AAR Milestone 6

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Optimal Stop Placement Strategies for Momentum Trades in Equities

I. Primary Research Question

<u>How can an algorithm be developed that sets a stop loss for an equity momentum trade to optimize the trade outcome, based on analysis of that security's historical price?</u>

Clarifications/Definitions:

1. A <u>stop loss</u> is a type of market order where shares in a security are sold if the price drops below a pre-specified limit. A <u>trailing stop loss</u> is similar, but where the lower limit follows the price upwards if it increases.
2. An <u>equity</u> is a tradeable asset that represents ownership of a publically traded company, essentially stocks, ETF (exchange traded funds), etc.
3. A <u>momentum trade</u> relies on the assumption that a stock that has been moving in one direction consistently (based on a quantifiable metric, such as moving average comparison) will continue to move in that direction for some time.
4. <u>(Technical) analysis</u> refers to analyzing the stock's past price, and looking for patterns or trends (Introduction to Chart Patterns).
5. <u>Trade optimization</u> is improvement of the risk return ratio given a portfolio of trades.

II. Abstract

The purpose of our Advanced Authentic Research project is to develop an algorithm that develops a strategy for stop loss placement to optimize trade outcome. What sets this algorithm apart is that it takes into account past historical characteristics of the stock, including but not limited to volume and volatility. Writing this algorithm involves several steps. First, data from financial sources such as the S&P 500 was acquired, and a few stocks were selected to work with. Then, a list of existing strategies used to place stop losses was collected. Third, a program that takes as input a signal, a data set, and a stop loss, and returns the output was written. This require that a program that generates the signals be written. Lastly, the return for one strategy was optimized using metrics such as the Sharpe and Sortino ratio, and then the stop losses was tested with a different strategy. The final program used the past history of a security to develop a stop loss value that maximizes the trade outcome. Overall, the project was mostly successful. Please see Section VI, Discussion, for a complete analysis of the results of this project.

III. Background and Significance

Research Problem

Investors use stop losses to minimize trading losses when investing in stocks. However, investors do not always account for past history, volatility, and volume of the stock when setting a stop loss (How I Determine Where to Set My Stop Loss). The restrictions placed on them can be too loose (too much money lost) or too tight (shares sold too early). In essence, these stop losses are not always intelligently placed. If investors could smartly place stop losses, each time they invest their money, the associated risk would be much lower (Building a Trading Indicator). Strategies to effectively place stop losses do exist, but they are developed by private parties who stand to get significant financial gain from the exclusive use of those strategies. Therefore, these parties have not made their placement strategies public. Having a public, freely usable strategy for the placement of stop losses, which is what our project aims to achieve, is important. This provides independent traders, who do not have the capital or time to develop complex stop-loss placement strategies, a base to work off of.

Literature Review

From our background research, we have gathered that there are two main avenues of research on stop losses. The first is the practical, application-based aspect. This includes several books on stop loss placement strategies, as well as about using computer software in trading. These materials are designed to be used by investors in the real world. Some examples of these books include *The Encyclopedia of Trading Strategies* (Katz and McCormick), *Design, Testing, and Optimization of Trading Systems* (Pardo), and *Computerized Trading* (Jurik), that we have been reading. The second main aspect of existing research is purely academic. This includes papers by Kathryn Kaminski and Andrew Lo, as well as the Adam Lei and Huihua Li studies.

Examining Our Unique Perspective

After conducting a multitude of research on topics pertaining to stop losses, we have found extensive research on various ways to predict stop losses. However, we have not seen research specific to momentum trades, where the trading strategy and other relevant statistical information on the expected profit from the strategy are laid out. Any strategy that is perfectly optimized is locked up behind the closed-doors of large investment companies, the issue we have addressed with our research problem. Therefore, public research can be done to optimize stock placements. Our project will be to use already existing strategies, and try to predict where a stop loss needs to be to optimize the outcome.

IV. Research Methodology

Steps for Project Completion

1. Conduct background research on stop losses, technical analysis, and related topics.
2. Acquire data on historical values of stocks from a source such as S&P 500.
3. Collect a list of existing strategies used for placing stop losses.
4. Write a program that develops signals for a specific stock based on historical prices, using one strategy. Signals are indicators of times to buy or sell a stock.
5. Write another program that takes in a data set, a stop loss, and signals from the previous program to return an output.
6. Optimize the return for the one strategy used, with metrics such as the Sharpe and Sortino ratio, and then test the stop losses with a different strategy.

Research Type: Our research type is applied. Our program solves a real-world problem of stop losses, and has a potentially useful application in the investment sector.
Data Type: Our data is quantitative. First of all, our program will take in a table of stock prices, obviously numbers. Second, our program will return values that are numbers, such as the value of the Sharpe ratio, the value of the Sortino ratio, and the max drawdown.
Methodology Type: Our methodology type is experimental. We will conduct numerical experiments using computer simulations.
Materials: The list of materials is nothing more than a laptop, with software such as the Atom or Sublime text editor and the Excel or Numbers applications.
Procedure: The procedure consists of the following steps.

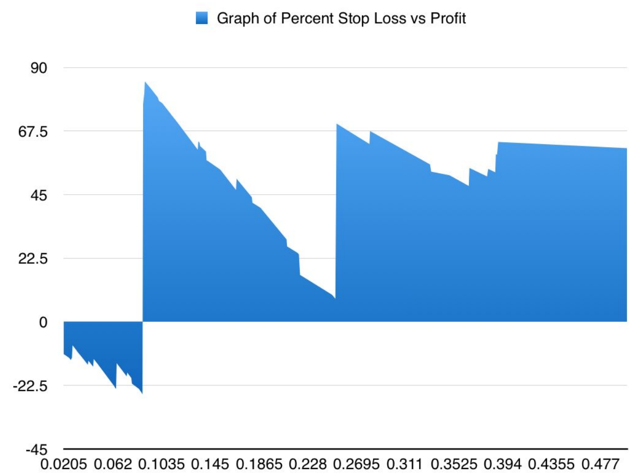
1. Conduct background research on stop losses.
2. Write simulation software to determine the trade outcome, given a dataset and a stop loss.
3. Write a program to optimize the trade outcome using metrics such as the Sharpe ratio, the Sortino ratio, and max drawdown.

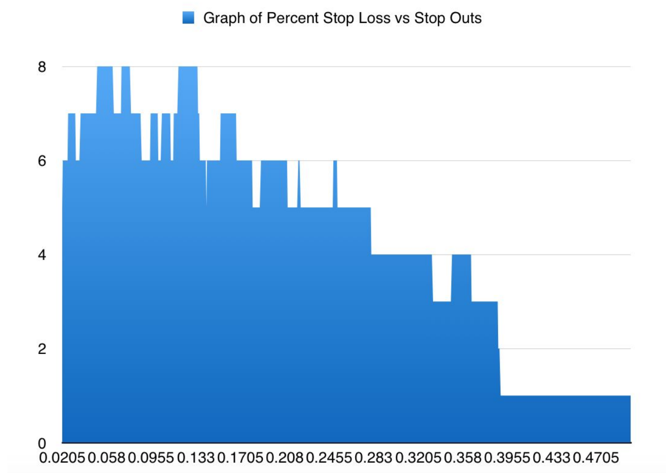
Population Being Studied: The general 'population' that we will study is the historical stock prices of several companies. A subset of the population will be the specific companies that we choose to use to test our program.
Population Selection Criteria: We will start with a subset of 10 or so randomly chosen stocks and test our algorithm on them first. Once we are satisfied, we can test our algorithm on a much broader range of stocks.
Data Collection Methods We will collect data through the simulations that will be run based off of the signal-generation program, but through the return-calculation program.
Data Analysis Methods We will analyze our data by tabulating and plotting the results from the aforementioned simulations to see what conditions optimize the return the best.

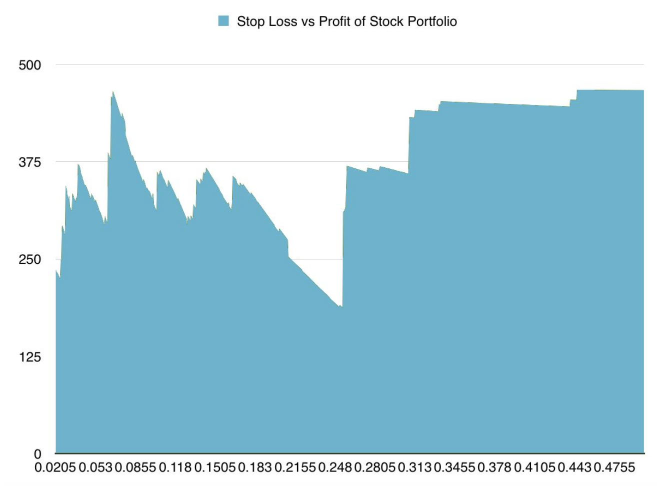
Timeline We would like to avoid a more 'divide-and-conquer' approach, and instead intend to work together on most parts of the project. Our preliminary timeline is as follows:

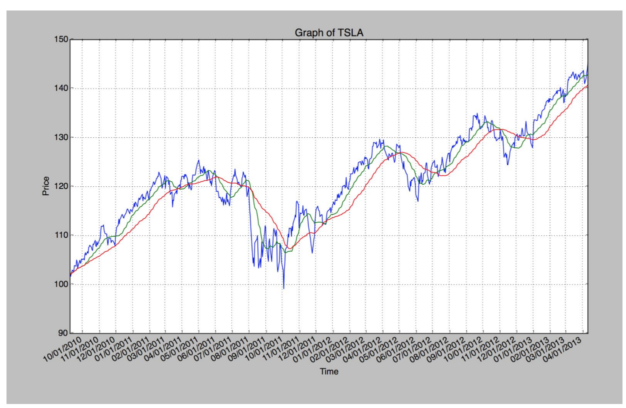
August-November: Background research
December-January: Coding the library (data collection, strategy selection, etc.)
January (end of): Run first simulations
February: Enhance code, complete project execution
March-May: Poster board and Research Paper

V. Results









Four graphs from the research process have been shown above. On the top left, there is a graph of percent stop loss versus the profit of the stock Apple. It can be seen that the most optimal profits are from when the stop loss is around 10-12%, while having the stop loss between 2% and 8% yields a loss. To the right of that is a graph that shows the number of trades, given a percent stop loss, also with Apple stock. When the stop loss is more than 40%, it makes sense that there would be very few trades, as the stock should rarely travel below 40% of its value. When the stop loss is very close, at a percent like 5%, many trades occur, as the stop loss is triggered whenever the stock losses any money. On the bottom left is a graph of portfolio profit, given a percent profit. The results for entire portfolios are inconclusive because of a few errors in the program. First of all, the code did not account for different stock prices, meaning that it did not weight all stocks equally. Because of this, a profit when compared to having no stop losses in the portfolio was not achieved. However, one property of stop losses is that a stop loss of percent p will have a maximum drawdown of p percent (a p percent stop loss limits losses to a maximum of p percent), so the maximum drawdown was limited significantly. The last graph is shown on the bottom right, showing where the strategy performs poorly with because of the growth structure. This strategy was created to operate on growth stocks that do not oscillate, but only have momentum in one direction (hence the name: momentum trades). This is principally due to the maximum drawdown concept. Because stability and security is a priority, the code limits the maximum drawdown, which does not give remove for oscillating stocks to oscillate. So, the program performs poorly on these types of stocks.

VI. Discussion

Overall, the final program met most of the project criteria outlined at the beginning of the project. Chiefly, the program effectively maximized the profit on a momentum trade. For example, when tested on Apple stock, the stop loss strategy gave a 32.15% increase in profit when compared to a simple buy-sell strategy. Furthermore, the program met another criterion outlined in the research proposal: minimizing risk. As demonstrated by the maximum drawdown metric, the program minimized the risk across an entire portfolio of stocks. However, as mentioned above, this only worked on stocks that do not oscillate.

These conclusions are significant for several reasons. First of all, once the few shortcomings of this project are addressed, this program will be established as a reliable and effective, as well as freely-accessible, stop loss placement strategy. This program optimizes the trade outcome by maximizing profit, and minimizes the risk across a portfolio of stocks. These successes are important for those independent investors who do not have the resources of a large investment firm. These investors would like to gain a profit, but they would like to reduce, as much as possible, the risk associated with the trades that they make. Thus, this project is significant for them.

There is an abundance of existing research on the placement of stop losses, as explored in Section III, Background and Significance. This covers everything from advanced mathematical models, including complex probability, to computer-science focused research. Despite the wide breadth and depth of the existing body of work, this project manages to find its own niche. The research conducted for this project covers a specific type of stock trade, a momentum trade, instead of stop loss placement for any type of trade. Therefore, this project complements the existing stop loss placement strategies by going in-depth into one small area of the stock investment field.

Overall, it is difficult to determine whether this project pointedly agrees or disagrees with prior research, because this the research conducted here was largely experimental. That being said, no findings in this project disputed any previous work done in the stop loss placement area. Therefore, it can be concluded that the conclusions of this project generally agree with prior research.

Despite its general success, the program did have some shortcomings in terms of testing full portfolios. The code did not support weighting all stocks equally, meaning that each stock did not have the same impact on the outcome of the portfolio as the next stock. Those that traded at a higher price were given more weight, and thus determined the outcome more than those stocks that traded at a line of weight. For example, when expensive Google stock was put in a portfolio with relatively inexpensive Verizon stock, the Google stock had a greater impact on the portfolio. This was the major weakness of the project, and it will be rectified with further research and study. Furthermore, instead of testing the program on a portfolio with a limited number of stocks, a more conclusive approach would be to test the code across an entire stock index. This will also be completed.

It would be preferable to create an easy-to-use format for the code, such as a mobile application or a website. Currently, the program cannot be easily used by someone who does not understand or know Python, so packaging it nicely would benefit the usability of the code.

VII. Human Subjects

This section is not applicable to our project.

VIII. Citations

Kaminski, Kathryn M., and Andrew W. Lo. "When Do Stop-Loss Rules Stop Losses?"

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