# Comparison of Slope Estimation Methods: Brown vs. LogNormal

This analysis was conducted using ChatGPT to compare the performance of two slope estimation methods over a simulated log-normal stock price process: Brown's double exponential smoothing and LogNormal parameter estimation.

A screenshot of a computer

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## Simulation Setup

- 500 simulations of a log-normal price process  
- 20 daily samples per simulation  
- True daily drift: 0.001 (0.1%)  
- True daily volatility: 0.02 (2%)  
- Brown smoothing factor: alpha = 0.3

## Methods Compared

1. Brown Double Exponential Filter:  
 - Tracks short-term trend (slope)  
 - Adaptively estimates slope using smoothed values

2. LogNormal Parameter Estimation:  
 - Estimates drift using: μ\_drift = mean(log(prices)) + 0.5 \* std(log(prices))²  
 - Designed for long-term modeling

## Results Summary

The histogram below compares the distribution of estimated daily slope from both methods.

- Brown Estimation: Centered tightly around the true drift with low variance.  
- LogNormal Estimation: Slightly biased and more variable over short samples.  
- Conclusion: Brown's method is more effective for short-term slope detection.

This analysis confirms that Brown's smoothing is more suitable for local trend estimation in short time windows (e.g., 20 days), while log-normal fitting is better reserved for longer-term parameter estimation.

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## Additional Observations

Upon visual inspection of the histogram comparing the two methods, we observe the following:

- The Brown estimator is more tightly centered around the true drift value (0.001) and provides an unbiased estimate of the short-term slope.  
- The LogNormal estimator shows a slight leftward bias but appears to have slightly less dispersion (narrower spread) in the region near its peak.  
- This apparent tightness arises because the LogNormal method performs a global statistical fit over the sample window, which can underrepresent sample-to-sample variability.  
- In contrast, Brown’s method reacts dynamically to local changes and noise, which can cause more variation between simulations but reflects true momentum shifts more accurately.  
- Therefore, for detecting short-term momentum or directional changes, the Brown double exponential smoothing remains superior despite slightly greater variance.

The histogram illustrating these observations is included below for reference.



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