

Hedging Strategy Memorandum

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SUBJECT: Hedging Stock Positions Using Future Indices

I. Introduction

This project hedges a portfolio using S&P 500 e-mini (ES=F) and Russell 2000 e-mini (RTY=F) futures indices over the course of 2 weeks, from October 18 to November 1, 2021. Hedging is a risk management strategy employed to offset losses in investments by taking an opposite position in a related asset. Our initial position consists of a portfolio of 10,000 shares of three stocks: two large-cap stocks, CAT and CSCO, as well as a small-cap stock ANIK. Although we believe that the stocks will gain value in the long term, portfolio may experience a negative shock over next two weeks, so to mediate this shock, we sell ES=F and RTY=F future contracts. By doing so, the loss in portfolio value would be offset by the gain in the value of future contracts. To justify hedging a stock according to a market index, we identified a stock beta for each of our securities. A stock beta is a measure of a stock's volatility in relation to the overall market. A stock beta of 1 indicates that the stock price moves along with its market. A stock beta that is lower or higher than 1 indicates that the stock is less or more volatile in relation to the market, respectively. In this case, we are looking for benchmarks that lead to the stock beta of 1 because we want to exactly offset the loss in stock value by the gain in the short future position. We analyzed how stock betas performed over different time periods compared to the S&P500 e-mini-index (a large-cap future index) and the Russell 2000 e-mini-index (a small-cap future index). Once we identified the most consistent betas, we choose an appropriate market benchmark for each of the stocks. We considered two hedging strategies, static and dynamic hedging. Static hedging is the strategy where we do not change our positions in future contracts over hedging period, while with dynamic hedging we change our positions after a week if the hedging strategy did not perform well that week.

II. Findings

- We found that Russell 2000 E-mini–Future Index is an appropriate benchmark for CAT whereas S&P 500 E-mini-Futures is appropriate for ANIK and CSCO.
- We chose 0.91, 0.88, and 0.89 as stock betas for CAT, ANIK, and CSCO respectively. Based on these stock betas, we sold 4 of ES=F future contracts and 16 of the RTY=F future contracts to hedge our stock positions.
- After the first week, our hedging position showed a change of 0.06% which is a miniscule change. The small change reflected the effectiveness of our hedging. Therefore, we did not change our hedging position after the first week. At the end of second week, our hedging position again showed only a change of 0.06% which accomplished our goal of hedging the stock positions for two weeks.

III. Discussion

1. Method

The first task in hedging the stock positions using the future indices is to find the appropriate benchmarks to be used for each stock. The most appropriate benchmark is the one that results in the stock beta which is close to 1. To find the appropriate benchmarks, we collected the daily price data for the most recent 90 days and monthly prices for the most recent 36 months. The data on stock prices and the future prices were collected from Yahoo Finance.

We found the daily returns and monthly returns for each stock and index. Then, we calculated the covariance of the returns for each stock with the returns of each future index using both monthly and daily data. Finally, we calculated stock beta for each stock using each benchmark using the formula: $\beta_i = Cov(R_i, R_M) / Var(R_M)$ where $Var(R_M)$ is the variance for returns on the benchmarks.

The initial findings of the stock betas suggested that RTY=F was a better benchmark for CAT. In the case of ANIK and CSCO, we found that ES=F was a better benchmark.

To justify the choice of benchmarks, we calculated the historical betas using a rolling window of 90 days (for the daily data) and 36 months (for the monthly data) for the last 10 years for each security. After comparing the mean and standard deviation of the historical betas in each case, the findings from the calculation of our historical betas were consistent with our initial findings using the most recent 90 days and 36 months data. After deciding on the benchmarks to be used for each stock, our next task was to decide on the value of the stock beta to be used for calculating the number of future contracts to be sold for hedging the stock positions.

We decided to go one step further and calculate stock betas using the most recent 15 days and 30 days daily data. After comparing our results with the previous results, we decided that the best stock beta in our case would be the stock betas calculated using the 90-day daily data.

Once we had the stock beta, the next task was to find the number of future contracts for each benchmark that we would have to sell to establish our hedging position. Since we were using two benchmarks for three stocks, we needed to find the weighted beta for each benchmark. The weighted beta for RTY=F was equal to the stock beta for CAT, and the weighted beta for ES=F was equal to $w_1 * \beta_1 + w_2 * \beta_2$ where w_1 and w_2 were the weights for ANIK and CSCO respectively, and β_1 and β_2 were stock betas for ANIK and CSCO respectively. The formula used for w_1 was $V(0)_{\text{anik}} / (V(0)_{\text{anik}} + V(0)_{\text{csc0}})$ where $V(0)_{\text{anik}}$ and $V(0)_{\text{csc0}}$ were the values of all ANIK stocks and CSCO stocks on the day we started the project. Similarly, we calculate w_2 using $V(0)_{\text{csc0}} / (V(0)_{\text{anik}} + V(0)_{\text{csc0}})$. Once the appropriate betas were calculated, the number of future contracts to be sold was calculated using the formula: $n = \beta * \text{Portfolio Value} / (\text{Price of Future Index} * \text{Appropriate Multiplier})$. The appropriate multiplier for ES=F and RTY=F is 50.

After finding the number of future contracts to be sold, we established our hedging position and started tracking the gain/loss in the portfolio and the futures positions. After a week, we found that the total value of our portfolio and future positions had increased only by 0.06% which demonstrated the excellent hedging. We decided to not change our hedging positions.

2. Main Analysis

Choice of Appropriate Benchmarks: Our primary choices for the benchmarks were S&P 500 E-mini-Future Index (ES=F) and Russell 2000 E-mini-Future Index (RTY=F). Using the 90-days daily returns data, we found that the beta for CAT using RTY=F was 0.91 which was closer to 1 than 1.40 which we got using ES=F. Similarly, for ANIK and CSCO, we found that the betas using ES=F were 0.89 and 0.88 respectively, which were closer to 1 in comparison to the betas calculated using RTY=F. The table 1, below, summarizes this result.

	CAT	CSCO	ANIK
Stock Beta (ES=F)	1.40	0.89	0.88
Stock Beta (RTY=F)	0.91	0.32	0.64

Table 1: Stock Beta using the most recent 90 days daily

	CAT	CSCO	ANIK
Stock Beta (ES=F)	0.73	0.90	0.87
Stock Beta (RTY=F)	0.61	0.61	0.73

Table 2 Stock Beta using the most recent 36 months monthly data

To validate our results, we used the 36-months monthly price data to calculate stock betas for each security using each benchmark. The results are summarized in the table 2 above. The table 2 supported our initial hypothesis that ES=F was the appropriate benchmark for CSCO and ANIK. However, the table 2 showed that RTY=F is not a good benchmark for CAT which contradicted our previous claim. So, to justify our reasons, we went a step further and did analysis using 10-year data with 90-days (daily price) and 36-months (monthly price) rolling windows.

	CAT	CSCO	ANIK
Beta (ES=F)	1.25	1.03	0.95
Beta (RUT)	0.92	0.71	0.80

Table 3: Mean of historical stock beta using 10-year data windows.

	CAT	CSCO	ANIK
Beta (ES=F)	1.36	1.15	1.46
Beta (RUT)	1.00	0.66	0.94

Table 4: Stock Beta Using 36 months rolling 90 days rolling window for 10-year data

Since RTY=F started from 2017, we used Russell 2000 regular index (RUT) for historical data instead of RTY=F. The use of RUT instead of RTY=F is justified by the fact that the index futures are closely correlated to the underlying index. Table 3 summarizes the results we got by using 10-year data with 90 days rolling window, which supported our initial claims. The beta for CAT using RUT was 0.92 which is close to 1 and consistent with our initial findings. For ANIK and CSCO, the beta using ES=F were 1.03 and 0.95 which were very close to 1 and the results were also consistent with our previous findings. Table 4 also showed consistency in the results. Since the results were consistent throughout the tables, we concluded that ES=F was the appropriate benchmark for ANIK and CSCO and RTY=F was the appropriate benchmark for CAT.

Analysis of Historical Beta: The historical betas showed consistency throughout the 10-year time, which is supported by the small standard deviation seen in Tables 5 and 6. In the case of CAT and CSCO, the standard deviations of betas using both benchmarks were small, suggesting less volatility in historical beta. This means that the beta which we had calculated using the 90 days daily data could be reliably used to calculate the number of future contracts to be sold.

	CAT	CSCO	ANIK
ES=F	32.7%	21.6%	52.4%
RUT	22.6%	20.7%	48.3%

Table 5: Standard deviation on historical using

	CAT	CSCO	ANIK
ES=F	33.3%	20.5%	39.3%
RUT	25.8%	16.8%	25.7%

Table 6: Standard deviation on historical beta

the 90-day rolling-window for 10-year data

using 36 months rolling-window for 10-year data

In the case of ANIK, the standard deviation was a bit higher. The betas were volatile in the case of ANIK. However, the betas for ANIK were very close to 1 for most of the cases as shown by Tables 1, 2, and 3. We believed this consistency would offset the volatility seen in the historical betas.

Therefore, the consistency of the historical beta throughout the 10-year period along with the consistency in beta seen across tables 1,2,3 and 4 strongly supports our choice of beta for the calculation.

Choice of Stock Beta: Since the hedging position was established for two weeks, we believed that the most recent data would be more relevant in comparison to the historical data. So, we decided to calculate stock beta using the most recent 15 days daily data. However, in this case, consistency was broken. For example, in table 7, we can see that the beta for CAT using ES=F is closer to 1. However, historical data and the 90 days data showed that the beta for CAT using RTY=F is closer to 1. The consistency was also broken in the case of ANIK.

	CAT	CSCO	ANIK
Stock Beta (ES=F)	0.91	0.83	0.65
Stock Beta (RTY=F)	0.67	0.84	0.74

Table 7 Beta using the 15 days daily data

	CAT	CSCO	ANIK
Stock Beta (ES=F)	1.25	0.82	0.52
Stock Beta (RTY=F)	0.96	0.61	0.47

Table 8 Beta using the 30 days daily data

Since the results using 15 days data were not consistent with the previous results, we decided to use 30 days data to test the stock beta which is summarized in the table 8. When the 30 days daily data were used, the results were consistent with our previous results. For example, in the case of CAT, the beta using RTY=F was close to 1, and the case was similar for CSCO, indicating that the results from 15-day daily data were unreliable. However, the stock beta for ANIK was still very small and it was important to use stock beta that was consistent and close to 1. Therefore, we chose to use the data from table 1 for two reasons. First, the betas for CAT and CSCO in tables 7 and 8 are consistent with the 90 days data (see table 1) but more importantly, the beta for ANIK in for 90 days data is closer to 1, whereas ANIK's beta for 15 and 30 days varies greatly.

Static Hedging or Dynamic Hedging: Using the appropriate stock beta, we found that we need to sell 4 of ES=F future contracts and 16 of RTY=F future contracts to hedge our position effectively. On October 18, 2021, we established our hedging position by selling the number of future contracts as mentioned above. After the first week, our overall position was up by 0.06% which is a small percentage. This suggested that the gains in the portfolio value were offset by the loss in our future positions meaning that if there is loss in our portfolio value in the next week, the losses would be covered by the gains in the future positions. This is what a good hedging position is supposed to do. We decided to not change our hedging position after the first week. Therefore, we chose not to dynamically hedge our portfolio. Our overall position after two weeks was up by 0.06% demonstrating an effective hedging strategy.

	Gain/loss in	Gain or loss in		Total	Hedging	Position
Date	Portfolio	RTY=F	ES=F	Gain/Loss	Position	change in %

11/1/2021	100600	-71680	-25650	-97330.00	3270.00	0.06%
10/29/2021	72500	-24480	-23900	-48380.00	24120.00	0.43%
10/28/2021	87400	-24320	-22000	-46320.00	41080.00	0.73%
10/27/2021	-7600	12160	-13400	-1240.00	-8840.00	-0.16%
10/26/2021	31800	-23360	-17550	-40910.00	-9110.00	-0.16%
10/25/2021	56000	-36480	-16100	-52580.00	3420.00	0.06%
10/22/2021	25300	-13360	-9900	-23260	2040.00	0.04%
10/21/2021	50300	-23520	-12850	-36370	13930.00	0.25%
10/20/2021	79400	-18240	-10100	-28340	51060.00	0.90%
10/19/2021	41300	-6480	-6750	-13230	28070.00	0.50%
10/18/2021	—	—	—	—	—	—

Table 9 Summary of our hedging position

3. Limitations

The main limitation of our project was the lack of the historical data for Russell 2000 E-mini-Future Index (RTY=F). We decided to use the historical data of the regular Russell 2000 index whose price is closely correlated to the price of RTY=F. However, they are not perfectly correlated. This might have caused some discrepancies in our calculations.

IV. Conclusions

The hedging position which we started on October 18, 2021, ended on November 1, 2021. We had anticipated that over 2-weeks, the stocks would lose their value. On the contrary, the stocks gained significant value. Since we were in short positions for the future contracts, our future contracts lost value when the stock prices went up. At the end of two weeks, our overall hedging position changed only by 0.06%. The temporary gain in the stocks were exactly offset by the loss from the future position which demonstrated a great hedging strategy. If the stocks had lost their values, our future positions would have offset that loss which was our original goal. Therefore, an optimal hedging position for our portfolio utilizes Russell 2000 e-mini for CAT, and S&P 500 e-mini for CSCO and ANIK.

V. References

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