

How does investment portfolio change in pre and post epidemic era?--experience from Chinese medical and pharmaceutical industry

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Abstract. The exogenesis shock, the Covid-19 epidemic, is considered as a big shock in the financial market. The paper discussed how the investment portfolio comprising of the top ten medical and pharmaceutical stocks, changes before and after the break of epidemic. Three constraints are taken into consideration to provide more information to investors. Also, the Medical and Pharmaceutical Index instead of the market return ratio is considered as standard, allowing it much closer to the reality. The research finds that the investors have greater confidence on medical and pharmaceutical industry in the post-epidemic era than in the pre-epidemic era, presented by higher annualized average return and lower Sharpe ratio. The research of this paper will provide some portfolio-construction experience under the global negative shock. At the same time, it is also worth noting that this paper mainly focused on the changes of portfolios with the aim of creating the maximum Sharpe ratio and the minimum standard deviation under certain constraints, whose results showed that the market are having growing confidence in the medical and pharmaceutical industry in the post-epidemic era and more capital is flowing to the corporations with out-standing performance in the anti-epidemic period.

Keywords: Covid-19; Epidemic Medical and Pharmaceutical Industry; Index Model.

1. Introduction

Since the beginning of 2020, the break of epidemic has become the biggest global crisis since the World-War II. The high variability, invisibility and infectivity of the new virus make locking-down one of the main means for prevention and control. Therefore, the daily production and operation activities of corporations are hampered under a series of anti-epidemic policies. Also, the break of Covid-19 had great negative impact on both people's life, by the end of March 2022, causing more than six million deaths [1], and the market activities, such high unemployment, low-interest rate and illiquidity environment, like the U.S. bond market [2], even many large equity drawdowns during the period, and so on. Such topics are widely researched by many scholars. Based on such a special global shock, a model framework is developed, which can even fit into the price and quantity changes of treasury securities [3]. It is obviously that in March 2020, the yields of CMT drop sharply and the one of VIX soared to a high point, which might reflect people's worries concerning the negative impact of the unknown epidemic. Some papers discovered investors' behavior. For instance, it is found that the relatively important part of the mutual fund sectors sold through life insurers can be subject to the mismatch of risk through minimum return guarantees and those life insurers are getting much closer to pension funds [4], which showed the fragility of market; it is also found that Robinhood investors performed well all the way in the cross section and earned positive alphas, abnormal return, regarding to the risk-free rate, even in the bear market during the post-epidemic era. And some uncovered the behaviors of corporates [5]. For instance, it is revealed that the stock market positively priced small amounts of managerial ownership but priced high levels of managerial ownership during the pandemic period negatively [6]. And even how a country's financial constraints would negatively impact its resilience to economic shocks is discussed [7].

However, this paper finds that the pharmaceutical industry actually had a better performance during the post-epidemic era compared to the time before the pandemic. This might be because medicine and pharmaceutical industry is treated as hedging instrument, which has a lower risk and weaker economic period, generally speaking. According to figure 2, it can be clearly recognized that

the annualized average return of it rise while the annualized standard deviation of it declines. It really interested me that pharmaceutical industry has such a converse trend against the whole market trend. Although it is reasonable to some extent for people's growing demand for hygiene products, it still makes us wonder what changes of behavior people who focused their investment portfolio on pharmaceutical or medicine industry all the way might have before and after the epidemic.

To note that this paper defines pre-epidemic era from Mar 2012 to Dec 2021, and post-epidemic era from Dec 2019 to Dec 2021. It begins in Mar 2012 and end in Dec 2021 because the medicine index provided by China Security starts in 2012 and the most up-to-date annualized data available end in 2021.

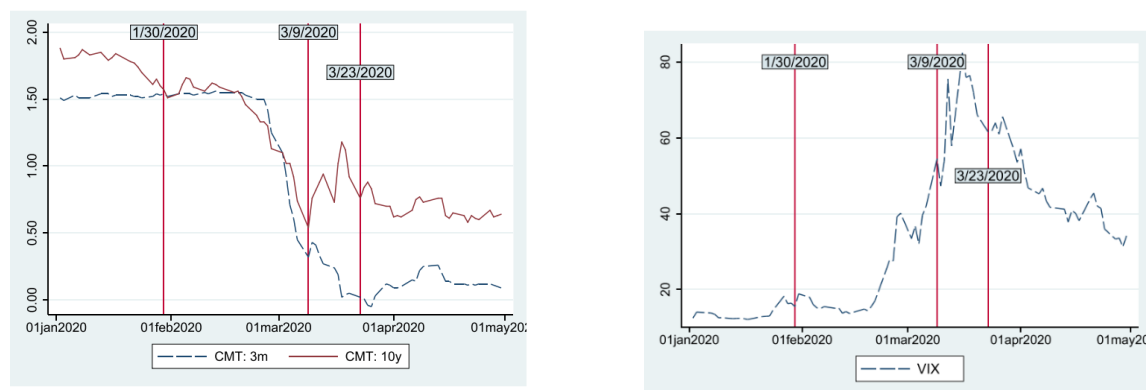


Fig. 1 Constant Maturities Treasury and Volatility Index

Note: This figure shows the return of three-month and ten-year Constant Maturities Treasury (CMT), and the Volatility Index of them, covering the time from Jan 1, 2020 to Jun 30, 2020, half the year in total. [3]

Table 1. Comparison of Key Statistics between pre and post epidemic

	Med Index	Yunnan Baiyao	Fosun Pharma	China Medicine	Shanghai Medicine	Hengrui Medicine
Before						
Annualized Average Return	-1.951	-1.951	-1.882	-1.985	-1.967	-1.718
Annualized Standard Deviation	0.304	0.386	0.386	0.384	0.363	0.352
After						
Annualized Average Return	-1.443	-1.603	-1.071	-0.802	-1.432	-1.624
Annualized Standard Deviation	0.284	0.280	0.744	1.478	0.341	0.386

Table 1. Comparison of Key Statistics between pre and post epidemic (continued)

	Kyushu Tong	Guangzhou Pharmaceutical	Changchun hi tech	Beijing Tongrentang	Renfu Medicine
Before					
Annualized Average Return	-2.023	-1.874	-1.679	-1.927	-1.984
Annualized Standard Deviation	0.356	0.452	0.448	0.419	0.373
After					
Annualized Average Return	-1.528	-1.513	-1.397	-1.197	-1.283
Annualized Standard Deviation	0.224	0.272	0.545	0.434	0.477

2. Data

This paper used revenue data from seasonal reports and monthly stock-price data of the companies, and all data is downloaded from CSMAR.

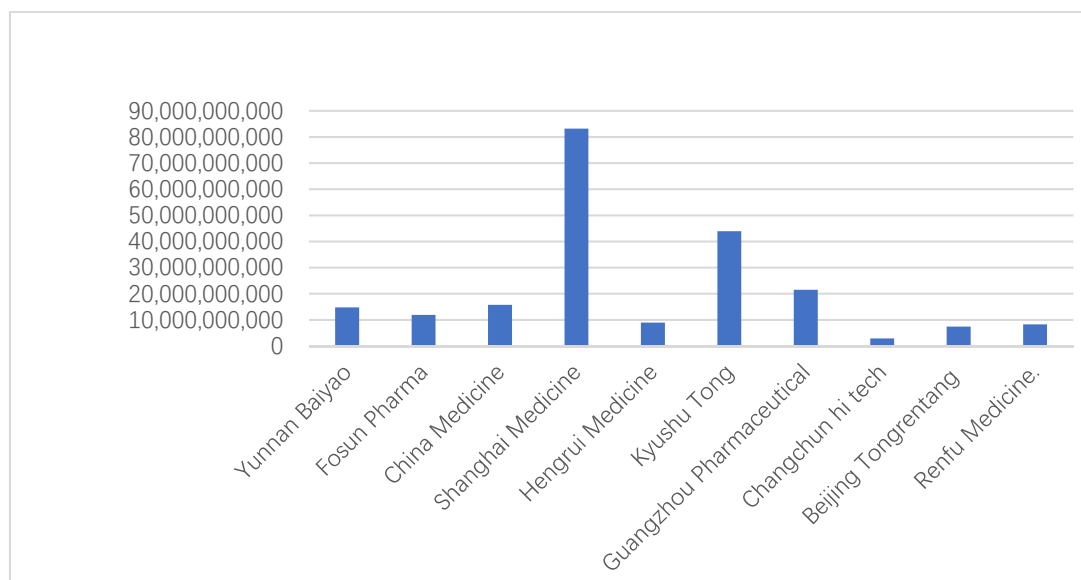


Fig. 2 Annualized Average Revenue, Mar 2012 – Dec 2021

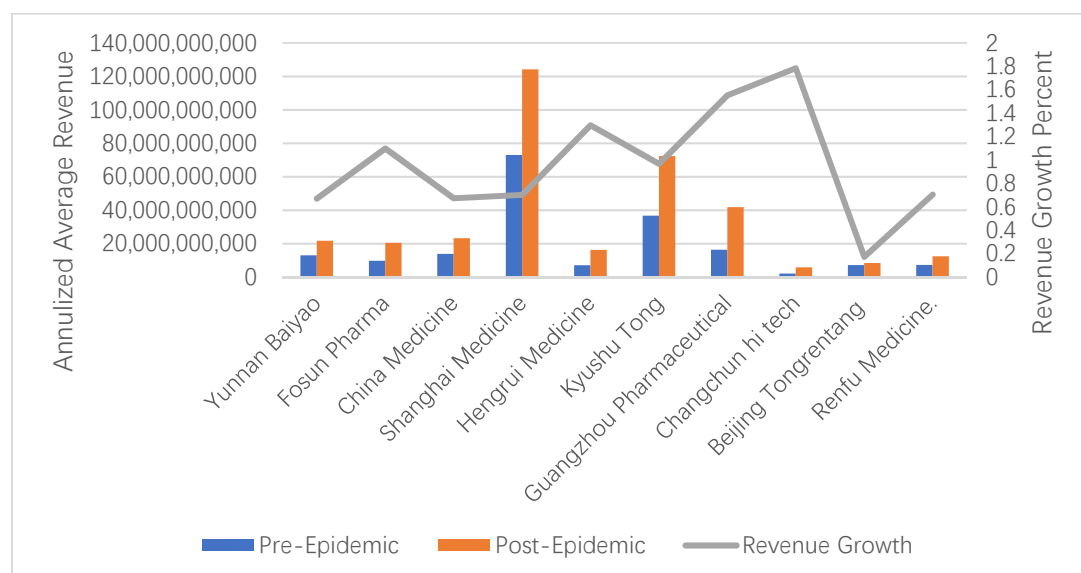


Fig.3 Comparison of Annualized Average Revenue between pre and post epidemic

The paper selected ten of the most outstanding medicine companies, which are Yunnan Baiyao, Fosun Pharma, China Medicine, Shanghai Medicine, Hengrui Medicine, Kyushu Tong, Guangzhou Pharmaceutical, Changchun hi tech, Beijing Tongrentang and Renfu Medicine. The reason why they are selected is that they are industry leaders in the medicine industry, and therefore be representative in the change before and after the Covid19 epidemic, which started in Dec.2019. According to figure2, it is found that the annualized revenue of all those leading pharmaceutical companies grew. The most out-standing revenue growth percentage is performed by Changchun hi-tech, which reached round 178.4%, and even the lowest growth percent has reached about 17.3%. It is also worth to be mentioned that the average revenue growth ratio is about 96.24%, almost double the pre-epidemic revenue.

It is obvious that the average annualized revenue earned by Shanghai Medicine is far ahead, nearly twice as much as Kyushu Tong, ranking the second place.

Table 2. Standard Deviation of Stock Price

Yunnan Baiyao	Fosun Pharma	China Medicine	Shanghai Medicine	Hengrui Medicine	Kyushu Tong	Guangzhou Pharmaceutical	Changchun hi tech	Beijing Tongrentang	Renfu Medicine
10.168%	13.856%	22.947%	9.313%	9.180%	8.606%	11.618%	12.700%	11.358%	10.842%

According the standard deviation of the stock price, China Medicine fluctuated most violently while Kyushu Tong is the smoothest one. The average Standard Deviation is 12.059% (the medicine index excluded), indicating that all the top companies, but Fosun Pharma and China Medicine, have a relatively small fluctuation.

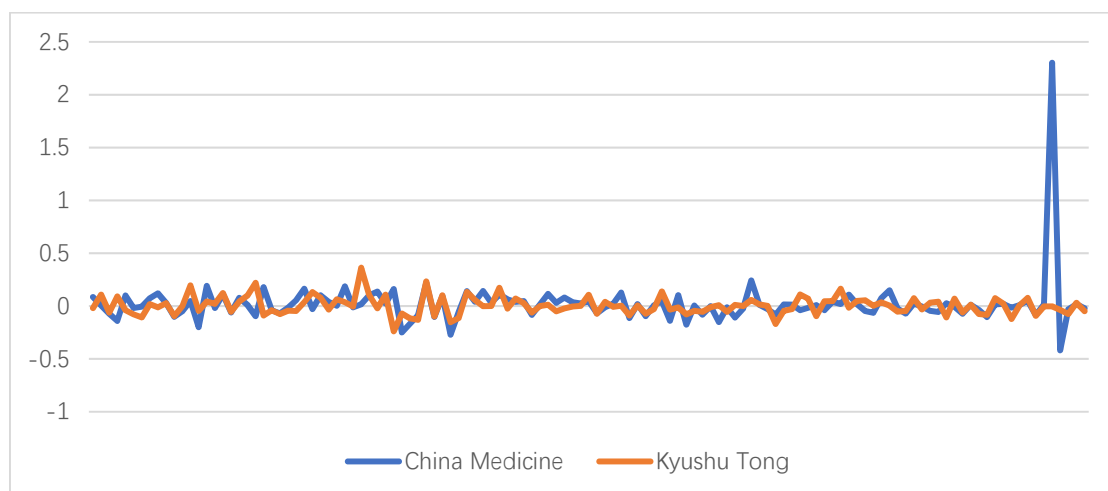


Fig. 4 Stock Price Trend

From the stock price trend, it is clear that the reason why China Medicine had the most violent fluctuation is that in the post-epidemic era, it is viewed to be outstanding and thus had a high-point.

3. Index Model

The index model, also known as the Fuzzy Suitability Model, is a probabilistic representation of nominal data. Values in the form of interval or ratio-scaled variables represent the level of certainty that a feature belongs to a nominal class. In a series of published papers, there are numerous ways proposed in order to optimize the accuracy of estimation. For instance, a constant correlation model consisting of a single group or multiple groups and a diagonal form of multi-index model [8] [9] [10]. In this paper, the Sharpe's single index model with different constraints will be applied. Last but the not least, unlike some paper concentrating on making prediction of the portfolios' future performance or the fluctuation in the stock market, the paper is going to calculate the expected return and its corresponding standard deviation under maximum Sharpe ratio and expected return and its corresponding Sharpe ratio under minimum standard deviation [11].

3.1 Components

The Index Model specifies two sources of uncertainty for a security's return. One is systematic (macroeconomic) uncertainty (which is assumed to be well represented by a single index of stock returns). The other is unique (microeconomic) uncertainty (which is represented by a security-specific random component)

The Index Model is more useful and closer to the reality because it takes into more than market factors into consideration. To be more specific, the more realistic model than the single index model, should allow the systematic risk to be driven by several factors. Also, the Index Model allow us to

derive the optimal portfolio for asset allocation (the tangent portfolio) by reducing the necessary inputs to the Markowitz Portfolio selection procedure. And it is described as follow:

$$R_i = \alpha_i + \beta_i R_m + e_i \quad (1)$$

Where R_i is the excess return of the company i , which equals to the return minus risk-free return. α_i is the residual return of the company i , which equals to the excess return minus the corresponding return ratio in CAL. β_i is the systematic risk, which is measured by the company risk to the market risk. And the risk is measured by standard deviation. R_m is the excess return of medicine index return minus risk free return. e_i indicates the unique risk of the company.

3.2 Assumptions

The index model has such two main assumptions mentioned here. The first one is that the covariance between excess return of market and the unique risk of the corporate is zero, indicating that the unique risk of the corporate is independent of whole market.

$$\text{Cov}(e_i, R_m) = 0 \rightarrow E[e_i - E(e_i)][R_m - E(R_m)] \rightarrow E[e_i][R_m - E(R_m)] = 0 \quad (2)$$

Another assumption is that the unique risk of corporate is totally independent of each other.

$$\text{Cov}(e_i, e_j) = 0 \quad (3)$$

3.3 Constraints

3.3.1 Constraint1: free problem

There is no constraint here. This is the situation without any additional optimization constraints, to illustrate how the area of permissible portfolios in general and the efficient frontier in particular look like if you have no constraints

3.3.2 Constraint2: $w_i \geq 0$

Under constraint2, no short available, the portfolio gets more concentrated. This additional optimization constraint is designed to simulate the typical limitations existing in the U.S. mutual fund industry: a U.S. open-ended mutual fund is not allowed to have any short positions, for details see the Investment Company Act of 1940, Section 12(a)(3). And it is also worth to be discussed under Chinese stock market background: $w_i \geq 0$, for $\forall i$.

3.3.3 Constraint3: $w_1 = 1$

Under constraint3, all stock should be divided among the real market stock, except for medicine market index. This paper would likely to reveal if the inclusion of the broad index into our portfolio has positive or negative effect, for that we would like to consider an additional optimization constraint: $w_1 = 0$.

4. Results

The paper compared the investment portfolio, which is consist of the same stock, between pre and post epidemic era. To notify that the medicine index produced by China Security rather than market index is selected, which is much closer to reality since the paper chose pharmaceutical enterprises as the analytical objects. The Medicine and Pharmaceutical Index is composed of 300 pharmaceutical stocks from Shanghai & Shenzhen exchange and 500 pharmaceutical stocks from Chinese Security. In this part, three constraints mentioned above are discussed, and those constraints will be considered in pre and post epidemic era respectively under the situations of minimum variance and maximum sharpe ratio.

4.1 Minimum Variance

Table 3. Weights of the Portfolio Under Minimum Variance

	Med Index	Yunnan Baiyao	Fosun Pharma	China Medicine	Shanghai Medicine	Hengrui Medicine
Before						
constrain1	0.520	0.113	0.025	0.068	0.048	0.060
constrain2	0.331	0.115	0.025	0.070	0.049	0.061
constrain3	0.000	0.155	0.079	0.118	0.122	0.148
After						
constrain1	1.288	0.000	-0.003	-0.230	-0.001	-0.026
constrain2	0.000	0.000	0.000	0.000	0.000	0.000
constrain3	0.000	0.031	0.009	-0.377	0.044	0.802

Table 3. Weights of the Portfolio Under Minimum Variance (continued)

	Kyushu Tong	Guangzhou Pharmaceutical	Changchun hi tech	Beijing Tongrentang	Renfu Medicine
Before					
constraint1	0.277	0.019	-0.128	-0.048	0.047
constraint2	0.282	0.019	0.000	0.000	0.651
constraint3	0.315	0.047	-0.086	-0.004	0.710
After					
constraint1	0.000	0.000	-0.002	-0.003	1.034
constraint2	1.000	0.000	0.000	0.000	0.000
constraint3	0.022	0.049	0.019	0.059	0.429

Table 4. Key Statistic of the Portfolio Under Minimum Variance

	Return	Standard Deviation	Sharpe Ratio
Before			
constraint1	-1.994	0.287	-6.943
constraint2	-1.959	0.290	-6.755
constraint3	-1.963	0.290	-6.766
After			
constraint1	-1.558	0.004	-418.013
constraint2	-0.505	0.337	-1.498
constraint3	-1.385	0.016	-88.813

In constraint1, the weights of medicine-industry index in the portfolio before and after the epidemic change from 0.518 to 1.288 and the minimum standard deviation of it drop from 0.287 to 0.004, indicating that during the post-epidemic era, the pharmaceutical industry is treated optimistic. To be more specific, we can avoid the risk as much as we can efficiently through just purchasing the pharmaceutical industry. In constraint2, such trend is more obvious in the post-epidemic era. In the pre-epidemic era, to construct the minimum standard deviation portfolio, the weights spread among eight stocks including the medicine index. But when it comes to post-epidemic era, the portfolio mainly concentrated in Kyushu Tong which out-stands during that time. In constraint3, in the light of the graph mentioned above, though the standard deviation drops from 0.29 to 0.02, the Sharpe ratio also drops from -6.766 to -88.813, which means a much lower efficiency of asset activity.

4.2 Maximum Sharpe Ratio

Table 5. Weights of the Portfolio Under Maximum Sharpe Ratio

	Med Index	Yunnan Baiyao	Fosun Pharma	China Medicine	Shanghai Medicine	Hengrui Medicine
Before						
constraint1	-5.23E+23	3.48E+21	6.37E+22	-2.71E+22	-1.86E+22	3.51E+23
constraint2	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
constraint3	0.00E+00	-3.90E+10	9.66E+09	-7.83E+10	-9.40E+10	2.67E+11
After						
constraint1	-6.44E+07	7.74E+06	-6.48E+06	-4.06E+06	1.17E+07	-2.35E+07
constraint2	0.00E+00	4.06E-02	0.00E+00	3.14E-03	9.26E-02	0.00E+00
constraint3	0.00E+00	6.54E+10	-7.41E+10	3.47E+10	9.96E+10	-6.83E+11

Table 5. Weights of the Portfolio Under Maximum Sharpe Ratio (continued)

	Kyushu Tong	Guangzhou Pharmaceutical	Changchun hi tech	Beijing Tongrentang	Renfu Medicine
Before					
constraint1	-4.49E+22	3.68E+22	1.76E+23	1.6E+22	-3.37E+22
constraint2	0.00E+00	0.00E+00	1.00E+00	0.00E+00	2.22E-10
constraint3	-8.51E+10	9.20E+09	1.37E+11	-2.93E+10	-9.74E+10
After					
constraint1	7.37E+06	1.08E+07	-9.99E+06	1.99E+07	5.10E+07
constraint2	5.55E-02	4.68E-02	0.00E+00	5.03E-01	2.58E-01
constraint3	6.61E+10	8.81E+10	-1.16E+11	1.77E+11	3.43E+11

Table 6. Key Statistic of the Portfolio of the Portfolio Under Maximum Sharpe Ratio

	Return	Standard Deviation	Sharpe Ratio
Before			
constraint1	143043358029516000000000	88473254303696500000000	2
constraint2	-2	0	-4
constraint3	113886410195	79698897521	1
After			
constraint1	72643442	2194309	33
constraint2	-1	1	-1
constraint3	673500812546	21676662815	31

In constraint1, to construct a portfolio that produces the maximum return, the weights among different stocks did not differ from each other obviously in the pre-epidemic era while ones in post-epidemic era varies a lot. The stocks that earn high returns like Shanghai Medicine, Kyushu Tong and Guangzhou Pharmaceutical, account for much more weights than others. In constraint2, it is also worth mentioning that to create the maximum-return portfolio, all the weight is laid in Changchun Hi-Tech before the epidemic and in China Medicine after the epidemic. Nevertheless, it indeed shows greater volatility when no short is allowed in the post-epidemic era. In a word the pharmaceutical industry indeed has a better performance in the post-epidemic market. In constraint3, what also worth notifying is that to construct the portfolio with maximum Sharpe ratio, Guangzhou Pharmaceutical should account for the excessively largest part, no matter in pre or post epidemic era.

5. Conclusion

How does the market performance change before and after the breakout of Covid-19 has drawn much attention from Financial and Economic fields. According to the classic fundamental analysis, the estimated-value is mainly decided by four factor- the performance of the companies themselves in the numerator, measured by ROE, FCF and so on, and market ratio, industrial uncertainty and the emotion of investors in the denominator. Therefore, when the global shock comes, such as pandemic in this paper, the industries with relatively weaker economic periods like technology, big consumption and pharmaceutical industries, which have negative PPI growth ratio, looser liquidity and declined margin interest, are preferred. This paper verified that after the shock of Covid-19, the confidence of investors who focused on medicine and pharmaceutical stocks grew a lot. The key statistic (table1) showed that the stocks of pharmaceutical industry have lower risk with higher return. The result of the paper showed that when the goal of investment is to construct a portfolio with minimum variance, a more diversified portfolio is preferred, which is presented by more the growing weights laid in Medicine Index under constraint 1. But when the maximum Sharpe ratio is pursued, the investors will lay almost all their weights in the stock that earns the highest revenue. Meanwhile, the paper considered three constraints in total to enrich the comparisons between pre and post epidemic era and make it closer to real world.

The research of the paper has enlightenments for investment decisions as followed. First, during the post-epidemic era, laying more weights of your investment portfolio in medicine and pharmaceutical industry will bring about lower investing risk and higher positive return. Second, the corporations whose stock prices are more volatile are worth trying, because these might due to their out-performance in the market.

6. Limitation and Future Development

The paper discussed changes in the weights of portfolio between pre and post epidemic era. Although Medicine and Pharmaceutical Stock Index is used to make it closer to reality, there are still some limitations. First, since the breakout of Covid-19 is quite recent, only two to three years from now, there is not enough data for post-epidemic era compared to the one of pre-epidemic. Therefore, there might be some deviations produced in comparison. Second, only top ten medical and pharmaceutical corporations, which keep their operations from 2012 to 2021, are included in the portfolio. But in reality, there are many new medical companies emerging and performing well in the post-epidemic era. Due to their lacking of data since before 2019, they are not included in the portfolio, for the reason that the comparison is not available if there is no data in the pre-epidemic era. Third, only three constraints are discussed in the portfolio construction and some of them are referring to the U.S. stock market. The unique constraints under Chinese stock markets are worth to be figured out.

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