Index Tracking in the Structure of Fund of Funds based on Cointegration

# Abstract

Index tracking funds have grown significantly in previous decade and attracted more and more investors as an outperforming passive investment vehicle. There are two main different ways to track indices. One is called full replication, funds can take long position on all the constituents as the same weights of an index. The other tracking method is known as sample replication, funds only buy part of the stocks from a family of index stocks using different analytics tools like correlation, mixed integer programming and cointegration. In this paper, our goal is to construct a portfolio to track S&P 500 in a structure of fund of funds (FoF) using cointegration analysis. In contrast with traditional index funds, we do not buy constituent stocks directly to mimic index, we buy sector ETFs. S&P 500 consists of 11 different sectors and industries, there are numerous sector ETFs on the market. We can construct an index fund by purchasing sector funds to track S&P 500 deploying cointegration analysis to make sure long run equilibrium. In FoF structure, we can cut transaction cost enormously and reduce turn over rate, which are essential for an index fund. Index funds hold stocks directly for both full and sample replication methodologies.

# Introduction

In general, there are two different equity portfolio management philosophies, active and passive. Active investment style is aiming to beat the market based on professional financial analysis and portfolio manager’s skills. On the contrary, the goal of passive investment is to match the market performance over a long period of time. Index tracking fund is a typical passive product, whom mission is to mimic a specified benchmark index passively with buy-and-hold strategy. Index tracking funds have grown significantly in previous decade and attracted more and more investors as an outperforming passive investment vehicle. There are two main traditional methods to track indices. One is called full replication, funds can take long position on all the constituents of an index in the respective weights with buy-and-hold strategy. The other tracking method is known as sample replication or called optimization. Funds purchase a sample of stocks that could represent for the overall performance of an index. In additional to traditional hold stocks, there is another alternative method so called synthetic portfolio to replicate an index without holding stock directly. In this paper, our goal is to construct a portfolio to track S&P 500 in a structure of fund of funds (FoF) by using cointegration analysis. As an approach of synthetic tracking portfolio, we buy sector ETFs to mimic index. S&P 500 consists of 11 different sectors and industries, there are numerous sector ETFs on the market. We can construct an index fund by purchasing sector funds to track S&P 500 deploying cointegration analysis to make sure long run equilibrium. In FoF structure, we can cut transaction cost enormously and reduce turn over rate, which are essential for an index fund.

# Statement of Problem

There are 11 individual sectors under S&P 500, Consumer Discretionary, Consumer Staples, Utilities, Technology, Health Care, Financial, Energy, Telecom, Industrials, Material, and Real Estate. Those sectors make up the S&P 500 as a whole; naturally, we consider tracking S&P500 through a combination of sector tracking funds which target individual sector index specifically. Such a structure is called Fund of Funds. There are many ETFs for every sector traded on market. For every sector, we can select about 10 outperforming ETFs to form a sampling pool, so total we have about 110 ETFs. Our goal is to create a portfolio of ETFs to mimic S&P 500 based on cointegration analysis. Cointegration is a powerful econometrics tool that could ensure the long run equilibrium relationship between ETF portfolio and S&P 500. Furthermore, we can do enhanced index tracking. We create an artificial index by adding a positive number to the original S&P 500, then we track the enhanced index with a portfolio with ETFs. We will discuss how to track original and track enhanced index in this paper.

# Literature Review

Alexander (2001) was a pioneer who applied cointegration to passive portfolio management field. This paper deployed cointegration analysis to track a stock index, then built the long short market neutral strategy based on index tracking. The purpose of using cointegration is to identify any common stochastic trends in stock prices, and then achieve stationary tracking errors between a portfolio of stocks and the stock index over the long run. The author divided the process of constructing index tracking portfolio into two parts, selection and allocation. This paper took ‘brute force’ approach to select stocks. Firstly, pick the number of stocks to form the portfolio, then use all the combinations of stocks as possible portfolios. Next step is to optimize the weights of each stocks from every possible combination by using Engle-Granger cointegration methodology. This paper amplified the ordinary index tracking to long short market neutral strategy, which consists of a long portfolio tracking index plus, and a short portfolio tracking index minus. This long short strategy, as one of statistical arbitrage strategies, could provide double alpha opportunities in stock markets. Vast back testing results confirmed that Engle-Granger cointegration is a sound methodology to build index tracking portfolios with relative few stocks and less turnover rates.

Glova, Pastor and Sabol(2015) studied cointegration as a time series model and discovered its application in passive portfolio management. They discussed the statistical characteristics of cointegration and compared it with correlation from asset management perspective. They noted that cointegration and correlation are related, both describe the relationship between assets. Cointegration is a long-term relationship among time series. If cointegration existing, then it could ensure long run equilibrium between stock prices. Correlation is a short time statistic based on assets’ returns, that is not appropriate for constructing a long term buy and hold strategy. This literature tracked Dow Jones Industrial Average Index and Dow Jones Composite Average Index by exploiting the mean reverting property of cointegration. They used daily closed prices of indices and daily closed prices of component stocks adjusted for splits and dividends from 2000 to 2013. This paper conducted a lot of portfolios from different selection process and compared each return and risk metrics. At the end, they approved that cointegration is a right apply in passive portfolio management, which can create a comparable low volatility and low-cost tracking portfolio.

Sant’Anna, Filomena and Caldeira (2017) compared cointegration and correlation methodologies in index tracking and enhanced index tracking on Brazil Ibovespa index and U.S. S&P 100 index. This paper pointed out that both methodologies are outperforming for index tracking portfolios, but no significant advantages turn towards neither method for enhanced index tracking. The authors constructed a series of portfolios consists of at most 10 stocks by different combinations between in sample and out of sample data intervals through both approaches. Then they found different patterns between Brazilian and U.S. stock markets. There is a trade-off between tracking performance and costs in Brazilian market, which is correlation based portfolios have larger average tracking errors, but smaller turnover values, on the other hand, cointegration based portfolios have smaller tracking errors, but higher turnover rates accompanied higher cost. However, no empirical evidences revealed the similar features on S&P 100 index, tracking results did no favor neither correlation nor cointegration.

Overall, this paper failed to find robust evidences to demonstrate different characterises of cointegration and correlation in passive portfolio management area. It is worth noting that all portfolios have only 10 assets, which may be a potential reason why this paper did not generate strong findings. We will build portfolios with relatively more stocks and compare between numbers of stocks.

# Research Design

# References