INTRODUCTION

Research on portfolio optimization has been popular in recent decades and in that time different algorithms have been developed. Each algorithm has its advantages and disadvantages. This Final Year Project aims to analyze and design portfolio structure using Covariance Shrinkage Algorithm, focusing on Ledoit-Wolf shrinkage estimator. This project, highly quantitative and mathematically based, compares the Ledoit-Wolf shrinkage estimator with the sample covariance estimator under different conditions. Basic metrics such as PRIAL, portfolio risk and portfolio expected return are tested.

AIM

Based on existing models, this project aims to test scenarios that were not studied before and suggests in what scenarios the estimators can reduce risk to an acceptable level.

OBJECTIVES

The objective of this project offers investors a wiser decision-making tool to better manage their portfolio. This analysis will be a meaningful reference to both researchers, who look forward to breaking through the barrier of conventional measures, and investors hoping to better manage their fortune.

METHODOLOGY

To accomplish the aims and objectives, Hang Seng Index is selected as the focused financial market and 47 stocks from 2008 to 2013 are chosen to be the test subjects. Artificial data are also included in the experiments. The main investment strategy is Global Minimum Variance Portfolio (GMVP), and it is compared with naive 1/N strategy that allocate capital into N equal portions and invest.

The rationale of shrinkage algorithm is to find an estimated covariance matrix that best bias from the original sample covariance matrix towards the shrinkage target based on a parameter. Ledoit and Wolf estimate the best bias, the shrinkage intensity, as in the following equation:

$$\Sigma = \frac{\alpha}{\beta} \mu \mu^T + \frac{\alpha}{\beta} S,$$

where $\alpha, \beta$ and $\delta$ are estimated parameters.

Percentage Relative Improvement in Average Loss (PRIAL) is an important metric.

$$PRIAL = \frac{\epsilon(||\hat{\mu} - \mu||^2) - \epsilon(||\hat{\mu} - \mu_{equal}\|^2)}{\epsilon(||\hat{\mu} - \mu_{equal}\|)}$$

RESULT

The results show that the Ledoit-Wolf shrinkage estimator can significantly outperform the traditional sample covariance estimator. By using shrinkage estimator, the portfolio return risk is reduced significantly. Additionally, the results suggest that investors should primarily increase the number of stocks in a portfolio and secondly choose a proper period (60-day returns) of daily returns to observe in order to minimize risk and maximize return.