Stock Price ("Adjusted Close" from Yahoo!Finance)

Date	AAPL	DIS	F	MCD
12/1/2018	37.66562	106.1806	5.748631	154.4323
1/1/2019	39.74303	108.8291	6.612804	155.4845
2/1/2019	41.34527	110.1173	6.705076	159.8853
3/1/2019	45.55134	108.3509	6.712719	166.2071
4/1/2019	48.12207	133.665	7.989511	172.9202
5/1/2019	41.98302	128.854	7.395251	173.5329
6/1/2019	47.64538	136.2706	7.946786	182.8157
7/1/2019	51.28522	139.5593	7.403019	185.5096
8/1/2019	50.25008	134.7775	7.229686	191.8922
9/1/2019	54.12127	127.9631	7.221801	190.0217
10/1/2019	60.11164	127.5703	6.77241	174.0825
11/1/2019	64.57967	148.8386	7.260187	172.1178
12/1/2019	71.17213	142.0143	7.45251	176.0087
1/1/2020	75.01613	136.6222	7.067863	190.5803
2/1/2020	66.25443	116.2143	5.672215	172.9447
3/1/2020	61.7787	95.4212	3.936321	148.1967
4/1/2020	71.37747	106.8303	4.148215	168.1027
5/1/2020	77.2422	115.8686	4.653498	166.9914
6/1/2020	88.86655	110.1493	4.955038	166.4356
7/1/2020	103.5412	115.513	5.386974	175.2866
8/1/2020	125.7384	130.2608	5.558118	192.6456
9/1/2020	113.0503	122.5659	5.427722	199.1905
10/1/2020	106.266	119.7704	6.299744	193.3007
11/1/2020	116.2132	146.2038	7.399958	197.3301
12/1/2020	129.7516	178.9691	7.163617	195.892
1/1/2021	129.0378	166.1178	8.581671	189.739
2/1/2021	118.5747	186.7332	9.535189	188.1871
3/1/2021	119.6235	182.2683	9.983424	205.8784
4/1/2021	128.7409	183.75	9.404793	216.8456
5/1/2021	122.0326	176.4699	11.84156	214.8341
6/1/2021	134.3549	173.6251	12.1105	213.3422
7/1/2021	143.0857	173.8721	11.36888	224.1667
8/1/2021	148.9421	179.0876	10.6191	219.3179
9/1/2021	139.0166	167.1056	11.54002	223.9098
10/1/2021	147.1709	167.0069	13.91975	228.0331
11/1/2021	162.3989	143.1318	15.63934	227.1509
12/1/2021	174.7081	152.9999	17.01223	250.3267
1/1/2022	171.9631	141.2254	16.62726	242.2773
2/1/2022	162.4588	146.6484	14.45694	228.5689
3/1/2022	172.0147	135.4863	13.9218	232.1973
4/1/2022	155.3068	110.2678	11.65776	233.9627
5/1/2022	146.6277	109.0923	11.33752	236.8266
6/1/2022	134.8858	93.24805	9.224164	231.8217
7/1/2022	160.3298	104.8053	12.17457	248.6765
8/1/2022	155.1108	110.7123	12.63039	238.2053
9/1/2022	136.5353	93.17891	9.374751	219.0595
10/1/2022	151.493	105.2399	11.19111	258.8575
11/1/2022	146.2469	96.6757	11.63474	258.9809
12/1/2022	128.5779	85.81981	9.836432	251.5988
1/1/2023	142.7884	107.1661	11.4265	255.2935
2/1/2023	145.876	98.39448	10.20857	251.9615
3/1/2023	163.4331	98.90813	11.32867	268.492
4/1/2023	168.1706	101.2492	10.68131	283.9903
5/1/2023	175.6733	86.88663	10.92396	273.7733
6/1/2023	192.5105	88.19052	13.77329	286.5444
7/1/2023	194.9718	87.80528	12.02546	283.0361
8/1/2023	186.4563	82.65887	11.1625	271.4038
9/1/2023	170.1512	80.06096	11.42937	255.675
10/1/2023	169.7139	80.59436	8.972331	254.4424
11/1/2023	188.7753	91.55892	9.588871	273.5327
12/1/2023	191.5914	89.1882	11.39263	289.4945

=(B5-B4)/B4

Holding Period Return

Date	AAPL	DIS	F	MCD
2019-01-01	5.52%	2.49%	15.03%	0.68%
2019-02-01	4.03%	1.18%	1.40%	2.83%
2019-03-01	10.17%	-1.60%	0.11%	3.95%
2019-04-01	5.64%	23.36%	19.02%	4.04%
2019-05-01	-12.76%	-3.60%	-7.44%	0.35%
2019-06-01	13.49%	5.76%	7.46%	5.35%
2019-07-01	7.64%	2.41%	-6.84%	1.47%
2019-08-01	-2.02%	-3.43%	-2.34%	3.44%
2019-09-01	7.70%	-5.06%	-0.11%	-0.97%
2019-10-01	11.07%	-0.31%	-6.22%	-8.39%
2019-11-01	7.43%	16.67%	7.20%	-1.13%
2019-12-01	10.21%	-4.59%	2.65%	2.26%
2020-01-01	5.40%	-3.80%	-5.16%	8.28%
2020-02-01	-11.68%	-14.94%	-19.75%	-9.25%
2020-03-01	-6.76%	-17.89%	-30.60%	-14.31%
2020-04-01	15.54%	11.96%	5.38%	13.43%
2020-05-01	8.22%	8.46%	12.18%	-0.66%
2020-06-01	15.05%	-4.94%	6.48%	-0.33%
2020-07-01	16.51%	4.87%	8.72%	5.32%
2020-08-01	21.44%	12.77%	3.18%	9.90%
2020-09-01	-10.09%	-5.91%	-2.35%	3.40%
2020-10-01	-6.00%	-2.28%	16.07%	-2.96%
2020-11-01	9.36%	22.07%	17.46%	2.08%
2020-12-01	11.65%	22.41%	-3.19%	-0.73%
2021-01-01	-0.55%	-7.18%	19.80%	-3.14%
2021-02-01	-8.11%	12.41%	11.11%	-0.82%
2021-03-01	0.88%	-2.39%	4.70%	9.40%
2021-04-01	7.62%	0.81%	-5.80%	5.33%
2021-05-01	-5.21%	-3.96%	25.91%	-0.93%
2021-06-01	10.10%	-1.61%	2.27%	-0.69%
2021-07-01	6.50%	0.14%	-6.12%	5.07%
2021-08-01	4.09%	3.00%	-6.59%	-2.16%
2021-09-01	-6.66%	-6.69%	8.67%	2.09%
2021-10-01	5.87%	-0.06%	20.62%	1.84%
2021-11-01	10.35%	-14.30%	12.35%	-0.39%
2021-12-01	7.58%	6.89%	8.78%	10.20%
2022-01-01	-1.57%	-7.70%	-2.26%	-3.22%
2022-02-01	-5.53%	3.84%	-13.05%	-5.66%
2022-03-01	5.88%	-7.61%	-3.70%	1.59%
2022-04-01	-9.71%	-18.61%	-16.26%	0.76%
2022-05-01	-5.59%	-1.07%	-2.75%	1.22%
2022-06-01	-8.01%	-14.52%	-18.64%	-2.11%
2022-07-01	18.86%	12.39%	31.99%	7.27%
2022-08-01	-3.26%	5.64%	3.74%	-4.21%
2022-09-01	-11.98%	-15.84%	-25.78%	-8.04%
2022-10-01	10.96%	12.94%	19.38%	18.17%
2022-11-01	-3.46%	-8.14%	3.96%	0.05%
2022-12-01	-12.08%	-11.23%	-15.46%	-2.85%
2023-01-01	11.05%	24.87%	16.17%	1.47%
2023-02-01	2.16%	-8.19%	-10.66%	-1.31%
2023-03-01	12.04%	0.52%	10.97%	6.56%
2023-04-01	2.90%	2.37%	-5.71%	5.77%
2023-05-01	4.46%	-14.19%	2.27%	-3.60%
2023-06-01	9.58%	1.50%	26.08%	4.66%
2023-07-01	1.28%	-0.44%	-12.69%	-1.22%
2023-08-01	-4.37%	-5.86%	-7.18%	-4.11%
2023-09-01	-8.74%	-3.14%	2.39%	-5.80%
2023-10-01	-0.26%	0.67%	-21.50%	-0.48%
2023-11-01	11.23%	13.60%	6.87%	7.50%
2023-12-01	1.49%	-2.59%	18.81%	5.84%

Average 3-month T-bill Rate

Risk-free Rate 0.1566%

Summary Statistics	**# of Obs = N**	**Expected return = R**	**Standard deviation**	**Sharpe ratio**
AAPL	60	3.11%	8.64%	0.3416
DIS	60	0.21%	10.18%	0.0049
F	60	2.02%	13.24%	0.1406
MCD	60	1.20%	5.55%	0.1883
	=COUNT(K5:K64)	=AVERAGE(K5:K64)	=STDEV.S(K5:K64)	=(O9-N3)/P9

Portfolio Weight = W

AAPL	7.98%	
DIS	5.95%	
F	-6.14%	
MCD	92.20%	
Sum	100%	=SUM(N13:N16)

Portfolio Expected Return = W'R

1.25% =MMULT(TRANSPOSE(N13:N16),O6:O9)

Population Variance-Covariance Matrix (from Excel Data Analysis)

	AAPL	*DIS*	*F*	*MCD*	
AAPL	0.007348862	0.004810508	0.005285506	0.00259764	=TRANSPOSE(N25:N27)
DIS	0.004810508	0.010180946	0.006712904	0.00256568	=TRANSPOSE(O26:O27)
F	0.005285506	0.006712904	0.017229231	0.00344839	=TRANSPOSE(P27)
MCD	0.00259764	0.002565681	0.003448393	0.00303155	

Sample Variance-Covariance Matrix = Ω

N/(N-1) 1.0169 =N6/(N6-1)

Press F4 to fix cell references.

	AAPL	*DIS*	*F*	*MCD*	
AAPL	0.007473	0.004892	0.005375	0.002642	=Q24*N31
DIS	0.004892	0.010354	0.006827	0.002609	
F	0.005375	0.006827	0.017521	0.003507	
MCD	0.002642	0.002609	0.003507	0.003083	

Portfolio Variance = W'ΩW

0.0030 =MMULT(MMULT(TRANSPOSE(N13:N16),N34:Q37),N13:N16)

Portfolio Standard Deviation

5.47% =SQRT(M40)

Portfolio Sharpe Ratio

0.1990 =(M20-N3)/M43

Minimum Variance Portfolio (MVP)

	Weight	Er(MVP)	Std(MVP)	Sharpe Ratio (MVP)
AAPL	7.98%	1.25%	5.47%	0.1990
DIS	5.95%			
F	-6.14%			
MCD	92.20%			

X

Optimal Risky Portfolio (P*)

	Weight*	Er(P*)	Std(P*)	Sharpe Ratio (P*)
AAPL	144.56%	4.86%	11.37%	0.4134
DIS	-80.71%			
F	11.33%			
MCD	24.81%			

Optimal Risky Portfolio (P*) with No Short Sale

	Weight*	Er(P*)	Std(P*)	Sharpe Ratio (P*)
AAPL	99.78%	3.11%	8.63%	0.3416
DIS	0.00%			
F	0.00%			
MCD	0.22%			