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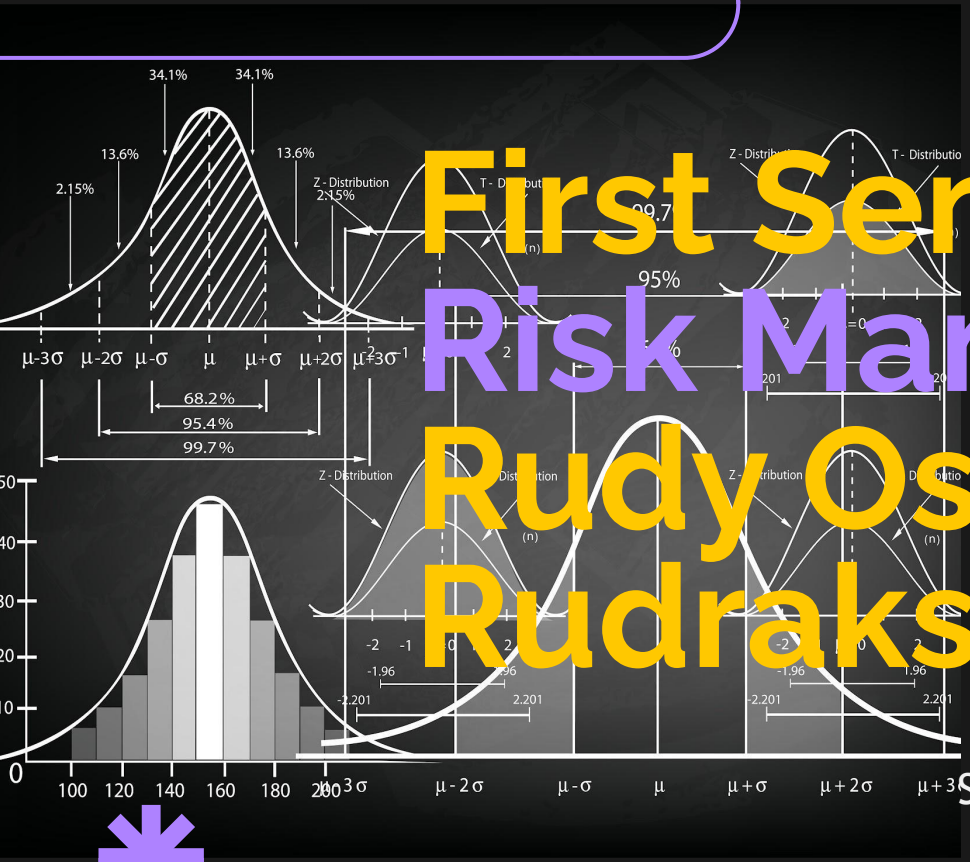

First Seminar Risk Management

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Strategic Shield: Principles of Risk Management and Hedging in Quantitative Finance

Agenda

01
Intro. to Risk Management

Definition, Statistics, Game Theory

02
Hedging Strategies

Cross Hedging, Stop Loss, Trailing Stop Loss, Risk To Reward

03
Derivatives Trading

Options Trading Refresher, Selling Options, Bid and Ask Spread

04
Real-World Applications

Pips and Lots, Implementations, + 2008 Case Study!

Disclaimer: this is not financial advice

Risk Management

Overview of Risk Management in Quantitative Trading

Risk Management is the Fundamental Idea of Quant Trading. Ensuring Robustness (portfolio stability), protects against adverse market movements, and supports long-term strategy.

- Quantifying potential losses using statistical measures
- Developing strategies to minimize or offset these risks
- Balancing risk and reward in investment portfolios

Disclaimer: this is not financial advice

Risk Management

Risk management involves:

- **Probability theory and statistical analysis**
- **Value at Risk (VaR) calculations**
- **Monte Carlo simulations**
- **Stress testing**
- Hedging Techniques
- Options Trading

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Statistics in Trading

$$E[X] = \sum_{i=1}^{n} x_i P(x_i)$$

Expected Value (E[X]):

- Calculating expected return of trading strategies
- Risk-reward ratio assessment
- Portfolio return forecasting

$$\sigma = \sqrt{Var(X)}$$

Standard Deviation (σ):

- Bollinger Bands calculation
- Stop loss placement
- Position size scaling

$$\operatorname{Var}[X] = \operatorname{E}[X^2] - (\operatorname{E}[X])^2$$

Variance (Var(X)):

- Measuring trading strategy volatility
- Risk assessment of positions
- Volatility-based position sizing

$$P(A) = \frac{\text{favorable outcomes}}{\text{total outcomes}}$$

Probability (P(X)):

- Win rate calculation
- Risk management thresholds
- Market regime classification

Game Theory!!

To introduce the idea of hedging, we will use fair 6-sided dice game:

Game 1 (Contract):

- You pay $3 to enter the game
- You get paid whatever the dice lands on (e.g. die lands on 4, payout is $4)

Would you play this game?

Game 2 (Contract):

- You pay $1 to enter the game
- Get paid $2 if the die lands on 3 or less

Would you play this game?

Source/Credits: QuantIntuition

Game Theory- Results

Takeaways - This scenario highlights perfectly how hedging works:

- **Reduces Risk by Lowering Variance and Max Drawdown**
- **Increased Capital Efficiency - Value at Risk (VaR)**
- **Zero E[X] contracts (Or even negative E[X]) CAN lead to a positive outcome: Maximizing E[X] or Var(x)**

Source/Credits: QuantIntuition

Hedging Strategies

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Hedging

Hedging is an investment strategy used to offset potential losses in one investment by taking an opposite position in a related asset. It can be expressed mathematically using the hedge ratio (h):

- $$h = \frac{\text{Size of position in hedging instrument}}{\text{Size of position being hedged}}$$

Cross Hedging—Hedging against price fluctuations in an asset by taking a position in a different but correlated asset—: $$h* = \rho \frac{\sigma_S}{\sigma_F}$$

- ρ is the correlation coefficient between the asset and hedging instrument
- σ_S is the standard deviation of the asset's price changes
- σ_F is the standard deviation of the hedging instrument price changes

HEDGING STRATEGY #1

Cross-Hedging ex:

Example:

- An airline company might use crude oil futures to hedge against jet fuel price fluctuations if direct jet fuel futures are unavailable or not perfectly aligned with their hedging needs.
- Although crude oil and jet fuel are not identical, they have a **strong positive correlation**, making crude oil futures an **effective cross-hedging instrument** for managing jet fuel price risk.

CROSS HEDGE

CROSS HEDGE is futures contract strategy to minimize loss from one asset from profits of other asset. This means, purchase of two commodities take place. When exact asset is not available in future market, companies search for closest alternative asset.

DEGREE OF CORRELATION

Degree of Correlation to be considered between assets.

Example : If correlation between crude oil & jet fuel is 0.5. This means every rise of $2 in price of crude oil, price of jet fuel will rise by $1 only.

LIMITATIONS

- Mismatch in hedging horizon.
- Mismatch in size of the risk covered.
- Asset mismatch.

[1] https://www.slideserve.com/kayleen/derivatives

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HEDGING STRATEGY #2

Stop Loss + R2R

A stop loss represents a fixed exit point that limits potential losses. In the context of our dice game analogy:

- Fixed risk amount (like Game 2's $1 entry fee)
- Known maximum loss (similar to the binary outcome in Game 2)

$$R2R = \frac{\text{Potential Profit}}{\text{Potential Loss}}$$

Risk To Reward - Used for:

- Position sizing calculations
- Stop loss and take profit placement

Example 1:2 R2R Ratio:

- Entry Price: $100 Initial position entry point.
- Stop Loss: $95 (5% loss)
- Take Profit: $110 (10% win)

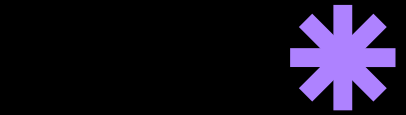
Trailing Stop Loss

A trailing stop loss adjusts the exit point as the trade moves in favor, similar to how Game 2 modified Game 1's risk profile:

- Dynamic risk management
- Locks in profits while maintaining upside potential
- Reduces variance while preserving positive expected value

Hedging Benefits:

- Reduced variance through defined risk parameters
- Maintained positive expected value
- Systematic risk management similar to Game 2's structure
- Position sizing optimization based on portfolio value



Trailing Stop Loss ex:

Via QuantConnect:

Clone backtest URL

Dedicated backtest URL

Options - Derivatives Trading

Options and The Greeks

Options (Rights, but Not Obligations):

- **Definition**: An option is a financial derivative that gives the buyer the **right, but not the obligation**, to buy or sell an asset (like a stock) at a predetermined price (strike price) before or on a specific date (expiry date).
- **Two Types of Options**:
  - **Call Option**: The right to buy a stock at a certain price.
  - **Put Option**: The right to sell a stock at a certain price.
- **Key Points**:
  - Options are used for **hedging** or **speculation**.
  - **Covered calls** (which you'll discuss later) involve selling call options on stocks you already own.

The Greeks - Quantifying Options Risk:

- **Delta (Δ)**: Measures the **sensitivity of the option's price** to changes in the price of the underlying stock. A Delta of 0.5 means the option's price will change by $0.50 for every $1 change in the stock price.
- **Theta (Θ)**: Measures the **rate of time decay** of an option. As expiration approaches, the option loses value (for *most* options). *KEY POINT*
- **Gamma (Γ)**: Measures the **rate of change of Delta**. It tells you how much the Delta will change for a $1 move in the underlying stock.
- **Vega (ν)**: Measures the option's sensitivity to changes in **implied volatility**. Higher volatility increases the option's value.
- **Rho (ρ)**: Measures the sensitivity of the option's price to changes in **interest rates**.

Selling Options - Theta and Delta:

Probability of Expiring in the Money (using Delta):

- **Recall: Delta (Δ)** Represents the sensitivity of an option's price to changes in the price of the underlying asset. For example, a delta of 0.50 means the option price will change by 50% of the stock price move.

Probability of Expiring in the Money:

- For **call options**, **Delta** roughly represents the probability that the option will expire **in the money (ITM)**. For example, if the delta is 0.30, there's a 30% chance the call will expire ITM.
- Traders use Delta to estimate the likelihood of an option expiring ITM, helping them assess the risks and rewards of the position.
- For **put options**, the probability is given by **(1 - Delta)**.

Theta (Θ) - Time Decay?:

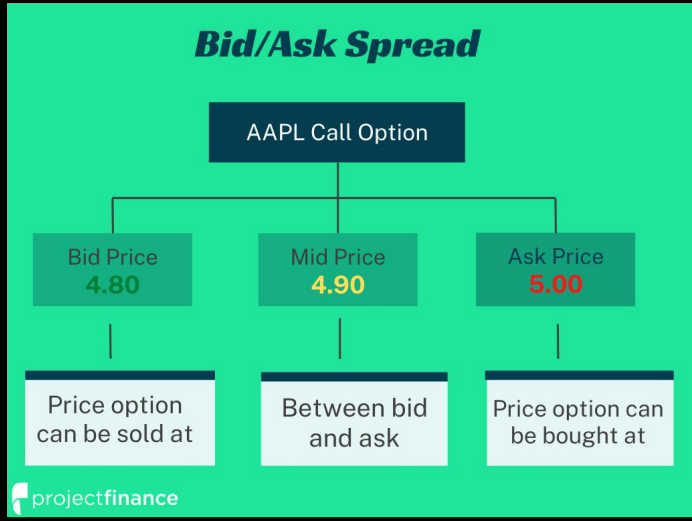
- When you sell covered calls, **Theta works in your favor**. As time decays, the option loses value, benefiting the seller because you get to keep the premium.
- This is especially useful in **short-term, monthly covered call strategies**, where Theta decay is more pronounced as expiration approaches.

Bid-Ask Spread ✱

The bid-ask spread is the difference between the highest price a buyer is willing to pay (bid) and the lowest price a seller is willing to accept (ask) for a security:

Bid_Ask_Spread = Ask_Price − Bid_Price

- Bid Price: The highest price a buyer is willing to pay for an asset.
- Ask Price: The lowest price a seller is willing to accept.
- Spread: The difference between bid and ask prices, often a measure of market liquidity.
- Example: If Bid = $99 and Ask = $101, Spread = $2.



✱

Real-World Applications

Pips and Lots

While primarily used in currency pairs, pips and lots offer a standardized way to measure price movement and transaction sizes across asset classes

- Pip (Price Interest Point): Represents the smallest price movement in a market.
  - Example: In a stock priced at $100, a 1% movement = 100 pips
- (Micro) Lot: Represents a standardized trading size
  - Example: 1 lot = 100 shares for stocks

Why Normalize to Pips and Lots?

- Simplifies complex financial calculations.
- Standardizes risk-to-reward ratios, making it easier to visualize and assess.
- Bridges the gap between traditional assets (shares) and derivatives (e.g., options).

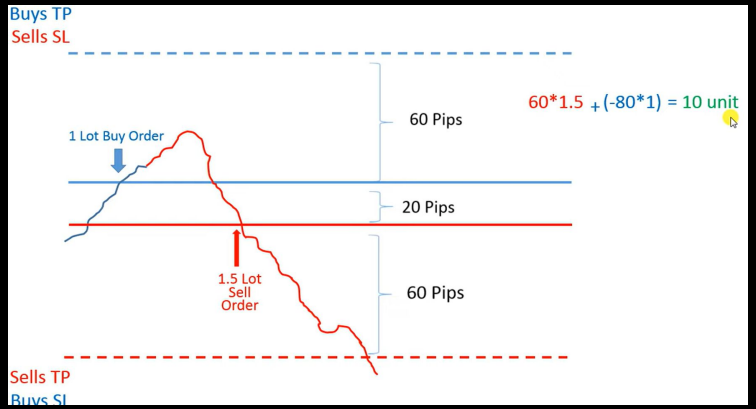
HEDGING STRATEGY #4

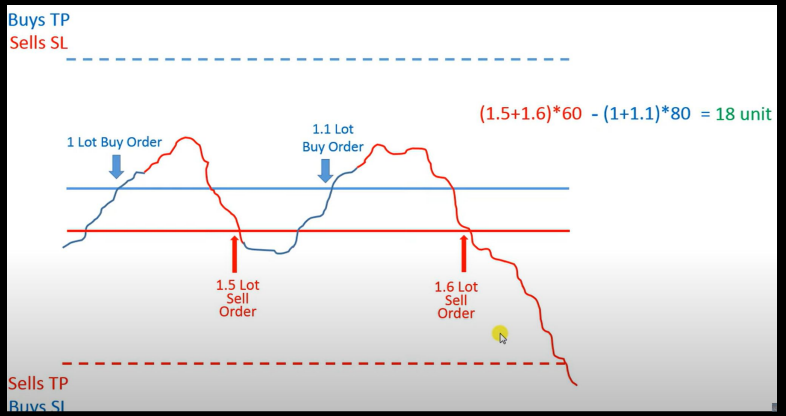
Pips and Lots ex:

Hedging in a Range-Bound Market:

- Objective: Maximize profits while minimizing risk by leveraging buying and selling at key price levels within a defined range.
- Key Idea: Use buy and sell orders (measured in lots) strategically placed at resistance (Sell Line) and support (Buy Line) levels.

Sum of Sell Lots (Sells Line) × 60 > Sum of Buy Lots (Buys Line) × 80





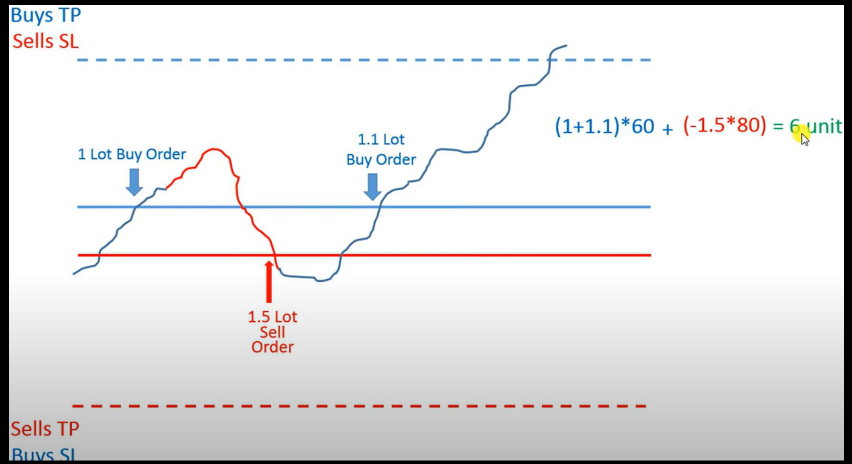
Source/Credits: EcoEngineering

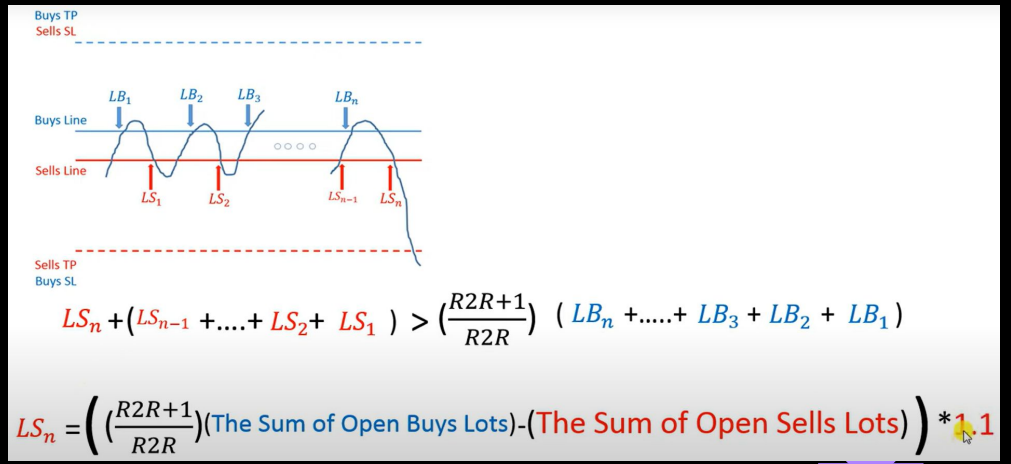
Code Implementation:

HEDGING STRATEGY #4

Via QuantConnect (Hyperlink):

Clone Backtest URL
Dedicated backtest URL





Source/Credits: EcoEngineering

Hedge Fund Strategies During the 2008 Financial Crisis:

Case Study

Recession 2008

Background 2008 Financial Crisis:

- Collapse of the U.S. housing bubble.
- Exposure of high-risk mortgage-backed securities (MBS) and collateralized debt obligations (CDOs).
- Lehman Brothers'—fourth-largest investment bank in the U.S—bankruptcy on September 15, 2008.

Market Characteristics in a Recession:

- Extreme volatility in global markets as well as limited diversification benefits.
- Liquidity evaporated in many markets, causing difficulty in executing trades.

Problems With Hedging in Recessions:

- Increased Correlations: Historically uncorrelated assets began moving together, reducing the effectiveness of diversification.
- Liquidity Risk: Funds faced difficulties exiting positions without significant slippage.
- Systemic Risk Amplification: Leverage exacerbated losses as margin calls forced liquidations, both affecting long and short positions.

Hedging Strategies Employed

Protective Puts:

Definition and Role During the Crisis:

- Protective puts acted as insurance for portfolios, protecting against significant declines in asset prices.
- Many funds purchased long-dated puts on major indices, such as the S&P 500, to cap downside risk.

Example from 2008:

- A hedge fund holding $1M worth of S&P 500 ETFs purchased at $140/share bought protective puts with a strike price of $120.
- When the index dropped to $100, the puts offset losses below $120.

Hedging Strategies Employed cont.

Covered Calls:

Definition and Role During the Crisis:

- A covered call involves holding a stock and selling a call option on it, generating premium income.
- During 2008, funds used covered calls to generate additional income, offsetting losses from declining asset prices.

Example from 2008:

- A fund holding shares of a large-cap stock worth $50 each sold call options with a $55 strike price for $2/share.
- If the stock dropped to $40, the call expires worthless, and the $2 premium reduced the net

2008 Hedging - Outcomes

Protective Puts:

- Protective puts are effective during sharp market downturns.
- They act as a direct hedge but come at the cost of the premium, which reduces net returns.
    - Relates directly to cross hedging by showing how protective puts can hedge correlated assets.
    - Links to Value at Risk (VaR), as the put defines a hard floor for losses.

Covered Calls:

- Covered calls can cushion losses in flat or mildly bearish markets but cap upside potential.
- Ideal for portfolios seeking income during turbulent periods.
    - Connects to stop-loss and trailing stop-loss strategies by providing an alternative way to mitigate losses while retaining some upside.

Attendance - Feedback Form

TQT - Discord

Thank You!

TQT Contact Us:

- Rudy Osuna - Quantitative Algorithmic Trader
- Rudraksh Bhandari - First Year Representative