Quant Trading Winter School

Abstractify

Description

Consulting, Trading, Mathematics - The Best of All Worlds, Coming Together.

"The curious task of economics is to demonstrate to men how little they really know about what they imagine they can design." -Friedrich August von Hayek

So if you find yourself interested in understanding how the world of finance works through a mathematical lens and the confluence of modeling theory and real-world practice, as well as helping others make better decisions through your consulting, this is the opportunity you wouldn't want to miss.

Economics Club, in association with Optiver Services BV, brings you a completely new twist on traditional case study challenges - Abstractify, as part of our Quant Trading Winter School 2023. In this event, we present a new and nuanced take on consulting using mathematical and simulation tools to give more robust and helpful insights for designing quantitative trading strategies.

Do you have the wit, vigor, and, most importantly, the hunger to solve some of the most challenging problems in quantitative finance using your problem-solving and consulting skills?

General Instructions:

1. Three case prompts are released for the competition, which are enclosed later in this rulebook. Ensure that you go through each section of the rulebook in detail.
2. You are provided some resources and background within the rulebook but are free to use the internet (with proper references) for the competition.
3. This is an individual event. Collaboration and discussion are strictly discouraged. We will disqualify any cases of plagiarism and cheating.
4. Participants are required to submit slide decks (see what to submit section) on their chosen prompt (as well as any supporting documents they think would help). They are also required to submit a video presentation no longer than 10 min, on their slide deck.
5. Participants must send in a pdf with the answer to the selected prompt (any 1) with all the participant details included. The pdf should be named "participant_name_prompt_no.pdf." The submission should be made before the deadline post which the form will be closed for submissions.

Details:

- Cases Released: 11th February 2023
- The last date to submit Deck and Video: 19th February 11:59 AM (Noon)
- Venue: Online
- Prizes worth: 2.5 Lakh INR

Introduction

This section will briefly introduce concepts and ideas that are important for tackling the three challenges. It is advised to attend the sessions conducted as part of Quant Trading Winter School to gain more insight and refer to the Internet to fill any gaps in knowledge.

Quantitative trading firms use mathematical models and algorithms to make decisions about buying and selling various financial instruments, such as commodities, stocks, bonds, and derivatives. These firms use "strategies" and "alphas" to identify potential opportunities in the market, such as mispricing or arbitrage opportunities. They then execute trades on these opportunities, to bring prices closer to their real value, provide liquidity and make markets more efficient as well as make profit.

A "strategy" in this context refers to a specific set of rules or instructions that a quantitative trader uses to make decisions about when to buy or sell a particular security. These rules can be based on a wide variety of factors, such as the historical performance of the security, the current market conditions, or the results of a statistical analysis.

An "alpha" is a measure of the excess return of an investment relative to a benchmark, such as the overall market or a particular market index. In the context of quantitative trading, an alpha is a measure of the performance of a trading strategy compared to a benchmark. For example, a strategy that consistently generates returns that are 2% higher than the benchmark on a monthly basis would be considered to have a positive alpha of 2%.

Trading firms aim to develop and identify alphas using large amount of historical data and then using techniques like machine learning, statistical analysis and mathematical modeling to identify patterns, predict future behaviour and test the performance of the strategy over time. And then deploys these strategies in live market and monitor the returns it generates. By taking advantage of mispricings in the market, quantitative trading firms can generate profits over time.

It's important to note that this is a simplified explanation and in reality, the quantitative trading is a complex field and It's not limited to equities or stocks but it encompasses various markets and financial instruments, also the strategies and alphas used are not simple but they are result of extensive research and iterations.

Let us dive deeper on what exactly an Alpha is. An "Alpha" can be said to be the firm's 'edge' over the market - something it has that can outperform a certain benchmark. Alphas can result from various types of edges such as:

- Speed: If the firm can trade faster than others, it can generate more profit than them usually.
- Access: If a firm has the resources and permissions to trade in more lucrative and better investments, it can again generate higher profits than the benchmark.
- Information: This is the most important. If a firm has better information or knowledge about how the market is going to be in the future, then they can use this information to generate higher profits.

We are going to focus on the third type of edge, and specifically, on "Correlation between different commodities". Suppose you are hired by one such Quantitative Trading firm, for consultation on how to solve some key problems they face in the above. They give you a brief tutorial on how they generate such Alpha (as described below), and then ask you to solve one of the below

challenges. It's important to note that correlation alone is not a guaranteed way to generate alpha, and a trading strategy that relies on correlation would also need to consider other factors such as the overall market conditions, the individual stock fundamentals, liquidity, etc. Also, correlation can change over time so it needs to be monitored and the strategy should be adjusted accordingly. We are looking at a very simplified example to get your feet wet.

Tutorial

Suppose you are trading on a commodity (such as the Tesla stock), which we will call the Target Commodity. You have a hypothesis that the stock value movements can be predicted reliably by knowing another piece of data (referred to as the Independent Variable henceforth), which usually is another commodity value or some known index value (such as S&P500, or even something like price of Platinum). The rationale behind this could be that since Platinum is used in the manufacturing of Tesla cars, the price of platinum should reflect in Tesla stock value. You want to understand this correlation between the two, and whether you can use it to actually build a strategy that allows you to trade on it profitably.

Here is how this simple model usually goes about:

1. You source the data for both the target commodity and the independent variable.
2. You use some tool (could be from Machine Learning, Statistical Analysis etc.) to figure out this correlation. One of the most common tools is Linear Regression, which you can consider for any further analysis.
3. Based on the correlation, you create a strategy on how you should trade given any changes in the independent variable.
4. Using historical and/or simulated data, you can test your strategy and identify if it would be profitable.

Consider the above model throughout the coming prompts. It is not expected to have previous knowledge of how any part of this works. The goal of this assessment is to see your ability to quickly learn and identify solutions in a new environment, as well as how rigorously you are able to do so. For more details, see the "What to submit" section.

Prompts
Now, you will be asked to provide workable solutions to the challenges the firm faces in their simple model. You should provide solutions that are efficient and powerful, while at the same time, you should be cautious about the assumptions you are making and what may lead to failures of your model.

Prompt 1: Trading in a New Market or Trading in a Market with unorganized/unavailable Data

The simple model can only work when there is good quality data available about both the target and independent variables. This is not always the case such as:
1. Suppose a new company enlists itself on the Stock Market that has a similar product to Tesla, called Edison. You do not have any past data on its stock, but do not want to let go of the lucrative chance to trade on this stock.
2. You have a theory that Target commodity is affected by some data index that is not easily available, but you can access data that can be used to reasonably predict it.
3. There are potential errors in the data you have.

Reason about what can be done to solve this issue. Make note of any assumptions you make, what you would require and how your model is good and when it can fail.

Prompt 2: Handling Risk
So far, we were only concerned about the profits associated with the strategy. For Quantitative Firms, risk is very crucial factor as well. Taking into account the need to also evaluate the risk associated with the strategy, how can we modify the above model to not only predict the correlation between the target commodity and the independent variable, but also to measure the risk associated with implementing the strategy?

By modifying the model to incorporate these risk-related considerations, we can gain a more comprehensive understanding of both the potential profits and the associated risks of the strategy, which will allow us to make more informed decisions about its implementation.

These are preliminary ideas; this section would be modified.

1. Incorporating volatility modeling: Measuring and modeling the volatility of the target commodity and the independent variable can provide insight into the level of risk associated with the strategy.
2. Incorporating Value-at-Risk (VaR) calculations: VaR is a statistical measure of the risk of loss for investments. Incorporating VaR calculations in the model can provide a more comprehensive understanding of the risk associated with the strategy.
3. Incorporating Monte Carlo simulations: by simulating different market scenarios and testing the strategy's performance, we can determine how well it will hold up in adverse market conditions and in this way assess the risk of the strategy.
4. Incorporating stress testing: stress testing the strategy by simulating extreme market events, such as a sudden market crash, can help identify potential vulnerabilities and weaknesses in the strategy and inform about how well the strategy would hold up in extreme events.
5. Incorporating backtesting in different market conditions: testing the strategy in different historical market conditions can provide a sense of how well the strategy would perform in various market scenarios and can inform about the risk associated with the strategy.

6. Position sizing and Risk management: Incorporating risk management techniques, such as position sizing and stop-loss orders, to limit potential losses and manage the risk.

Prompt 3: Trading against a Large Player

The price of the commodity you are trading on is affected by your trades as well as the trades of others. The higher your share of the total trading volume, the higher impact you have on the prices. In this prompt, you are supposed to incorporate the fact that you and a competitor are large players in the trading of a certain commodity (each contributing to around 20% of the total trading volume) into your trading model. How should you do this? It may be beneficial here to not focus on your model but on how the strategy works, using ideas from Game Theory.

When considering the impact of large traders, such as yourself and your competitor, on the prices of the target commodity, it is important to consider the trading volume each of you contributes. Specifically, in this scenario, it is given that you and your competitor each contribute around 20% of the total trading volume of the target commodity.

One approach to incorporating this information into your trading strategy could be to adjust your strategy based on the actions of your competitor. For example, if your competitor is buying large amounts of the target commodity, it could be a signal that the price is likely to rise, and you may want to adjust your strategy accordingly.

Another approach could be to track the price changes caused by the trading activity of yourself and your competitor, and use this information to inform your trading decisions. For example, if you and your competitor are consistently pushing the price of the target commodity in a particular direction, you may want to adjust your strategy to take advantage of this trend.

Additionally, you could focus on understanding and adjusting the exposure to the specific commodity. If you're large player and have a significant share of the trading volume it is important to control the exposure to the specific commodity on your portfolio. This can help to minimize the impact of any sudden changes in the commodity price caused by your or competitor's large trades.

It's also worth considering the risk management practices and position sizing, you need to be aware of the effect of your large trades on the market and design your strategy in a way that limits the downside risk and take into account a large volatility caused by your and competitor trading activities.

Overall, incorporating information about your and your competitor's trading volume into your trading strategy can provide valuable insights and help you make more informed decisions about when and how to trade the target commodity.

Resources - Supply Demand basics for understanding stock prices, Some oligopoly models to help understand how game theory can be used in scenarios like this.

What to submit?

You must choose one of the prompts and prepare a presentation deck on one or two modeling approaches to better understand or predict in the given scenario. You can select a particular subproblem in the general problem, to have a more in-depth analysis. There is some leeway in

your choice of the Problem Statement and you can modify it to your understanding, but significant variation may be penalized. The problems are designed such that multiple approaches can be applied.

Expectations: The goal of the assessment is to see how you learn about a new scenario, and using a wide range of resources, quickly develop preliminary ideas to tackle the challenge. You are allowed to use the internet (but do cite your resources). You can use research as well as common industry solutions for the problems, however, make sure they have been adapted to the prompt. You will be judged on how well you have understood the problem and your solution, and how well you are able to explain it to others. Make sure you outline every aspect with clarity (see the various criteria below). Ideally, make your solution simple and relevant to general problems.

Here are the criteria you will be judged on:
1. Problem Statement: How well you have understood the problem.
2. Model description: Inclusion and Clarity of Key aspects in your problem and model analysis. These may include, but not be limited to the following features :
   a. Assumptions
   b. Model Description
   c. Example - You can use a toy example or historical data to demonstrate validity of your model.
   d. Future Extensions
   e. Applications
   f. SWOT analysis (what your model does well and what it does poorly, and where it might fail)
3. Originality and Relevance of the model
4. Presentation and Professionalism (Academic Honesty, Clarity of Explanation, etc.)

Note: There is a hard limit of 12 slides (excluding Title and end) as well as 10 minutes for the presentation. Keep this in mind to avoid penalties. You can also submit a short report to clarify your model if necessary (however, there is no penalty for not submitting such a report).