

# MARKET SIMULATION REPORT

BY JOHN VAN BREDERODE

## COVID-19 PORTFOLIO (2020-2021)

The first portfolio I created and simulated was the COVID data, using BUY and sell orders from 2020 and 2021. The order book was as follows:

### ORDERS:

Date	Symbol	Order	Shares
2020-02-03	MMM	BUY	5000
2020-02-05	ZM	BUY	5000
2020-02-05	AMD	BUY	500
2020-03-05	BDX	BUY	500
2020-05-07	AMD	SELL	500

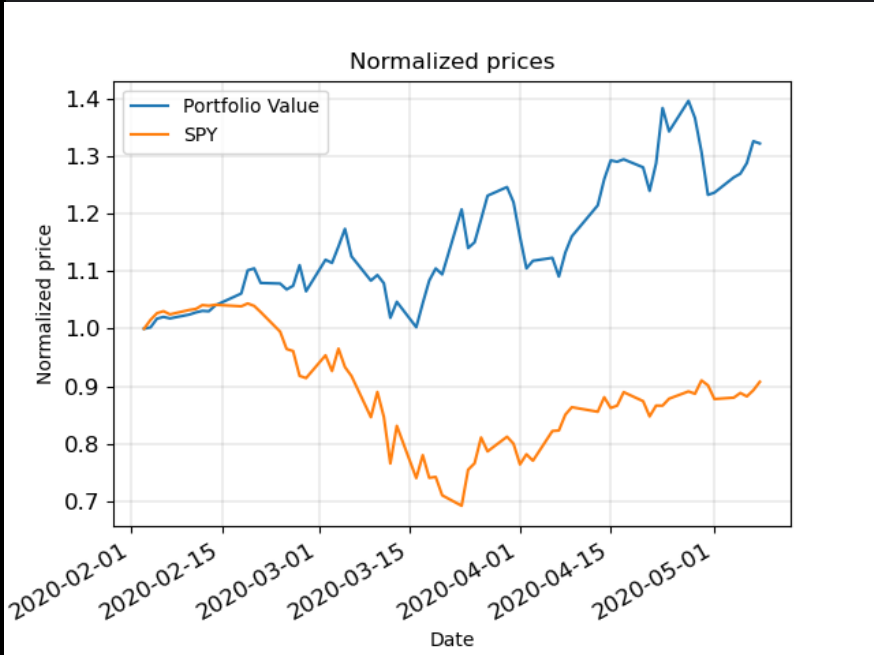
MMM is a mask manufacturing company, ZM is Zoom, AMD is a computer parts manufacturer, and BDX is a medical technology company.

These stocks were chosen due to their high likelihood of good performance during the COVID-19 pandemic.

Below are the relevant statistics for this portfolio:

RELEVANT PRICES:						PORTFOLIO CHANGES					
	ZM	MMM	AMD	BDX	Cash		ZM	MMM	AMD	BDX	Cash
2020-02-03	87.6600	107.5381	48.0200	254.6260	1.0000	2020-02-03	0	5000	0	0	-540389.0619
2020-02-04	85.7900	107.9845	49.4500	259.3116	1.0000	2020-02-04	0	0	0	0	0.0000
2020-02-05	86.9900	111.4801	49.8400	260.7156	1.0000	2020-02-05	5000	0	500	0	-462189.2393
2020-02-06	87.2600	111.8646	49.3200	229.9574	1.0000	2020-02-06	0	0	0	0	0.0000
2020-02-07	88.6400	109.9349	49.7300	225.0893	1.0000	2020-02-07	0	0	0	0	0.0000
...	...	...	...	...	...	...	...	...	...	...	...
2020-05-04	143.4400	102.8365	52.5600	233.4819	1.0000	2020-05-04	0	0	0	0	0.0000
2020-05-05	144.8200	102.1644	52.1900	239.3630	1.0000	2020-05-05	0	0	0	0	0.0000
2020-05-06	149.5900	101.3120	52.1600	237.0123	1.0000	2020-05-06	0	0	0	0	0.0000
2020-05-07	157.8000	100.9932	51.9500	234.3782	1.0000	2020-05-07	0	0	-500	0	25835.1754
2020-05-08	155.4000	102.9128	53.1900	232.7593	1.0000	2020-05-08	0	0	0	-500	115787.7905

ASSETS						DAILY HOLDINGS:					
	ZM	MMM	AMD	BDX	Cash		ZM	MMM	AMD	BDX	Cash
2020-02-03	0.0000	537690.6586	0.0000	0.0000	459610.9381	2020-02-03	0	5000	0	0	-540389.0619
2020-02-04	0.0000	539922.6379	0.0000	0.0000	459610.9381	2020-02-04	0	5000	0	0	-540389.0619
2020-02-05	434949.9893	557400.4364	24920.0001	0.0000	-2578.3012	2020-02-05	5000	5000	500	0	-1002578.3012
2020-02-06	436300.0107	559323.2346	24659.9998	0.0000	-2578.3012	2020-02-06	5000	5000	500	0	-1002578.3012
2020-02-07	443199.9969	549674.4919	24864.9998	0.0000	-2578.3012	2020-02-07	5000	5000	500	0	-1002578.3012
...	...	...	...	...	...	...	...	...	...	...	...
2020-05-04	717200.0122	514182.7393	26280.0007	116740.9286	-114426.7049	2020-05-04	5000	5000	500	500	-1114426.7049
2020-05-05	724100.0366	510821.8765	26094.9993	119681.4880	-114426.7049	2020-05-05	5000	5000	500	500	-1114426.7049
2020-05-06	747949.9817	506560.0204	26079.9999	118506.1722	-114426.7049	2020-05-06	5000	5000	500	500	-1114426.7049
2020-05-07	789000.0153	504966.2018	0.0000	117189.0945	-88591.5295	2020-05-07	5000	5000	0	500	-1088591.5295
2020-05-08	776999.9695	514563.9038	0.0000	0.0000	27196.2610	2020-05-08	5000	5000	0	0	-972803.7390



### ANALYSIS

The selected COVID-19 portfolio of ZM, MMM, AMD, and BDX significantly outperformed the market, with a Sharpe Ratio of 2.32. This can be seen in the graph to the left, plotting the normalized prices. The cumulative return of the portfolio was 32% and was much larger than the -9% from the SPY. Additionally, the average daily return of the portfolio was 0.4%, which was also much larger than the SPY daily return.

Date Range: 2020-02-03 to 2020-05-08 (portfolio)		Portfolio Value	SPY
Number of Trading Days:	68	2020-02-03	997301.5967 302.4357
Sharpe Ratio of Fund:	+2.32167121386	2020-02-04	999533.5761 307.0453
Sharpe Ratio of SPY:	-0.34569253133	2020-02-05	1014692.1246 310.5911
Cumulative Return of Fund:	+0.32232830933	2020-02-06	1017704.9439 311.6362
Cumulative Return of SPY:	-0.09243574357	2020-02-07	1015161.1874 309.9752
Standard Deviation of Fund:	+0.03200107893	...	...
Standard Deviation of SPY:	+0.03632560623	2020-05-04	1259976.9759 266.1546
Average Daily Return of Fund:	+0.00468020706	2020-05-05	1266271.6956 268.6137
Average Daily Return of SPY:	-0.00079104756	2020-05-06	1284669.4694 266.7928
		2020-05-07	1322563.7821 270.0121
Final Portfolio Value:	+1,318,760.13427047734	2020-05-08	1318760.1343 274.4799

## POST 2022 PORTFOLIO (TOP ESG STOCKS ONLY)

For my post-2022 portfolio, I selected stocks from the 2022 top 100 ESG list.

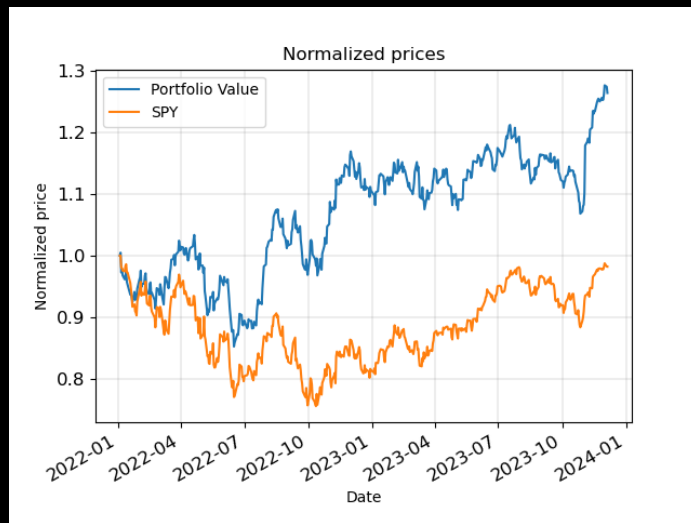
The portfolio included Texas Instruments, Apple, Chevron, Gartner, Merck, Coca-Cola, First-Solar, and Sempra.

Date, Symbol, Order, Shares			PORTFOLIO CHANGES									
			TXN	CVX	FSLR	IT	KO	AAPL	SRE	MRK	Cash	
2022-01-03, TXN, BUY, 500			2022-01-03	500	500	500	1500	500	0	1500	500	-827540.9434
2022-01-03, KO, BUY, 500			2022-01-04	0	0	0	0	0	0	0	0	0.0000
2022-01-03, IT, BUY, 1500			2022-01-05	0	0	0	0	0	0	0	0	0.0000
2022-01-03, CVX, BUY, 500			2022-01-06	0	0	0	0	0	0	0	0	0.0000
2022-01-07			2022-01-07	0	0	0	0	0	0	0	0	0.0000
2022-07-05, AAPL, BUY, 500			...	...	...	...	...	...	...	...	...	...
2022-01-03, FSLR, BUY, 500			2023-12-01	0	0	0	0	0	0	0	0	0.0000
2022-01-03, SRE, BUY, 1500			2023-12-02	0	0	0	0	0	0	0	0	0.0000
2023-12-05, AAPL, SELL, 500			2023-12-03	0	0	0	0	0	0	0	0	0.0000
2022-01-03, MRK, BUY, 500			2023-12-04	0	0	0	0	0	0	0	0	0.0000
2022-01-07			2023-12-05	0	0	0	0	0	-500	0	0	95852.7341
RELEVANT PRICES:												
			TXN	CVX	FSLR	IT	...	AAPL	SRE	MRK	Cash	
2022-01-03	175.8912	107.2701	88.5800	321.9600	...	179.2736	60.9777	71.5640	1.0000			
2022-01-04	176.0758	109.2219	87.2800	323.4100	...	176.9983	62.0772	71.6943	1.0000			
2022-01-05	172.4029	109.9324	83.5100	303.2100	...	172.2902	62.4561	73.4352	1.0000			
2022-01-06	172.3475	110.8679	83.9700	306.2300	...	169.4141	62.9042	73.3887	1.0000			
2022-01-07	165.5924	112.4599	84.6800	299.3900	...	169.5816	63.8513	74.7572	1.0000			
...	...	...	...	...	...	...	...	...	...			
2023-11-29	149.9367	139.3736	155.4300	430.1200	...	188.6541	71.1386	99.1768	1.0000			
2023-11-30	149.4572	139.0734	157.7800	434.8400	...	189.2319	71.0606	100.5007	1.0000			
2023-12-01	151.9039	140.2453	160.2900	441.1400	...	190.5171	71.3824	101.4618	1.0000			
2023-12-04	154.0668	140.3034	159.5400	439.5800	...	188.7139	71.0020	103.0309	1.0000			
2023-12-05	153.9005	138.3567	155.3900	434.8300	...	192.6888	69.7386	104.1783	1.0000			
ASSETS												
			TXN	CVX	FSLR	...	SRE	MRK	Cash			
2022-01-03	87945.6024	53635.0250	44290.0009	...	91466.5890	35781.9862	172459.0566					
2022-01-04	88037.8876	54610.9428	43639.9994	...	93115.8714	35847.1603	172459.0566					
2022-01-05	86201.4618	54966.2247	41755.0011	...	93684.1278	36717.6132	172459.0566					
2022-01-06	86173.7671	55433.9447	41985.0006	...	94356.3194	36694.3436	172459.0566					
2022-01-07	82796.2112	56229.9728	42340.0002	...	95776.9260	37378.6125	172459.0566					
...	...	...	...	...	...	...	...					
2023-12-01	75951.9653	70122.6349	80144.9966	...	107073.5321	50730.9036	102192.3209					
2023-12-02	75951.9653	70122.6349	80144.9966	...	107073.5321	50730.9036	102192.3209					
2023-12-03	75951.9653	70122.6349	80144.9966	...	107073.5321	50730.9036	102192.3209					
2023-12-04	77033.4167	70151.6876	79769.9966	...	106503.0670	51515.4495	102192.3209					
2023-12-05	76950.2411	69178.3676	77694.9997	...	104607.9483	52089.1571	198045.0550					

## ANALYSIS

The selected ESG portfolio post-2022 performed moderately, with a Sharpe Ratio of 0.73. The overall volatility of the fund was almost identical to SPY, and the average daily return was 0.00056. The cumulative return was 0.26.

I chose ESG stocks to gauge the profitability of stocks with high ESG scores. I expected a better performing portfolio, but the portfolio seemed to follow the market quite closely.



	Portfolio Value	SPY	Date Range: 2022-01-03 to 2023-12-05 (portfolio)	
2022-01-03	995813.5774	460.1273	Number of Trading Days:	484
2022-01-04	1000576.9441	459.9732	Sharpe Ratio of Fund:	+0.73031793275
2022-01-05	968579.6392	451.1407	Sharpe Ratio of SPY:	+0.05107464083
2022-01-06	974281.3203	450.7169	Cumulative Return of Fund:	+0.26478228803
2022-01-07	963835.2353	448.9350	Cumulative Return of SPY:	-0.01790269337
...	...	...	Standard Deviation of Fund:	+0.01217816921
2023-11-29	1248607.3542	449.9203	Standard Deviation of SPY:	+0.01245722823
2023-11-30	1257633.8664	451.6919	Average Daily Return of Fund:	+0.00056026527
2023-12-01	1271851.7524	454.3640	Average Daily Return of SPY:	+0.00004007989
2023-12-04	1269525.4889	451.9789		
2023-12-05	1259487.3749	451.8898	Final Portfolio Value:	+1,259,487.37486763019

## VARYING TRANSACTION COSTS AND MARKET IMPACT FACTOR

```
Date Range: 2022-01-03 to 2023-12-05 (portfolio)
Number of Trading Days:                484
Sharpe Ratio of Fund:                  +0.72673452272
Sharpe Ratio of SPY:                   +0.05107464083
Cumulative Return of Fund:             +0.26530623293
Cumulative Return of SPY:              -0.01790269337
Standard Deviation of Fund:            +0.01228547397
Standard Deviation of SPY:             +0.01245722823
Average Daily Return of Fund:          +0.00056242865
Average Daily Return of SPY:          +0.00004007989

Final Portfolio Value:                 +1,249,582.31310386676
```

The above image shows the result when the market impact factor is 0.015, and the transaction fee is 10.95.

As expected, the portfolio value is slightly lower.

## MARKET SIMULATOR APPROACH AND CHALLENGES

---

*For the simulator, I followed the approach in the provided slideshow.*

*First, I created the ORDERS data frame, sorted by date. The execution of the orders allowed me to make a PORTFOLIO CHANGES data frame. I used this data frame to create a DAILY HOLDINGS frame, which stored the daily values of the portfolio by numbers of shares and cash. This was done using cum\_sum(). After this frame was created, I used this frame to create an ASSETS data frame, with the total share values each day for each stock. Finally, the ASSETS frame was used to calculate the total portfolio value by summing across the columns.*

*One of the biggest challenges for this project was the vague project specifications. It was hard to tell what the deliverables were, and it was confusing to determine what data to use to match outputs correctly. Additionally, some of the provided data (from the ZIP) was incomplete, causing numerous issues with the functions.*

*Overall, this project was an interesting learning experience, but could benefit from better organization. I had fun building the simulator, and hope to learn more in future projects.*

---