MULTI-FACTOR QUANTITATIVE INVESTMENT MODEL IN AN

UNPRECEDENTED RECESSIONARY RECOVERY

By

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Abstract

This competition was an equity portfolio management competition that challenged students across the nation to create a market-neutral portfolio over several months. The competition ran in three phases starting on November 2nd, 2020 and concluding on March 31st, 2021. The timeframe ran through the 2020 Presidential Election of Biden / Trump and the tribulations of the COVID-19 pandemic. Our team, UAlpha, was comprised of five students, including Nick Aleman, Lauren Chitren, Ryan Cramer, Abelardo Ramirez, and myself (Trevor Volpe). We were able to make it through the semifinal round, and our competition concluded on February 14th, 2021. Initially, we created our model to outperform the index during a market correction. However, with negative returns during the first two months, while the market went positive, we decided to shift away from a bear model towards a bull model on December 30th, 2020. In the end, we finished the competition with an overall return of -22.63%, placing 11th out of 39 teams.

Delineation of Duties

I was appointed as the team captain by Professor Haertzen, and my duties were to lead the team throughout this competition. Ryan Cramer and Nick Aleman oversaw compliance, making sure our portfolio was within the boundaries set by the CQA Challenge. This responsibility was carried out every Friday around 1 pm before market close (2 pm MST). Lauren Chitren and Abelardo Ramirez helped to better understand the overall trends of the market and help make security selections. All team members contributed equally to the competition.

The Competition

The CQA Investment Challenge is entering its fifth year with the involvement of 35 of the top universities from around the world. The competition runs in three phases. The first phase is judged 100% on compliance (ties broken with return). The second phase is judged 50% on compliance and 50% on return. The third round is judged 30% on compliance, 50% on returns, and 20% on the video presentation. The overall objective of the competition is to successfully manage an equity long/short market-neutral portfolio while within certain constraints.

The guidelines of the competition are as follows:

- **Limit on # of trades:** There is a limit of 1,000 trades in the competition. If you buy a stock and then sell it, then that constitutes two trades. Although you could day trade, it's discouraged as there is a 1,000 trade limit.

- **Stocks only:** Portfolios can ONLY invest in individual stocks on US exchanges. ETFs and ETNs are not allowed. ADRs are allowed.

- **Portfolio Size:** Each team will initially manage a $2,000,000 long/short stock portfolio with about $1,000,000 in long picks and $1,000,000 in short picks.

- **Minimum # of stocks:** The portfolio must always own AT LEAST 40 stocks on the long side and 40 stocks on the short side. A suggestion (but not a requirement) – hold more than 40 stocks, as previous teams have found that they sometimes end up with 39 stocks due to an acquisition, delisting, etc. That delisting/acquisition can create a compliance violation if you are not closely monitoring.

- **Minimum Stock Price for Buying:** $5

- **Minimum Stock Price for Shorting:** $5

- **Position Weight:** The maximum position weight on both the long and short side is 5% of the value of the Fund. This means the maximum position size is less than $50,000 for each stock at the start of the challenge.

- **Dollar Neutrality:** Portfolios must remain dollar neutral with a ratio that is greater than or equal to 0.9 and less than or equal to 1.1.

- **Cash:** Portfolios may not hold more than a 5% weight in cash.

- **Compliance:** Compliance is checked each weekend.

Macro Thesis

Initial Outlook

Initially, the team decided to take an approach to the market that created positive returns in an overall negative return environment. Based on the increasing rates of COVID-19 in the nation and continued economic shutdowns, the team thought the market was overvalued because the P/E ratio of the market was roughly 60% higher than the previous year (S&P 500 PE Ratio by Month). The team expected the market to drop 10% to 20% from its most recent peak. Despite the 31.81% market crash that the S&P 500 saw from February 14, 2020, to March 20, 2020, the market experienced a rapid "V-Shaped" recessionary recovery (Smith, 2020). However, our team believed that the market was overvalued and held up by unprecedented stimulus and quantitative easing (Liesman, 2020). Also, we expected a democratic control of the government to throw the country into a further lockdown state. Overall, the team expected the V-shaped recovery to turn into a W-shaped recovery after a secondary market correction due to increased cases, lockdowns, and volatility in the market (Aldrich, 2020).

Adjusted Outlook

After the above thesis did not materialize, the team had to shift our focus away from a market correction to a continuation of the bull market at play despite the risk of a complete democratic sweep in the Senate run-off election (Domm, 2020). The news of the COVID-19 vaccine helped drive an already strong market in November, and even with a Democratic victory in the Presidential seat, there were no additional lockdowns put in place. The team could not continue to wait because we were continuing to pick up negative returns daily. A shift away from expectations to reality occurred on December 30th, 2020, for our model.

Portfolio Construction

Overview

First Iteration		
Outlook:	**Bear Market**	
Normalization	**Z-Scores**	
Factors	Bet	Weight
Volatility		
30 Day Volatility	Lower is better	20%
Size		
Market Cap	Bigger is better	20%
Momentum		
6 Month Return	Bigger is better	20%
Quality		
ROA LF	Bigger is better	6.67%
Interest Coverage Ratio	Bigger is better	6.67%
EV / CFO	Lower is better	6.67%
Value / Growth		
EV / EBITDA	Lower is better	20%

*avoided stocks with less than 5,000 volume / day

Second Iteration		
Outlook:	**Bear Market**	
Normalization	**Percentile**	
Factors	Bet	Weight
Volatility		
1 Month Beta	Lower is better	20%
Size		
Market Cap	Bigger is better	20%
Momentum		
1 Month Return	Bigger is better	20%
Quality		
ROA LF	Bigger is better	10%
Interest Coverage Ratio	Bigger is better	10%
Value / Growth		
EV / FCF	Lower is better	10%
EV / EBITDA	Lower is better	10%

*avoided stocks with less than 5,000 volume / day

Third Iteration		
Outlook:	**Bull Market**	
Normalization	**Percentile**	
Factors	Bet	Weight
Volatility		
1 Month Beta	Bigger is better	20%
Size		
Market Cap	Lower is better	20%
Momentum		
1 Month Return	Bigger is better	20%
Quality		
ROA LF	Bigger is better	10%
Interest Coverage Ratio	Bigger is better	10%
Value / Growth		
EV / FCF	Lower is better	10%
EV / EBITDA	Lower is better	10%

*avoided stocks with less than 5,000 volume / day

Initial Model

The first iteration of our model was an overall negative market outlook. From the bottom of the recession on March 23, 2020, to the start of our competition on November 2, 2020, the S&P 500 index was up 47.95%. This was the quickest recovery from a recession that the U.S. stock market has seen, ten times faster than that of the Great Recession (Lambert, 2021). The price to equity ratio of the S&P 500 during the month of November in 2020 was a staggering 36.13. This ratio was up from the 22.62 level seen just a year prior (S&P 500 PE Ratio by Month).
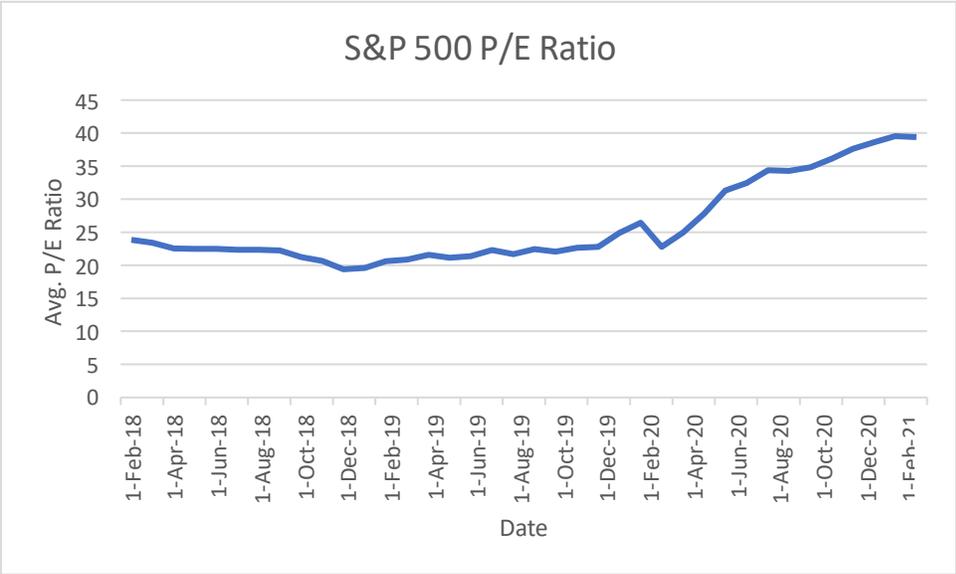
From a sentiment standpoint, according to *Investor's Intelligence* Advisors Sentiment survey Bullish advisors climbed to 60.6%. Many analysts questioned whether the market was truly

being bought on fundamental and intrinsic value (Economist, 2020). Based on this frothy market, we believed that investors overvalued the market, and they were buying on poor fundamentals. For this reason, the team expected a market correction to happen soon, especially with the state lockdowns around that time.

This model used five overall factors including volatility, momentum, quality, value/growth, and size. The quality factor was broken down into three different metrics. The selection process was a weighted value of the z-score for each of the metrics. Outliers were removed from the security selection sequentially. The outliers were identified by calculating the interquartile range of each metric and setting an upper bound 1.5 times the IQR above Q3 and setting a lower bound 1.5 times the IQR below Q1 (3.2 – Identifying Outliers: IQR Method). Any security with a metric outside of this upper or lower bound would be removed from our selection list. This process was repeated for each metric until no outliers, in any metric, remained in our selection list.

Volatility

The metric we used for volatility was the 30-Day Volatility, which comprised 20% of the weight of our multifactor model. We used this time frame because our competition was only over the span of 5 months, so we wanted to make sure to capture data relevant to our time horizon. Most significant alphas in a long-short portfolio are driven by short positions in high volatility stocks (Ang, et Al, 2006). For this reason, we decided to short stocks that had high 30-day volatility percentile rankings and long stocks that had low 30-day volatility percentile rankings.

Momentum

For momentum, we decided to use the historical 6 month return of our stocks. Research showed that buying stocks with high 6 month returns while shorting stocks with low 6-month returns resulted in an alpha over a 6-month period (Jegadeesh & Titman, 1993). Since our timeframe was 5 months, we thought that this 6-month period was close enough to our time horizon. We used a 20% weighting for momentum in our multifactor model.

Size

In terms of size, we decided to take a bet on large-cap stocks. The reason we took a bet on large-cap stocks was that we were expecting another market correction. Based on the correction seen on February 14th, 2020, we concluded that small-cap securities were more sensitive to a recessionary event than large caps. In the time frame of February 14, 2020, to March 20, 2020, the S&P 500 lost 31.81%. At that same time, the Russell 2000 lost 39.91% (Yahoo! Finance). We gave the market cap a 20% weighting in our multi-factor model.

Quality

For quality, we had three different metrics. The first was the forward-looking return on assets, the second was the enterprise value / cash from operations, and the last was the interest coverage ratio. We took the first two from Piotroski's F-score which is a quality measure that uses the sum of nine different binary variables (Piotroski, 2000). To make these numbers comparable, we decided to normalize the second metric by making it a ratio instead of a counting measurement. Although we could not use all nine metrics, we decided that these two were the most important for our purposes. The last metric was used to measure the company's ability to pay the interest on their outstanding debt. With the low rate environment, many companies were borrowing debt

at an extremely cheap cost. Rather than looking at metrics such as their leverage or return on equity, we decided to look at a metric that wouldn't be as a bias towards a company borrowing a large amount of debt. We gave each of the above three metrics a 6.67% weighting in our multifactor model.

Style

Lastly, we wanted to take a style bet. We decided to bet on value stocks rather than on growth stocks. We took this bet because we saw that the overall P/E ratio of the S&P 500 was far above the average. Although growth had been outperforming value in the months leading to our first day of competition, we believed that there would be a shift away from the growth style and into the value style because "value generally outperforms growth during the pre-and early stages of a sustained economic recovery." (Taschler, 2020). With the continued shutdowns seen in November and December, we believed that growth-oriented companies were becoming overpriced, and there would be a shift towards value for a better bargain. The metric used to measure this style was enterprise value / earnings before interest, taxes, depreciation, and amortization, which can be more advantageous than the P/E ratio because it strips out debt costs, taxes, appreciation, and amortization. This metric can give a clearer insight into the future growth potential of a company. Since we wanted to take a bet on value companies, we gave companies with lower EV / EBITDA ratios a better percentile ranking. The EV / EBITDA percentile rank attributed to 20% of the overall rank of a company in our multi-factor model.

Summary

Over the roughly 2-week period of our first iteration (November 2nd, 2020 to November 20th, 2020), the portfolio lost 16.55%. Much of this negative return came on November 9th, 2020, the Monday following the positive news surrounding the COVID-19 vaccine (Pfizer, 2020). In just one trading day, our portfolio went from -0.61% (November 6th, 2020) to -12.63% (November 9th, 2020). Most of this negative return is attributed to the short positions we held. These positions reacted positively to the news of the vaccine, and we lost upwards of 40% on a few short positions, including Chefs' Warehouse, Inc.. We also realized that the companies being traded the most (Tesla, Apple, Google, etc.) in the competition were considered outliers within our z-score model. For this reason, and the lack of risk management that we had within our portfolio, we decided to rebalance and rerun the second iteration of our rankings on November 20th, 2020.

<u>*Second Iteration*</u>

Regardless of the vaccine news, the second iteration of our multi-factor model stuck with the bear outlook. Shutdowns were still happening across the country, and cases continued to grow. "The United States reported more than 4 million coronavirus cases in November, which is higher than the total number of cases seen all year by any country in the world except India and Brazil." (Silverstein, 2020). For this reason, we still believed a market correction was due. The market was treating the vaccine as a silver bullet despite the staggering growth in COVID-19 cases. We rebuilt our model, this time using percentile rankings rather than z-scores as it was a more encompassing means of normalization. By doing so, we were able to include every stock within the parameters of the competition in our model, which gave us more exposure to the bigger names that we were missing out on in the first iteration of our model. Also, we looked at some of our metrics and updated them. The market cap, ROA, EV/EBITDA, and interest coverage

metrics all stayed the same and had the same magnitude (i.e. bigger is better / smaller is better for percentile rankings). However, we switched the momentum factor metric, volatility factor metric, and one of the three quality metrics to an additional value metric.

Momentum

The first metric we decided to switch was the momentum metric. In our first iteration, we used the past 6-month historical returns. In the second iteration, we shortened our historic time horizon down to 1-month of returns to try to capture more relevant information. Since we were playing from behind, we were willing to take quicker positions and make more trades to try to make up for the extreme negative return that we had made in the first three weeks of trading. Momentum was one of the most difficult factors to incorporate into our model because the market was experiencing an unprecedented phenomenon. According to Daniel and Moskowitz, "In normal environments, consistent price momentum is both statistically and economically strong and manifests itself across numerous equity markets." (Daniel & Moskowitz, 2016), but in panic states and extended bear markets, "the expected returns of past losers are very high, and the momentum effect is reversed during these times." (Daniel & Moskowitz, 2016). This was an issue because the market was in a bull state yet there was still an immense amount of panic in the air. We often saw stocks with large one-month momentums perform poorly the following month and vice versa.

Volatility

The second metric we changed was our volatility measure. Initially, we were using a 30-day volatility metric. We found that this metric may not be exactly what we were looking for, as this measures the volatility of a stock, rather than the volatility of a stock in comparison to the overall market. The market was seeing large swings back and forth. Therefore, many stocks were experiencing high volatility, as seen in the VIX graph below (yahoo finance).
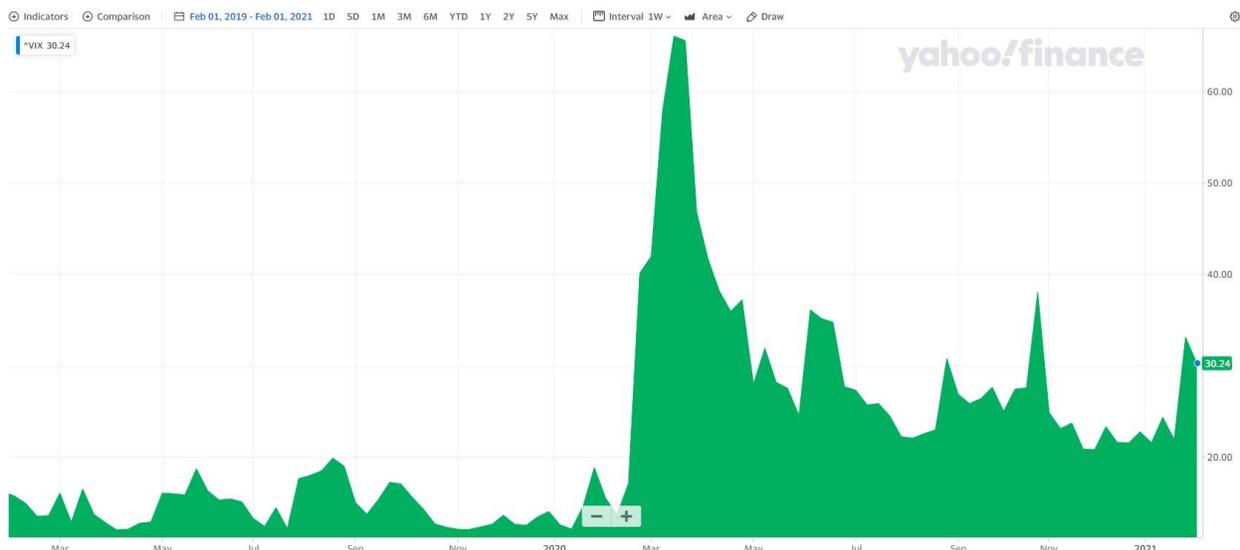
We decided to change our metric to the one-month beta, which measures how a stock will move with the market's movement. This metric was normalized and tied to the market, unlike the initial volatility metric but had the same time frame. Our model continued to use an approach

similar to the betting-against-beta factor of Frazzini and Pederson, "which takes a long position in low beta stocks and shorts high beta stocks." (Frazzini and Pederson, 2014).

Quality

The last metric we changed was one of our quality measures. We realized that the EV / CFO metric was more so a value bet than a quality bet. Therefore, we got rid of this metric and swapped it for an additional value/growth metric. The first iteration incorporated EV / CFO as a quality metric. We switched this to EV / FCF because "it accounts for required investments in the business such as CAPEX (which CFO ignores). It identifies how much cash the company can distribute to providers of capital regardless of the company's capital structure." (*EBITDA vs. CFO vs. FCF, 2021*). We increased the weightings of the remaining two quality metrics to 10% each (ROA and Interest Coverage Ratio), and then redistributed the weighting of the style/growth metrics to 10% each (EV / EBITDA and EV / FCF).

Summary

In addition to the metric changes that we made in this second iteration, we also implemented stop losses for both our short and long positions. These stops were set 15% above the short positions and 15% below the purchase price of the long positions. Once one of our positions reached our predetermined price points, a trade would be automatically executed to get us out of the position and stop our loss from increasing. This risk mitigation technique was a major addition to our portfolio management. If we had these stops added in our first iteration, we would have reduced the loss that we encountered on November 9th, 2020. Throughout the second iteration, we had upwards of 3 securities a week that would automatically cover due to the stop set. In one instance, there was an input error where we put a stop order in that was one less share than our short order. It covered and saved us from most of the negative returns. However, one share was left uncovered due to the input error. Rather than losing 15%, this one share lost nearly 40%. This example goes to show how important these stop implementations were in our portfolio and how much risk they mitigated. Every Friday, we would go over which securities hit their stops and we would add a short or a long into the portfolio to make up for it. Over the duration of the second iteration (November 20th, 2020 to December 31st, 2020), the portfolio went from -16.55% return to -24.50%. Most of this loss was attributed to short positions growing in value rather than decreasing. We had many shorts hit their 15% stop point and automatically cover. Due to this continued negative return that we were seeing, we decided to flip our model to a bull market outlook to catch back up in the competition rather than continue to wait for an uncertain market correction.

Within this iteration, we also received our first Axioma risk report that showed us whether the bets we were trying to make were the bets that played out in the portfolio. The period for this report ran from November 20th, 2020, to December 3rd, 2020. During this period, the CQA Index lost 2.65%, while our portfolio gained 4.43%. This was one of the unique periods where our initial macro thesis played out. The highest contributor to our return was our volatility (1.05%) bet followed by our market sensitivity (0.38%), liquidity/quality (0.32%) bet, and momentum (0.25%) bet. However, the bet that hurt us the most was our size (-1.40%) bet. The breakdown of the style contribution can be seen below. Overall, this showed us that we were making the bets that we were intending to make and that our macro thesis was effective during this short-lived period.

Factor Attribution Summary

Portfolio: CQA_UAlpha
Benchmark: None
Risk Model: US4AxiomaMH

Period: 2020-11-20 to 2020-12-03
Frequency: Daily

Return Scaling: Cumulative
Base Currency: USD
Risk Type: Realized Risk

Contributors to Return by Style

Style	Contribution	Avg Wtd Exp	HR	IR
Volatility	1.05 %	0.3634	75.00 %	21.51
Market Sensitivity	0.38 %	0.2129	62.50 %	12.06
Liquidity	0.32 %	0.3482	75.00 %	16.76
Medium-Term Momentum	0.25 %	-0.1534	62.50 %	9.74
Value	0.03 %	0.2346	50.00 %	2.37
Earnings Yield	0.01 %	-0.0305	62.50 %	5.37
Leverage	0.00 %	0.1376	50.00 %	1.18
Growth	0.00 %	-0.0216	50.00 %	-4.45
Profitability	-0.01 %	0.0359	50.00 %	-4.29
Exchange Rate Sensitivity	-0.01 %	-0.0525	50.00 %	-6.58
MidCap	-0.03 %	0.2308	25.00 %	-3.02
Dividend Yield	-0.10 %	-0.1636	37.50 %	-15.52
Size	-1.40 %	-0.7116	25.00 %	-27.08
Total	**0.49 %**			

Third Iteration

On December 30th, 2020, the team sold every position in the portfolio and switched to a bull market outlook. Our model metrics stayed the same as the second iteration, but the magnitude of the size factor and volatility factor switched. The reason for this change was that we were seeing continued negative returns within our bear outlook portfolio that were being driven by a bull market. Regardless of whether the fundamentals and sentiment of the market were pointing towards a correction, we could no longer play the waiting game as there were only two months left in the second phase of the competition to make up for the large losses we incurred in the first two months of competition. Therefore, we decided to hop on the bull wagon and amplify the returns that the market was seeing.

Size

The first metric that we decided to flip in terms of magnitude for the percentile ranking was the market cap. As stated before, our size style factor was the factor that was attributing the most to our negative returns in comparison to the index. Small-caps were seeing major gains, yet we were trying to long large caps and short small-caps. This was because we were expecting a correction, and historically, the large-cap stocks performed better in a market correction than the small-cap stocks did. However, the market never corrected during our competition, and we could not continue to wait on this uncertain event. We took what the market was telling us and decided to switch towards longing more small-caps and shorting more large-caps (Nelson, 2020).

Volatility

The second metric that we flipped the magnitude of was the one-month beta (volatility) metric. In our first two iterations, we wanted to long securities with low volatility/beta metrics. The reason for this is because we believed the market would have a correction, and we wanted the securities that we were longing to have a weak connection to market movement or have a negative relation to it (i.e., if the market corrects, our longs will rise in value). However, with the market continuing to run on a bull spree, we decided we needed to switch the magnitude of this

metric and long securities with high betas because they overreact in the same direction as the market's movement. Since the market was generally on an upward trend, we wanted to capture this through high beta long positions and low beta short positions.

Summary

Over the third iteration, the portfolio saw a return go from -24.50% on December 30th, 2020 to -22.63% on February 14th, 2020, which was the conclusion of the second phase and the conclusion of the competition for UAlpha. This was the only iteration where the team saw overall positive movement, 1.87%, of the portfolio. This can be largely attributed to the stops put on the short and long positions, as well as to the switch from a bear market outlook to a bull market outlook. We were able to follow the trends of the market, rather than try to predict the correction, to achieve a position return over this iteration. In addition, we tried to focus on making bets in sectors that we had performed well in during the first phase (consumer discretionary, real estate, and utilities) while staying away from sectors that we tended to perform poorly in (health care, IT, industrials).

Contributors to Return by Sectors

Sectors	Contribution	Avg Wtd Exp	HR	IR
Consumer Discretionary	0.43 %	-4.78 %	51.28 %	1.33
Real Estate	0.31 %	-4.86 %	56.41 %	1.26
Utilities	0.14 %	-0.80 %	23.08 %	2.21
Materials	-0.01 %	1.13 %	46.15 %	-0.13
Financials	-0.09 %	-0.74 %	51.28 %	-2.29
Telecommunication Services	-0.16 %	3.28 %	43.59 %	-2.85
Energy	-0.19 %	-2.75 %	48.72 %	-1.04
Consumer Staples	-0.25 %	5.06 %	28.21 %	-4.06
Industrials	-0.31 %	11.79 %	48.72 %	-1.24
Information Technology	-0.32 %	-4.95 %	43.59 %	-0.75
Health Care	-0.48 %	13.20 %	35.90 %	-1.56
Total	**-0.93 %**			

Compliance Deductions

Overall, the team lost 3 points, all in the first round, on compliance violations. These violations were created in fault with the stops that we had in place. Although these stops helped us from incurring large negative returns, they also hurt us in compliance. The stops were in place to automatically trade once a position made a -15% return. With that said, many of the automatic trades could go by unnoticed. The team would regularly meet an hour before the market closed to make sure that we were within the compliance restraints of the competition. However, we quickly realized that many major moves and volatility happen just before the close of the market on the Friday going into the weekend. Due to this increased volatility, positions would cover just prior to the market close and it would not give us enough time to get our portfolio back into compliance. There was an instance where a position was covered just one minute before the market closed. Although we were hit a few times for compliance violations, we still managed to be one of the teams with the least amount of violations throughout the competition.

Conclusion

In the end, the team finished in 11th place out of a total of 39 teams. We missed the final round of the competition by just one spot, which was largely due to the negative return that we had generated over the first two rounds of the competition. Throughout the competition, we learned the importance of having risk protocols in place. I believe if we had the proper stops in place during the first two weeks of competition, we would have placed top 10 overall. Although we dug ourselves into a deep hole, we were able to switch our macro thesis in the end to generate a positive return over the third iteration of our model. Regardless of the return, our portfolio generated, the portfolio was making the bets that we intended it to make. Waiting for an uncertain event can be extremely costly, as seen by our decision to wait for a market correction which costs us upwards of 20% return. Ultimately, keeping an open mind to what is going on in the market is vital to generating a positive return, which could be seen by our switch from a bear market outlook to a bull market outlook.

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