# AMD Stock:

## Analysis of Returns:

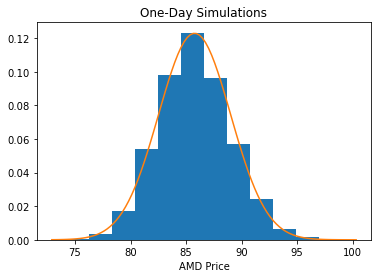
The distribution of returns on AMD stock is normal with a couple outliers on the right end tail, however the behavior appears to be normal. Similarly, the Q-Q plot shows that the behavior can mostly be described by a normal distribution, but the points that trail off at the end indicate a bit of right skewedness.

Chart, line chart

Description automatically generated

## One Step Predictions

By running Monte Carlo Simulations on geometric Brownian models, thousands of one-day predictions can be estimated. In this scenario, 10,000 simulations were run with the resulting simulation mean as 85.808, and simulation standard deviation as 3.174. This produced the following density plot:



As seen in the figure, the resulting density plot for one-day predictions fits a normal distribution very well. Because of the normal behavior, the probability of the true AMD price at time t=1 can be calculated from the normal probability density function.

|  |  |  |  |
| --- | --- | --- | --- |
| Actual (t=1) | Predicted (Avg) | PDF | CDF |
| $85.07 | $85.79 | 0.1211 | 0.4109 |

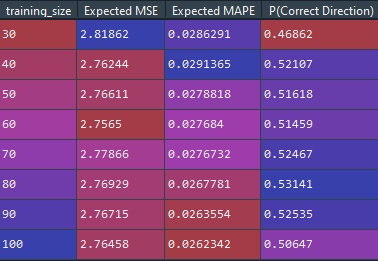
In layman’s terms this means that there was a 12.11% chance of the price of an AMD share to hit its true price of $85.31, and that out of all simulated prices, 41.09% of those are less than the true price of AMD on that day.

## Extended One Step Predictions:

The one-step predictions can be applied over a set period to determine how well it forecasts future values of price. In the research paper **[INSERT RESEARCH CITATION]**, it was determined that a training set of 60 days produced the best predictions based on the mean squared value. That experiment is repeated, but with the addition of the mean absolute percentage error as another criterion of forecasting accuracy. 100,000 simulations from training sets of 30 to 100 days each, and the resulting simulations are compared to the actual stock price to obtain the MSE and MAPE.

Another interesting methodology that the same research paper conducts is examining the experimental probability of predicting the correct direction of the price change. According to the same research paper, 100-day sets produced the most accurate direction prediction. To perform this experiment, 100,000 one-day simulations will be generated for training sizes from 30 to 100 each. The resulting experimental prices will be subtracted by the true *s(t-1)* price, and the direction will be checked against the true price change direction of *s(t)-s(t-1)*.

The following results are summarized in the figure below:

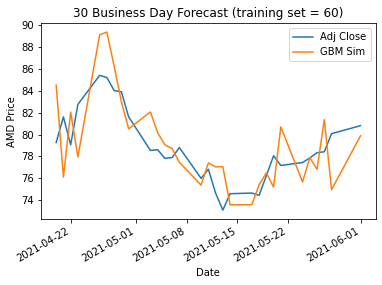
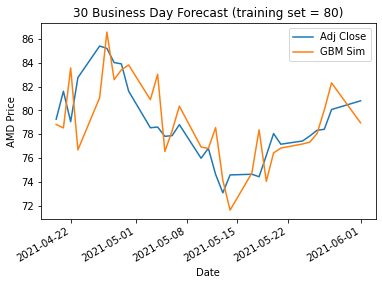


The expected MSE for the 60-day set is the lowest amongst the training sets, while the expected MAPE for the 100-day set is the lowest. In terms of the expected MSE, this reinforces the findings in **[INSERT RESEARCH CITATION]**

In comparison to the paper’s results of 100 days being the most accurate training size when it comes to predicting the correct direction of the price change, this scenario results in a training size of 80 being the most accurate.

Perform hypothesis testing to determine if difference is significant? Expected MSE and MAPE are all close.

## Sample 30 Business Day Forecasts:

# S&P500 ETF (SPY):

## Analysis of Returns:

The distribution of returns on SPY ETF is a bit skewed to the left. However, it does still hold a general normal shape. The Q-Q plot reinforces this assessment since only a few of the points trail off in the beginning, indicating left skewedness.

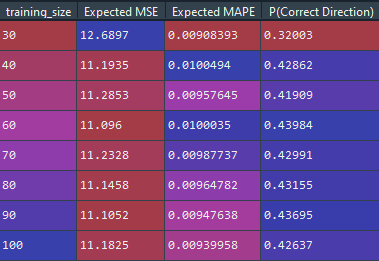
Chart, line chart, scatter chart

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## Extended One Step Predictions:

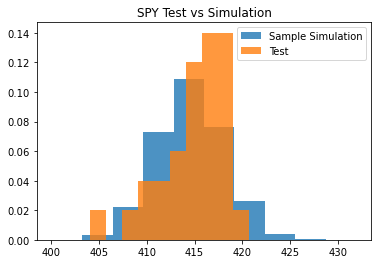
Using varying training set sizes, the size that resulted in the most accurate predictions is a 60-day set with an expected MSE of 11.096. When determined by the expected MAPE, a 30-day set produces the most accurate predictions.

When attempting to determine the best training size to measure direction accuracy, the size that produced the most accurate direction predictions is a 60-day set too.

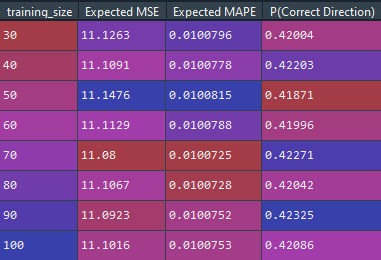
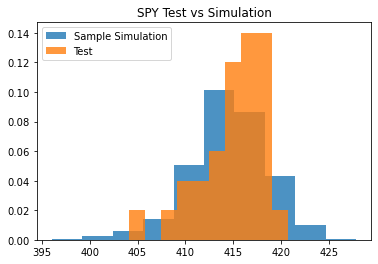


It should be noted that the expected MSE and is significantly higher than AMD’s expected MSE, and the probability of predicting a correct directional change has also decreased quite drastically. This could be due to the fact that the distribution of returns doesn’t exactly follow a normal distribution.

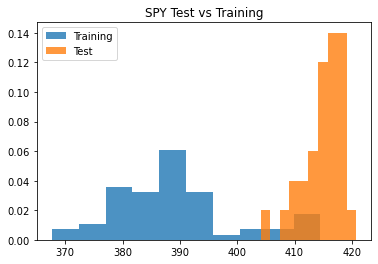
This is made apparent when looking at the distribution between the test data, and a sample Brownian motion realization distribution. The test data is already developing a left skew despite a sample size of only 30 days.



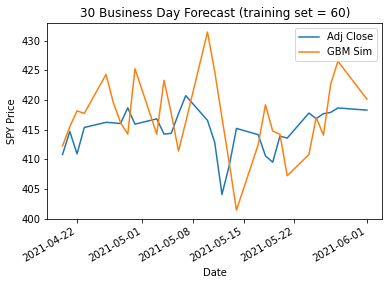
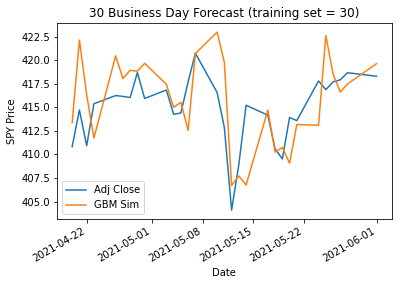
Attempting to resolve this via KDE, results only in slightly better MSE and probability of predicting a correct directional change. Attempting to diagnose the issue via the distribution shows that the behavior during the test data timeframe has an even greater skew than the KDE of the training data:

Looking at the differences between the training and test data made it apparent that the training data saw a different distribution from the test data, which would have resulted poor forecasting capabilities:



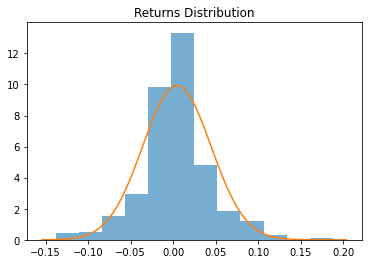
## Sample 30 Business Day Forecasts:

# Bitcoin (BTC):

## Analysis of Returns:

While the general shape and the Q-Q plot can be interpreted as generally normal, the normal distribution does not cover the peaks of the returns enough. Kernel density estimation can be employed to create a distribution that would capture this behavior better.

Chart, line chart

Description automatically generated