12/16/2019

SYS 611-TERM PROJECT

Stock Price Prediction of Texas Instruments for the year 2018-2019

Advisor: Prof. Paul Grogan

By: Ajay Rana
STEVENS INSTITUTE OF TECHNOLOGY

1. Introduction Modeling

The stock market refers to the array of markets and exchanges where routine transactions take place in the acquisition, selling, and issuance of publicly held companies ' stocks. These financial activities are carried out through standardized structured exchanges over the marketplaces of the counter (OTC) operating under a prescribed set of regulations.

It is a risky business to invest in stocks. There are some threats that we have some control over, and there are others that we can protect. Thoughtful investment options that meet our priorities and risk profile retain an appropriate level of individual stock and bond risks.

Traders are also finding it difficult to beat the market as most of the big firms are using computer algorithms to predict the stock price. As the use of computer algorithms virtually eliminates any chance for mere mortals to make short-term money trading.

Due to various risks involved in investments, we might want to try and look into the future and try to predict what kind of returns we might expect and with what type of likelihood. We might also be interested in investigating what possible extreme outcomes we can encounter and how vulnerable we are to the possibility of failure or higher returns on the flip side.

1.1 Objective

The objective of this project is to predict the average price returns and range of the future stock price of Texas Instruments using previous year data and compare the data to the available real-world data based on the results of the Monte Carlo simulation.

1.2 System Boundary

We will use a model based on Monte Carlo simulation to look overtime at the future progression of stock prices. If they are subject to a normal distribution of daily returns. We know that returns on stock prices usually follow a more fat-tailed curve than a normal distribution. However, we have used a normal distribution for this purpose, which is standard practice. This type of price change is called a random walk.

A random walk is a mathematical object, known as a stochastic or random process, that describes a path that consists of a succession of random steps on some mathematical space.

We need to estimate the expected daily return of stock price using drift and volatility of the stock in question to set up our simulation. Based on historical prices, this data can be estimated with the most straightforward methods, just assuming that the past mean return, drift, and volatility levels will continue in the future. However, historical data could also be adjusted to reflect investor views or changes in the market regime as we know that many unknown factors affect the way stock price changes. We are just setting simple return and drift levels based on past price data to keep things simple.

1.3 Key Performance Measure

Critical performance measurers here are the average predicted stock price, and the range of the stock price gives how closely we have successfully predicted the stock price of Texas Instruments.

The predicted average stock price will tell us how close we are to average stock price since the everyday stock price will vary. Comparing each day's stock price with 10,000 paths with different stock prices will not give us and the correct figures of the predictions.

The range of the stock prices predicted will give us an idea of how wether real-world data prices lie within this range or not and gives us the lowest and highest prices that stock prices can rise or fall in the future.

2. Modeling Approach

2.1 Collecting and Processing Real Data

We generate the initial data we need as inputs to our Monte Carlo simulation. We need to estimate the expected daily return for that we first find out the mean, variance, standard deviations to calculate drift and volatility of the stock in question to set up our simulation.

In probability theory, stochastic drift is the change in the average value of a stochastic (random) process. In this, we calculate the amount of drift in the stock price over a few years. Drift is the best approximation of the future rates of return of the stock. Another parameter used for approximation of future stocks is Volatility is the set of security interactions with price changes over a given period. The security has low volatility if the price remains relatively stable. Highly volatile security rapidly reaches new highs, shifts erratically, and has rapid rises and drastic drops.

We have used Adj Close for the following calculation of drift and volatility. Where Adj close is the closing price of a stock is the price of that stock at the close of the trading day.

To estimate the expected return price of the stock. We use past year data from yahoo finance directly importing to python using inbuilt modules from the year 1/1/2011 to 31/12/2018. Alternatively, we could directly download the data from yahoo finance in CSV format and process that data in python.

Firstly, we calculate the Mean return for that we have to calculate the historical log-returns of the past dataset, and then we find the mean of the log-returns values. To calculate the log returns, we use percent change to obtain simple returns from a provided dataset. Now we calculate other vital parameters that are variance, drift, and standard deviation.

Results obtained were:

$$Mean = 0.00063$$

$$Variance = 0.0000229$$

$$Standard\ deviation = 0.015125$$

$$Drift = 0.000516$$

2.2 Formulating, Developing and Documenting the Model

After the collection of data and finding initial input parameters needed for the Monte Carlo simulation. The method we are applying here is Brownian motion to predict the stock prices.

A Geometric Brownian motion (GBM) (also known as exponential Brownian motion) is a continuous-time stochastic process in which the logarithm of the randomly varying quantity follows a Brownian motion (also called a Wiener process) with drift.

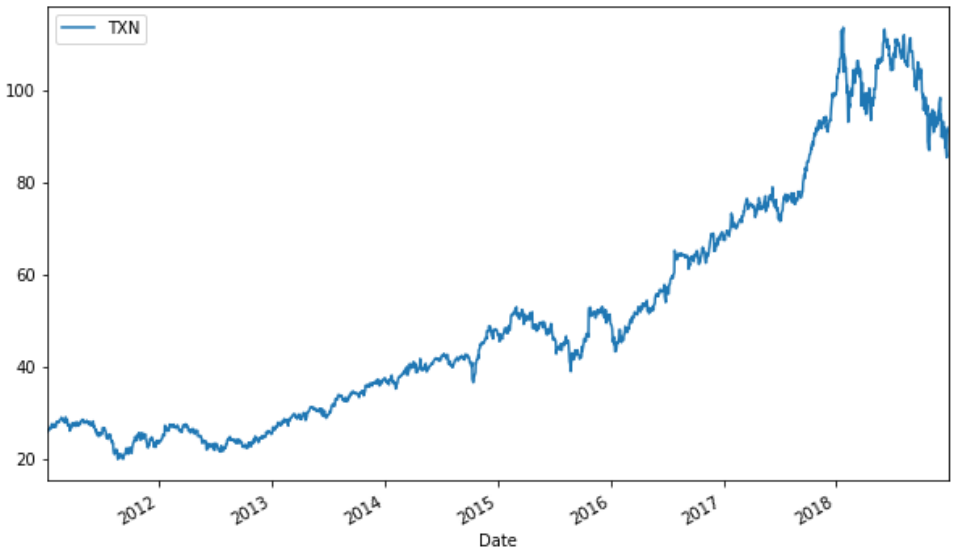

Fig.1 Stock price of Texas Instruments from 2011-2018

In Fig.1, we can see that Texas Instruments (TXN) stock price has been gradually growing during the past decade.

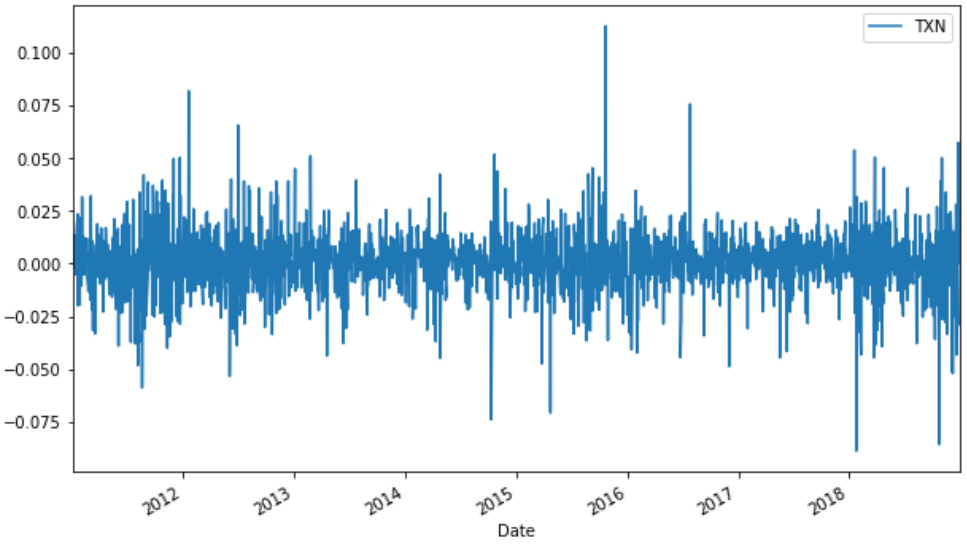

Fig.2 Log returns of past stock prices

In fig.2, we have plotted the log-returns of past stock prices TXN. The above plot shows us that the returns are normally distributed and have a stable mean.

All the calculation of the initial parameters such as Mean(μ), Variance(σ^2), Standard deviation(σ), and drift are calculated from the log of daily returns of the historical dataset.

Brownian motion: Used for calculation of daily returns of the future stock price.

There are two components used for the calculation of the daily returns.

1. **Drift:** The direction rates of return in the past. It is the best approximation of the future prices or expected daily return of the stock.
2. **Volatility:** This is a random variable

$$price\ today = price\ yesturday * e^{r}$$

$$r = \ln\left(\frac{price\ of\ today}{price\ of\ yesturday}\right)$$

$$Random\ variable: \sigma * Z(rand(0;1))$$

$$Z = Number\ of\ the\ standard\ devation\ away\ from\ the\ mean$$

$$drift = \mu - \frac{1}{2}\sigma^2$$

$$Price\ today = Price\ yesterday * e^{\left(\mu - \frac{1}{2}\sigma^2\right) + \sigma * Z(rand(0;1))}$$

We find the daily returns using random normal distribution using the drift and volatility as an input parameter for derived parameter daily returns. After finding the daily return, we set the starting price and create price series generated by random daily returns using the above formula of the price today.

For finding daily returns, the first stock price in the list must be the last one in our data set, which is the stock price on the date 31/12/2018. Moreover, from this point, all future stock predictions will be continued.

We performed a single simulation of potential price series evolution over a trading year (252 days) based on a drawing of random daily returns following a normal distribution, and this gave us a simulation of a year's worth of future daily price data. However, this does not give us much insight into risk and return characteristics of the stock as we have only randomly generated a path. The likelihood of the actual price evolving, as similar to the real data world is very less or almost to zero.

So, then we simulated 10,000 simulations for better accuracy, with each run producing a different series of potential price evolution.

2.3 Validating the Model

The data validation of the Model is carried out by comparing the output of the Monte Carlo simulation with that of the real-world data for the year 2018-2019.

Fig.3 Real-world stock prices for the fiscal year 2018-2019

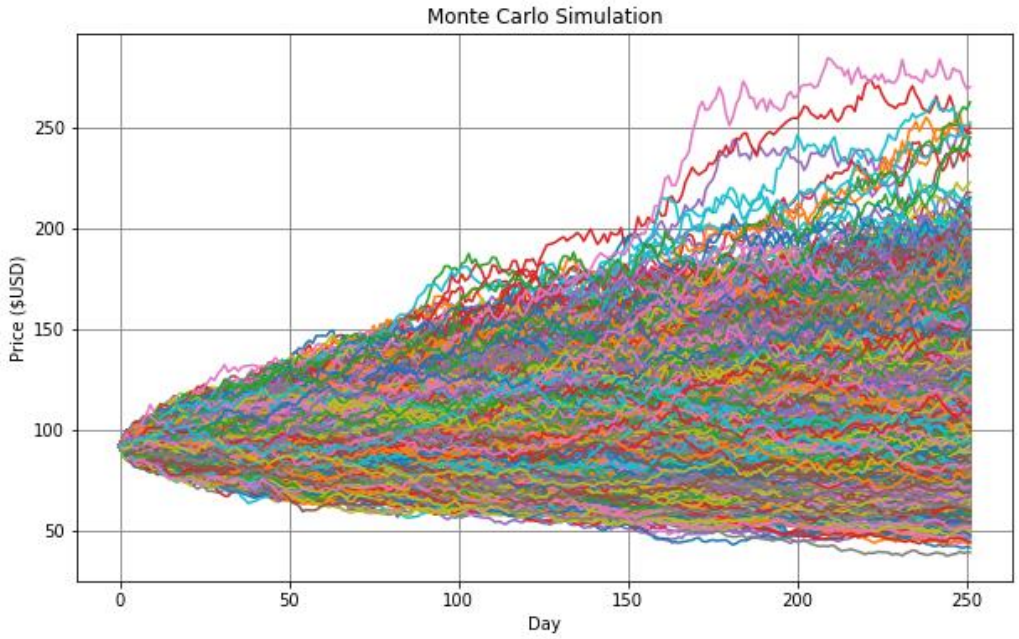

Fig.4 Predicted Stock price with 10,000 Simulations for 2018-2019

Comparisons:

Real-world data

- The all-time high Texas Instruments stock closing price was **131.69** on **October 15, 2019**.
- The Texas Instruments 52-week high stock price is **132.20**, which is **4.4%** above the current share price.

- The Texas Instruments 52-week low stock price is **87.70**, which is **30.7%** below the current share price.
- The average Texas Instruments stock price for the last 52 weeks is **114.19**.

Simulations output

- After the 10,000 simulation runs, the spread of final prices is quite large, ranging from around **$70.20 to $155.24**. Since the spread of the data is quite large and it is challenging to use the data for any conclusions, so we draw the histogram of the Distribution of end simulation prices as opposed to the distribution of regular returns for a particular simulation.
- We now calculate the mean of the distribution to get our expected value, which comes out to be **$107.59**. The real mean is slightly different because these are simulations of random daily return draws.

3. Results and Analysis

3.1 Study and Design Conditions

The objective of the study is to predict the future stock price based on the historical data from the year 2011-2018. Since the system in consideration is random and is affected by many different conditions such as

- Company news and performance
- Industry performance
- Investor Sentiment
- Economic factors

These factors can make the stock price rise or fall depending on the no. of the factors getting affected positively or negatively. The historical data of the stock price gives us the overall changes that occurred in the last decade or year in the company. Moreover, assuming that then there will not be a drastic change in the future stock price due to the mentioned factors and will only vary as much as it was in the past. Assuming all this, we will be able to predict our future Mean stock price as close as possible as to the real data.

3.2 Study Execution and Results

Texas Instruments was selected for simulation of the model since it has overall stable stocks in the past year. It ensured that there would not be any sudden fall if any unstable company was selected. Since the past data trend usually continues in the future and drift and volatility of the stock prices of the past gives us the best approximation of the future stock price. These parameters are most important for any investor while investing. We did the 10,000 simulations of the daily returns for 252 trading days. The more the simulations better will the estimate of the average stock price. Since more simulations were not possible due to the slow nature and simulation and computing power, we limited the simulation no. up to 10,000.

Since we have thousands of paths that predict the stock price of each day in the future. We calculate the quantiles to find out the potential price distribution and get an idea of the likelihood of the very high or very low returns.

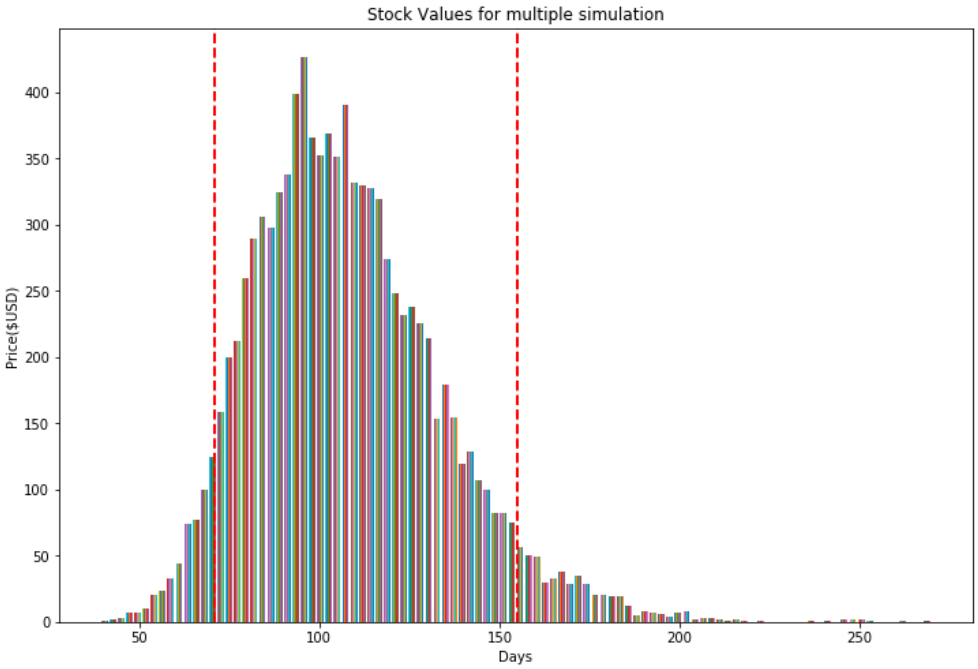

Fig.5 Stock values for multiple simulations

$$The\ average\ stock\ price = \$107.59$$

$$5\%\ quantile = \$70.50$$

$$95\%\ quantile = \$155.21$$

The above histogram tells us that there is a 5% chance that our stock price will end up below around $70.50 and a 5% chance that it will finish above $155.21. Moreover, the average stock price for the year is around $107.59.

4. Discussion and Conclusion

Based on the results of the study, we were able to calculate the average stock price of Texas Instruments for the year 2018-2019. Comparing the two data, the real ($114.19) and simulated resulted ($107.59). The stimulated stock price is within the range of the real average stock price of the Texas Instruments. The highest real stock price is $132.20, and the lowest real stock price is $87.70, which also falls with the range of the simulated results of $70.50-$155.21. The results show us that with enough simulations, we can predict the average and the range of future stock prices with the Monte Carlo simulation.

These simulations are instrumental when one is interested in finding the expected shortfall for a particular stock with a certain degree of confidence. To perform any predictions or risk

management analysis, one should generate as many simulations as possible as it gives better output compared to a few simulations.

The predicted stock price is challenging to match the real-data collected after all these are predictions. Furthermore, buying and selling stock on these predictions involves risk. It becomes much more comfortable for investors to invest in stocks with some information about future data at disposal.

5. Reference

[1] https://www.macrotrends.net/stocks/charts/TXN/texas-instruments/stock-price-history
[2] https://finance.yahoo.com/quote/TXN/history?p=TXN&.tsrc=fin-srch
[3] https://learning.oreilly.com/library/view/python-for-finance/9781492024323/
[4] https://subscription.packtpub.com/book/big_data_and_business_intelligence/9781787125698/12/ch25lvl1sec132/simulation-of-stock-price-movements
[5] https://en.wikipedia.org/wiki/Geometric_Brownian_motion
[6] https://www.geeksforgeeks.org/random-walk-implementation-python/
[7] https://www.investopedia.com/terms/s/stockmarket.asp