ECON106V LAB #3

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Exercise 1: Monte Carlo Simulation

SP500(^GSPC)

Monthly Mean: 0.006447673028

Monthly Standard Deviation: 0.04498489826

NASDAQ(^IXIC)

Monthly Mean: 0.008870881968

Monthly Standard Deviation: 0.05259863719

According to the simulation, the estimate of the standard deviation is more precise. Graphically, it can be seen that the estimates of the standard deviation are clustered together, whereas the estimates of the mean are more spread out. The reason behind it might be because the estimates of the standard deviation of the same data set are roughly the same, hence the estimates of the standard deviation tend to cluster around a certain zone; whereas the estimates of the mean are specific points hence they are more spread out.
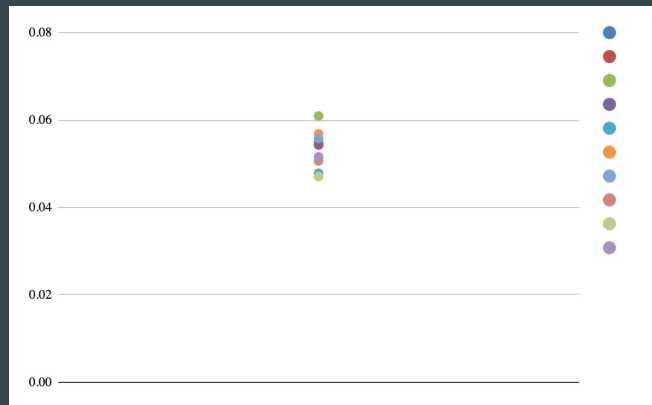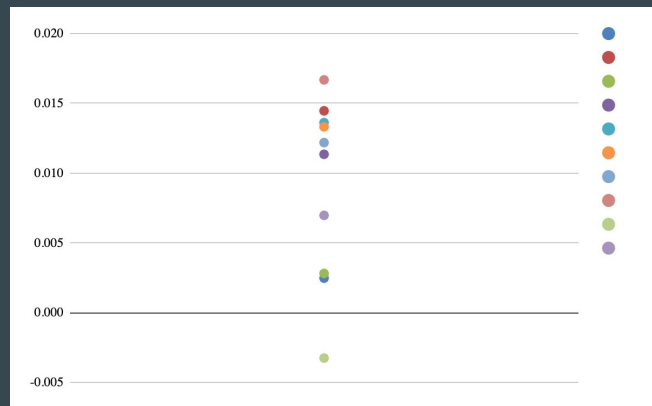
Exercise 2: Volatility, Skewness, and Kurtosis

SP500 Returns	NASDAQ	BTC-USD
Volatility: 0.04383512324	Volatility: 0.05203796071	Volatility: 0.2280098856
Skewness: -0.4113762503	Skewness: -0.2736997277	Skewness: 0.4841093941
Kurtosis: 0.7737557221	Kurtosis: 0.4333548751	Kurtosis: 0.04894074633

If the kurtosis is close to zero, then a normal distribution is often assumed. Since the kurtosis values are all close to zero, it can be assumed that the returns don't have a "fat tail."

A skewness value -0.5 and 0.5 indicates that the distribution is fairly symmetrical, which reinforces the implications of the kurtosis values indicating that the distributions are close to normal. A negative value for the skewness indicates that the distribution is skewed left, and a positive value for the skewness indicates that the distribution is skewed right. ⅔ of the returns (SP500 & NASDAQ) are skewed left, indicating larger positive returns is more likely than larger negative returns. BTC-USD is skewed right, indicating a larger negative return is more likely than a larger positive return. It follows the trend of traditional investments gaining positive returns over time, versus a cryptocurrency having an unpredictable return—which has a high probability of leading into negative returns.

Exercise 3: Stochastic Volatility

Daily Returns

Mean: 0.0004191716048

Standard Deviation: 0.01070327917

Skewness: -0.1658800927

Kurtosis: 262676.0986

According to the measures, the SP500 returns have a fat tail because it has a kurtosis greater than the standard normal kurtosis value. If the kurtosis value is greater than the standard normal kurtosis value, the dataset has heavier tails than a normal distribution. A negative value for the skewness indicates that the distribution is skewed left, indicating larger positive returns is more likely than larger negative returns.

Exercise 3: Stochastic Volatility (Continued)

Scatter Plot of Realized Volatility
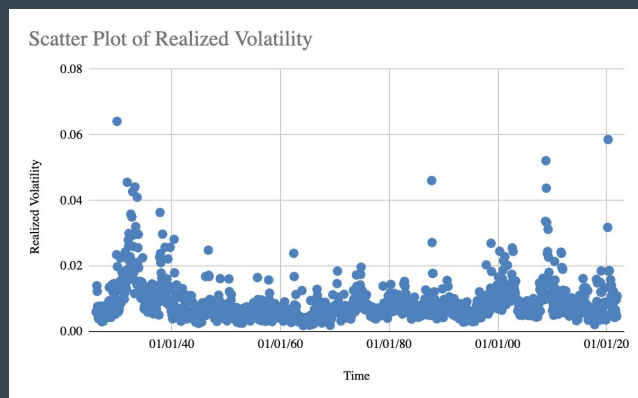
Volatility varies a lot, and far from constant.

The three most recent biggest spikes of volatility occurred during the Dot-com Bubble (1999-2000), Global Financial Crisis (2008-2009), and the COVID-19 pandemic (2020). The dotcom crash was triggered by the rise and fall of technology stocks. The growth of the Internet created a buzz among investors, who were quick to pour money into startup companies. These companies were able to raise enough money to go public without a business plan, product, or track record of profits, which eventually led to the crash. The Global Financial Crisis began with the housing market bubble, created by an overwhelming load of mortgage-backed securities that bundled high-risk loans. Reckless lending led to unprecedented numbers of loans in default; bundled together, the losses led many financial institutions to fail and require a government bailout. The COVID-19 pandemic caused the Stock markets across the world to crash due to a growing instability.

Exercise 3: Stochastic Volatility (Continued)

Scatter Plot of Realized Volatility From 1939 to 1942
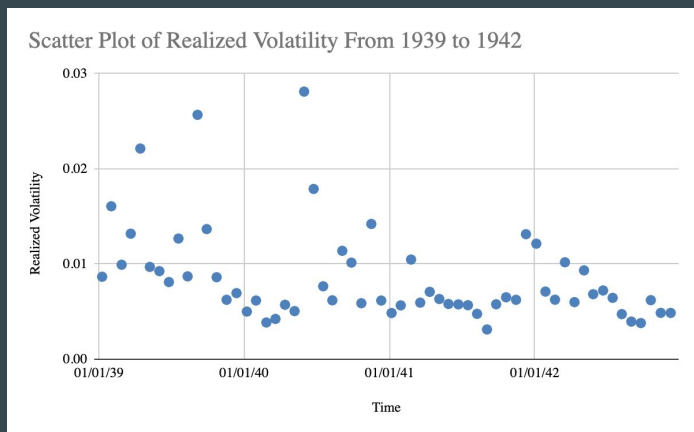
The volatility spikes can be linked to World War II, a period of time when Hitler and the Nazis were causing major trouble throughout the world. Hitler invaded Poland in 1939 and the Battle of Britain occured in 1940. Volatility spikes can be seen in both years. The small spike in volatility on 1941 may be due to the Lend-Lease Act being signed into law. The small spike in volatility on 1942 may be due to U.S. manufacturers adjusting to produce materials for war. Essentially throughout 1939-1942, the volatility was directly affected by events of World War II.

Exercise 3: Stochastic Volatility (Continued)

Correlation between realized volatility: 0.6627185862

Correlation between current return and 20 days earlier: 0.01315661512

Correlation between volatility and return: 0.1241250336

Correlation values range from -1 for a perfectly inverse, or negative, relationship to 1 for a perfectly positive correlation. Correlation values at, or close to, zero indicate no linear relationship or a very weak correlation. Correlation coefficients whose magnitude are between 0.5 and 0.7 indicate variables which can be considered moderately correlated. Correlation coefficients whose magnitude are less than 0.3 have little correlation.

Based on the correlation coefficient, the current realized volatility and the volatility 20 days earlier are moderately correlated, hence the volatility of the past 20 days can be referenced upon to predict the volatility over the next 20 days. However, since it's only moderately correlated, it's not necessarily "easy" to predict the volatility based on the data.

It is most definitely not easy to predict the mean return over the next 20 days based on the returns in the past 20 days. It has a correlation coefficient close to 0, indicating a very weak correlation. Returns are less predictable than volatility. Returns are based on a specific company and industry, whereas volatility is based on the entire economy, hence volatility is easier to predict. The economy has a direct influence on the volatility, so if there is a major shift in the economy, volatility can be expected to shift too. The constant updates (news) on the economy allows volatility to be more predictable than returns as well.

The correlation between volatility and return generally means during periods when volatility in the market is high, returns are lower, and vice versa. However, based on the calculated value, the two variables have little correlation. The general meaning would be consistent with the observations between events of large volatility spikes and low returns. Volatility and return would have little correlation if the company was unaffected by negative economic factors, and instead gain benefits from the negative factors. For example, some companies profited a lot during the COVID-19 pandemic, hence their return increased—the volatility of the general market didn't affect their industry.