Comparative Analysis of Collar Strategy Performances Across Market Cycles

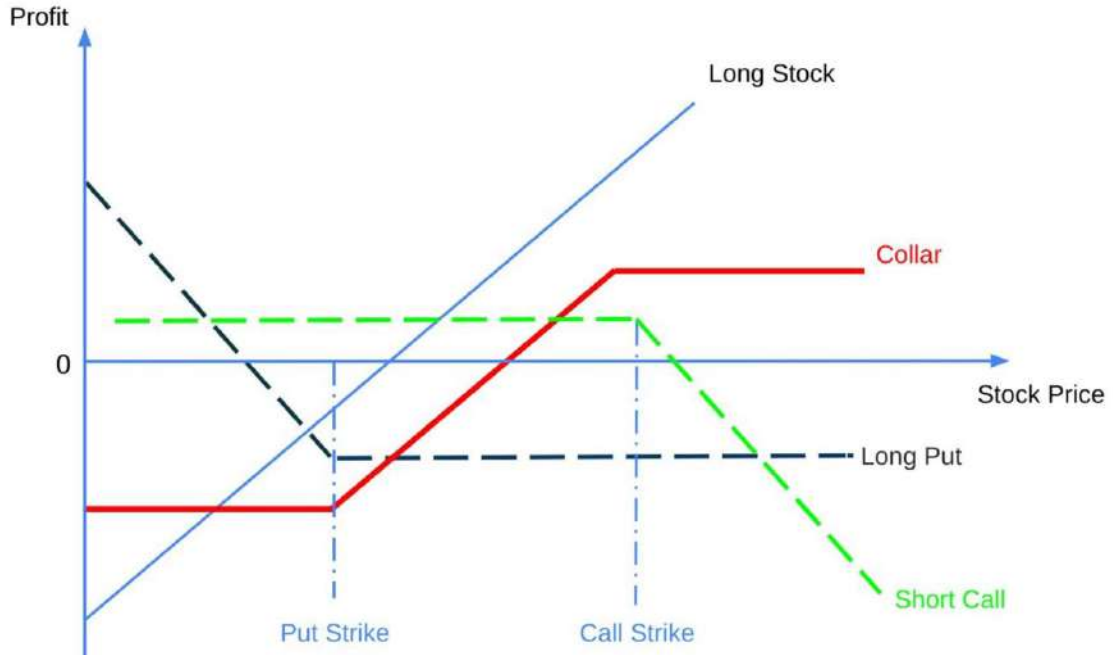
Our goal

- **Create different portfolios of options strategies and compare their performances across 2017-2019 (Pre Covid), 2019-2020 (Covid), 2020-2023 (Post Covid)**
- **Portfolio construction methodology further explained later**
- **Attempt to construct a portfolio that will be profitable in different market conditions: down trend, up trend, and range bound**

Introduction to collar strategy

- **Risk Mitigation Strategy**: Designed for investors holding stocks or other assets.
- **Components**: Involves buying protective puts and selling covered calls.
- **Protective Puts**: Guard against losses if asset prices fall.
- **Sold Calls**: Generate income but limit potential gains if prices rise.
- **Balance**: Aims to balance risk protection with profit potential.
- **Ideal for**: Investors seeking to minimize significant losses while accepting capped gains.
- **Use in Volatile Markets**: Effective in managing risks and protecting investments.

Introduction to collar strategy



Portfolio Construction

1. **Naked long S&P 500**
2. **Portfolio with Call Moneyness = 3%, Put Moneyness = 5%**
3. **Portfolio with Call Moneyness = 5%, Put Moneyness = 3%**
4. **Portfolio with Call Moneyness = 3%, Put Moneyness = 7%**
5. **Portfolio with Call Moneyness = 5%, Put Moneyness = 1%**

- **Monthly rebalancing**
- **Because of this, the strike price of the options we buy each month will be different**

Reference Research Paper

- **Methods and Performances of Collar Strategies**
- **Ilknur Tulunay, Anthony Hall, Nadima El-Hassan**
- **University of Technology, Sydney, Australia**
- **Constructing different collar portfolios and comparing their performances across 2008-2016**
- **2008 after global financial crisis, excluding periods of extreme black swan event**
- **Result comparison is slightly altered to account for lack of market data (too expensive)**

Black-Scholes Model (BSM)

- **Mathematical formula to generate prices of European options given 5 different inputs**
- **Spot price, Time to maturity, Strike, Volatility, and Risk-free rate**
- **Volatility is assumed to be constant in BSM pricing, but in practice this is not realistic**
- **After 1987 financial crash, volatility smile is observed in the market, leading to a breakdown of BSM constant vol. Assumption**
- **Necessitate the need of a better vol. Measure: 10 day rolling window volatility**

Black-Scholes Model (BSM)

The Black-Scholes Formulas

$$c = S_0\, N(d_1) - K\, e^{-rT} N(d_2)$$

$$p = K\, e^{-rT}\, N(-d_2) - S_0\, N(-d_1)$$

where $d_1 = \dfrac{\ln(S_0 / K) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}}$

$$d_2 = \frac{\ln(S_0 / K) + (r - \sigma^2 / 2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

$C(S, t)$	(call option price)
$N(\,)$	(cumulative distribution function)
$T = (T_1 - t)$	(time left til maturity (in years))
S	(stock price)
K	(strike price)
r	(risk free rate)
σ	(volatility)

Assumptions of BSM

Assumptions:

- **No dividends are paid out during the life of the option.**
- **Markets are random (i.e., market movements cannot be predicted).**
- **There are no transaction costs in buying the option.**
- **The risk free rate and volatility of the underlying asset are known and constant.**
- **The returns of the underlying asset are normally distributed.**
- **The option is European and can only be exercised at expiration.**

Data collection and cleaning

Data Gathering

- Use the yfinance library to pull monthly spot data of S&P 500.
- Extracted 'Date' and 'Adj Close' columns for analysis.
- Downloaded risk-free rate data from FRED.

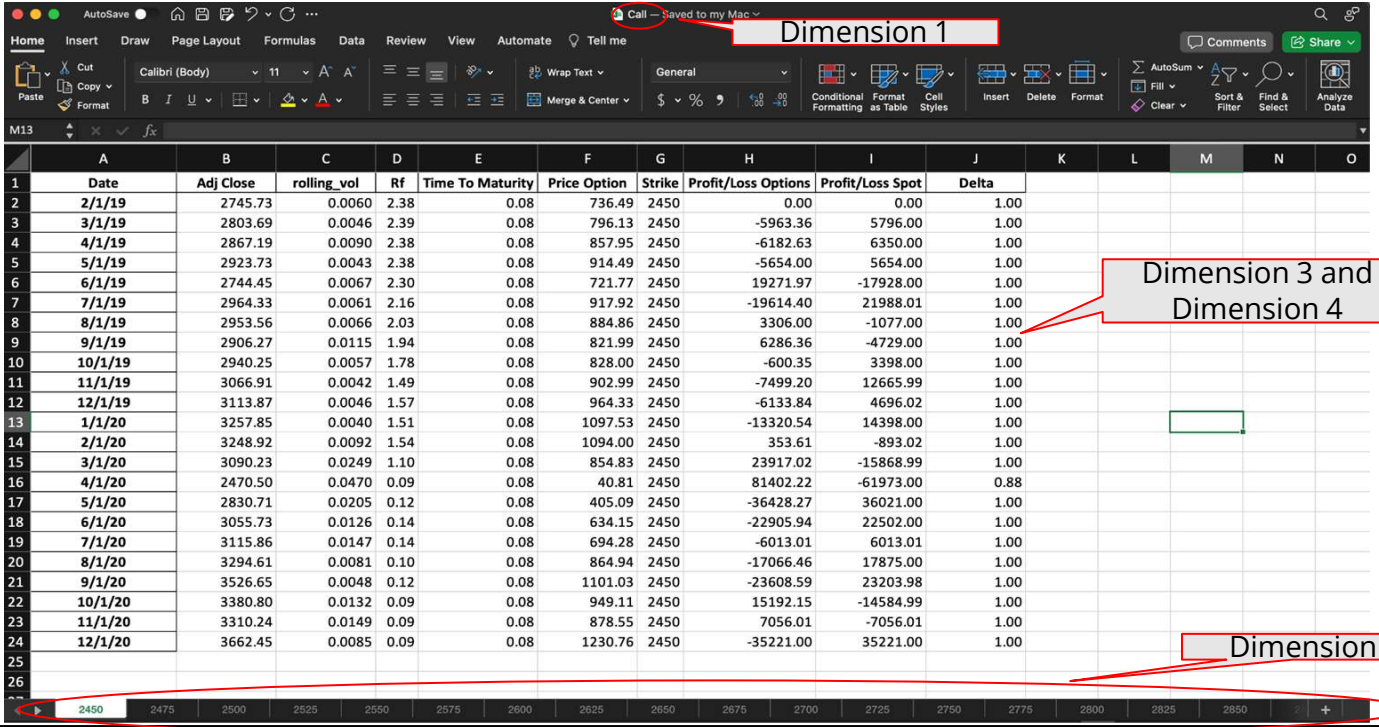
Data Manuplation

- Calculated Adjusted Return based on percent change in 'Adj Close'.
- Computed 10-day rolling historical volatility from spot price data..
- Generated strikes ± 25 from spot of each month for completeness.

Optimization

- Generated 4-dimensional array for Call/Put, Possible Strikes, BSM Parameters, and price of option.
- Profit columns.

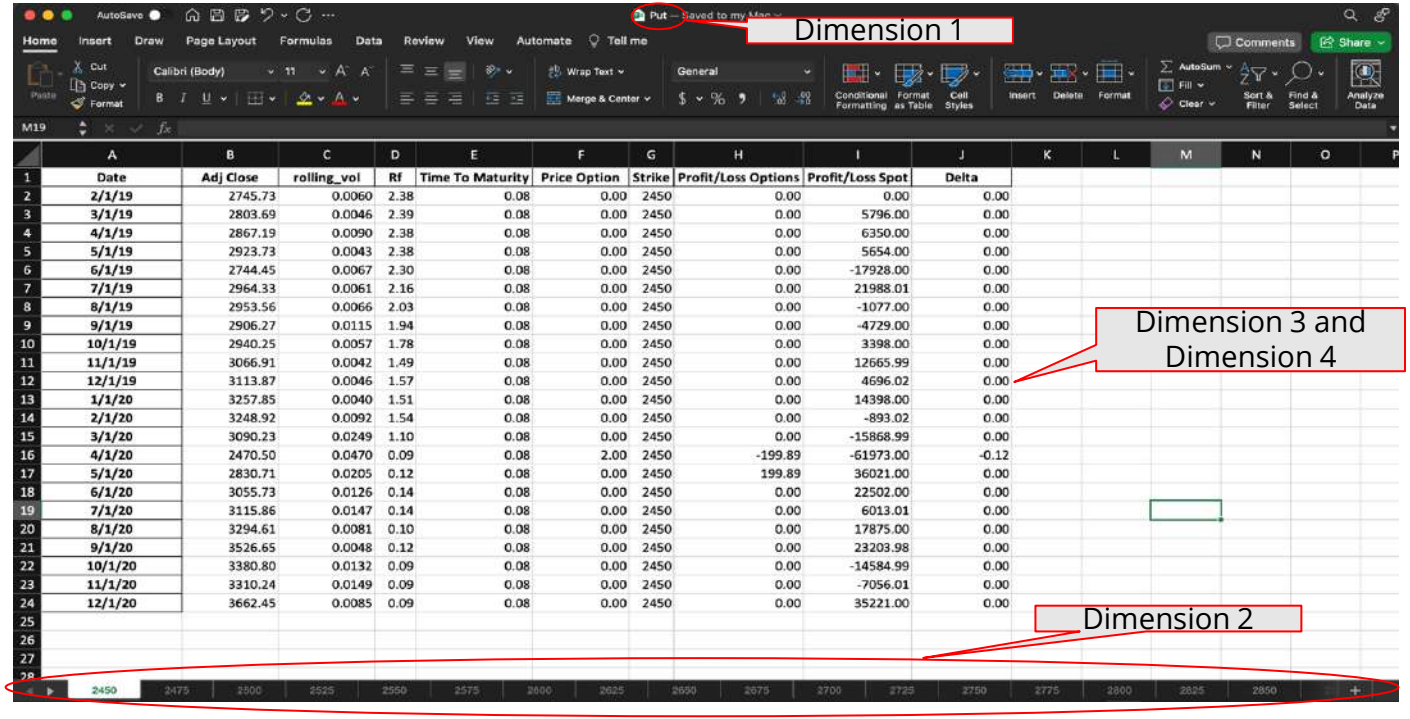
Data collection and cleaning



	A	B	C	D	E	F	G	H	I	J
1	Date	Adj Close	rolling_vol	Rf	Time To Maturity	Price Option	Strike	Profit/Loss Options	Profit/Loss Spot	Delta
2	2/1/19	2745.73	0.0060	2.38	0.08	736.49	2450	0.00	0.00	1.00
3	3/1/19	2803.69	0.0046	2.39	0.08	796.13	2450	-5963.36	5796.00	1.00
4	4/1/19	2867.19	0.0090	2.38	0.08	857.95	2450	-6182.63	6350.00	1.00
5	5/1/19	2923.73	0.0043	2.38	0.08	914.49	2450	-5654.00	5654.00	1.00
6	6/1/19	2744.45	0.0067	2.30	0.08	721.77	2450	19271.97	-17928.00	1.00
7	7/1/19	2964.33	0.0061	2.16	0.08	917.92	2450	-19614.40	21988.01	1.00
8	8/1/19	2953.56	0.0066	2.03	0.08	884.86	2450	3306.00	-1077.00	1.00
9	9/1/19	2906.27	0.0115	1.94	0.08	821.99	2450	6286.36	-4729.00	1.00
10	10/1/19	2940.25	0.0057	1.78	0.08	828.00	2450	-600.35	3398.00	1.00
11	11/1/19	3066.91	0.0042	1.49	0.08	902.99	2450	-7499.20	12665.99	1.00
12	12/1/19	3113.87	0.0046	1.57	0.08	964.33	2450	-6133.84	4696.02	1.00
13	1/1/20	3257.85	0.0040	1.51	0.08	1097.53	2450	-13320.54	14398.00	1.00
14	2/1/20	3248.92	0.0092	1.54	0.08	1094.00	2450	353.61	-893.02	1.00
15	3/1/20	3090.23	0.0249	1.10	0.08	854.83	2450	23917.02	-15868.99	1.00
16	4/1/20	2470.50	0.0470	0.09	0.08	40.81	2450	81402.22	-61973.00	0.88
17	5/1/20	2830.71	0.0205	0.12	0.08	405.09	2450	-36428.27	36021.00	1.00
18	6/1/20	3055.73	0.0126	0.14	0.08	634.15	2450	-22905.94	22502.00	1.00
19	7/1/20	3115.86	0.0147	0.14	0.08	694.28	2450	-6013.01	6013.01	1.00
20	8/1/20	3294.61	0.0081	0.10	0.08	864.94	2450	-17066.46	17875.00	1.00
21	9/1/20	3526.65	0.0048	0.12	0.08	1101.03	2450	-23608.59	23203.98	1.00
22	10/1/20	3380.80	0.0132	0.09	0.08	949.11	2450	15192.15	-14584.99	1.00
23	11/1/20	3310.24	0.0149	0.09	0.08	878.55	2450	7056.01	-7056.01	1.00
24	12/1/20	3662.45	0.0085	0.09	0.08	1230.76	2450	-35221.00	35221.00	1.00
25										
26										

2450 2475 2500 2525 2550 2575 2600 2625 2650 2675 2700 2725 2750 2775 2800 2825 2850

Data collection and cleaning



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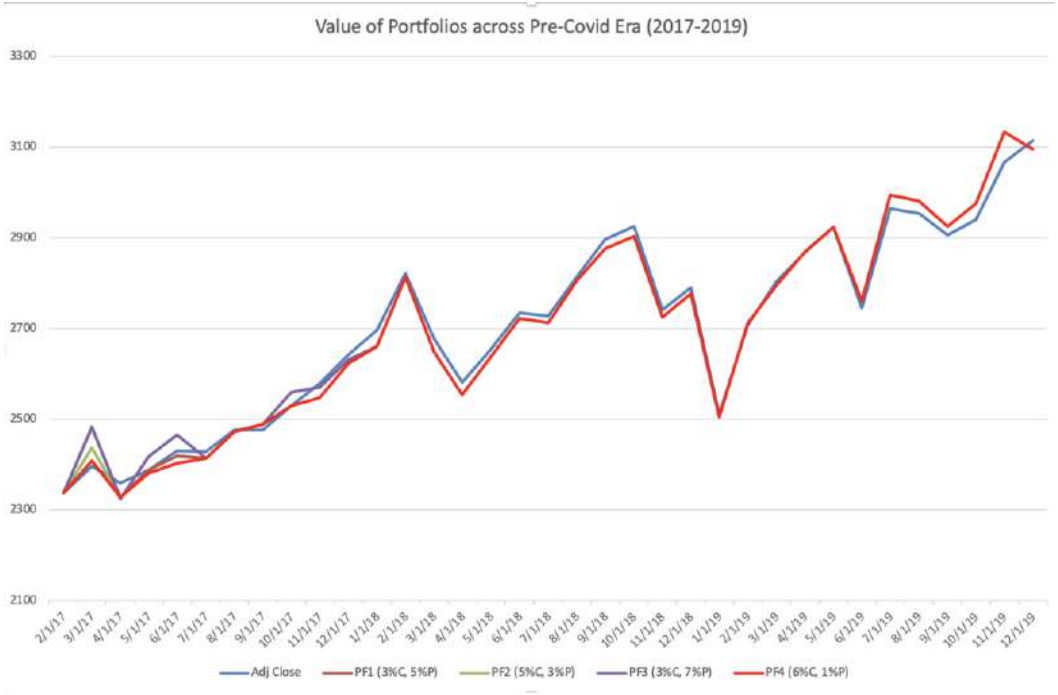
4	4/1/19	2867.19	0.0090	2.38	0.08	0.00	2450	0.00	6350.00	0.00
5	5/1/19	2923.73	0.0043	2.38	0.08	0.00	2450	0.00	5654.00	0.00
6	6/1/19	2744.45	0.0067	2.30	0.08	0.00	2450	0.00	-17928.00	0.00
7	7/1/19	2964.33	0.0061	2.16	0.08	0.00	2450	0.00	21988.01	0.00
8	8/1/19	2953.56	0.0066	2.03	0.08	0.00	2450	0.00	-1077.00	0.00
9	9/1/19	2906.27	0.0115	1.94	0.08	0.00	2450	0.00	-4729.00	0.00
10	10/1/19	2940.25	0.0057	1.78	0.08	0.00	2450	0.00	3398.00	0.00
11	11/1/19	3066.91	0.0042	1.49	0.08	0.00	2450	0.00	12665.99	0.00
12	12/1/19	3113.87	0.0046	1.57	0.08	0.00	2450	0.00	4696.02	0.00
13	1/1/20	3257.85	0.0040	1.51	0.08	0.00	2450	0.00	14398.00	0.00
14	2/1/20	3248.92	0.0092	1.54	0.08	0.00	2450	0.00	-893.02	0.00
15	3/1/20	3090.23	0.0249	1.10	0.08	0.00	2450	0.00	-15868.99	0.00
16	4/1/20	2470.50	0.0470	0.09	0.08	2.00	2450	-199.89	-61973.00	-0.12
17	5/1/20	2830.71	0.0205	0.12	0.08	0.00	2450	199.89	36021.00	0.00
18	6/1/20	3055.73	0.0126	0.14	0.08	0.00	2450	0.00	22502.00	0.00
19	7/1/20	3115.86	0.0147	0.14	0.08	0.00	2450	0.00	6013.01	0.00
20	8/1/20	3294.61	0.0081	0.10	0.08	0.00	2450	0.00	17875.00	0.00
21	9/1/20	3526.65	0.0048	0.12	0.08	0.00	2450	0.00	23203.98	0.00
22	10/1/20	3380.80	0.0132	0.09	0.08	0.00	2450	0.00	-14584.99	0.00
23	11/1/20	3310.24	0.0149	0.09	0.08	0.00	2450	0.00	-7056.01	0.00
24	12/1/20	3662.45	0.0085	0.09	0.08	0.00	2450	0.00	35221.00	0.00

Model Construction

- **BSM Function:**
  - Takes parameters such as Risk-Free Rate, Strike, Call/Put Type, Adj Close, Rolling Volatility, and Time to Maturity.
  - Returns the calculated option price.
- **Profit Calculation Function:**
  - Based on the BSM option price, calculates profit/loss for:
    - Buying 1 put
    - Shorting 1 call
    - Naked Spot Profit/Loss
- **Monthly Returns with Collar Strategy:**
  - Utilizing various moneyness levels defined for our portfolio.
  - Calculates returns on a monthly basis(Re Balancing Period) using a collar strategy.
- **Comparison with Naked Call:**
  - Compares the results of different portfolios with the naked call strategy.

Portfolio Performances for 2017-2019 (Pre-Covid Era)

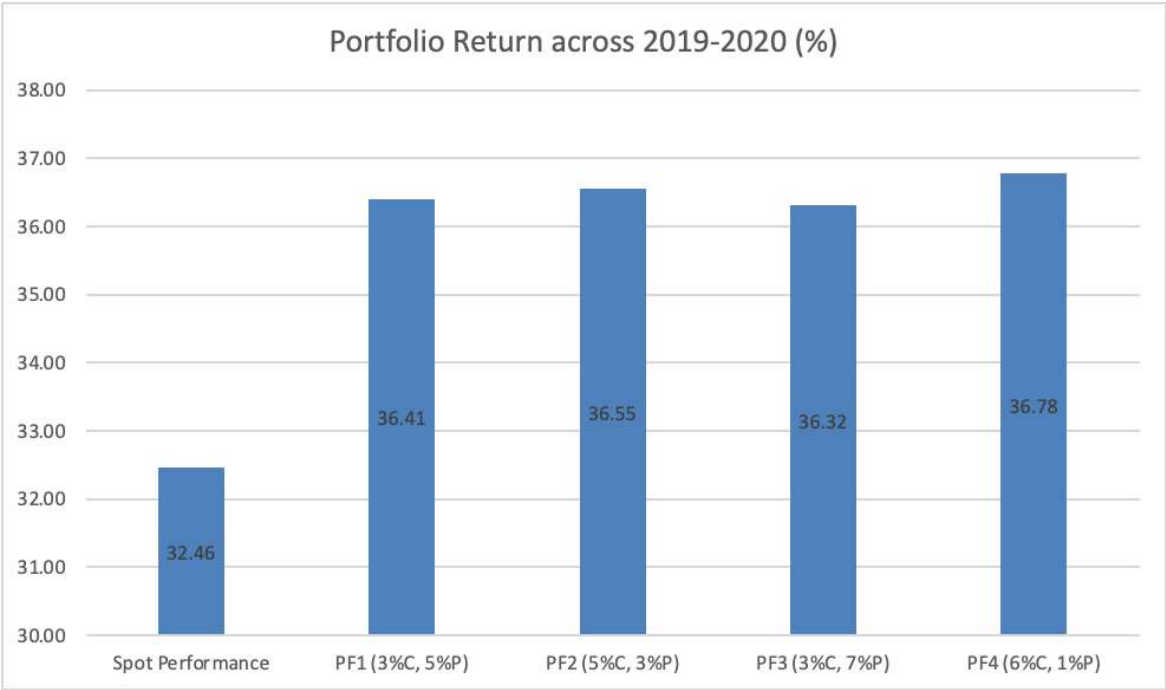


Date	Adj Close	PF1 (3%C, 5%P)	PF2 (5%C, 3%P)	PF3 (3%C, 7%P)	PF4 (6%C, 1%P)
2/1/17	2337.58	2337.58	2337.58	2337.58	2337.58
3/1/17	2395.96	2482.60	2437.27	2483.49	2408.75
4/1/17	2358.84	2328.02	2328.02	2323.22	2328.02
5/1/17	2388.33	2387.89	2380.61	2418.13	2380.61
6/1/17	2430.06	2419.30	2402.71	2465.99	2402.71
7/1/17	2429.01	2413.52	2413.52	2413.52	2413.52
8/1/17	2476.35	2472.42	2472.42	2474.48	2472.42
9/1/17	2476.55	2488.37	2488.37	2488.37	2488.37
10/1/17	2529.12	2529.12	2529.12	2559.69	2529.12
11/1/17	2579.36	2546.76	2546.76	2570.77	2546.76
12/1/17	2642.22	2623.74	2623.74	2631.77	2623.74
1/1/18	2695.81	2660.32	2660.32	2660.32	2660.32
2/1/18	2821.98	2813.33	2813.33	2813.34	2813.33
3/1/18	2677.67	2649.17	2649.17	2649.17	2649.17
4/1/18	2581.88	2554.73	2554.73	2554.73	2554.73
5/1/18	2654.80	2638.99	2638.99	2638.99	2638.99
6/1/18	2734.62	2722.51	2722.51	2722.51	2722.51
7/1/18	2726.71	2712.66	2712.66	2712.66	2712.66
8/1/18	2813.36	2805.16	2805.16	2805.16	2805.16
9/1/18	2896.72	2875.63	2875.63	2875.63	2875.63
10/1/18	2924.59	2903.50	2903.50	2903.50	2903.50
11/1/18	2740.37	2724.73	2724.73	2724.73	2724.73
12/1/18	2790.37	2776.53	2776.53	2776.53	2776.53
1/1/19	2510.03	2504.69	2504.69	2504.69	2504.69
2/1/19	2706.53	2710.36	2710.36	2710.36	2710.36
3/1/19	2803.69	2795.76	2795.76	2795.76	2795.76
4/1/19	2867.19	2869.22	2869.22	2869.22	2869.22
5/1/19	2923.73	2923.73	2923.73	2923.73	2923.73
6/1/19	2744.45	2760.08	2760.08	2760.08	2760.08
7/1/19	2964.33	2994.12	2994.12	2994.12	2994.12
8/1/19	2953.56	2981.31	2981.31	2981.31	2981.31
9/1/19	2906.27	2925.34	2925.34	2925.34	2925.34
10/1/19	2940.25	2975.08	2975.08	2975.08	2975.08
11/1/19	3066.91	3133.87	3133.87	3133.87	3133.87
12/1/19	3113.87	3094.94	3094.94	3094.94	3094.94
	Excess Returns (%)	-0.07	-0.15	0.07	-0.18

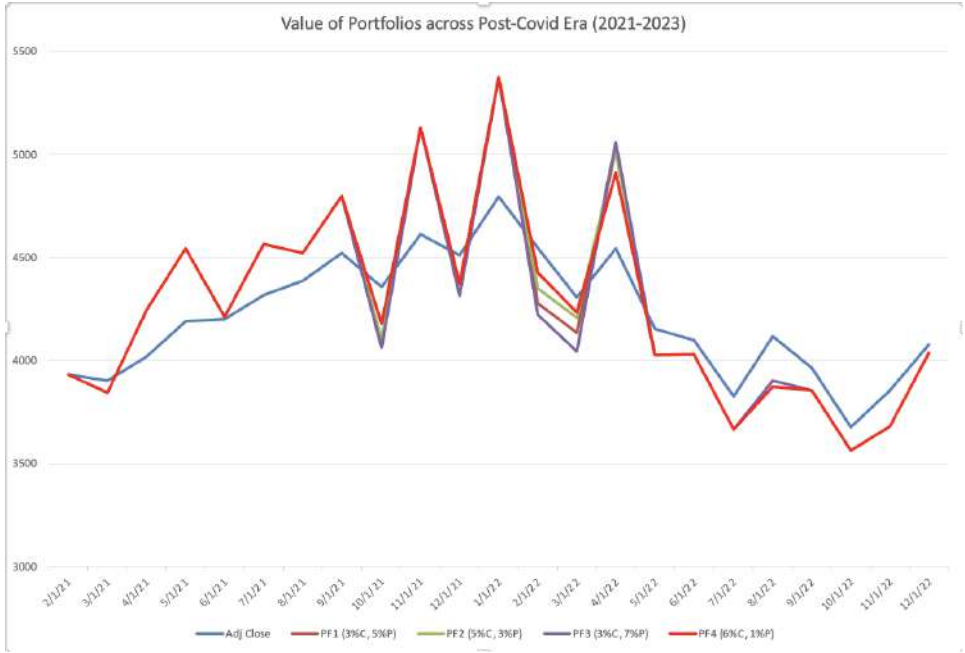
Portfolio Performances for 2019-2020 (Covid Era)

Date	Adj Close	PF1 (3%C, 5%P)	PF2 (5%C, 3%P)	PF3 (3%C, 7%P)	PF4 (6%C, 1%P)
2/1/19	2745.73	2745.73	2745.73	2745.73	2745.73
3/1/19	2803.69	2801.71	2801.71	2801.71	2801.71
4/1/19	2867.19	2869.22	2869.22	2869.22	2869.22
5/1/19	2923.73	2923.73	2923.73	2923.73	2923.73
6/1/19	2744.45	2760.08	2760.08	2760.08	2760.08
7/1/19	2964.33	2994.12	2994.12	2994.12	2994.12
8/1/19	2953.56	2981.31	2981.31	2981.31	2981.31
9/1/19	2906.27	2925.34	2925.34	2925.34	2925.34
10/1/19	2940.25	2975.08	2975.08	2975.08	2975.08
11/1/19	3066.91	3133.87	3133.87	3133.87	3133.87
12/1/19	3113.87	3094.94	3094.94	3094.94	3094.94
1/1/20	3257.85	3272.69	3272.69	3272.69	3272.69
2/1/20	3248.92	3241.54	3241.54	3241.54	3241.54
3/1/20	3090.23	3195.35	3195.35	3195.31	3195.35
4/1/20	2470.50	2503.77	2552.89	2454.15	2594.34
5/1/20	2830.71	3558.50	3558.38	3558.69	3556.67
6/1/20	3055.73	3511.09	3510.96	3511.17	3509.42
7/1/20	3115.86	3236.12	3236.12	3236.12	3229.56
8/1/20	3294.61	3640.64	3640.89	3640.39	3641.05
9/1/20	3526.65	3996.88	3996.76	3996.96	3996.63
10/1/20	3380.80	3153.76	3203.38	3141.59	3277.38
11/1/20	3310.24	3169.55	3169.99	3169.55	3224.27
12/1/20	3662.45	4366.87	4366.87	4366.87	4366.24
	Excess Returns (%)	3.95	4.09	3.86	4.32

Portfolio Performances for 2019-2020 (Covid Era)



Portfolio Performances for 2020-2023 (Post-Covid Era)



Date	Adj Close	PF1 (3%C, 5%P)	PF2 (5%C, 3%P)	PF3 (3%C, 7%P)	PF4 (6%C, 1%P)
2/1/21	3932.59	3932.59	3932.59	3932.59	3932.59
3/1/21	3901.82	3843.68	3843.62	3843.75	3844.29
4/1/21	4019.87	4245.44	4245.63	4245.19	4245.81
5/1/21	4192.66	4545.60	4545.43	4545.72	4545.31
6/1/21	4202.04	4213.44	4213.57	4213.32	4213.73
7/1/21	4319.94	4567.08	4566.83	4567.27	4566.65
8/1/21	4387.16	4521.60	4521.60	4521.60	4521.60
9/1/21	4524.09	4797.95	4797.95	4797.95	4797.95
10/1/21	4357.04	4061.94	4104.81	4061.86	4179.56
11/1/21	4613.67	5130.96	5130.89	5131.04	5130.81
12/1/21	4513.04	4315.72	4315.64	4315.81	4373.26
1/1/22	4796.56	5376.15	5375.90	5376.39	5375.21
2/1/22	4546.54	4278.66	4352.42	4222.33	4427.24
3/1/22	4306.26	4135.69	4208.01	4046.69	4235.36
4/1/22	4545.86	5056.60	5010.34	5058.34	4912.98
5/1/22	4155.38	4027.03	4027.03	4025.36	4027.03
6/1/22	4101.23	4030.02	4030.02	4030.03	4030.02
7/1/22	3825.33	3667.01	3667.01	3667.01	3667.01
8/1/22	4118.63	3874.18	3874.18	3902.50	3874.18
9/1/22	3966.85	3857.53	3857.53	3857.53	3857.53
10/1/22	3678.43	3566.01	3566.01	3566.01	3566.01
11/1/22	3856.10	3680.85	3680.85	3680.85	3680.85
12/1/22	4076.57	4036.91	4036.91	4036.91	4036.91
	Excess Returns (%)	0.85	0.15	-0.26	0.41

Conclusion

- **Portfolios returns are very similar in stable market conditions**
- **PF3 (3% Call, 7% Put) performed the best in Pre-Covid Era with 0.07% of excess returns**
- **PF1 (3% Call, 5% Put) performed best in Post-Covid Era with 0.85% of excess returns**
- **Need to factor in transaction cost from rebalancing in practice, reducing returns**
- **PF4 (6% Call, 1% Put) performed the best during Covid times generating 4.31% excess returns**
- **Surprising considering a higher OTM % Call write should decrease the delta of the collar leading to less profits in bull market; providing more downside protection**

Q & A

Thank you!