Master's Thesis

# Portfolio Optimization with Distributionally Robust Entropic VaR

Guidance

Professor Nobuo Yamashita
Program-Specific Associate Professor Hiroyuki Sato

Yerin CHOI

Department of Applied Mathematics and Physics

Graduate School of Informatics

Kyoto University


February 2020

**Abstract**

There are a lot of risk measures to evaluate losses in investments. However, some studies proved that most of the risk measures cannot be precisely evaluated under perturbations of the data or probability distributions. Recently, to overcome the difficulties, robust risk measure have attracted much attention. The robust risk measures are a worst-case of a certain risk measure under a given uncertainty. Most of the existing robust measures is evaluated by solving complex or large scale optimization problem.

In this thesis, we concentrate on Entropic Value-at-Risk (EVaR) with uncertainty set in probability distributions. We call the EVaR with mixture uncertainty set in some probability distributions, Worst-case Entropic Value-at-Risk (WEVaR). We show that when calculating WEVaR, under some assumption, we do not need to consider all probability distributions in a mixture uncertainty, but only some of the probability distributions. Then, an optimization problem with WEVaR becomes simple and relatively small problem. We conduct some numerical experiments on the portfolio optimization problem with real data to investigate numerical properties of WEVaR. We compare WEVaR with wost-case Conditional-Value-at-Risk (WCVaR), another well-known robust risk measures. We find out that the optimal solution of the WEVaR is more sparse and has better revenue compared to WCVaR. We also show that WEVaR outperforms in execution time when dealing with big data.