

Investment in the Covid-19 Period

Peiyuan Shan *

College of Literature, Science, and the Art, University of Michigan-Ann Arbor, Michigan, United States

*Corresponding author: pyshan@umich.edu

Abstract. From 2019 to 2022, the covid-19 pandemic has lasted for three years. Its impact to society activity and economy is prominent. As a result, investors must change their investment strategy to suit the new environment. In this research, I used Markowitz model and Index Model to analyze the past data I collected and handled from past years in some specific conditions and the current information, like the impact of covid-19 to supply chain and Ukraine war, to correct the simulation coming from these two models. By the Markowitz model and Index model, people can find the weights of stocks in portfolio that can help they get maximum expected return over risk rate and minimum risk. Of course, people can some other suggestions from these weights, like which sector's stocks is more stable or has higher interest rate. Additionally, I concluded some investment suggestions about the investment direction and strategies from some articles. They include the relationship between government debt and financial debt, impact of Covid-19 to different sectors, spread of collapse, natural resource volatility, investment diversification, value of bitcoin for investment, and others.

Keywords: Covid-19; Markowitz Model; Index Model; Investment.

1. Introduction

In today's world, the Covid-19 has been one of the biggest factors which influences economy significantly. Many professors, experts and financial workers have analyzed the impact of pandemic from many different viewpoints. However, many of them only focus on one influence of the Covid-19, the simulation of future investment environment is only impacted by this influence. Now, I want to use the Markowitz Model and Index Model to analyze data of S&P 500 Index (SPX) and other 10 stocks from 4 different industries in a more general way. Let me introduce these two model to you. Markowitz Model and Index Model are two models help people find the maximum Sharpe ratio (expected return of portfolio/expected risk of portfolio) portfolio and the minimum risk (minimum standard deviation) portfolio. Markowitz Model and Index Model are different, Markowitz Model needs a lot of calculation, sometimes it can be millions of times. The Index model needs much less than it, it only needs hundreds to thousands of times of calculation. Does not like Markowitz Model, Index Model can help people specialize analysis by industry. So, we use the Index Model more in the practice because of its simplicity. However, the cost of this kind of simplicity is the ignore of industry specific events, which will not affect the macro economic environment in theory, but in fact will affect the macro environment. The drawbacks of Markowitz Model is the model depends on many estimates from historical sample averages. However, the past data can be unreliable, especially in the case of some big events happened like war, pandemic or political issues. The result of the Markowitz Model and Index Model is the investment weights of Maximum Sharpe (Sharpe=Expected Return/Risk) and Minimum Risk. I will use different constraints to simulate the investment under different situations. After this, I will use the facts happening currently to correct my simulation.

1.1 Markowitz Model and Index Model Simulation

1.1.1 Data used.

In this paper, the portfolio is formed by 10 stocks covering 4 industries. These 10 stocks include Amazon.com Inc (AMZN), Apple Inc (AAPL), Citrix Systems Inc (CTXS), JPMorgan Chase & Co (JPM), Berkshire Hathaway Inc (BRK/A), The Progressive Corporation (PGR), United Parcel Service (UPS), FedEx Corporation (FDX), J.B.Hunt Transport Services Inc (JBHT), Landstar System (LSTR).

The four industries include Consumer Cyclical (AMZN), Technology (AAPL, CTXS), Financial Service (JPM, BRK/A, PGR) and Industrials (UPS, FDX, JBHT, LSTR).

1.1.2 Tables

Table 1.

Date	SPX	AMZN	AAPL	CTXS	JPM	BRK/A	PGR	UPS	FDX	JBHT	LSTR
4/28/21	6,205.37	3,458.50	155.10	142.81	274.11	410,988	173.60	331.61	327.08	203.48	194.70
4/29/21	6,247.67	3,471.31	154.98	132.00	279.43	417,905	176.35	340.55	336.94	207.22	197.50
4/30/21	6,203.22	3,467.42	152.64	127.70	276.95	412,500	174.26	340.79	330.40	205.64	198.78
5/3/21	6,220.29	3,386.49	153.89	127.23	276.14	420,000	177.41	354.73	346.60	209.72	202.69
5/4/21	6,178.75	3,311.87	148.45	122.90	279.96	421,420	178.39	358.26	346.30	212.70	206.06
5/5/21	6,183.13	3,270.54	148.74	122.88	283.63	424,840	179.55	358.61	348.86	209.18	204.46
5/6/21	6,234.59	3,306.37	150.64	125.47	289.34	435,120	180.25	359.04	353.90	211.05	202.99
5/7/21	6,281.61	3,291.61	151.44	124.79	290.33	437,131	181.94	363.59	358.14	215.12	205.97
5/10/21	6,216.19	3,190.49	147.53	123.00	290.29	439,460	182.91	361.30	351.98	217.77	208.54
5/11/21	6,162.36	3,223.91	146.44	122.94	285.47	430,258	181.77	358.29	347.85	212.91	203.92
5/12/21	6,031.01	3,151.94	142.79	120.43	283.50	425,308	181.21	352.22	336.89	208.97	198.05

In the table 1, I showed the 10 stocks' price from 4/28/2021 to 5/12/2021.

Table 2.

	SPX	AMZ N	AAP L	CTX S	JPM	BRK/ A	PGR	UPS	FDX	JBHT	LSTR
Annualized Average Return (%)	7.542 %	33.79 6%	34.01 6%	15.63 5%	11.86 5%	9.002 %	15.40 6%	9.850 %	12.95 2%	22.52 4%	17.38 7%
Annualized Standard Deviation	14.85 0%	41.41 0%	34.45 2%	41.51 4%	29.01 3%	16.24 3%	21.05 9%	21.43 7%	26.69 0%	30.65 5%	23.92 3%
beta	1	1.351 3	1.256 89	1.220 55	1.360 8	0.572 13	0.712 05	0.829 62	1.103 63	1.076 3	0.797 56
alpha	0.000 %	23.60 4%	24.53 6%	6.429 %	1.601 %	4.687 %	10.03 5%	3.592 %	4.628 %	14.40 6%	11.37 2%
Annualized Residual Standard Deviation	0.000 %	36.22 2%	28.95 7%	37.34 8%	20.81 8%	13.84 4%	18.21 1%	17.54 3%	21.06 6%	26.15 8%	20.78 5%

In the table 2, I posted the data of Annualized Average Return, Annualized Standard Deviation, beta, alpha and Annualized Residual Standard Deviation of 10 stocks

Table 3.

correlatio ns	SPX	AMZ N	AAPL	CTXS	JPM	BRK/ A	PGR	UPS	FDX	JBHT	LSTR
SPX	1	0.484 6	0.541 77	0.436 61	0.696 52	0.523 06	0.502 13	0.574 72	0.614 05	0.521 39	0.495 08
AMZN	0.484 6	1	0.376 98	0.216 57	0.251 83	0.117 61	0.199 77	0.296 27	0.280 03	0.307 79	0.256 49
AAPL	0.541 77	0.376 98	1	0.331 73	0.244 43	0.173 47	0.239 69	0.231 44	0.329 53	0.268 44	0.287 01
CTXS	0.436 61	0.216 57	0.331 73	1	0.324 11	0.180 91	0.271 41	0.264 3	0.330 74	0.289 83	0.252 05
JPM	0.696 52	0.251 83	0.244 43	0.324 11	1	0.452 12	0.393 29	0.360 54	0.439 61	0.441 54	0.374 65

BRK/A	0.523 06	0.117 61	0.173 47	0.180 91	0.452 12	1	0.263 65	0.404 07	0.384 9	0.239 06	0.233 89
PGR	0.502 13	0.199 77	0.239 69	0.271 41	0.393 29	0.263 65	1	0.391 64	0.364 6	0.280 38	0.289 19
UPS	0.574 72	0.296 27	0.231 44	0.264 3	0.360 54	0.404 07	0.391 64	1	0.674 86	0.458 88	0.440 73
FDX	0.614 05	0.280 03	0.329 53	0.330 74	0.439 61	0.384 9	0.364 6	0.674 86	1	0.536 7	0.482
JBHT	0.521 39	0.307 79	0.268 44	0.289 83	0.441 54	0.239 06	0.280 38	0.458 88	0.536 7	1	0.589 53
LSTR	0.495 08	0.256 49	0.287 01	0.252 05	0.374 65	0.233 89	0.289 19	0.440 73	0.482	0.589 53	1

In the table 3, I showed the correlation coefficient between these stocks, this is a measure of degree to which one variable's change to another variable. The range for correlation coefficient is -1 to 1, the correlation coefficient is bigger, the growth/reduction rate between two stocks is similar. When correlation coefficient equals to 1, the change of two stocks will be completely same. When correlation coefficient equals to -1, the change of two stocks will be completely opposite.

1.2 Different Constraints

1.2.1 No Constraint, Benchmark Free

In this situation, investors are free to invest money as much as they can and can sell stocks freely. Result for this situation:

Table 4. Markowitz Model:

free	SPX	AMZ N	AAPL	CTXS	JPM	BRK/ A	PGR	UPS	FDX	JBHT	LSTR
Min	0.7223	-	-	-	-	0.3620	0.1390	0.0343	-	-	0.1075
StDev	8157	0.0234 857	0.0384 548	0.0104 505	0.1847 078	9601	8446	385	0.102 8326	0.0054 897	2061
Max	-	0.3705	0.6539	0.0041	0.1729	0.9158	0.6818	0.0127	-	0.3096	0.3402
Sharpe	2.3751 911	9019	5359	8915	7222	2461	8583	3221	0.086 8435	6204	2478

free	Return				StDev			Sharpe			
Min StDev	0.07146383				0.12239046			0.58390029			
Max Sharpe	0.49613266				0.32248087			1.53848712			

Table 5. Index Model

free	SPX	AMZ N	AAPL	CTXS	JPM	BRK/ A	PGR	UPS	FDX	JBHT	LSTR
Min	0.6579	-	-	-	-	0.3450	0.1342	0.0855	-	-	0.0724
StDev	2695	0.0413 848	0.0473 527	0.0244 39	0.1286 824	6132	0155	7274	0.0360 948	0.0172 348	2599
Max	-	0.4301	0.6996	0.1102	0.0883	0.5847	0.7235	0.2791	0.2493	0.5034	0.6293
Sharpe	3.2978 523	5292	3657	1071	3982	5346	0944	0815	7395	2041	4687

free	Return				StDev			Sharpe			
Min StDev	0.06464384				0.12432521			0.51995763			
Max Sharpe	0.60905152				0.38161249			1.59599472			

1.2.2 Constraint 1: $\sum |w_i| \leq 2$ Sum of stocks' absolute values is smaller or equal to 2. This is a simulation to Regulation T by FINRA. This regulation allows broker-dealers to allow their customers to have positions, 0.5 or more funded by customers' account equity.

Table 6. Markowitz Model

	SPX	AMZ N	AAPL	CTXS	JPM	BRK/ A	PGR	UPS	FDX	JBHT	LSTR
MinVarPo int1	0.722 38	- 0.023 49	- 0.038 46	- 0.010 45	- 0.184 71	0.362 1	0.139 08	0.034 34	- 0.102 83	- 0.005 49	0.107 52
MaxSharp 1	- 0.411 05	0.177 57	0.384 44	- 0.000 46	- 0.046 47	0.231 45	0.356 67	0.076 23	- 0.041 68	0.183 7	0.089 6
	Return					StDev			Sharpe		
MinVarPoint1	0.07146					0.12239			0.5839		
MaxSharp1	0.28904					0.2105			1.37316		

Table 7. Index Model

	SPX	AMZ N	AAPL	CTXS	JPM	BRK/ A	PGR	UPS	FDX	JBHT	LSTR
MinVarP oint1	0.657 927	- 0.041 38	- 0.047 35	- 0.024 44	- 0.128 68	0.345 061	0.134 202	0.085 573	- 0.036 09	- 0.017 23	0.072 426
MaxShar p1	- 0.472 97	0.178 37	0.305 215	0.004 991	- 0.026 75	0.224 393	0.315 317	0.011 691	0.001 085	0.192 012	0.266 645
	Return					StDev			Sharpe		
MinVarPoint1	0.064644					0.124325			0.519958		
MaxSharp1	0.285719					0.199809			1.42996		

1.2.3 Constraint 2: $|w| \leq 1$ absolute value of single stock's weight is equal to or smaller than 1 for all stocks. This is a simulation to some arbitrary "box" constraints on weights.

Table 8. Markowitz Model:

	SPX	AMZ N	AAPL	CTXS	JPM	BRK/ A	PGR	UPS	FDX	JBHT	LSTR
MinVarPo int2	0.722 38	- 0.023 49	- 0.038 46	- 0.010 45	- 0.184 71	0.362 1	0.139 08	0.034 34	- 0.102 83	- 0.005 49	0.107 52
MaxSharp 2	-1 0.411 05	0.223 3	0.397 64	- 0.012 01	- 0.004 97	0.624 74	0.460 1	- 0.031 12	- 0.105 64	0.208 81	0.239 16
	Return					StDev			Sharpe		
MinVarPoint2	0.07146					0.12239			0.5839		
MaxSharp2	0.33183					0.22112			1.50064		

Table 9. Index Model:

	SPX	AMZ N	AAP L	CTXS	JPM	BRK/ A	PGR	UPS	FDX	JBHT	LSTR
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MinVarP oint2	0.657 927	- 0.041 38	- 0.047 35	- 0.024 44	- 0.128 68	0.345 061	0.134 202	0.085 573	- 0.036 09	- 0.017 23	0.072 426
MaxShar p2	-1 448	0.218 448	0.366 237	0.030 877	- 0.087 86	0.333 176	0.399 797	0.095 18	0.056 156	0.249 719	0.338 267
						Return		StDev		Sharpe	
MinVarPoint2						0.064644		0.124325		0.519958	
MaxSharp2						0.340682		0.223984		1.521016	

1.2.4 Constraint 3: $w \geq 0$ all weights of stocks must be bigger or equal to 0. This a simulation to typical limitations that a America open-ended mutual fund is not allowed to have any short positions.

Table 10. Markowitz Model:

	SPX	AMZ N	AAPL	CTX S	JPM	BRK/ A	PGR	UPS	FD X	JBHT	LSTR
MinVarPoi nt4	0.384 7	0	0	0	-1E- 08	0.384 9	0.142 32	0.007 22	0	-1E- 08	0.080 86
MaxSharp4	0	0.129 62	0.252 07	0	-1E- 08	0.192 63	0.227 23	0	0	0.088 07	0.110 39
						Return		StDev		Sharpe	
MinVarPoint4						0.10036		0.13088		0.76684	
MaxSharp4						0.22093		0.17623		1.25362	

Table 11. Index Model

	SPX	AMZN	AAPL	CTX S	JP M	BRK/ A	PGR	UPS	FD X	JBHT	LSTR
MinVarPoi nt4	0.3046 21	0	0	0	0	0.3765 31	0.1464 41	0.0933 77	0	0	0.0790 31
MaxSharp 4	0	0.1546 03	0.2711 94	0	0	0.0326 4	0.2135 95	0	0	0.1397 64	0.1882 04
						Return		StDev		Sharpe	
MinVarPoint4						0.102372		0.129871		0.788259	
MaxSharp4						0.244548		0.191561		1.276605	

1.2.5 The analysis to the result of two models in different constraints

In the freest condition, if an investor want to make a less risk investment, they should invest most of their money in SPX, a small part in Berkshire Hathaway Inc, The Progressive Corporation and United Parcel Service, Inc. For other stocks, investors should sell them as their risk is high and use the money from selling to invest SPX, BRK/A, PGR and JPM. From this lowest risk portfolio, people can find that the financial service companies have much higher stability than companies in other industries. If an investor wants a max sharp portfolio, they should invest mainly in AAPL, BRK/A and PGR, invest mediumly AMZN, JBHT and LSTR, invest a few in CTXS, JPM and UPS. You should sell SPX stocks. From these two portfolios, investors can know that in the totally free investment situation the BRK/A and PGR have high stability and growth speed, they are good choices for most of investors. The SPX's stock has very high level of stability, but lacks profitability, it is a good choice only for conservative investors in no constraint environment.

In the situation to Regulation T by FINRA ($\sum |w_i| \leq 2$), the Minimum Risk portfolio is same as the Minimum Risk portfolio in free investment environment. If an investor wants a MaxSharp

portfolio, they should invest mainly in AAPL, BRK/A and PGR, invest mediumly in AMZN and JBHT, invest a few in UPS and LSTR. They should sell a lot of their SPX stocks and a few of their CTXS, JPM and FDX. In this situation the BRK/A and PGR are also good choices for most of investors. In this constraint, the AAPL is a good choice for investor who wants high sharp.

In the situation of box constraint ($|w| \leq 1$). The Portfolios are similar to the portfolios in the constraint 2. The only difference is more investment and selling.

In the situation to typical limitations that an America open-ended mutual fund is not allowed to have any short positions ($w \geq 0$). BRK/A and PGR are still good choice for most of investors. SPX is good only for conservative investors. AAPL and AMZN are suitable for investors who want high sharp.

After all, the PGR and BRK/A are stable and profitable stocks in all constraints and investment preferences. The SPX stock is very stable, it can be a part of portfolio if investors want more stability.

2. Correction from Current events:

2.1 Automatic Manufacturing:

The article written by Mary Beth Allen who comes from Division of Pulmonary and Critical Care of University of Miami and Mehdi Mirsaedi who comes from Department of Public Health Science of University of Miami says “Further, the impact of the global economy most specifically from the burden of disease in China has placed entire supply chains at risk for critical medical supplies. The US should use this crisis as an opportunity in invest in the automation of the manufacturing sector, shrink supply chains, and create higher level jobs as a benefit to the economy.” [1] During the past decades, the United States had been depending too much on the foreign supply chain and discarded many very important industries. This a profit maximization way in a stable world economic environment. However, when it comes worldwide crisis like Covid-19 pandemic, the defect of supply chain will cause serious economic problems like hyperinflation. Meanwhile, the supply chain of basic industries cannot generate enough profit to maintain current welfare and United States’ population cannot supply such a huge supply chain – the unemployment rate of United States was 3.7% in August 2022 [2]. The only way to solve this problem is developing automatic manufacturing, this needs a lot of investment for robot industry, artificial intelligence industry and mechanical manufacturing industry. So, the technology companies researching these technologies might be the policy supporting target, investors can increase the investment in these companies. Additionally, the automatic manufacturing needs large labor with high level of technology knowledge and machinery equipment operation skill. This requires more better and lager vocational and technical education system. So, investors can enlarge their investment in education companies who focus on high level automatic machinery operation.

2.2 Ukraine and Russia War

Because of the war happening in Ukraine and the deteriorating relationship between Europe and Russia, the energy shortage is happening in Europe. The monthly Producer Price Index (PPI) of Germany in August 2022 is 7.87%, [3] this is a huge increase of production cost. As the industry center of Europe, Germany’s economy is very important for the whole Europe. The Consumer Price Index (CPI) of European Union is 120.61 now, increase from 119.81 in June and 112.67 in the beginning of this year. These information shows that the future commodity sales will be much less than previous years and cost price will be much higher. The result is the acute decreasing profitability, even some companies will loss money. This an warning for investors, they should decrease their investment to the company who has manufacturing industry in Europe.

3. Literature Review

3.1 Government Debt and Financial Policy

The article “Federal Deficits, Growing Debt, and the Economy in the Wake of COVID-19” written by Lida R. Weinstock, published in 2021, wrote that the United States’ government had achieved a high level and may influence its financial policy. “Before P.L. 117-2 was enacted, CBO projected the FY2021 deficit to be 10.3% of gross domestic product (GDP). To finance these deficits, the government needs to borrow money. The federal debt-to-GDP ratio rose significantly in FY2020, reaching slightly above 100%. CBO projects that deficits and debt will trend upwards in the coming decades, with the debt-to-GDP ratio surpassing 200% by 2051 under current policy.” [4] From this article, the government debt has been a big problem to the economy. Under the huge debt, the government’s ability of increasing interest rate is limited seriously. United States government is increasing the interest rate now, then the money currency is leaving for the treasury. As a result, the current stock’s prices are the low point. The government debt does not allow more policy of increasing interest rate. When the interest rate come back to its original level, the stock prices will increase to the level it should be. Now is a good time to do the long-term investment.

3.2 Impact and stimulus of covid-19 to stocks

The article “COVID-19: stock market reactions to the shock and the stimulus” written by Maretno Agus Harjoto, Fabrizio Rossi and John K. Paglia, published by 2020, analyzed the influence of Covid-19 to different companies. “Using the event study method, our study reveals that the adverse impact of COVID-19 on the equity markets is greater for emerging countries than developed countries. Consistent with Yan (2020), we also find that small firms were experiencing greater negative shocks from COVID-19 relative to large firms.” [5] From this article, the impact of Covid-19 is greater to smaller companies and developing countries. For this, the investors who has the idea of investing a company when it is still a company should change their mind. The small companies, especially in developing countries, have greater chance of collapsing than bigger companies, and bigger companies can get the market from these small companies. As a result, the bigger companies will be bigger after the pandemic, and their stocks’ prices will increase too. Investor should increase their investment in more stable big companies’ stocks and decrease the risky small companies’ stocks they are holding.

3.3 Stock Market Collapse

The article “The international spread of COVID-19 stock market collapses” written by Contessi, Silvio, De Pace and Pierangelo, published in 2021, analyzed the spread of stock market collapse in the Covid-19 period. “[6] We find robust evidence of instability and crashes spreading from China to other countries (especially European countries) during the most dramatic phases of circulation of the pandemic.” From this we can know that the collapse is spread to world’s main economic blocks, but United States is far away from the center of collapsing. Investors should keep their money in United States, but do not invest it to other countries.

3.4 Impact of Stock in different sectors

The article “COVID-19's Impact on Stock Prices Across Different Sectors-An Event Study Based on the Chinese Stock Market” written by He, Pinglin; Sun, Yulong; Zhang, Ying ; Li, Tao, published in 2020, analyzed the impact of Covid-19 to different sectors of China. “The pandemic greatly affected the transportation, mining, electric and heating, and environmental industries. However, the manufacturing, information technology, education, and health industries strongly responded to the pandemic in a positive fashion, providing a boost to confidence on the stock market.” [7] This article pointed out the high-level technology companies affected by Covid-19 less than traditional companies. Investors should increase their investment in new type companies, but not traditional companies.

3.5 Natural Resource and Economic Performance

The article “China economic performance and natural resources commodity prices volatility: Evidence from China in COVID-19” written by Deng Ming, published in 2022, analyzed the relationship between natural resource price and China economy.

“On the other hand, investment in renewable energy, renewable electricity output, and green finance are found the significant contributor of economic performance before and during the Covid-19 pandemic. The obtained results are robust and consistent to the literature, as confirmed by Robust regression.” [8] The author pointed that economy needs stable natural resource price; the volatility is harmful to economy. The new energy industries will reduce the volatility of energy. These industries become very important after the Covid-19 and Ukraine-Russia war and will get policy suggest in the future. Investors can add investment in these new energy industries.

3.6 Bitcoin and Covid

The article “Is Bitcoin really more than a diversifier? A pre- and post-COVID-19 analysis” written by Huang, Yingying ; Duan, Kun ; Mishra, Tapas, published in 2021, analyzed bitcoin’s diversification and risk management function. “The COVID-19 bear market offers a critical testing ground for the safe haven role of Bitcoin against stock and bond investments. Considering the potential interaction and heterogeneity across country/region-segmented markets, our results indicate that Bitcoin in each economy can contribute to effective diversification and/or risk mitigation against not only its own traditional assets, but also across market borders.” [9] Just like what the author said bitcoin has the ability of escaping from the specific country’s economy collapse and is a good choice for more international investors.

3.7 The Relationship between Investment Diversification and Covid-19

In the article “Household investment diversification amid Covid-19 pandemic: Evidence from Chinese investors”, the author pointed out that “The results suggest that individual investors living in a city with more confirmed cases of Covid-19 hold greater number of stocks.” [10] This tells us that the people who lives in a situation where has more Covid-19 cases prefer to buy more stocks. They may be the target of investment fund.

4. Conclusion

In this article, I used Markowitz Model and Index Model to analyze the stock price of 10 companies from 4 industries. From these two models, the financial service companies like BRK/A and PGR have higher profitability and stability, they are good choices in most situation. Because of Covid-19’s impact to supply chain and labor market, automatic manufacturing related industries will get a great development in the future, people can increase their investment to these industries. Additionally, the Ukraine war and energy crisis happening in Europe make people should be more careful about the investment to company who has industries in Europe.

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