

Analyzing and Simulating Returns

Kyle Evan Murphy

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Return Analysis

We'll use the SPDR S&P500 ETF "SPY" as our proxy for SP500 returns due to it's high liquidity and consistently low tracking error. 20 years of price history will be downloaded but only 2018 is shown in the chart below.

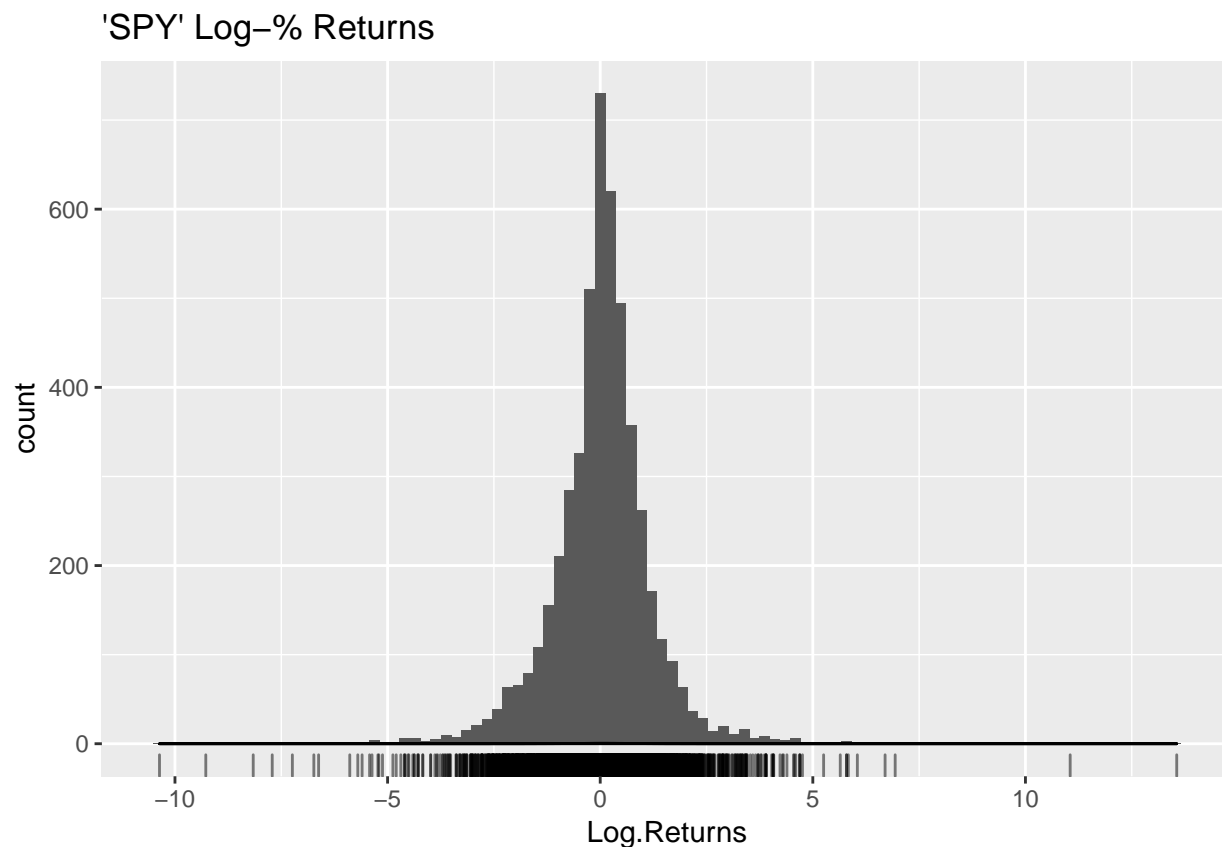
```
## [1] "SPY"
```



Next, we'll calculate the log returns of 'SPY'. Below are the 5 most recent observations.

```
##          daily.returns
## 2018-10-15 -0.0056328594
## 2018-10-16  0.0216302598
## 2018-10-17  0.0001783650
## 2018-10-18 -0.0145464286
## 2018-10-19 -0.0005428174
```

Let's visualize the returns as a histogram.



We can look at different quantiles of the distribution, followed by the mean and standard deviation of log returns.

```
##          0.5%          2.5%          25%          50%          75%
## -0.0435913434 -0.0250838729 -0.0048411449  0.0006480581  0.0059076566
##          97.5%          99.5%
##  0.0231401091  0.0401164558
```

Displaying the mean and standard deviation values

```
## [1] "Mean log return:"          "0.000261516193370556"
## [3] "Std.Dev of log returns:" "0.0120502337249791"
```

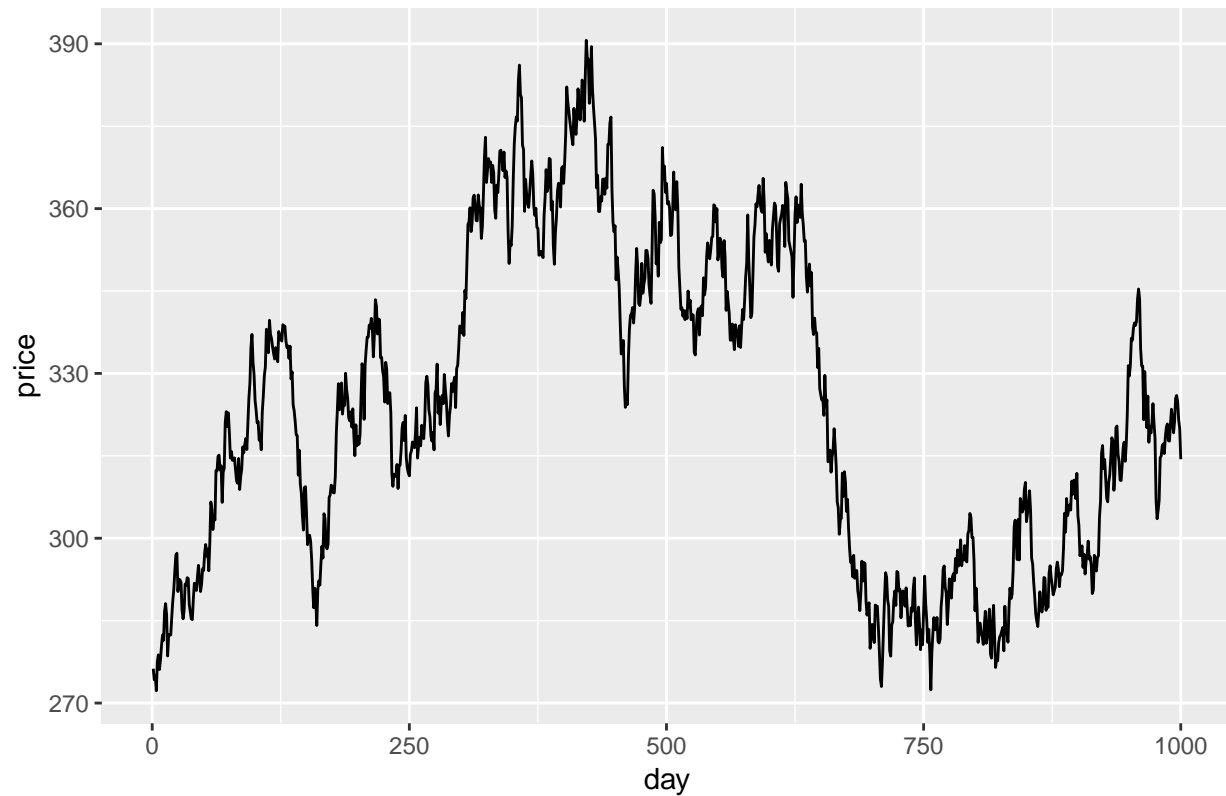
We will re-transfrom the log returns with exponentiation to get the actual return which is:

```
## [1] 1.000262
```

Our average daily percent return is:

```
## [1] 0.02615504
```

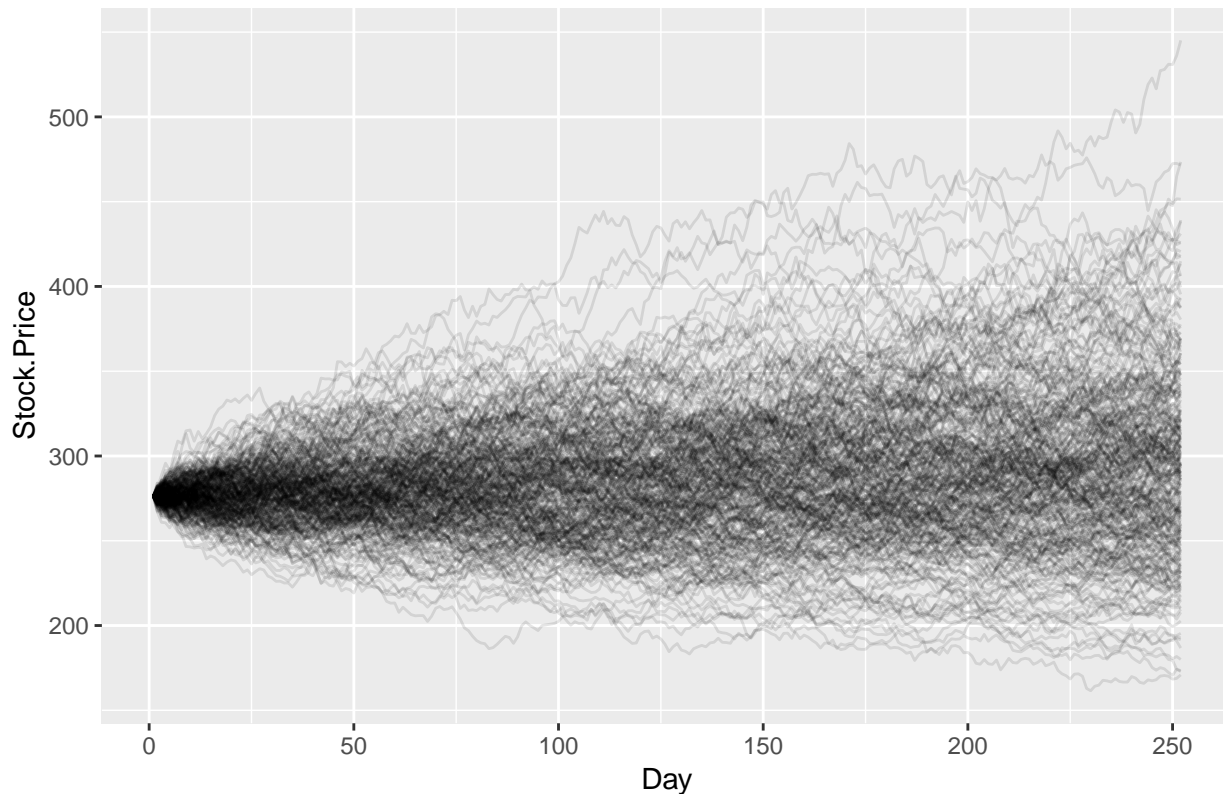
SPY: Simulated Prices for 1000 Trading Days



This particular simulation isn't useful itself - but we can generate many of these simulations in what is called a "Monte Carlo Analysis". Using the parameters below, we can simulate 252 trading days forward - 300 different times.

```
N <- 252 # number of days to simulate  
M <- 300 # number of monte carlo simulations
```

SPY: 300 Monte Carlo Simulations for Prices Over 252 Trading Days



The confidence intervals for our simulation:

```
## 0.5% 2.5% 25% 50% 75% 97.5% 99.5%
## 173.16 198.87 256.18 293.90 331.71 425.82 472.56
```

The median value of these price simulations is:

```
## [1] 293.9
```

Is this a realistic number? We can compare the CAGR for our entire dataset (20 years of SPY data) and compare it to our simulation's CAGR.

```
## [1] "SPY CAGR %: " "6.81"
```

```
## [1] "Simulation CAGR %: " "6.39"
```

Conclusion

We calculated 20 years of logarithmic returns on the SP500 ETF “SPY” and viewed them as a histogram. We determined the mean and the standard deviation of our empirical distribution and the average daily return percentage. (May not seem like a lot, but compounds daily.) We then constructed a “Random Walk” model given our SPY’s log return distributions moments (mean and variance). After simulating the random walk model several hundred times (Monte Carlo Simulation) and evaluating the confidence intervals - we finished by comparing the actual historical CAGR to our simulations hypothetical CAGR.