Financial Optimization under Uncertainty and Information Ambiguity

This project proposal is concerned with financial optimization problems under uncertain circumstances and asymmetric information structures. The need for sophisticated stochastic models in finance is well recognized, and most industrial activities in the area are motivated by studies of various mathematical models. Traditionally, however, uncertainty about the future is incorporated through a model ("the known unknowns"), whereas more recent research also focuses on effects of possible mis-specification of models ("the unknown unknowns"), and more flexible models where learning about model parameters and financial optimization take place simultaneously.

One theme of the current proposal is to study the effects of model uncertainty for various financial optimization problems. A particular instance of such problems is model-free hedging, where hedging results are obtained not only for a particular model, but for whole classes of models simultaneously. These problems, where market prices of vanilla options are given and price bounds for more complicated derivatives are obtained, often lead to challenging inverse problems.

Another theme is the effect of information asymmetry in financial markets. Here there are symmetric cases, where various agents use differently calibrated models but with full knowledge about the other agents' beliefs (i.e. they "agree to disagree"). For example, many trading strategies used by AP2 and other investors are based on a view about model parameters which differs from the market view, as expressed by prices of derivatives. Examples of such trading strategies include spreads, pair trades, rolling of options and momentum trading. These strategies, as natural as they are in the financial industry, have been surprisingly neglected in the academic literature. We also study more involved situations where the other agents' initial beliefs are unknown, but revealed sequentially through their actions. A key ingredient in the study of such problems is the concept of mixed strategies, which use randomization to allow for hiding of information. A related problem is where the sheer existence of other agents is uncertain, and how to behave optimally in such situations.

Moreover, the recent surge of Deep Learning in various applications of Computer Science has increased the interest of these techniques in Finance as well. Deep Learning has the potential to address problems that have previously not been successfully solved by "classical" methods. For example, the problem of how to deal with so-called factor rotation is ever important in active portfolio management. In short, it means that an investor who trades according to a set of factors such as momentum and value will want to find ways to predict in what time periods these factors will perform better. Deep Learning offers a completely new approach to this set of problems, and initial research in the area looks very promising.

The techniques that are employed in the current project span over a wide range of scientific areas, including probability theory, numerical analysis, finance, financial engineering, computer science and statistics, and the ideal candidate has a strong background in one or more of these areas. The project is based on an active interplay between the financial industry and academia, and regular visits at AP2 in Gothenburg will take place.

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