



Options VaR Risk Analysis of Butterfly Spread Options Portfolio

Assessing 1-Day Risk with t-Copula and Black-Scholes Model

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Quantitative Risk Management

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Long Butterfly Spread: options VaR

Outline

Portfolio

Evaluation

Scenarios

Value at Risk

Goal

- Evaluate risk associated with the long Butterfly spread portfolio on BRK/B shares
- Quantify 1-day market risk using a 95% Value at Risk (VaR) measure

Portfolio Strategy

- **Long butterfly spread:** A low-risk strategy with capped profit and loss potential

Risk Factors

- SPX (S&P 500 Index): overall market performance
- VIX (Volatility Index): market's implied volatility, essential for risk modeling

Long Butterfly Spread: options VaR

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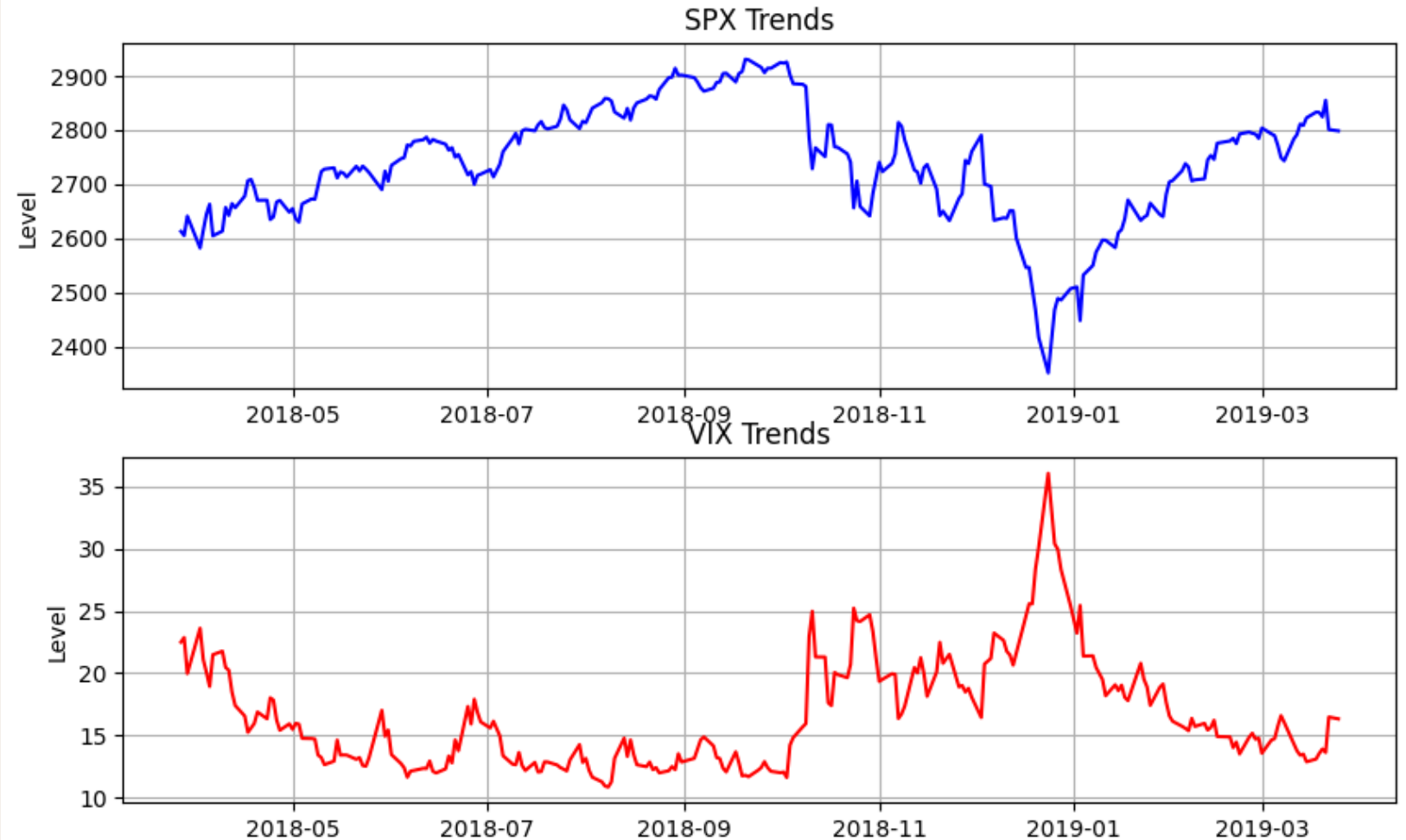
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SPX and VIX Price Trend

From 2018-03-26 to 2019-03-25



Long Butterfly Spread: options VaR

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SPX and VIX
historical data



Monte Carlo
simulation



Cholesky
decomposition



Gaussian Copula
with t-marginals



Call option price
calculation



Implied Volatility
using VIX



Pricing the option
(**Black-Scholes**
model)



Portfolio value of
each scenario



1-day 95% **VaR**

Long Butterfly Spread: options VaR

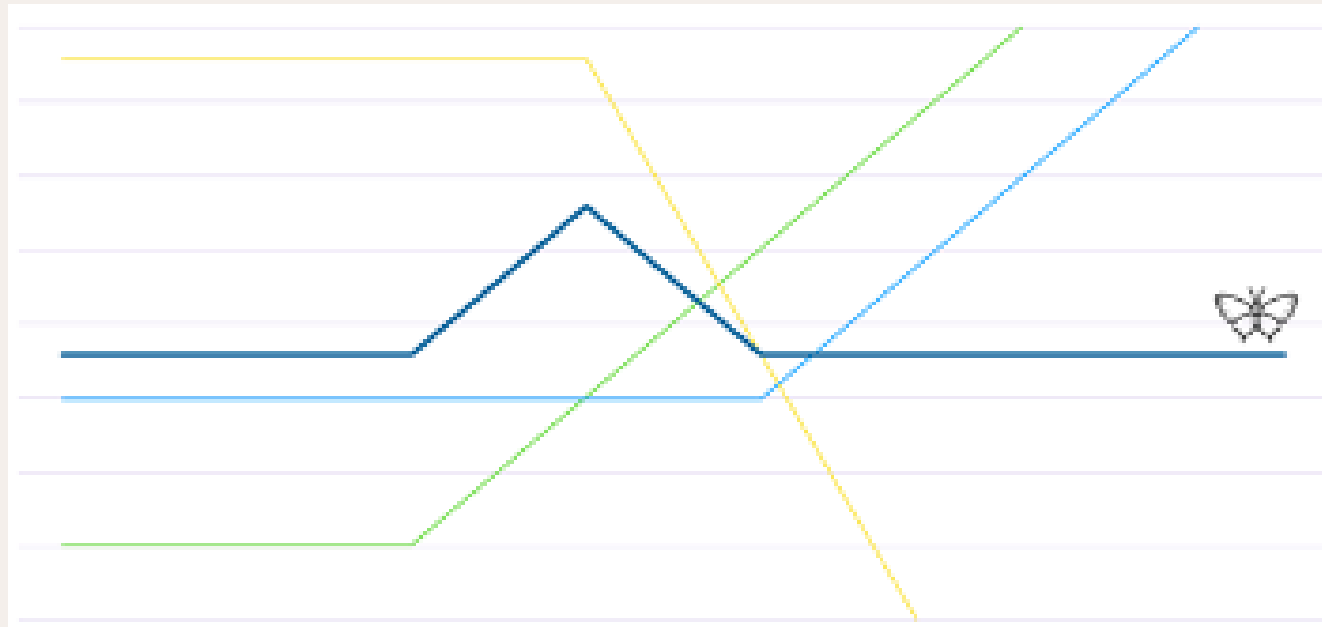
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— Long call (\$195) — 2 short calls (\$200) — Long call (\$205) — Butterfly spread

Portfolio Structure

- Long: 100 call options, strike \$195
- Short: 200 call options, strike \$200
- Long: 100 call options, strike \$205
- Cash: \$20



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4-BLOOMBERG

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< > BERKSHIRE HATH-B Equity OMON Related Functions Menu Message

BRK/B US \$ 200.62 +1.18 N200.66 / 200.67N 3x174

At 17:05 d Vol 3,737,771 0 200.83P H 201.32T L 198.70Z Val 747.097M

BRK/B US Equity 95) Actions 97) Settings Option Monitor

BERKSHIRE HATH-B 200.62 1.18 .5917% 200.66 / 200.67 Hi 201.32 Lo 198.70 Volm 3737771 HV 13.66

Center 200.62 Strikes 121 Exp 18-Apr-19 Exch US Composite 92) 05/06/19 E | ERN »

Calc Mode As of 26-Mar-2019

81) Center Strike 82) Calls/Puts 83) Calls 84) Puts 85) Term Structure 87) Moneyness

Strike		Mid	Rate	DyEx	IVM	DM	GM	Px/S	Volm	VM
187.50	12)	14.00	2.45	22	24.08	.88	.0337	1.07		.1029
190.00	13)	12.18	2.45	22	24.50	.83	.0415	1.06		.1284
192.50	14)	9.73	2.45	22	23.18	.77	.0523	1.04		.1528
195.00	15)	7.25	2.45	22	16.65	.78	.0717	1.03	50	.1510
197.50	16)	5.85	2.45	22	18.72	.66	.0781	1.02	7	.1847
200.00	17)	3.83	2.45	22	16.34	.56	.0963	1.00	1644	.1985
202.50	18)	2.77	2.45	22	14.62	.43	.1069	.99	38	.1974
205.00	19)	1.36	2.45	22	14.47	.30	.0958	.98	1348	.1749
207.50	20)	.67	2.45	22	13.73	.18	.0768	.97	26	.1339
210.00	21)	.34	2.45	22	13.64	.11	.0536	.96	84	.0924
212.50	22)	.21	2.45	22	14.96	.06	.0337	.94	6	.0637
215.00	23)	.08	2.45	22	14.83	.03	.0175	.93		.0313
217.50	24)	.44	2.45	22	23.52	.08	.0260	.92		.0762
220.00	25)	.10	2.45	22	19.54	.03	.0132	.91	1	.0322
222.50	26)	.31	2.45	22	25.65	.06	.0179	.90		.0580
225.00	27)	.28	2.45	22	27.26	.05	.0151	.89		.0520
227.50	28)	.26	2.45	22	28.91	.04	.0130	.88		.0474
230.00	29)	.01	2.45	22	20.99		.0025	.87	50	.0066
240.00	30)	.19	2.45	22	36.41	.03	.0070	.84		.0332
250.00	31)	.16	2.45	22	42.02	.02	.0048	.80		.0265

Suggested Functions GPO Track the open/high/low/close price GIP Chart intraday price movements

Key indicators:

- Underlying price: \$200.62
- Expiration: 23 days
- Rate: 2.45%
- Volatilities: 16.65%, 16.34%, 14.47%

Black-Scholes pricing formula:

- Call 1 at strike = \$7.07
- Call 2 at strike = \$3.76
- Call 3 at strike = \$1.34
- Portfolio market value: \$108.83

Long Butterfly Spread: options VaR

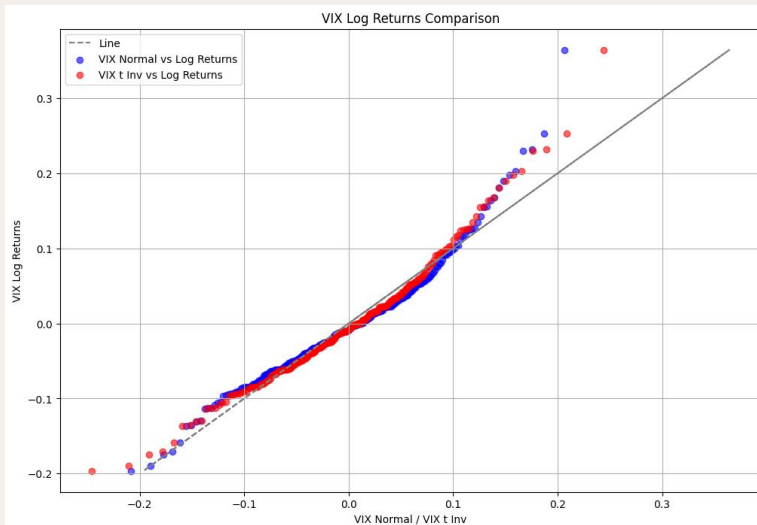
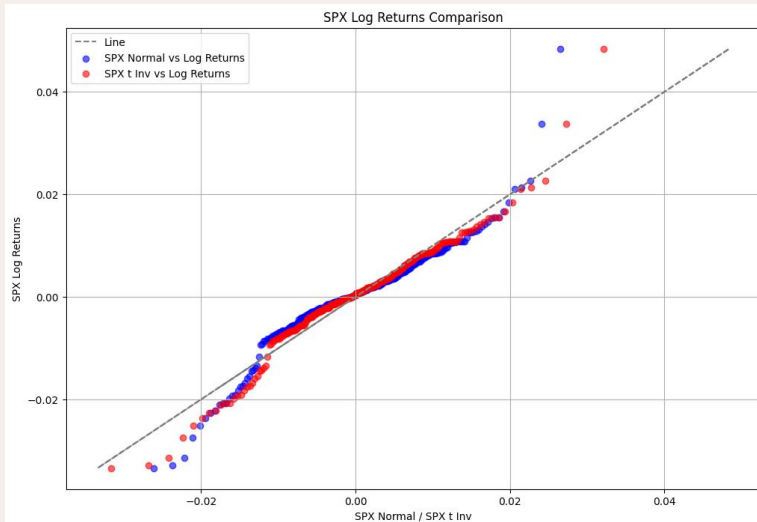
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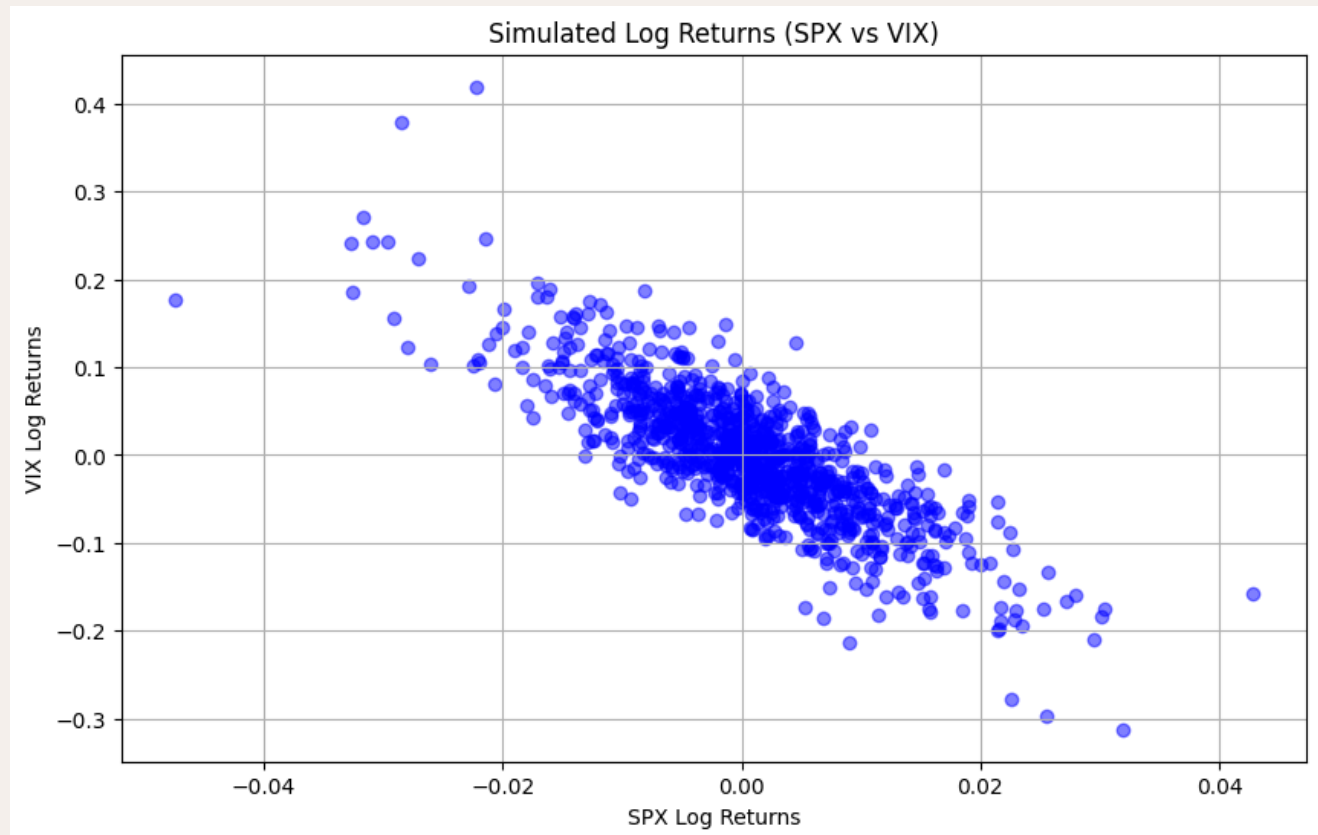


Risk Factors

- SPX: market performance
- VIX: implied volatility

Gaussian copula

- t-distribution fits better
- 1,000 scenarios



Long Butterfly Spread: options VaR

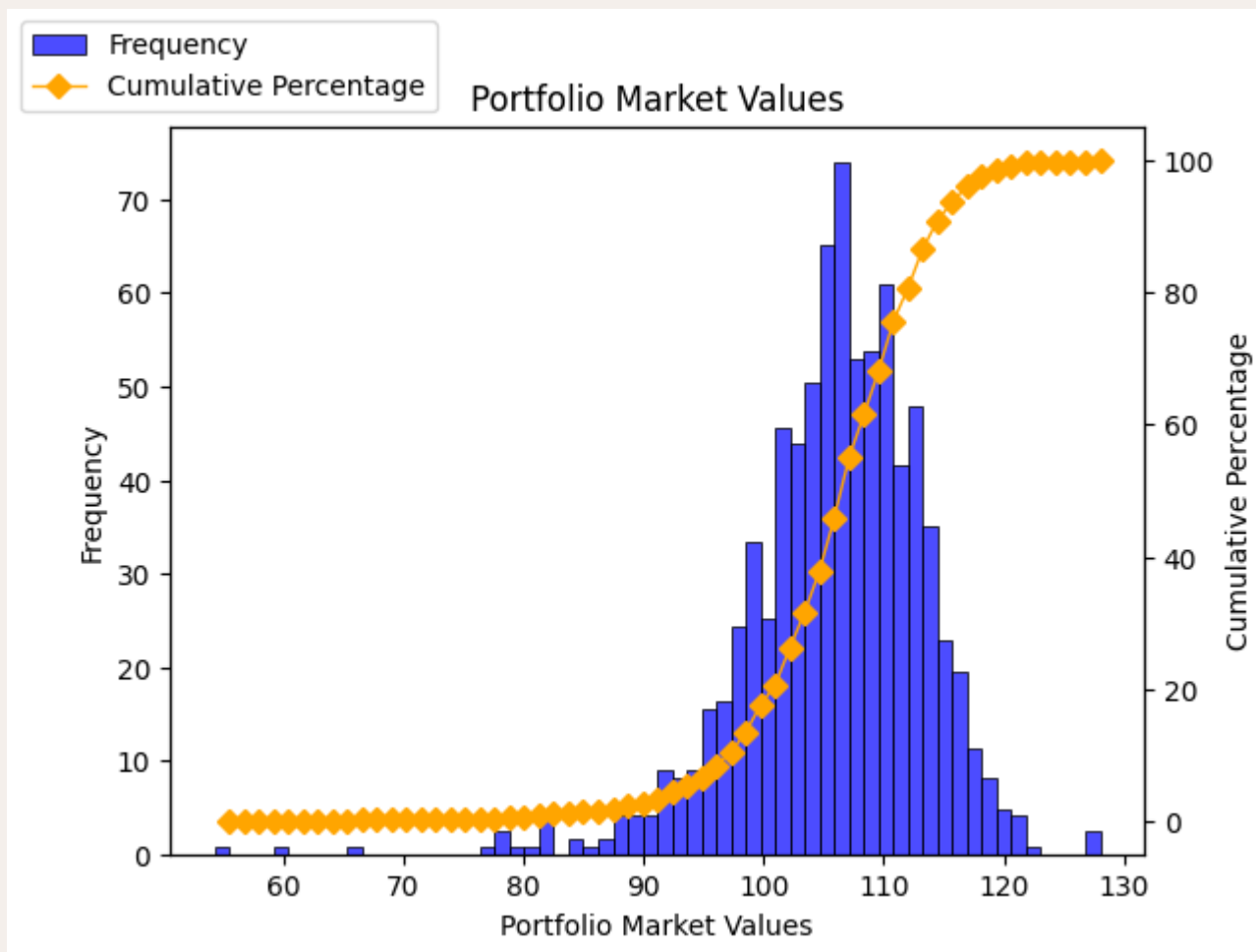
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Generated scenarios:

- Mean market value: \$105.82
- Mean PnL: -\$3.01
- Mean return: -0.03%
- Volatility of return: 0.07%

Value at Risk (95%):

- PnL: \$15.88
- Return: 14.59%

THANK YOU

Any questions?