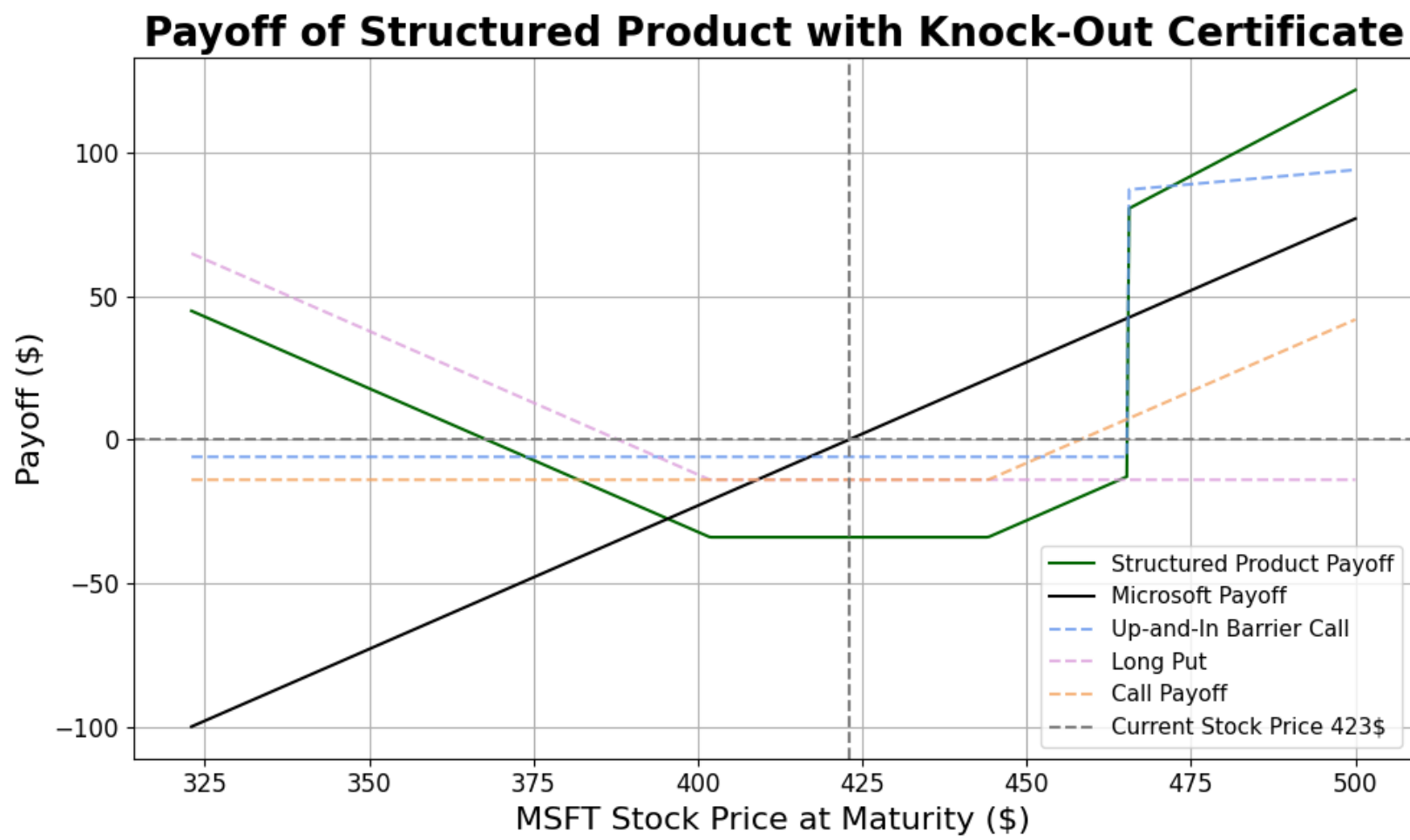




Part 1: Designing Certificates

Product Design & Payoff

This structured product offers exposure to Microsoft's upside potential driven by its strong position in the AI sector while providing partial downside protection against broader AI-related risks. Microsoft has strengthened its AI leadership through strategic investments, particularly its partnership with OpenAI. However, developments such as the Deepspeak presentation highlight ongoing uncertainties in the U.S. AI landscape. The product consists of three components designed to outperform Microsoft stock in expected market scenarios. First, a 5% out-of-the-money (OTM) put option provides partial downside protection. This is mirrored by a 5% OTM call option to capture moderate upside. Additionally, a binary call option is included, with a barrier set at 10% above the current spot price. The structured product outperforms the stock in scenarios where Microsoft decreases by up to 6% or increases by 10% or more.



Target Group & Volume

The market expectations of potential buyers should align with the core idea of the product. The structured product is primarily designed for moderately risk-averse investors who are strategically optimistic about the long-term opportunities in the AI sector, particularly Microsoft's role as a market leader. These investors are not speculative traders but seek a risk-managed way to participate in high-growth scenarios while protecting capital during downturns. The target audience includes sophisticated retail and semi-institutional investors with a solid understanding of financial instruments, given that mutiple and exotic components were used. Clients with enforced downside protection are not suitable.

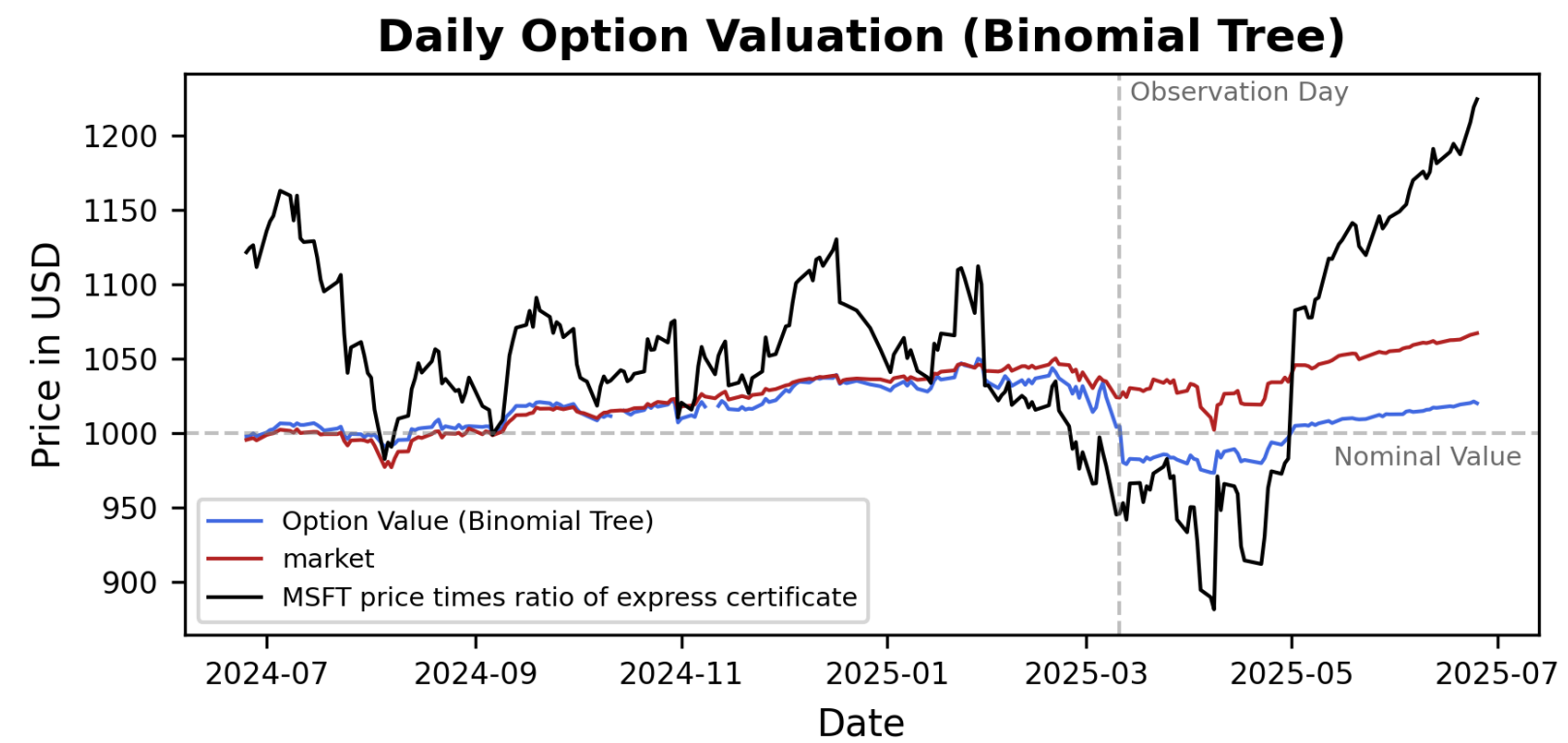
The emission volume of the product is based on the market volume estimate for Q1 2025 published by the Bundesverband für Strukturierte Wertpapiere (BSV) [1]. According to the report, the average market volume of structured products without capital protection amounts to approximately €44.1 billion, of which 18.1% are based on equities. Given the asymmetric payoff profile of the product—comparable to bonus certificates but incorporating exotic options and a thematic focus on overall market growth—the expected emission volume is estimated to range between €5 million and €10 million. This estimate is consistent with the issuance volumes of comparable products linked to Microsoft stock by major investment banks. If overall market growth slows down, a decline in investor interest and emission volume can be expected.

Part 2: Valuation of certificates

The Product is an **Express Certificate (WKN: HW6V4D, ISIN: DE000HW6V4D8)** on the **Microsoft Stock**, offered by **UniCredit**, with Maturity Date at the 04.03.2027. The Nominal Value is 1000. The Threshold on the Observation Dates (11.03 each year) is set to 402.09\$ and the Barrier Level is set to 201.045\$ [2].

Valuation

The Express Certificate was valued using binomial tree method over the observation window starting from the 25.06.2024 to the 25.06.2025. The annualized annualized historical volatility and a daily varying risk free rate calculated with the Svensson Method is used for the valuation [3]. The binomial tree provides a reasonable approximation of the express certificate's market value over time, particularly in the period leading up to the first observation date. Around the observation date, both the market and model values decrease in response to the underlying Microsoft stock price falling rapidly below the predefined express threshold, resulting in the non-occurrence of early redemption. Capturing the increased risk associated with the extension of the product's maturity and the reduced probability of favorable early payout.

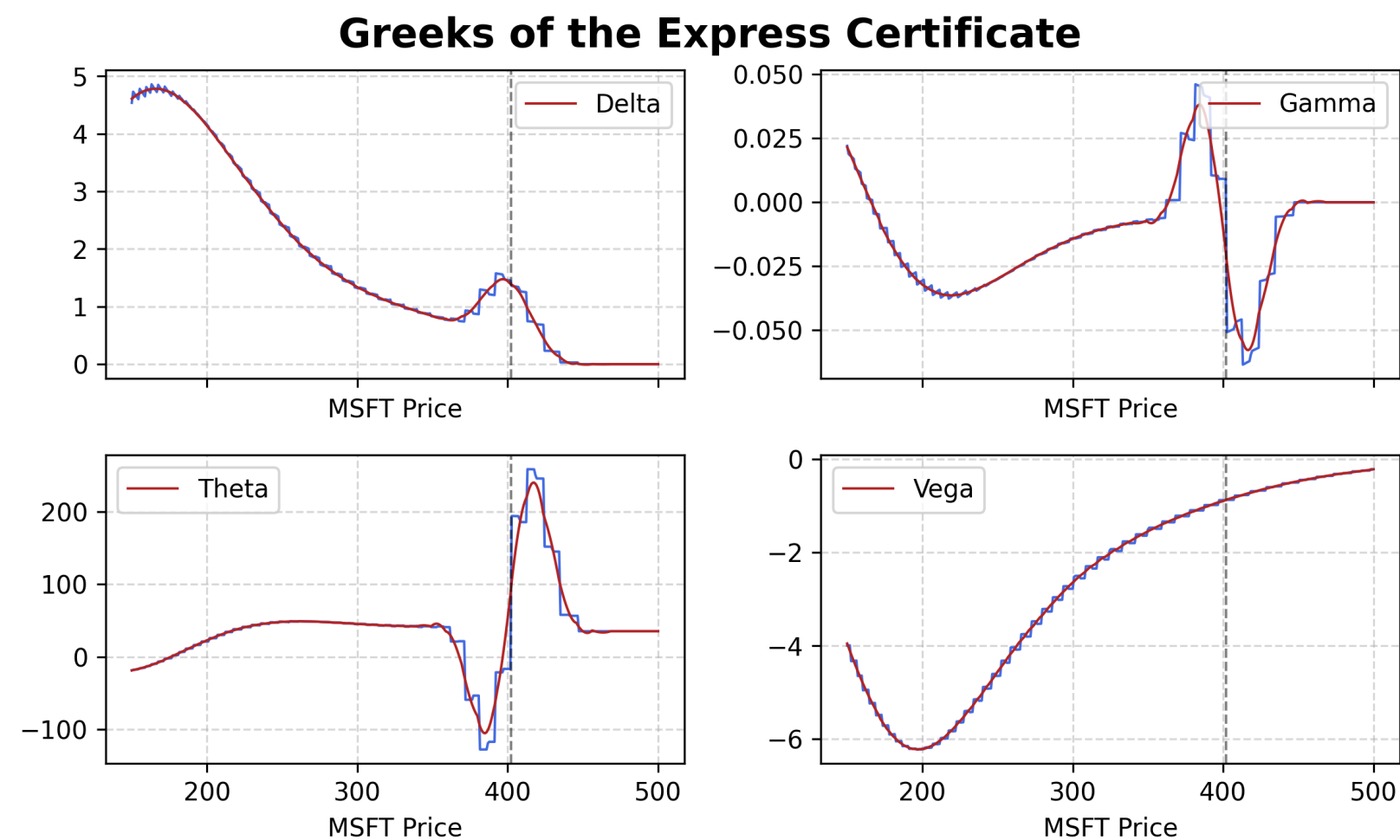


The binomial tree exhibits greater sensitivity around observation dates, which could be due to it strictly reflecting risk-neutral expectations without accounting for market frictions, which tend to smooth observed prices in practice. The Error metrics quantify this deviation between the valuation and the observed market prices. The Mean Error of -13.16 USD indicates a slight systematic undervaluation of the certificate by the model on average, suggesting a conservative bias. The RMSE of 23.68 USD and MAE of 15.94 USD reflect moderate deviations, capturing the typical magnitude of pricing differences across the valuation period. Importantly, the MAPE is low at 1.54%, indicating that the relative pricing accuracy remains high despite some absolute deviations. The 5th percentile error is -47.17 USD, implying that on the worst days, the model significantly undervalued the certificate relative to market prices. In contrast, the 95th percentile is +6.20 USD, suggesting limited overvaluation. The distribution is clearly left-skewed, consistent with the ME and indicating that larger negative deviations dominate. This asymmetry may reflect the model's heightened sensitivity to downside risk around observation dates.

Error Metric	Value	Quantile	Value
Mean Error (ME)	-13.16	5%	-47.17
MAPE	1.54%	25%	-37.79
MAE	15.94	50%	-4.81
RMSE	23.68	75%	2.44
		95%	6.20

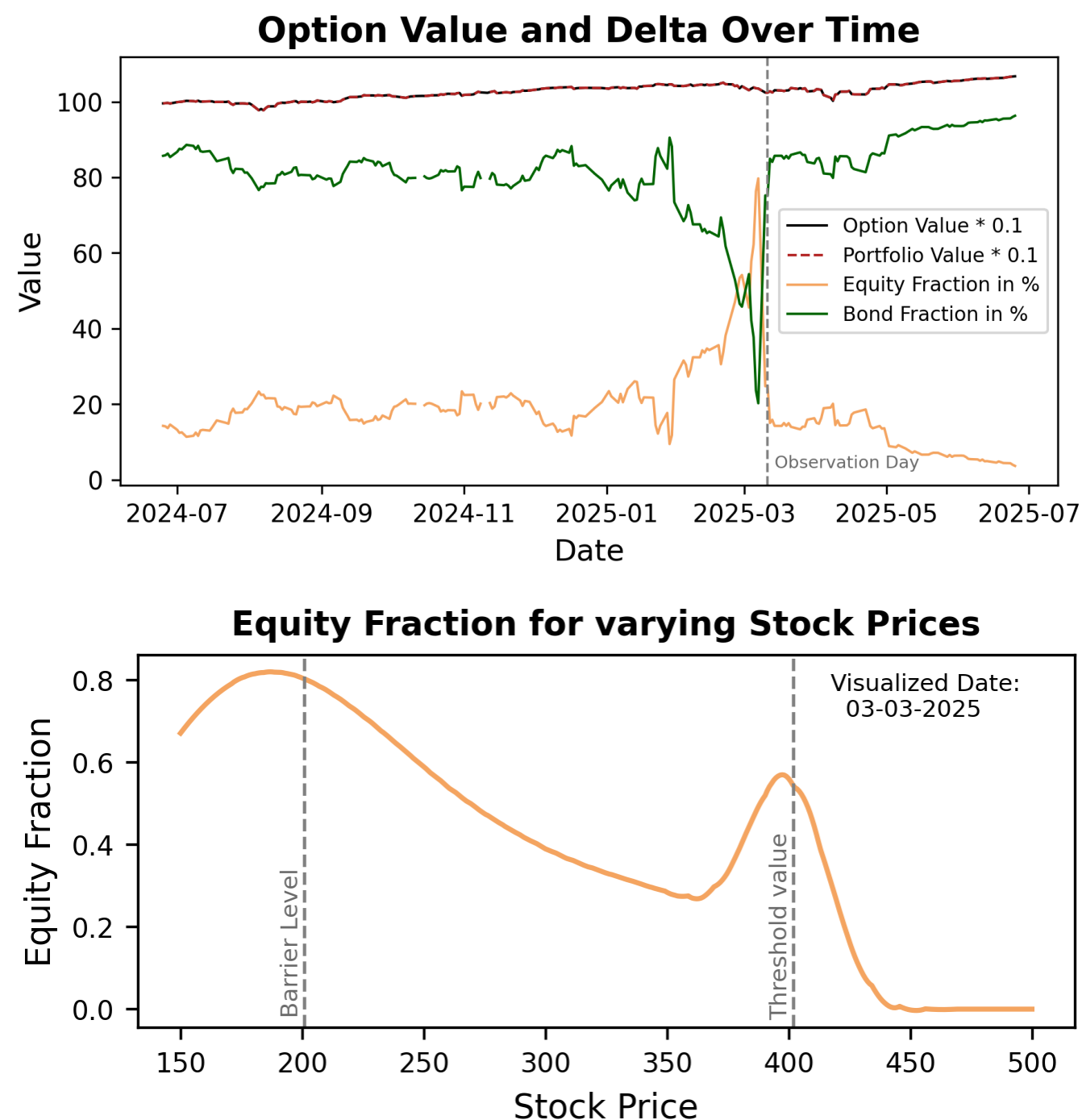
Sensitivity Analysis

The Greeks were estimated as of 03.03.2025, shortly before the observation date on 11.03.2025, using numerical calculations according to John C. Hull (2012, Ch. 20). Delta shows higher values when the underlying is far below the barrier (deep out-of-the-money), as the certificate behaves increasingly like a position in the underlying stock due to the potential for physical delivery. It peaks again around the early redemption threshold, where small changes in the stock price can abruptly alter the expected payoff. Gamma, capturing the rate of change of Delta, exhibits pronounced peaks around this threshold, reflecting strong convexity in the payoff structure and signaling elevated hedging risk in this critical region. Vega, the sensitivity to volatility, is strongly negative at lower price levels, as increased volatility raises the likelihood of hitting the lower barrier and thus reduces expected returns. Theta, measuring time decay, shows highly negative values near the redemption threshold, reflecting the rapid decline of time value as the observation date approaches and binary outcomes become more imminent. The Greeks illustrate that the express certificate's risk exposures are highly state-dependent. Near thresholds, the product becomes particularly sensitive to small movements in the underlying and changes in volatility.



Replicating Portfolio

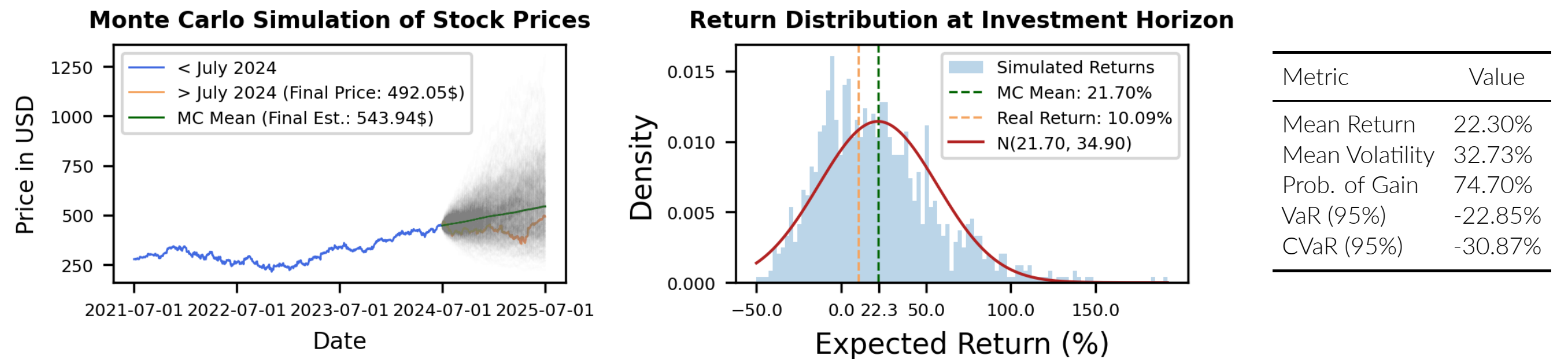
The replicating portfolio is constructed daily using the certificate's delta, with the corresponding equity fraction invested in the underlying and the remainder in a risk-free bond. The portfolio value closely follows the modeled option value over time, confirming replication accuracy. The equity fraction is modeled as a function of the stock price on 03.03.2025 and exhibits behavior similar to the computed delta. Equity exposure increases significantly when the underlying trades near or below the barrier, reflecting the certificate's growing resemblance to a direct equity position due to the potential for physical delivery. As the price approaches the early redemption threshold, the equity fraction rises again, capturing the heightened sensitivity of the certificate's value to stock price movements near this discontinuous payout point. In falling markets, equity exposure increases sharply as the barrier risk becomes more relevant. This means the replicating portfolio becomes more stock-heavy exactly when the underlying performs poorly, highlighting a key risk characteristic of the product: it offers conditional protection, but exposes the investor to high equity risk if the protection fails.



Portfolio insurance strategy

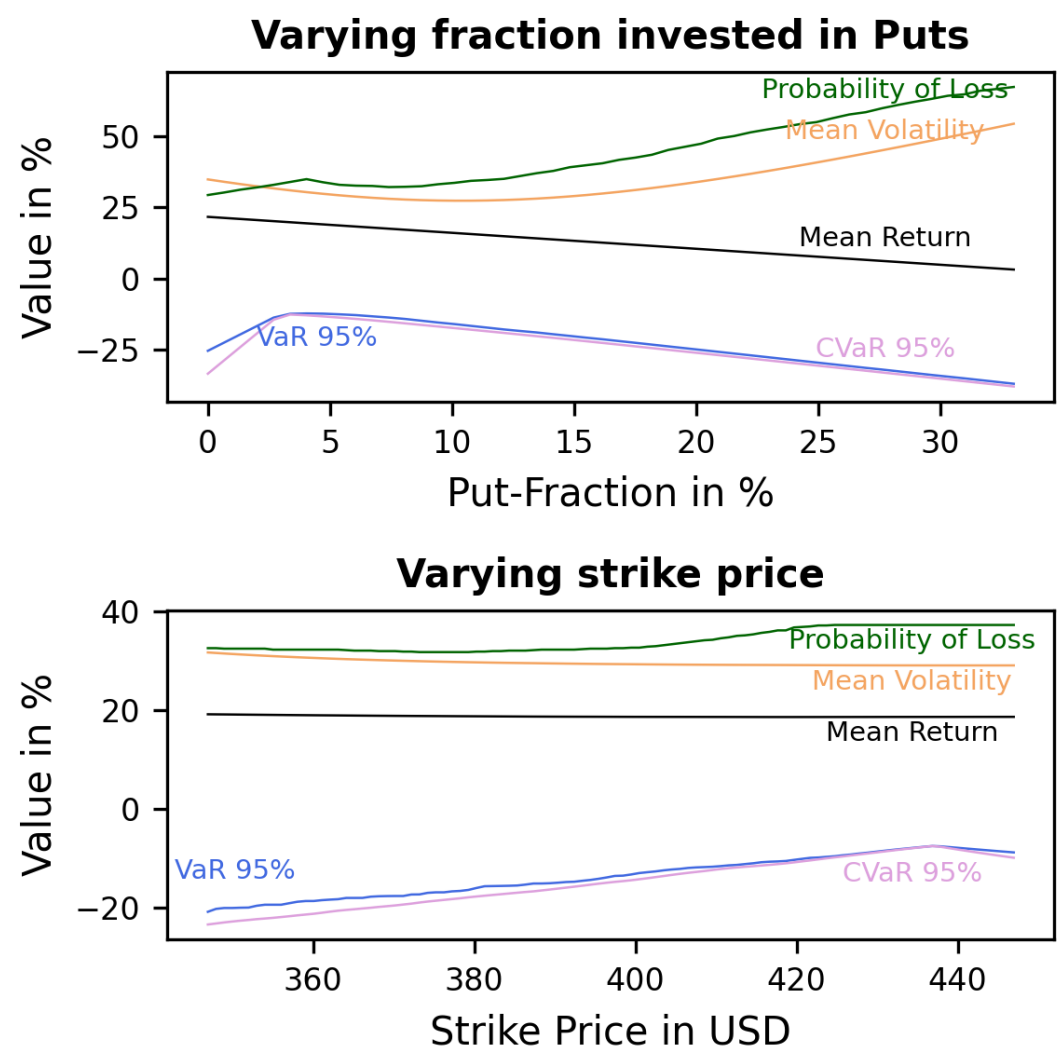
Performance Analysis (without risk management)

The Results of the Monte Carlo Simulation starting from 01.07.2024 for a 1 Year investment of 10000 \$, with 1000 simulation indicates a favorable return outlook on the investment with the Probability of a profit being 74.7% and an average return of 22.30 %. Despite the optimistic mean, downside risks remain as the 95% Value at Risk (VaR) is -22.85%, and the Conditional VaR is -30.87%, highlighting the potential severity of losses in adverse scenarios.



Performance Analysis (with risk management)

Fictious put options were included to implement a portfolio insurance strategy. Varied fraction of initial wealth invested in put options and the strike price were used separately, with a fixed strike of 402.255\$ and a fixed put fraction of 5%, respectively. The top graph shows the effect of varying the fraction of wealth allocated to put options, while keeping the strike price fixed. The optimal fraction, in terms of risk-adjusted performance, is approximately 5%, as indicated by the lowest (most favorable) VaR and CVaR. Increasing the fraction beyond this point leads to a deterioration in both metrics. This is because allocating more to puts leaves less capital invested in the stock, thereby reducing potential gains if the puts expire worthless. The mean return steadily decreases with increasing put allocation, while volatility initially declines but begins rising slightly for higher fractions. The probability of loss increases monotonically, reflecting over-hedging and lower overall exposure to upside movements in the underlying. The bottom graph illustrates the effect of varying the strike price of the put options while fixing the fraction invested in puts at 5%. The optimal strike price is around 440 USD, where both VaR and CVaR reach their minimums. Deviations from this level in either direction worsen downside risk metrics. The probability of loss slightly increases for strikes significantly higher than the current spot price, as the insurance becomes more expensive, again reducing the capital available for investment. Mean volatility declines marginally with higher strikes, while mean returns remain relatively stable.



Stress Scenario Analysis

To evaluate the portfolios resilience under combined shocks to volatility and price a stress scenario analysis was conducted. The scenarios include ±5% changes in volatility and a 20% drop in the stock price after six months.

The most notable finding is that a 20% price drop significantly increases the probability of loss, yet the mean return remains positive. As the price of put options rises with increasing volatility, fewer can be included in the portfolio when the fraction invested is fixed. This causes both +5% volatility scenarios to exhibit significantly worsened VaR and CVaR, indicating that increased volatility, regardless of price movement, amplifies tail risk due to higher market uncertainty. In contrast, the scenario with a 5% volatility decrease and no price drop yields the most favorable outcome, with a mean return of around 20% and minimal tail risk, as indicated by low VaR and CVaR at the 95% confidence level.

The effect of the put options is evident in the baseline scenario (0), where compared to the results in Task VIII we observe only a slightly lower mean return but a substantially reduced downside risk. Furthermore, the portfolio achieves lower VaR and CVaR values across all scenarios compared to Task VIII, confirming the effectiveness of put option hedging in mitigating downside exposure.

