

Industry Asset Allocation Portfolio Analysis

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Abstract. Since the beginning of the 21st century, there have been many excellent fund managers, but excellent asset portfolios are rare. Therefore, it is of great interests to implement in-depth investigations on this issue. In this paper, Markowitz model and Index model are selected to measure the returns and volatility of ten different excellent assets to get a better result. At the same time, according to the preferences of different customers, five different constraints are selected to meet the characteristics of more groups. Based on this, this paper optimizes the asset portfolio. This result shows that: First, when the Markowitz model and the Index model are combined with the capital market line and the efficient frontier, it is very effective to apply it to the risk asset portfolio. Second, Alaska Air Group and Hawaiian Holdings tend to be short under various constraints, while Wells Fargo is the opposite. It is of great significance to the research on the optimal allocation of financial assets in the industry.

Keywords: Portfolio, Markowitz model, Index model, Constraint.

1. Introduction

Based on the Markowitz portfolio theory, investors can calculate the minimum variance portfolio and obtain the effective boundary when the average return rate and covariance matrix of each security in the security portfolio are known [1]. Today, almost everyone has investment needs, it is very necessary to provide everyone with an effective and reasonable investment portfolio. At the same time, the portfolio of risky assets is an essential part of financial research. Not only that, adding different constraints according to the requirements of different customers also provides the possibility for a better asset ratio, which makes the portfolio management attracting.

After a careful study of financial risk asset portfolios, this paper noticed that most of the current industry research focuses on the theory itself and individual assets for investing and hedging. For example, Medeiros in his paper says It consistently showed superior results when compared with the VW, EW and Markowitz portfolios even when transaction costs were included. Finally, it consider the parametric approach to be very flexible to the inclusion of constraints in weights, transaction costs and listing and delisting of stocks.[2] Also, Xing in his paper establish the first order asymptotics of the spectral risk measure of portfolio loss. [3] It can be seen that most of the research in the industry continues to dig deep into its connotation and extension on the basis of theory. And based on portfolio theory of Markowitz, we want to consider the influence on VaR by dependence when we use VaR to measure risk. [4] To some extent, it focuses on the theory and the formula itself. Actually, there are also researches on the application side in the industry, and most of their research are aimed at a specific field. The few peers who do portfolio research still have less portfolio research on the companies and stocks it choose. Zhou in her Research on the resource allocation model of university library based on Markowitz's investment theory. [5] And Neumann says the problem of parameter calibration is solved by applying an advanced tool for such floating car data systems, called “self-evaluation”. [6] The research of this article focuses on the application side, through the flexible use of a variety of theories to provide the industry with an excellent portfolio of risky assets. It flexibly combines Markowitz theory with real stocks to achieve a breakthrough leap.

Based on this, this paper carefully selected the stocks of these ten outstanding companies for asset allocation. By analyzing the data of ten stocks in the past ten years, the Annual Average Return, Annual Standard Deviation, Beta, Alpha and Residual Standard Deviation of these ten stocks can be obtained. Moreover, the correlation of each two stocks can be analyzed to obtain lots of valid data and build a matrix from it. This matrix can tell many things, it can hedge the risk within the portfolio

according to their positive correlation, negative correlation or no correlation to achieve lower volatility. At the same time, this paper found in the calculation that setting a constraint that does not contain SPX will make the portfolio have higher returns and risks, especially when compared to not setting any constraints.

The structure of this paper is as follows. Section 2 shows in detail the results of original processing of the initial data. Section 3 describes the results of this data processing and modeling using the Markowitz model and index model. Section 4 presents the constraints and the related results. Section 5 is the conclusion.

2. Data

Yahoo Finance and Investing are world-class in providing accurate industry information. And actually, they seldom go wrong. Based on this, all the data in the paper comes from Yahoo Finance (<https://finance.yahoo.com/>) and is double corroborated by the data retrieved from Investing (<https://cn.investing.com/equities/>). In order to ensure the reliability of the selected data, the data range in this paper is from 11/05/2001 to 05/12/2021. The paper transfer the date to Annualized average return and Annualized standard deviation and some basic information is shown in Table 1. Overall, these ten stocks have performed steadily in the past two decades. Good investors are always waiting, always patient, waiting for the market to confirm their judgment. In fact, the performance of these ten stocks in the market confirms their own strength. In order to facilitate the allocation and hedging of risk in this portfolio, the stocks selected in this paper are distributed in various fields with a large span.

Table 1. Descriptive statistics of the selected assets

	ADBE	IBM	SAP	BAC	C
Annual Return	19.578%	4.754%	11.996%	11.101%	1.032%
Annual StDev	31.790%	23.181%	33.909%	39.338%	42.470%
residual StDev	23.753%	17.627%	25.784%	31.403%	30.260%
	WFC	TRV	LUV	ALK	HA
Annual Return	8.888%	9.064%	9.849%	17.431%	26.872%
Annual StDev	28.133%	19.960%	31.796%	37.734%	62.074%
residual StDev	23.397%	16.004%	26.824%	33.435%	57.2%

As can be seen from Table 1, among these ten stocks, Hawaiian Holdings has the highest average return, and it also has the highest variance. In contrast, Citigroup has a stable return, but it still has a high variance. And Travelers, on the other hand, has a good return with the lowest risk factor. The returns and risks of stocks like Adobe and SAP are more balanced.

3. Method

The central theme of Markowitz's work is that investors conduct themselves in a rational manner which reflects their inherent aversion to absorbing increased risk without compensation by an adequate increase in expected return.[7] Investment in securities and other risky assets must first address two core issues: expected return and risk. So how to measure the risk and return of portfolio investment and how to balance these two indicators for asset allocation are the problems that market investors urgently need to solve. Typical portfolio optimization problems are extensions of the classical Markowitz mean-variance portfolio optimization model.[8] It is in this context that Markowitz's mean-variance model was born. Although various theories and models have been developed in the field of asset allocation today, Markowitz's theory can be called the "Ancestor" of the asset allocation.

This paper denote the fluctuating assets returns as:

$$\vec{r} = \{r_1, r_2, \dots, r_n\}^T. \quad (1)$$

Further, denote the averages of the above fluctuating assets returns as:

$$\vec{m} = \{\mu_1, \mu_2, \dots, \mu_n\}. \quad (2)$$

Where it denoted $\mu_i = \langle r_i \rangle$. If the set $\vec{w} = \{w_1, w_2, \dots, w_n\}$ is a set of unknown portfolio weights, then $R = \vec{r}^T \vec{w}$ is a portfolio fluctuating return and $M = \vec{\mu}^T \vec{w}$ is its average return. While, when denote as $\Sigma = \langle (\vec{r} - \vec{m})(\vec{r} - \vec{m})^T \rangle$ the variance-covariance matrix of our assets returns, then the expression for portfolio variance is the following quadratic form:

$$Var = \vec{w}^T \Sigma \vec{w} \quad (3)$$

Markowitz model contains two important contents: mean-variance analysis method and portfolio efficient frontier model. In the developed stock market, Markowitz's portfolio theory has been proved to be effective in practice and has been widely used in portfolio selection and asset allocation. For the first time, Markowitz accurately defined the two basic concepts of risk and return in investment management. Since then, both risk and return have been considered as two indispensable factors in describing reasonable investment goals.

Markowitz uses the expected value of investment return to express the investment rate of return and uses the variance or standard deviation to express the risk of return, solves the problem of risk measurement of assets, and believes that typical investors are risk averse, they are in pursuit of high expected returns while avoiding risks as much as possible. Accordingly, Markowitz provides a set of portfolio investment theory based on mean-variance analysis of maximizing utility.

In this paper, It use the following notations: $\vec{\mu} = \{\mu_1, \mu_2, \dots, \mu_n\}^T$ is the set of instruments' average returns; $\vec{w} = \{w_1, w_2, \dots, w_n\}$ is the unknown set of instruments' weights; $\vec{\sigma} = \{\sigma_1, \sigma_2, \dots, \sigma_n\}^T$ is the set of instruments' standard deviations; $\vec{\beta} = \{\beta_1, \beta_2, \dots, \beta_n\}^T$ is the set of instruments' betas; $\{\sigma(\varepsilon_1), \sigma(\varepsilon_2), \dots, \sigma(\varepsilon_n)\}^T$ is the set of the residuals' standard deviations; $\vec{v} = \{w_1\sigma_1, w_2\sigma_2, \dots, w_n\sigma_n\}^T$ is an auxiliary vector; and

$$P = \begin{pmatrix} \rho_{11} & \rho_{12} & \dots & \rho_{1n} \\ \rho_{21} & \rho_{22} & \dots & \rho_{2n} \\ \dots & \dots & \dots & \dots \\ \rho_{n1} & \rho_{n2} & \dots & \rho_{nn} \end{pmatrix} \quad (4)$$

is the matrix of instruments' cross-correlation coefficients. This paper uses more formula for the MM portfolio return:

$$r_P = \vec{w} \cdot \vec{\mu}^T \quad (5)$$

And the formula for the MM portfolio standard deviation:

$$\sigma_P = \sqrt{\vec{v} P \vec{v}^T} \quad (6)$$

Similar to above, in the Index model, this paper uses more formula for the IM portfolio return:

$$r_P = \vec{w} \cdot \vec{\mu}^T \quad (7)$$

And the formula for the IM portfolio standard deviation:

$$\sigma_P = \sqrt{(\sigma_M \beta_P)^2 + \sum_{i=1}^n w_i^2 \sigma^2(\varepsilon_i)} \quad (8)$$

Where it have denoted $\beta_P = \vec{w} \cdot \vec{\beta}^T$ as the portfolio beta. Actually, when an investor is equally ambiguous about all assets, then the optimal portfolio corresponds to Markowitz's fully diversified portfolio.[9]

4. Result

By calculating and observing the correlation coefficient matrix between these ten stocks, it shows that the correlation coefficient of BAC and CitiGroup is the highest among all pairwise combinations, which is convenient to conduct research in the same field or fields with the same interest relationship invest. The correlation coefficient between Adobe and HA holding is the lowest in the portfolio. If investor buy and short these two stocks at the same time, you can well achieve risk hedging, reduce the overall risk of the portfolio, and reduce the potential tail to a certain extent. huge losses due to risk.

Table 2. Correlation coefficient between ten stocks

	SPX	ADBE	IBM	SAP	BAC	C	WFC	TRV	LUV	ALK	HA
SPX	1	0.665	0.649	0.649	0.602	0.702	0.555	0.598	0.537	0.464	0.390
ADBE	0.665	1	0.455	0.534	0.423	0.463	0.298	0.452	0.388	0.233	0.180
IBM	0.649	0.455	1	0.585	0.313	0.420	0.267	0.382	0.347	0.357	0.246
SAP	0.649	0.534	0.585	1	0.331	0.434	0.298	0.375	0.318	0.282	0.144
BAC	0.602	0.423	0.313	0.331	1	0.826	0.761	0.393	0.428	0.275	0.338
C	0.702	0.463	0.420	0.434	0.826	1	0.703	0.512	0.428	0.304	0.343
WFC	0.555	0.298	0.267	0.298	0.761	0.703	1	0.345	0.406	0.347	0.358
TRV	0.598	0.452	0.382	0.375	0.393	0.512	0.345	1	0.407	0.360	0.240
LUV	0.537	0.388	0.347	0.318	0.428	0.428	0.406	0.407	1	0.519	0.422
ALK	0.464	0.233	0.357	0.282	0.275	0.304	0.347	0.360	0.519	1	0.404
HA	0.390	0.180	0.246	0.144	0.338	0.343	0.358	0.240	0.422	0.404	1

The follows is the purpose of setting these five constraints:

Constraint1: In the real securities market, customers deposit a certain amount of funds in the designated trading account opened for on-exchange transactions as a guarantee for securities dealers and traders to buy and sell securities on their behalf. The essence of the margin is that the client promises to the securities firm that he has sufficient funds for the securities firm to act on his behalf to buy and sell securities, and he bears the adverse consequences of his designated transactions within the scope of the margin, so it is essentially a kind of capital. The limit is the credit guarantee in the form of expression. Under normal circumstances, margin is crucial and necessary. Considering this situation, this combination requires users to have a certain percentage of the deposit in Constraint1.

Constraint2: There are a thousand Hamlets in a thousand readers, and the same is true in finance. Every investor and account manager has his own preference and unique style, for this reason, this combination has set up this special "box".

Constraint3: In the absence of restrictions, the characteristics of each stock itself can be brought into full play in the portfolio.

Constraint4: In some markets, short-selling is not allowed in these markets because the financial system is not sound enough and there are few types of financial derivatives. For example, China's A-share market. In order for investors in these markets to have a good portfolio, this article sets up Constraint4 for them - no shorting allowed.

Constraint5: The SPX benchmark is often used for sound investments and is often used in investment portfolios to reduce the risk factor of the portfolio. This Cons is intended to explore whether the portfolio can achieve higher returns or achieve lower risk without adding SPX.

Through the flexible application of the above theories, it draws a diagram of the effective frontier and different constraints.

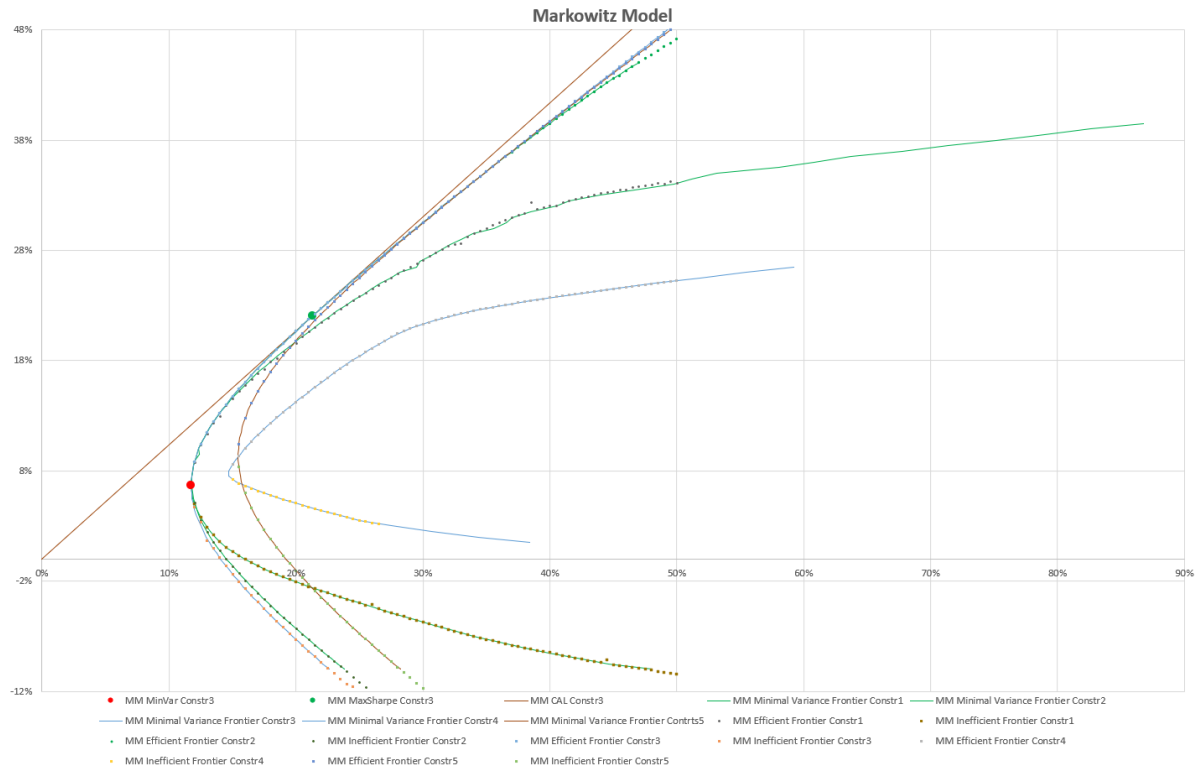


Figure 1. Effective frontiers under different constraints for mean-variance model

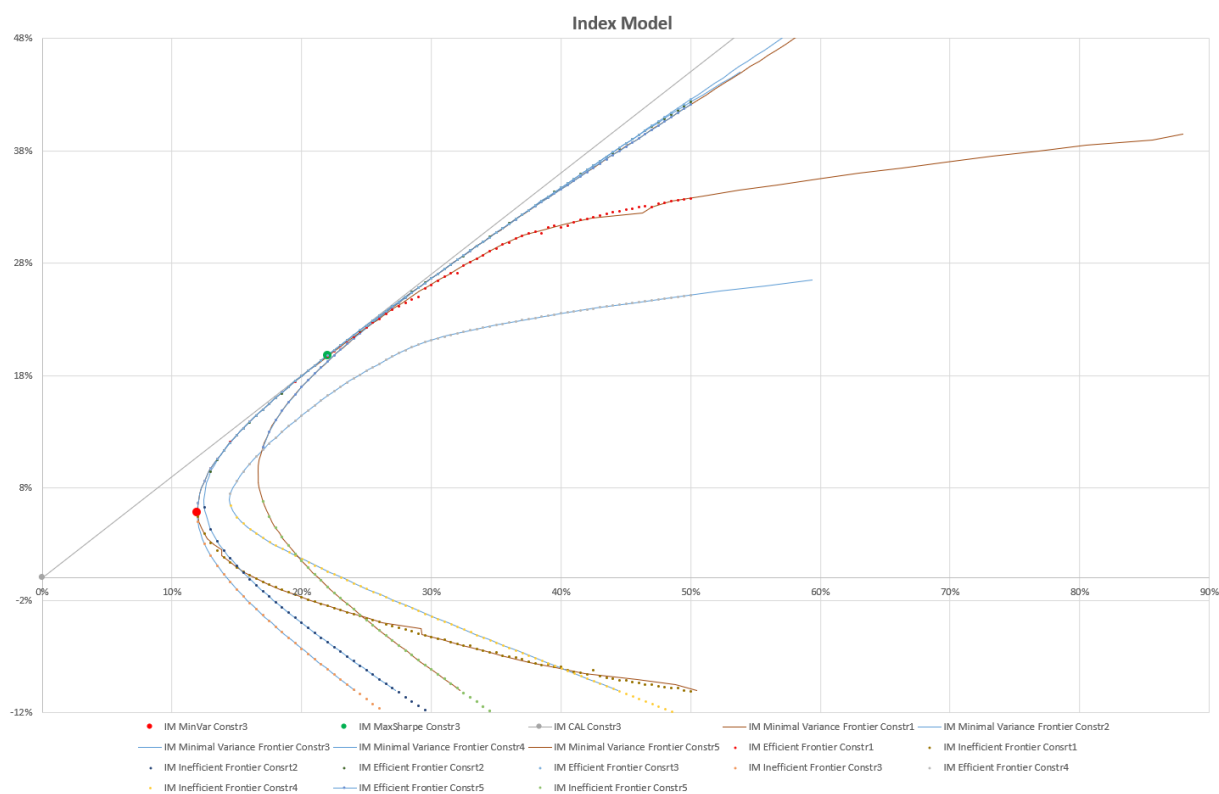


Figure 2. Effective frontiers under different constraints for index model

Table 3. Portfolio performance of Markowitz model

MM (Constr1): Return StDev Sharpe SPX							
MinVar	10.52%	11.31%	0.931	18.86%	CAL:	0.0%	0.0%
MaxSharpe	15.78%	13.02%	1.212	41.25%	2.5	39.4%	32.5%
MM (Constr2): Return StDev Sharpe SPX							
MinVar	10.52%	11.31%	0.931	18.86%	CAL:	0.0%	0.0%
MaxSharpe	19.15%	15.25%	1.255	92.00%	2.5	47.9%	38.1%
MM (Constr3): Return StDev Sharpe SPX							
MinVar	10.52%	11.31%	0.931	18.86%	CAL:	0.0%	0.0%
MaxSharpe	19.15%	15.25%	1.255	92.00%	2.5	47.9%	38.1%
MM (Constr4): Return StDev Sharpe SPX							
MinVar	10.71%	11.53%	0.928	2.78%	CAL:	0.0%	0.0%
MaxSharpe	13.49%	12.65%	1.067	0.00%	2.5	33.7%	31.6%
MM (Constr5): Return StDev Sharpe SPX							
MinVar	11.27%	11.38%	0.991	0.00%	CAL:	0.0%	0.0%
MaxSharpe	15.26%	13.23%	1.153	0.00%	2.5	38.1%	33.1%
MM (Constr1): ADBE IBM SAP BAC C							
MinVar	-6.53%	-4.19%	8.72%	7.05%	-6.09%		
MaxSharpe	-2.98%	-2.41%	26.12%	25.13%	-3.28%		
MM (Constr2): ADBE IBM SAP BAC C							
MinVar	-6.53%	-4.19%	8.72%	7.05%	-6.09%		
MaxSharpe	-4.01%	-2.45%	34.58%	32.58%	-3.05%		
MM (Constr3): ADBE IBM SAP BAC C							
MinVar	-6.53%	-4.19%	8.72%	7.05%	-6.09%		
MaxSharpe	-4.01%	-2.45%	34.58%	32.58%	-3.05%		
MM (Constr4): ADBE IBM SAP BAC C							
MinVar	0.00%	0.00%	8.42%	6.15%	0.00%		
MaxSharpe	0.00%	0.00%	20.99%	20.53%	0.00%		
MM (Constr5): ADBE IBM SAP BAC C							
MinVar	-5.19%	-3.21%	10.30%	8.35%	-4.02%		
MaxSharpe	-10.26%	-7.03%	25.95%	25.24%	-12.66%		
MM (Constr1): WFC TRV LUV ALK HA							
MinVar	18.74%	39.12%	5.82%	13.89%	4.61%		
MaxSharpe	19.67%	35.38%	19.77%	-0.06%	23.89%		
MM (Constr2): WFC TRV LUV ALK HA							
MinVar	18.74%	39.12%	5.82%	13.89%	4.61%		
MaxSharpe	32.64%	45.38%	32.23%	-9.85%	33.94%		
MM (Constr3): WFC TRV LUV ALK HA							
MinVar	18.74%	39.12%	5.82%	13.89%	4.61%		
MaxSharpe	32.64%	45.38%	32.23%	-9.85%	33.94%		
MM (Constr4): WFC TRV LUV ALK HA							
MinVar	14.95%	39.49%	6.06%	15.88%	6.26%		
MaxSharpe	4.26%	26.09%	8.38%	0.00%	19.76%		
MM (Constr5): WFC TRV LUV ALK HA							
MinVar	21.41%	41.12%	9.08%	15.72%	6.43%		
MaxSharpe	19.74%	35.93%	15.93%	-16.86%	24.02%		

Table 4. Portfolio performance of Index model

IM (Constr1): Return StDev Sharpe SPX							
MinVar	10.53%	10.64%	0.989	3.14%	CAL:	0.0%	0.0%
MaxSharpe	15.18%	12.21%	1.243	-47.52%	2.5	37.9%	30.5%
IM (Constr2): Return StDev Sharpe SPX							
MinVar	10.53%	10.64%	0.989	3.14%	CAL:	0.0%	0.0%
MaxSharpe	17.67%	13.75%	1.285	100.00%	2.5	44.2%	34.4%
IM (Constr3): Return StDev Sharpe SPX							
MinVar	10.53%	10.64%	0.989	3.14%	CAL:	0.0%	0.0%
MaxSharpe	17.78%	13.83%	1.286	102.30%	2.5	44.5%	34.6%
IM (Constr4): Return StDev Sharpe SPX							
MinVar	10.40%	10.81%	0.963	0.00%	CAL:	0.0%	0.0%
MaxSharpe	13.27%	12.21%	1.087	0.00%	2.5	33.2%	30.5%
IM (Constr5): Return StDev Sharpe SPX							
MinVar	10.65%	10.65%	1.001	0.00%	CAL:	0.0%	0.0%
MaxSharpe	13.74%	12.09%	1.136	0.00%	2.5	34.4%	30.2%
IM (Constr1): ADBE IBM SAP BAC C							
MinVar	-1.07%	-2.36%	9.84%	5.31%	-6.43%		
MaxSharpe	-0.03%	-0.04%	25.87%	22.23%	-2.33%		
IM (Constr2): ADBE IBM SAP BAC C							
MinVar	-1.07%	-2.36%	9.84%	5.31%	-6.43%		
MaxSharpe	1.73%	1.63%	32.27%	28.05%	-0.66%		
IM (Constr3): ADBE IBM SAP BAC C							
MinVar	-1.07%	-2.36%	9.84%	5.31%	-6.43%		
MaxSharpe	1.87%	1.76%	32.56%	28.32%	-0.47%		
IM (Constr4): ADBE IBM SAP BAC C							
MinVar	0.00%	0.00%	8.77%	4.29%	0.00%		
MaxSharpe	0.00%	0.00%	21.74%	19.03%	0.00%		
IM (Constr5): ADBE IBM SAP BAC C							
MinVar	-0.83%	-2.16%	10.11%	5.54%	-6.14%		
MaxSharpe	-5.91%	-4.71%	23.52%	20.54%	-9.91%		
IM (Constr1): WFC TRV LUV ALK HA							
MinVar	12.55%	38.16%	-0.08%	26.10%	14.84%		
MaxSharpe	17.99%	34.11%	10.09%	11.15%	28.48%		
IM (Constr2): WFC TRV LUV ALK HA							
MinVar	12.55%	38.16%	-0.08%	26.10%	14.84%		
MaxSharpe	28.03%	38.72%	18.39%	15.86%	35.98%		
IM (Constr3): WFC TRV LUV ALK HA							
MinVar	12.55%	38.16%	-0.08%	26.10%	14.84%		
MaxSharpe	28.40%	38.88%	18.71%	15.98%	36.29%		
IM (Constr4): WFC TRV LUV ALK HA							
MinVar	10.32%	37.87%	0.00%	25.19%	13.55%		
MaxSharpe	6.28%	27.50%	1.73%	1.38%	22.34%		
IM (Constr5): WFC TRV LUV ALK HA							
MinVar	13.07%	38.47%	0.32%	26.45%	15.18%		
MaxSharpe	11.54%	29.18%	5.90%	4.97%	24.88%		

We construct portfolios whose out-of-sample performance, as measured by Sharpe ratio, is consistently and significantly better than that of the naïve portfolio comprising equal investments in each available asset.[10]Overall, Constraint1, 2, 3, 5 present a near coincidence of CAL, from the picture, the line of Constraint 2 and Constraint 5 are covered with the orange line(constraint 3), their slope, which is the Sharpe Ratio, is all 1.03 approximately which is greater than that of Constraint 4. This means that although the short sales constraint plays an important role in reducing investment risks and diluting the excessive speculative atmosphere of investors, it reduces the overall return rate meanwhile. In the example in the figure, the return corresponding to the short sales constraint drops by about 28% compared with that corresponding to the other four constraints.

In addition, it has two specific lines: Constraint 3 and 5. One is no constraints, the other is setting the weight of SPX to zero. As depicted in the line chart, even though the two lines overlap almost completely, with slopes of 1.03 and 1.02 respectively, this paper infer that whether or not it include inclusion of the broad index in this portfolio has very little impact on these returns.

5. Conclusions

This research is to organically combine the original theoretical research in the financial industry and apply it to practice. It is a breakthrough and innovative change that implements theoretical research into empirical research. But everything is not absolute, as it may be meaningful to choose a good stock than to adjust the weight of the portfolio.[11] Perhaps this research will provide the industry with a better portfolio idea. This paper found that airlines represented like LUV and ALK are mostly in buy positions in the calculated portfolio. At the same time, companies such as ADOBE and IBM recommend selling and shorting. Among the ten results of the five Constraints of the two models presented in this article, the proportion of SPX and WFC are more sensitive to the changes of Constraint.

However, deficiencies exist. For example, a dynamic correlation is often assumed in empirical finance, this paper adopts a constant correlation for calculation, thus, adopting alternative methods to explore portfolio management deserves further investigations.

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