Options 3

After having worked on complex option trading strategies (Options 2 - OP2 case), your employer, a hedge fund, asks you to work on a new strategy: you will have to speculate on volatility by trading options.

Having studied the theory relevant for options and remembering how the options' Greeks are calculated, you decide that you will be trading only options that show an implied volatility higher or lower than your forecasts while keeping your portfolio's delta neutral.

Your new task is challenging but also very exciting. Your boss has asked you to focus on options on one security, RTM, which is a non-dividend paying Exchange Traded Fund (ETF) that tracks a major stock index. The price of the ETF is generated using the following (martingale) process:

$$P_{RTM,t} = P_{RTM,t-1} * (1 + r_t); where\ r_t \sim N(0, \sigma_t)$$

That is the ETF price is based on the previous price adjusted by a return that is drawn from a normal distribution with a mean of zero and standard deviation (volatility) of sigma. Sigma's starting value is 20% (on an annualized basis).

You will be able to trade shares of the ETF and 1-month call/put options with 5 different strike prices. The options available for you to trade are summarized in the table below:

Call Ticker	Strike Price	Put Ticker
RTM48C	48	RTM48P
RTM49C	49	RTM49P
RTM50C	50	RTM50P
RTM51C	51	RTM51P
RTM52C	52	RTM52P

Information including the stock price, option prices, and news releases are provided throughout the case.

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RTM is a very popular ETF and its options are priced by a very large market-maker who will always quote a bid/ask spread of 2 cents (e.g. \$50.00/\$50.02 for the RTM, or \$4.11/\$4.13 for the RTM49C). The bids and asks have a sufficient quantity such that any market order can be immediately executed without price impact (there are no liquidity constraints in this case).

The market maker quotes prices for options using the Black-Scholes pricing model. **It is important to note that the case assumes a risk-free interest rate of 0%.** The volatility forecasts made by the market maker are uninformed and therefore will not accurately reflect the future volatility of the underlying RTM. Since the market maker is uninformed, we assume that his/her expected realized volatility will not be as accurate as the informed predictions provided by analysts.

Your analysts have developed a very effective model to forecast the realized volatility of the underlying asset; they will be sending you weekly updates. Your job is to look for mispricing opportunities in the options markets and profit from that mispricing. When a mispricing opportunity occurs, you should take a position in the options and at the same time trade the underlying security to hedge your delta exposure in order to build a delta neutral portfolio.

For example, if a call option has an implied volatility that is 5% greater than the analysts' forecasted realized volatility of the ETF, the option is overpriced. In this case, you should write call options and then hedge the delta exposure by trading the underlying asset appropriately.

For ease of computation, one trading year is assumed to be 240 days ($20\ days\ \times 12\ months$). The case represents one month (20 days) of calendar time. The trading period is 10 minutes (600 seconds) and is divided into 4 weeks, with t=1...150 being week one, t = 151…300 week two, and so on. At the beginning of each week, the volatility value (sigma) will shift, and the new value will be provided to the students. In addition, at the middle of each week (e.g. t=75) an estimate of next week's volatility value will be announced.

The Chief Risk Officer (CRO) at the hedge fund wants you to focus on trading volatility without exposing your position to changes in the price of the underlying. That is, the CRO requires you to hedge the delta of your portfolio. Recognizing the transactions costs of delta hedging continuously, you are asked to keep the delta of your portfolio between -7000 and 7000. The risk management office will monitor your position throughout the month and will charge you a penalty if you exceed that limit. For every second that you exceed the delta limit (+/- 7000), you will be charged 0.5% of the excess calculated as follows:

$$Penalty\ for\ second\ t = (|Portfolio's\ Delta\ at\ time\ t| - Delta\ Limit) \times 0.5\%$$

Where
$Portfolio's\ Delta\ at\ time\ t$ is the delta of your portfolio at time t
$Delta\ Limit$ is the limit imposed by the CRO that is assumed to 7000

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Please note that you will receive a penalty each second that you exceed the delta limit imposed by the CRO. Penalties will be charged to your account at the end of the case[1].

Sample Information Release Schedule

Time	Week	Release
1	Week 1	The analysts have informed you that the realized volatility of RTM for this week will be 20%
75	Week 1	The analysts have informed you that the realized volatility of RTM for next week will be between 20-23%
150	Week 2	The analysts have informed you that the realized volatility of RTM for this week will be 22%
….		
450	Week 4	The analysts have informed you that the realized volatility of RTM for this week will be 26%

Trading Limits and Transaction Costs

Each student will be subject to gross and net trading limits specific to the security type as specified below. The gross trading limit reflects the sum of the absolute values of the long and short positions across all securities of the same type; while the net trading limit reflects the sum of long and short positions such that short positions negate any long positions. Trading limits will be enforced and students will not be able to exceed them.

Security Type	Gross Limit	Net Limit
RTM ETF	50,000 Shares	50,000 Shares
RTM Options	2,500 Contracts	1,000 Contracts

The maximum volume per trade will be 10,000 shares for the RTM ETF and 100 contracts for RTM options. There are no transaction fees.

Position Close Out

Any outstanding position in the RTM ETF will be closed at the end of trading based on the last-traded price. There are no liquidity constraints for either the options or the ETF. All options will be cash-settled based on their exercise value.

Follow up questions:

1) How would you use option Greeks to calculate your delta portfolio exposure?

2) If you sell an overpriced option and hedge your delta exposure, what is the Gamma of your portfolio?

[1] Penalties will be calculated by the instructor after the simulation ends; you will not be able to see their effect on your P&L in the 'Trader Info' tab.

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