Bollinger Bands and Variation

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Rehearsal Participants: All team members + Xinyue Li, Nianyun Liu (TA)

Technology Used: C++, R, Excel

Review: What is a Bollinger Band Strategy?

- Bollinger Bands mark standard deviations above (upper bands) and below (lower bands) a security price using the recent daily closing prices of a security
- If prices move above the upper band, the strategy considers the security overpriced
- If the price moves below the lower band, the strategy considers the security underpriced


See how the price get repelled by the resistance of the upper band
See how the price get repelled by the support of the lower band
See how the price get repelled by the support of the lower band

Why should mean reversion work?

- If prices are normally distributed, 96% of prices should fall within two standard deviations, and 68% within one standard deviation.
- Mean-reversion seeks to exploit these properties by predicting a “correction” back into the normal distribution whenever prices stray from within this range
- Empirical studies show rather that roughly 88% of prices fall within the range of two standard deviations of the Simple Moving Average[1]

Explored Measures of Volatility

Simple Moving Average

- SMA records the average price over a specified length of time, with all prices weighted equally

$$SMA = \frac{p_M + p_{M-1} + \cdots + p_{M-(n-1)}}{n}$$

$$= \frac{1}{n} \sum_{i=0}^{n-1} p_{M-i}$$

Explored Measures of Volatility Continued

Exponential Moving Average (EMA)

- Weights recent prices more heavily by using a discount factor $\alpha \subset (0,1)$.
- Higher values of α discount older prices more rapidly. The most common formula for EMA is

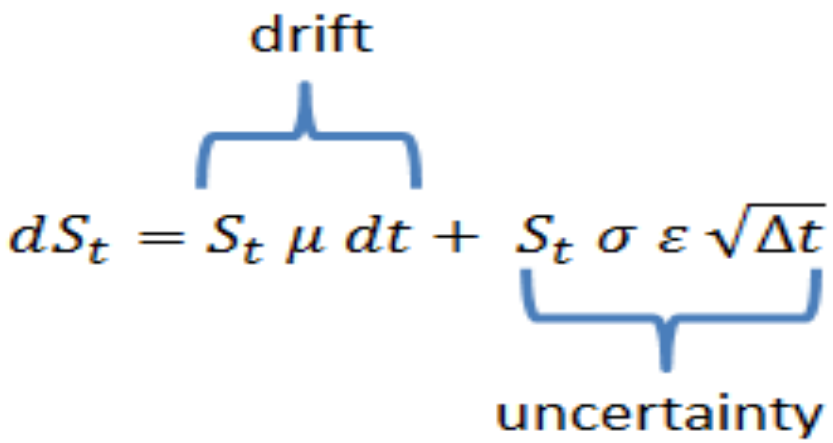
$$EMA = \frac{p_1 + (1-\alpha)p_2 + (1-\alpha)^2 p_3 + (1-\alpha)^3 p_4 + \cdots}{1 + (1-\alpha) + (1-\alpha)^2 + (1-\alpha)^3 + \cdots}$$

Where $\alpha = \frac{2}{N+1}$

Explored Measures of Volatility Continued

Geometric Brownian Motion

- GBM allows our predicted price to account for the upward drift of the S&P 500 over time with a 10% drift coefficient
- SMA and EMA only use historical data to predict the average price. However, we have fair assumptions about the movement of markets and GBM allows us to account for these.



Motivation for Our Analysis

- How well does a traditional Bollinger Band strategy perform over the course of a year?
- Are there ways to improve upon predictors of **price?** For example, in SMA price changes 20 days ago carry the same weight as price changes yesterday.
- Evidence suggests prices are serially correlated, meaning recent stock prices are better predictors than earlier prices.[2]

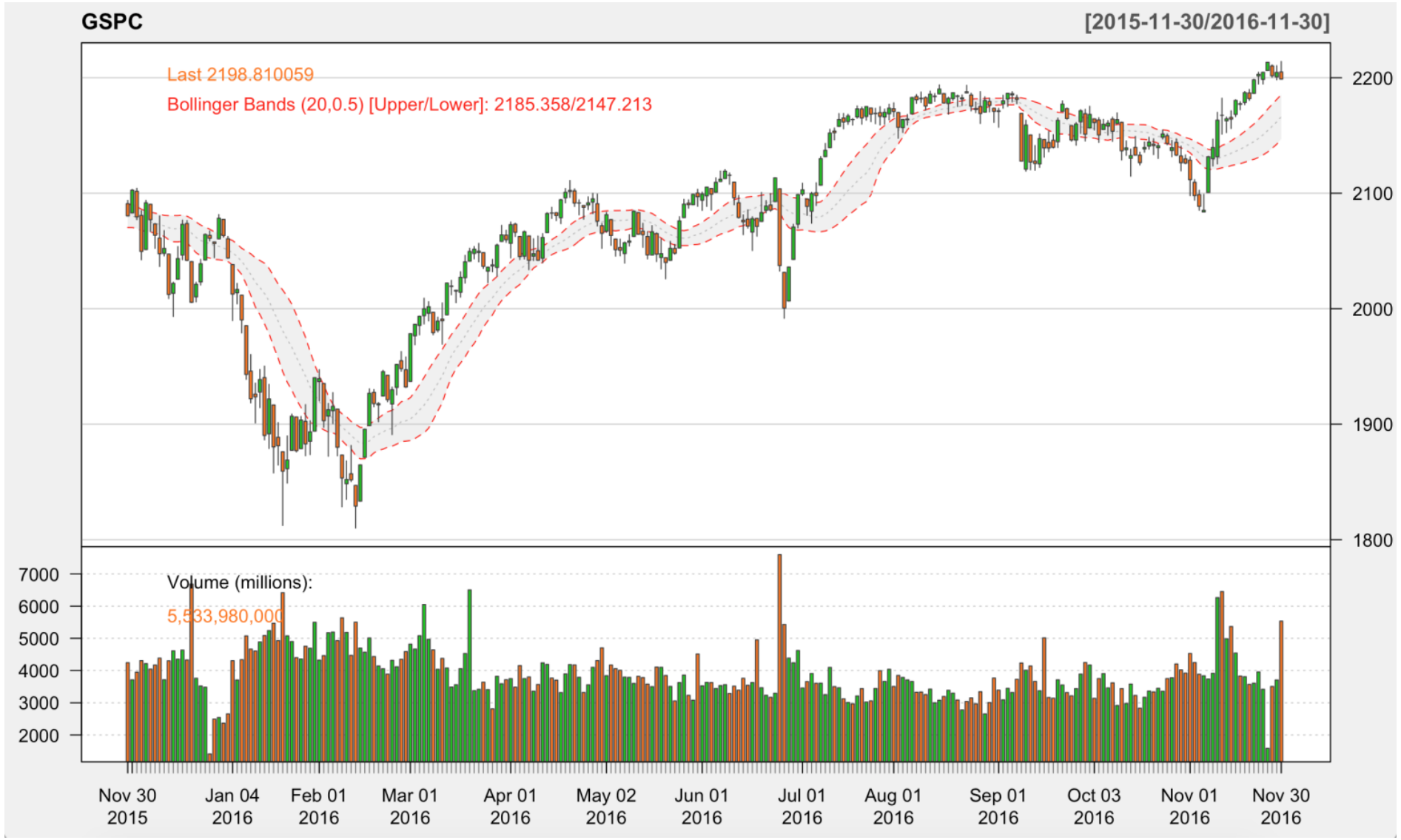
Methodology

Our team decided to explore three different methods to calculate the size of Bollinger Bands.

- Simple Moving Average, Exponential Moving Average, and a Geometric Brownian Motion model
- We then used these measures to simulate Bollinger Band trading strategies on the S&P 500 from December 2015 to December 2016
- From these results, we draw conclusions on the effectiveness of these measures to predict future security prices

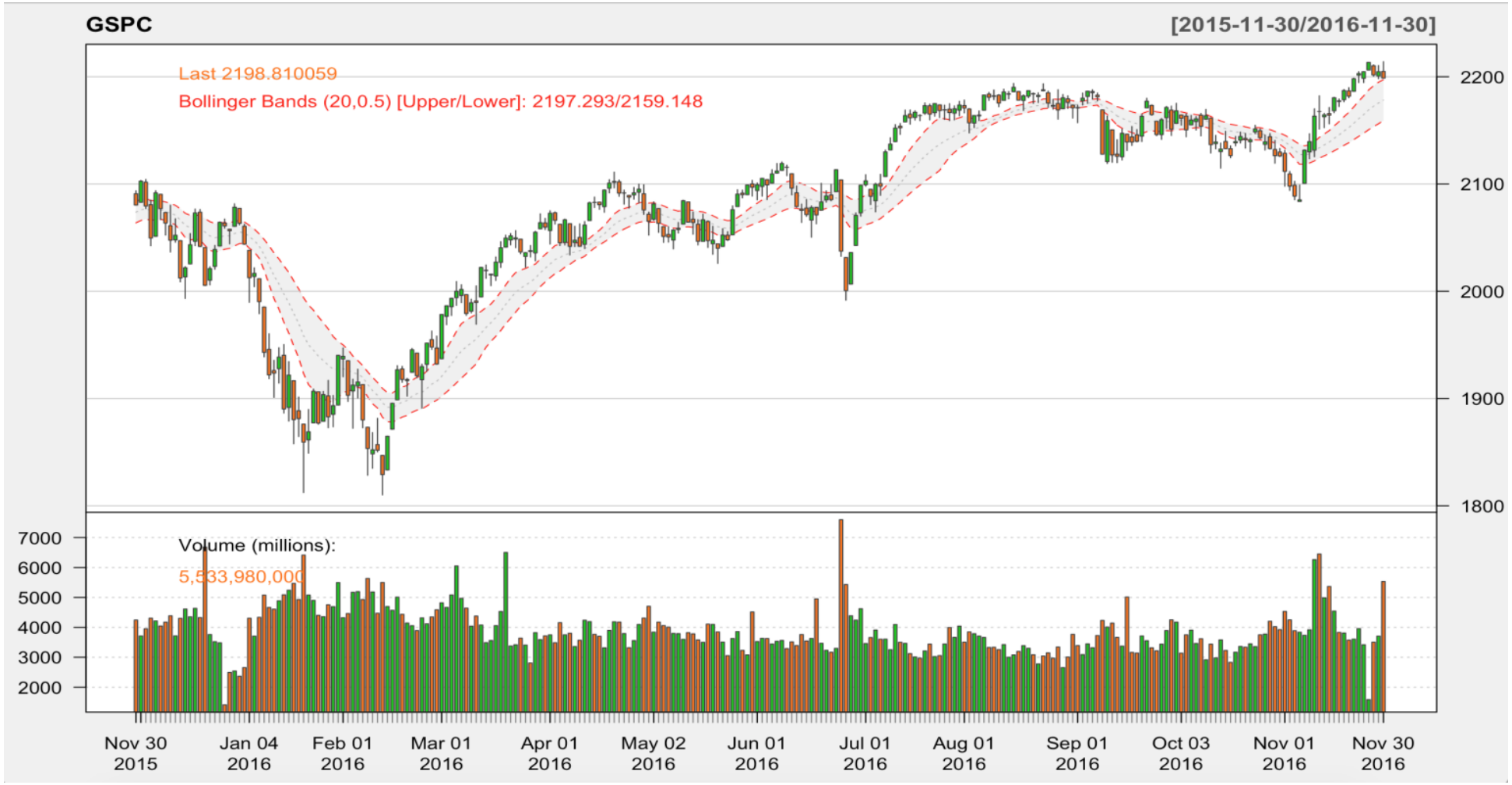
Results: Simple Moving Average

Number of trades: 21 Performance: 9.07%



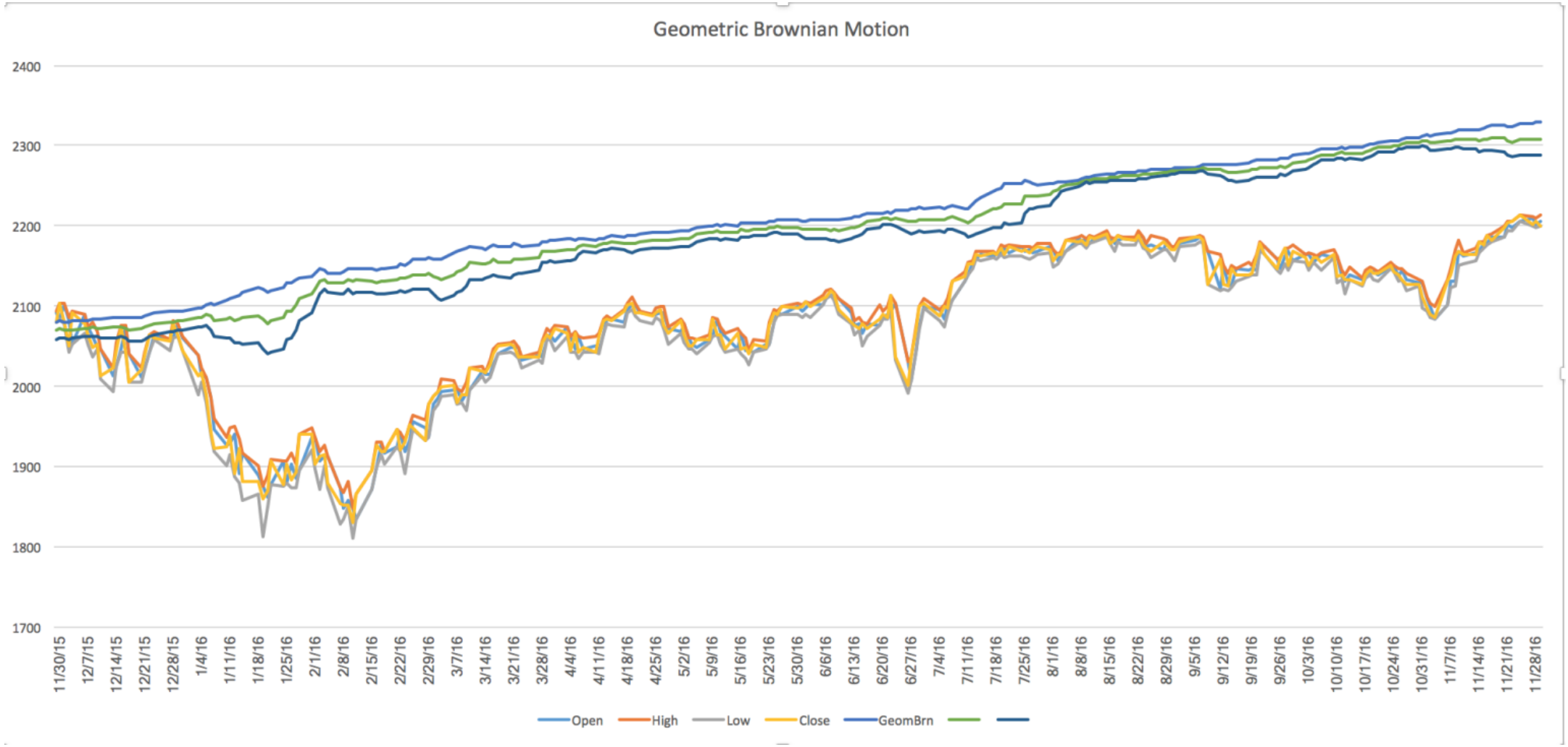
Results: Exponential Moving Average

Number of Trades: 21 Performance: 9.04%

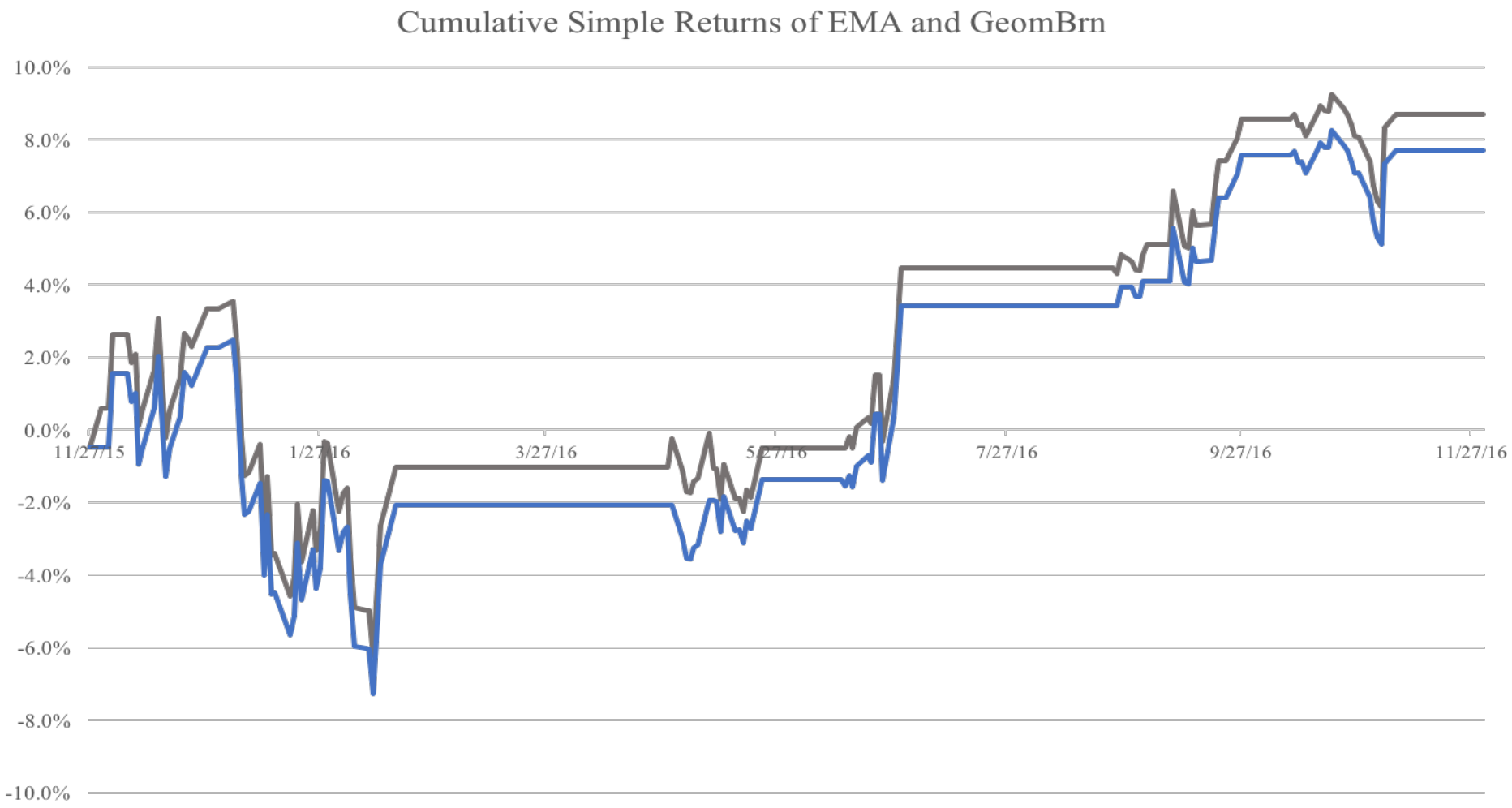


Results: Geometric Brownian Motion

Number of Trades: 25 Performance: 8.04 %



Result Comparison



Summary of Statistics

Parameters	20-Day MA	20-Day EMA	GeomBrn
95% VaR	-1.88%	-1.88%	-1.88%
CVaR	-2.14%	-2.14%	-2.14%
Sharpe Ratio	0.7369	0.7369	0.6537
Drawdown	-6.22%	-6.22%	-7.28%
Skewness	-0.1972	-0.1972	-0.1841
Kurtosis	-0.0851	-0.0851	-0.1105

Works Cited

1. Adam Grimes (2012). *The Art & Science of Technical Analysis: Market Structure, Price Action & Trading Strategies*. John Wiley & Sons. pp. 196–198.
2. Poterba, James M., and Lawrence H. Summers. "Mean reversion in stock prices: Evidence and implications." *Journal of financial economics* 22.1 (1988): 27-59.