Novel Approaches to Portfolio Construction: Multiple Risk Models and Multiple Solution Generation

Sebastian Ceria
CEO, Axioma Inc.

Francois Margot
Carnegie Mellon University and
Sr. Associate, Research, Axioma Inc.

Anthony Renshaw
Director, Applied Research, Axioma Inc.

Anureet Saxena
Associate, Research, Axioma Inc.

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Abstract

Optimization as an applied discipline has a history spanning more than six decades. Although highly successful in a variety of real-world applications such as supply chain management, manufacturing, scheduling, etc., the penetration of optimization in the financial world has been less than remarkable. While the practice of using optimization based techniques in constructing portfolios has gained wide acceptance in the past decade, it has still not reached its full potential. The community of portfolio managers continues to perceive optimizers as black box tools that only partly capture the complexities of real world portfolios. We believe that there are two factors that have hindered the growth of financial optimization.

First, unlike other application areas, uncertainty has a focal position in the world of financial optimization. Risk management, the practice of managing and controlling the inherent stochastic nature of portfolio returns, is an indispensable component of any quantitative

model. It entails complex interaction between statistics and optimization, and is often encumbered with problems ranging from parameter mis-estimation to overfitted models. With the emergence of global markets, fading international trading boundaries and current economic turbulence, the risk model business itself has undergone a paradigm shift. A contemporary portfolio manager (PM) trading in stocks on NYSE to Nikkei needs access to a robust risk model that can provide multiple views of risk, and can quickly adapt to the ever changing financial landscape. These factors make software design for financial optimization extremely challenging.

Second, constructing an optimal portfolio is only one aspect of the practice of portfolio management. An optimized portfolio often undergoes a series of refinements and alterations each of which addresses a practical concern that was not captured by the underlying mathematical model. As appealing as it may seem, a single optimal portfolio hardly provides any insight to complement the tremendous amount of expertise it takes to mutate the output of a black-box solver into a practically tradable portfolio. For instance, it offers little insight into the manner in which the constraints present in the strategy affect the choice of the optimal portfolio. While some of the constraints in a strategy, such as budget constraint, are mandatory, several others just represent tentative guidelines that the PM is expected to follow. A single optimal portfolio restricts the PM from exploring portfolios that violate some of these tentative constraints but have other extremely desirable characteristics such as expected return, transfer coefficient, implied beta, etc. To overcome these shortcomings, software providers need to break from the image of being black box optimizers and design flexible products that assist the PM in portfolio design from inception through trade execution.

As a leading provider of portfolio optimization tools, Axioma has undertaken several initiatives to address these concerns. Our product suite employs ideas from robust optimization to tackle parameter mis-estimation problems thereby giving rise to portfolios that are less sensitive to estimation errors. Our Robust risk models are updated on a daily basis to reflect the latest changes in the financial markets across the globe. Our modeling environment allows PMs to incorporate multiple risk models thereby giving him a better risk assessment. This chapter offers a snapshot of the latest research developments at Axioma that further enhance our capacity to address challenging problems in financial optimization. The rest of the chapter is organized as follows.

In section 2, we present a systematic calibration procedure for incorporating more than one risk model in a portfolio construction strategy. The addition of a second risk model can lead to better overall performance than one risk model alone provided that the strategy is

calibrated so that both risk models affect the optimal portfolio solution. Our computational results illustrate that there is a substantial, synergistic benefit in using multiple risk models in a rebalancing.

In section 3, we address the issue of generating multiple interesting solutions to the portfolio optimization problem. We borrow the concept of "elasticity" from Economics, and adapt it within the framework of portfolio optimization to evaluate the relative significance of various constraints in the strategy. We show that examining heatmaps of portfolio characteristics derived by perturbing constraints with commensurable elasticities can offer crucial insights into tradeoffs associated with modifying constraint bounds. Not only do these techniques assist in enhancing our understanding of the terrain of optimal portfolios, they also offer the unique opportunity to visualize tradeoffs associated with mathematically intractable metrics such as transfer coefficient. The section concludes with a carefully designed case study to highlight the practical utility of these techniques in generating multiple interesting solutions to portfolio optimization.

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