IE 423 Quality Engineering

Project Part 2, Due December 11, 2023

You are expected to follow the similar submission format and requirements as you did in your first project assignment (i.e. Project Part 1). Please go over section "5. Report & Code Documentation" in your first assignment for further details about your submission. Note that this part of the project requires some research on pairs trading. Although a brief background information is provided in this document, you can refer to other references to have a better understanding. Please provide your references in a reference section if you benefit from other sources.

Application of Control Charts in Pairs Trading: An Analysis of BIST30 Stock Indices

Objective

This assignment explores the application of control charts in pairs trading, focusing on the hourly time series data of BIST30 stock indices. You are expected to identify highly correlated stock pairs, model their relationship through linear regression, and apply control charts to monitor residuals for potential trading opportunities.

Data

You will find the past data in the **Project Descriptions** section on Moodle.

The data includes hourly average prices of selected stocks from Borsa İstanbul, presented in separate csv files for each time interval, encompassing about 5 years of data in long format. Make sure to understand the data format, including timestamps and stock identifiers.

Background

Brief Introduction to Pairs Trading Pairs trading is a market-neutral trading strategy that involves identifying two highly correlated financial instruments, such as stocks, and trading on the relative movement between them. The strategy was pioneered in the 1980s by quantitative analysts at Morgan Stanley. The essence of pairs trading lies in identifying two securities whose prices have historically moved together and are expected to continue doing so.

When these securities' price relationship deviates from its historical norm (i.e., one stock outperforms or underperforms the other), a pairs trader would short (sell) the outperforming stock and go long (buy) on the underperforming one, betting on the reversion to their mean price ratio. This strategy is appealing as it aims to be market-neutral, meaning it is less affected by market movements and focuses more on the relative performance of the paired securities.

In the context of financial markets, pairs trading is particularly relevant as it allows traders to capitalize on temporary market inefficiencies, providing opportunities for profit regardless of market trends. This strategy requires a robust method for identifying and monitoring pairs, which is where control charts can play a vital role, offering a systematic approach to detecting deviations from the mean relationship of a stock pair.

Connection Between Pairs Trading and Control Charts Control charts can be adapted to monitor the relationship between paired securities in pairs trading. In this context, a linear regression model defines the expected relationship between two correlated stocks, with residuals representing the deviation from this expected relationship. These residuals can be plotted on a control chart to monitor the deviation of the paired stocks from their expected relationship over time. Significant deviations, indicated by the residuals moving outside the control limits, suggest potential trading opportunities under the assumption of mean reversion. This approach not only aligns with the principles of statistical process control but also adapts these principles to the domain of financial trading, offering a unique crossover of quality engineering techniques into financial strategies.

Task 1: Basic Pairs Trading Strategy Using Constant Variance Assumption

In this task, you are to explore a basic pairs trading strategy using a constant variance assumption. Your challenge is to analyze the BIST30 stock indices dataset to identify highly correlated stocks. You will then apply linear regression modeling to these stock pairs to understand their relationship. The key here is to investigate how to calculate residuals under the assumption of constant variance and use these findings to establish control limits for trading. Your goal is to set up a trading simulation based on these control chart signals and quantify the potential gains over a specified period, using a predetermined amount of trading capital. Choose at least two stock pairs for your analyses.

Task 2: Advanced Pairs Trading Strategy Using Time Series Analysis

The second task requires a more advanced pairs trading strategy on the pairs you have selected, incorporating time series analysis. This task expects you to explore suitable time series methodologies to better understand and model the residuals of your selected stock pairs. You will then apply these advanced models to redefine your control limits and carry out a revised trading simulation. This task results in a comparative analysis where you will assess and visually represent the differences in outcomes between the basic and advanced trading strategies, providing insights into their relative effectiveness.

Discussion

- Analyze the results from both tasks.

- Discuss the effectiveness and limitations of each approach.

Conclusion

- Summarize key findings and insights from the assignment.