

Index Portfolio of 3D Printing

Lu Cao

I Investment Thesis

- (1) Underlying: a class of equities that are exposed to 3D Printing services and technologies
- (2) Weighting: use an optimal weighting schema to assign weights to each equity
- (3) Rebalancing: implement daily rebalancing based on updated metric data

II Content Universe

- (1) Companies exposed to 3D Printing from 3D Printing Business Directory
 - <https://www.3dprintingbusiness.directory/companies/>
- (2) List companies in the world from Yahoo Finance
 - <https://finance.yahoo.com/quote>
- (3) Stock prices and fundamental data from Bloomberg Terminal
- (4) Google Search and Google Trends

III Asset Selection Criteria

- (1) Listed companies & Exposed to 3D Printing services and technologies

Select listed companies that are exposed to 3D Printing services and technologies.

Information about all listed companies is from Yahoo Finance. Information about all companies exposed to 3D Printing services and technologies is from 3dprintingbusiness.com. Through string match, word match and google search verification, I successfully get company names and tickers of 87 listed companies from 3665 companies.



Figure 1: String Match Filter

Matched Companies 1.0

Matched Companies 2.0

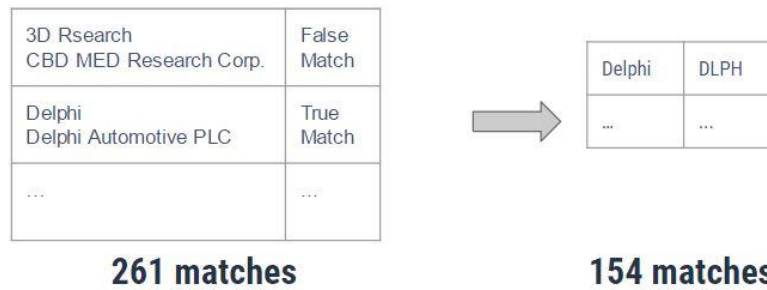


Figure 2: Word Match Filter

Matched Companies 2.0

Matched Companies 3.0

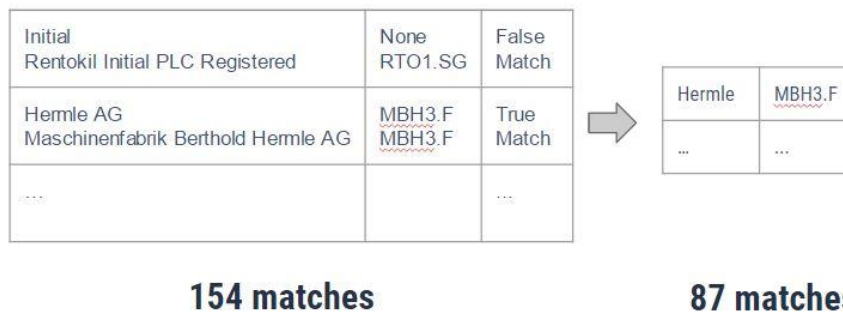


Figure 3: Google Search Match Verification

(2) Region

Select companies listed in United States to avoid the problem of different currency units and different market environments.

(3) Data Quality

Select companies with stocks whose data has smaller than 1% null and zero values. For data with small size missing data, we can use data imputing to clean data. However, for data with large size missing data, result based on it becomes much less reliable.

(4) Liquidity

Select companies with non-zero daily trading volume. Low-volume stocks are harder to buy or sell quickly and at the market price and they impose risks such as Challenges in fair price discovery, price manipulation possibility and etc.

(5) Volatility

Select companies with market cap above \$50 million to avoid the risk and volatility brought by small companies since events such as take out often occur for small companies.

IV Index Construction Methodology

Each of the index portfolio below will select the 28 stocks above and weight those constituent stocks by the metric below. The traditional market cap index works as a baseline.

Index Portfolio	Metric
Market-cap Weight Index	Market-cap
Price Weight Index	Close price
Equal Weight Index	Equal
Beta Weight Index	Beta
Revenue Weight Index	Trailing Revenue(3 months)

V Backtest

The time frame of backtest is from 2011-01-01 to 2017-09-22. Based on google trends, the popularity of 3d printing experienced sharp increase starting from 2011.

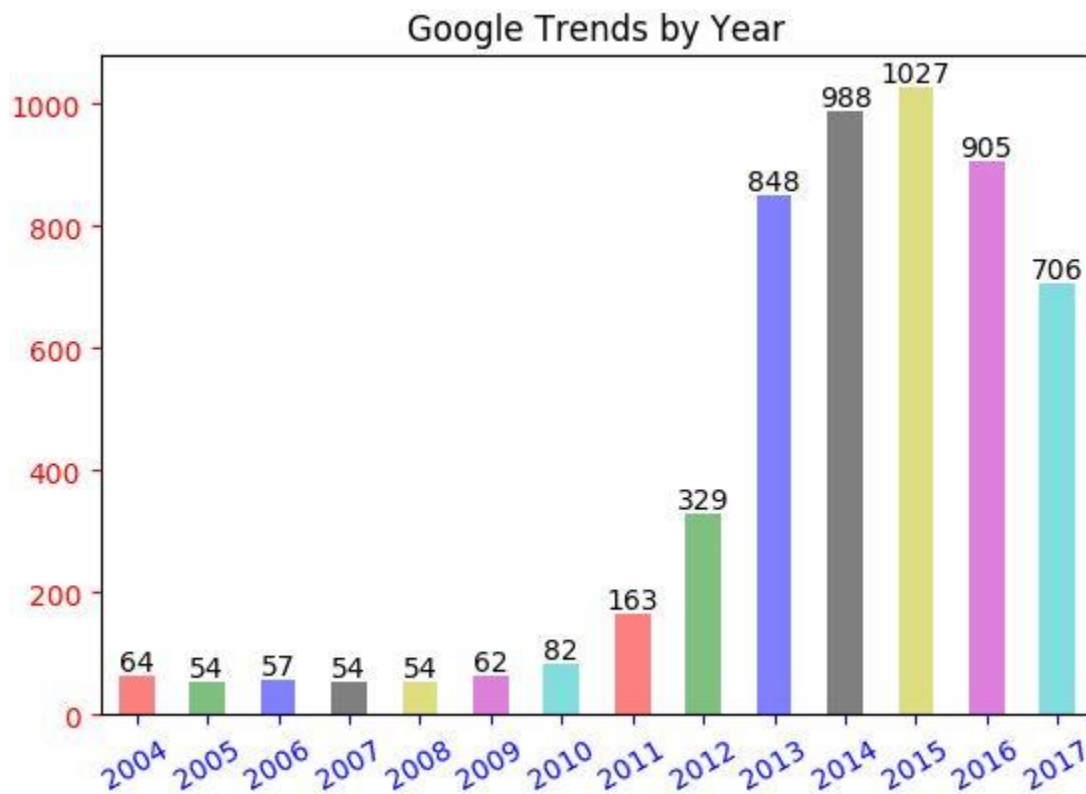


Figure 4 Google trends of "3d printing" by each year from 2004 to 2017

Below is a chart showing cumulative returns of each index type. The market-cap weight is at the top of the pack. It shows that alternative weights don't give us superior returns.

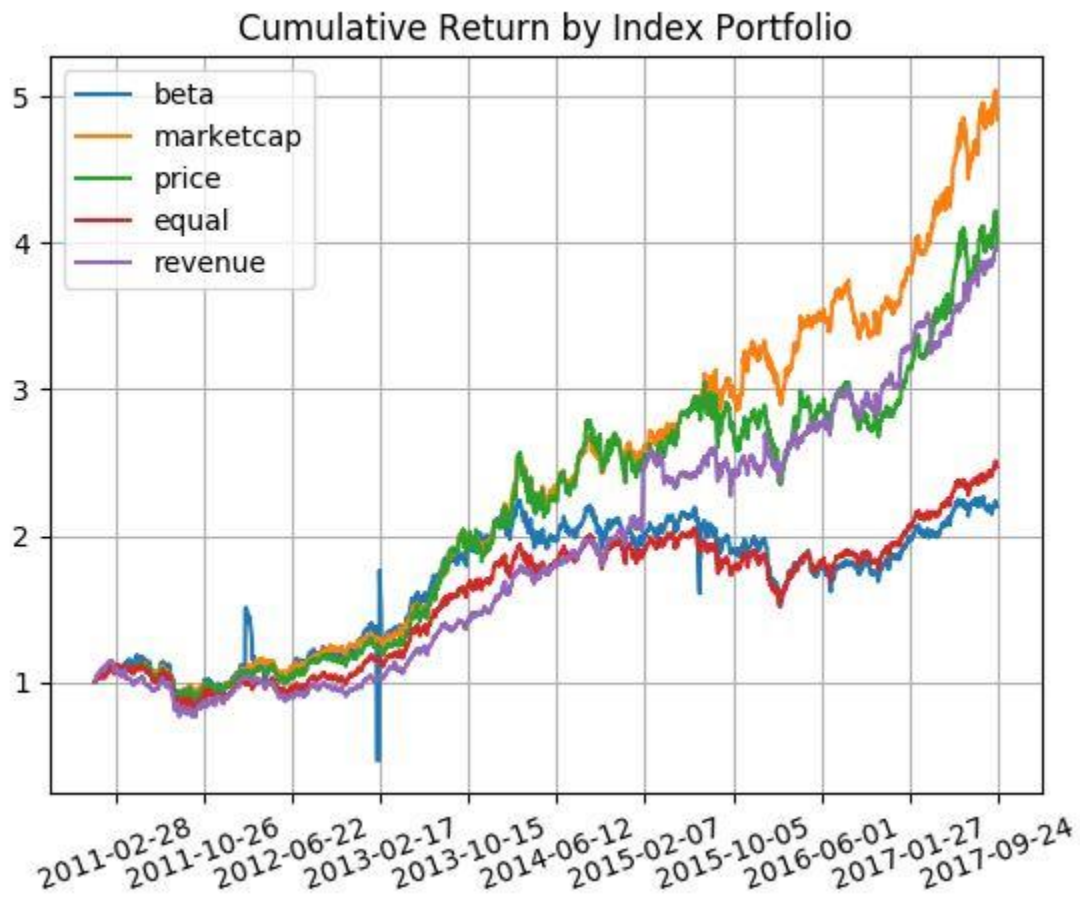


Figure 5 Cumulative return by index portfolio from 2010-01-01 to 2017-09-22

Below is a table showing the risk metrics of each index type. The market-cap weight gives the best cumulative return and Sharpe ratio and the smallest maximum drawdown and maximum daily loss.

Risk Metrics of Index Portfolio				
Index Portfolio	Cumulative Return	Sharpe Ratio	Max Drawdown	Max Daily Loss
Market-cap	4.84	1.18	23.56%	-6.66%
Revenue	3.95	1.00	33.66%	-7.32%
Price	4.00	0.85	24.86%	-6.59%
Equal	2.47	0.58	30.32%	-7.47%

Table 1 Risk metrics of index portfolio

VI Conclusion

Based on the backtest results, market-cap index portfolio has the best performance among other index alternatives from 2011-01-01 to 2017-09-22 with 484% cumulative return, 1.18 annualized Sharpe ratio, 23.56% max drawdown and -6.66% max daily loss.

In this project, the benefits of market-cap weighted strategy such as passive management liquidity and broad market participation overcomes its drawbacks such as overweighting overvalued equities. Other index alternatives don't provide a more effective barometer with which to gauge value than market cap.

VII Further Work

(1) Data Source

Refer to a better data source or multiple data sources to enhance data quality. Here I remove some equities due to poor data quality.

(2) Domain Knowledge

Apply domain knowledge to help do more sophisticated company selection.

(3) Portfolio Optimization

Employ portfolio optimization techniques to compute asset weights in a portfolio, such as mean variance optimization and Markowitz optimization. With a relatively large size of equities, the process would be very time consuming and we need to spend a lot time on optimal optimization method search and on parameter optimization.

Below shows a portfolio optimization demo using 3 tickers (SSYS, HPQ, DDD), 21-day lookback window and mean variance optimization. In this demo, portfolio optimization doesn't provide better performance.

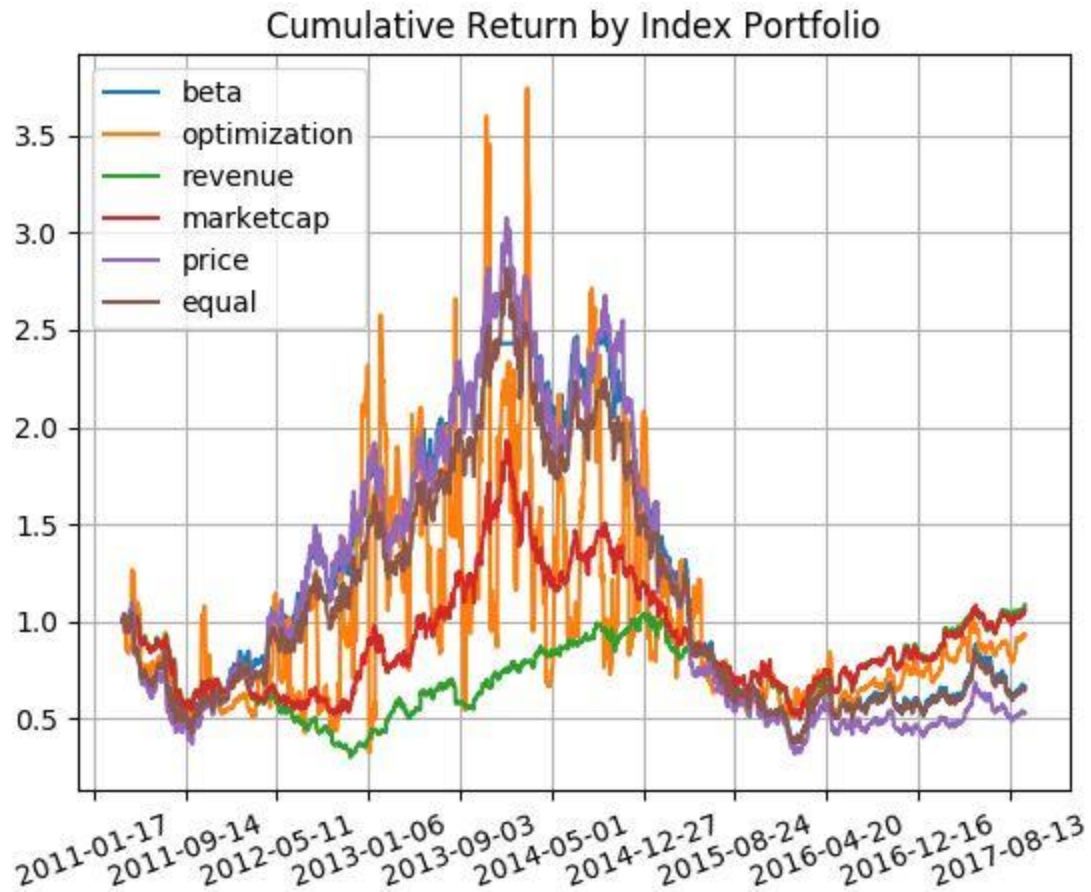


Figure 6 Portfolio optimization demo using SSYS, HPQ, DDD with 21-day lookback window and mean-variance optimization

VIII Reference

[1] Smart Beta Index Analysis in Python. (2016, June 10). Retrieved from <https://practicalquant.com/2016/06/10/whats-the-deal-with-smart-beta-indices/>