Objective Enhanced Index Tracking Problem

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Abstract

The index tracking problem is the problem of determining a portfolio of assets whose performance replicates, as closely as possible, that of a financial market index chosen as benchmark. In the enhanced index tracking problem the portfolio is expected to outperform the benchmark with minimal additional risk. In this paper, we study the bi-objective enhanced index tracking problem where two competing objectives, i.e., the expected excess return of the portfolio over the benchmark and the tracking error, are taken into consideration. A bi-objective Mixed Integer Linear Programming formulation for the problem is proposed. Computational results on a set of benchmark instances are given, along with a detailed out-of-sample analysis of the performance of the optimal portfolios selected by the proposed model. Then, a heuristic procedure is designed to build an approximation of the set of Pareto optimal solutions. We test the proposed procedure on a reference set of Pareto optimal solutions. Computational results show that the procedure is significantly faster than the exact computation and provides an extremely accurate approximation.

Keywords: Enhanced Index Tracking, Mixed Integer Linear Programming, Bi-Objective Optimization, Bi-Objective Heuristic Framework.

1 Introduction

In modern economies, market indices serve as indicators of the behavior of financial markets but also as benchmarks in financial trading. Indeed, indices are used, nowadays, as standard benchmarks for evaluating the performance of fund managers and the number of funds managed by index-based investment strategies has grown significantly in recent years. Index-based fund management strategies have been traditionally classified into two broad classes: passive and active management. With *passive management* a fund manager is expected to create a portfolio of assets whose performance replicates, as closely as possible, that of a financial market index (i.e., the *benchmark*) provided by statistical bureaus like Standard & Poor's. This strategy is commonly referred to as *index tracking*. The goal is to minimize a *tracking error*, that measures the deviations of the performance of the portfolio from the benchmark. With *active management* a fund manager has the goal of yielding a higher return than the benchmark. A common active management strategy consists in underweighting or overweighting stocks compared with the benchmark based on the manager beliefs (e.g., see Li *et al.* [38]). Therefore, fund managers adopting an active management strategy