On Online Portfolio Selection

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Research Background

Massive financial data are generated every second in the financial market under the big data environment. The financial market state is changing so fast that the investors have to adjust the investment strategy constantly according to the changing market. Frequently estimating the distribution functions of risky assets will significantly harm the efficiency of investment decision making. Therefore, the traditional portfolio selection studies are not qualified for dealing with such practical investment problems. With the rapid development of artificial intelligence and improvement of computational capacity of the computers, the Fintech is achieving great improvement which provides a novel technical framework and solution for the financial issues in big data environment. This project focuses on one of the most important issues in finance: online portfolio selection optimization, which studies how the investors employ the artificial intelligence techniques to predict the future returns of risky assets when market information is constantly renewed, and make the best investment decisions based on the predicted returns.

Research Objective

There are two significant features for online portfolio selection: (1) predict the future returns of risky assets directly by analyzing the constantly renewed financial data instead of estimating the distribution functions of assets; (2) There are many investment periods and the time length for each period is very short, which means that the investors need to derive the optimal investment strategy instantly. Therefore, online portfolio selection has a higher requirement on the running speed of trading algorithm. This project tries to predict the future returns of risky assets directly based on the constantly renewed market information by using the artificial intelligence techniques. The adaptive online moving average method is designed, and the net profit maximization model is formulated, which can be transformed into linear programming and solve the optimal investment strategy in a very short time.

Adaptive Online Moving Average Method

This project proposes the adaptive online moving average method (AOLMA) to predict the future returns of assets, where the decaying factors can be adjusted automatically according to the performance of risky assets and constantly renewed financial data, which is able to significantly improve the return prediction accuracy. This method has strong robustness to the selection of parameters.

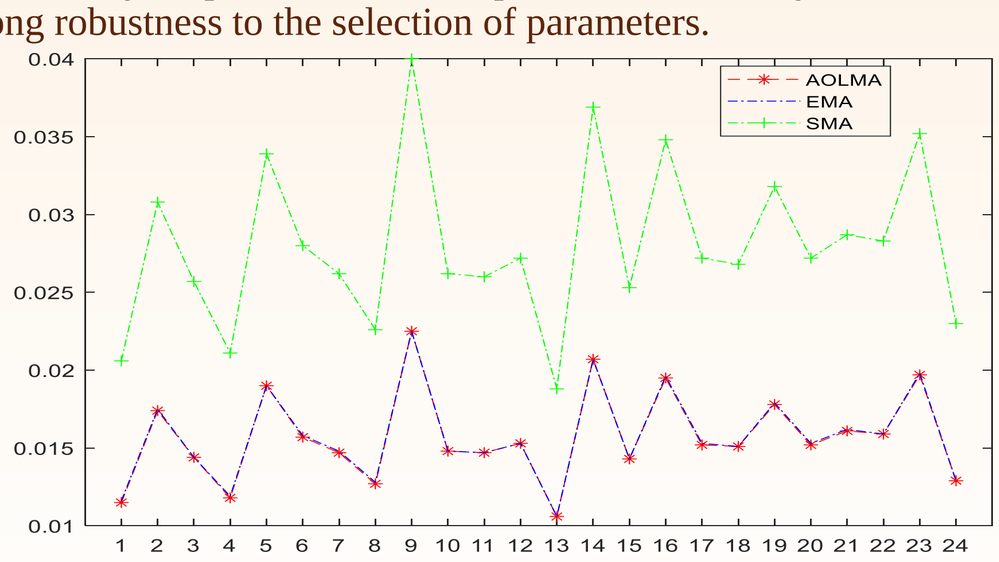

Fig. 1. Average relative error of the return prediction

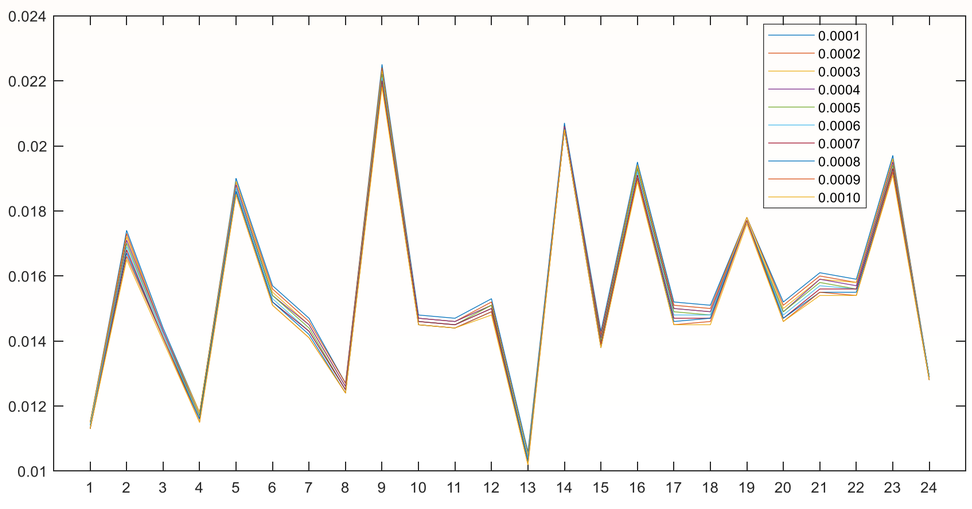

Fig. 2. Robustness test of algorithm

Optimization Model

The net profit maximization model (NPM) is constructed, which is transformed into a linear programming by using the method of change of variables and can be solved in a very short time to derive the optimal investment strategy.

$$\max \boldsymbol{r}_t \boldsymbol{x}_t - \frac{c}{2}\sum_{i=1}^{m} | x_{ti} - \tilde{x}_{(t-1)i} |$$

$$s.t. \quad \mathbf{1}\boldsymbol{x}_t = 1$$

$$\mathbf{0} \le \boldsymbol{x}_t \le \mathbf{1}$$

The AOLNPM algorithm is designed by combing the AOLMA and NPM together.

Numerical Experiments

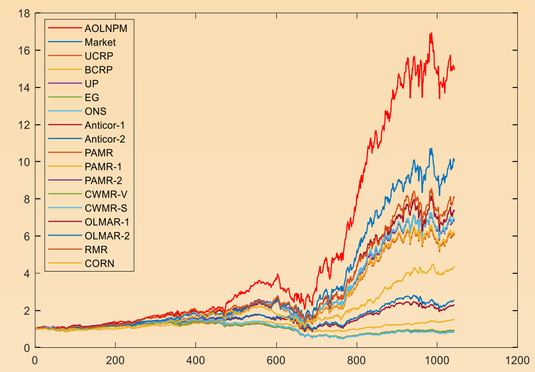

Fig. 3. Cumulative returns on MSCI

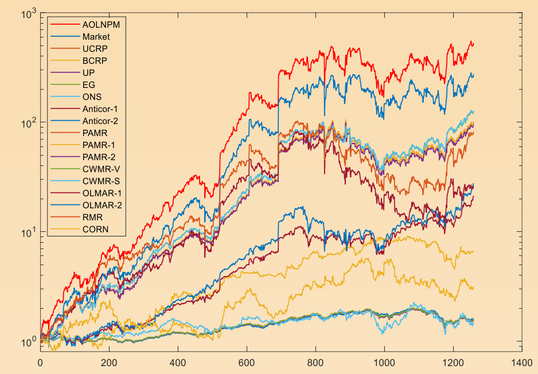

Fig. 4. Cumulative returns on TSE.

AOLNPM performs best on data sets MSCI, NYSE-O, NYSE-N and TSE.

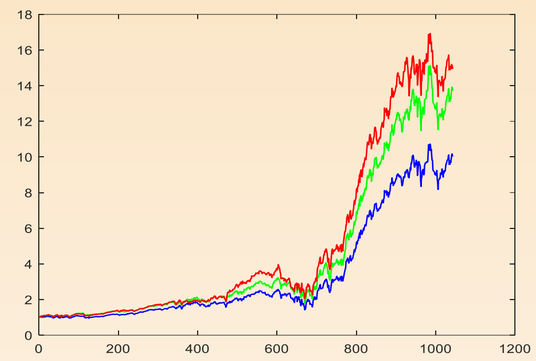

Fig. 5. Impact of AOLMA and NPM

Based on traditional online portfolio selection algorithm (blue curve), the cumulative return is increased to the green curve when NPM model is introduced. When the AOLMA is introduced, the cumulative return turns to be the red curve.

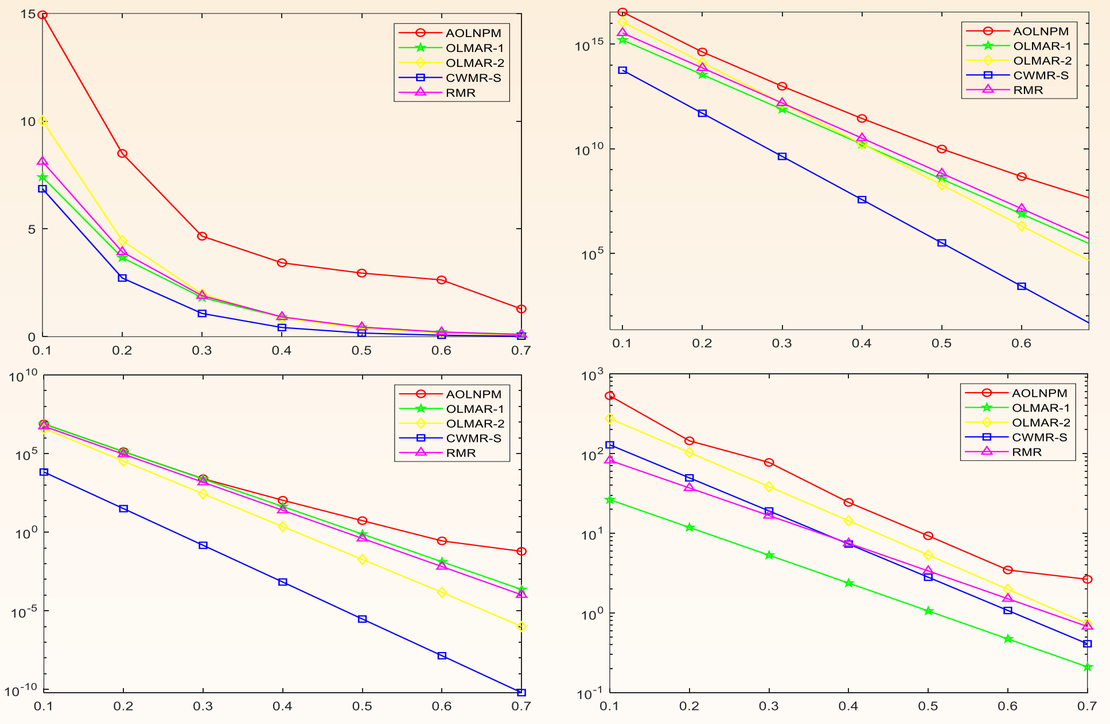

Fig. 6. Change of return when transaction cost rate alters（MSCI,NYSE-O,NYSEN,TSE）

As the transaction cost rate changes, the performance of AOLNPM is closer to real online asset trading process. The work of this project is published in [1].

References

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