Pricing Energy Derivatives: An Exploration with the Schwartz-Smith Model

Vittorio Balestrieri

.

Abstract

This paper delves into the application of the Schwartz-Smith model to price energy derivatives, with a specific focus on Asian and American options. The volatile nature of energy markets necessitates sophisticated financial instruments for risk management and speculative purposes. By incorporating mean reversion and stochastic volatility—characteristic features of energy commodities—the Schwartz-Smith model provides a nuanced approach to derivative pricing. Through Monte Carlo simulations, this study evaluates the model's effectiveness in pricing derivatives, highlighting the impact of key parameters on pricing outcomes and offering insights into model adaptability across different option types.

1 Introduction

Energy markets play a pivotal role in the global economy, influenced by a myriad of factors including geopolitical events, regulatory changes, and technological advancements. Derivatives in these markets serve as essential tools for managing price risk and speculation. The complexity of these markets demands robust modeling techniques capable of capturing their unique dynamics. The Schwartz-Smith model, renowned for its ability to model mean reversion and stochastic volatility, is explored in this paper for its application in pricing energy derivatives, specifically Asian and American options.

2 Literature Review

A brief overview of existing literature underscores the evolution of commodity pricing models, culminating in the development of the Schwartz-Smith model. Key studies by Schwartz (1997) and Smith (2005) laid the groundwork for understanding commodity price behaviors, emphasizing the need for models that account for mean reversion and stochastic volatility. Further contributions by Longstaff and Schwartz (2001) introduced practical approaches for American option pricing, paving the way for this study's methodology.

3 Methodology

3.1 Model Parameters and Simulation

The study employs a Monte Carlo simulation approach, guided by carefully selected model parameters to simulate energy spot prices. The parameters, including initial spot price (S_0), long-term mean price (μ), and volatility (σ), are calibrated to reflect realistic market conditions.

3.2 Option Pricing Techniques

The pricing of Asian and American options is conducted through simulations. The Asian option, with its payoff dependent on the average spot price, and the American option, featuring early exercise flexibility, are evaluated to demonstrate the model's versatility.

4 Results

Simulated pricing outcomes reveal the sensitivity of option prices to model parameters. Adjustments to volatility and strike price parameters yield more realistic pricing for Asian options, illustrating the model's adaptability. The American option pricing, facilitated by the Least Squares Monte Carlo method, further exemplifies the model's robustness.

5 Discussion

The findings illuminate the critical role of parameter selection in derivative pricing and underscore the Schwartz-Smith model's efficacy in capturing the complex dynamics of energy markets. The study also identifies potential areas for model refinement, including enhanced parameter calibration techniques and exploration of model extensions to encompass a broader range of derivative products.

6 Conclusion

This comprehensive analysis affirms the Schwartz-Smith model as a potent tool for pricing energy derivatives, adept at navigating the intricacies of volatile energy markets. Future research directions include the integration of real-world market data for model calibration and the examination of the model's applicability to emerging energy commodities.

References

1. Schwartz, E. S. (1997). The stochastic behavior of commodity prices: Implications for valuation and hedging. *The Journal of Finance*, 52(3), 923-973.

2. Smith, J. E. (2005). Alternative approaches for solving real-option problems. *Decision Analysis*, 2(2), 89-102.

3. Longstaff, F. A., & Schwartz, E. S. (2001). Valuing American options by simulation: A simple least-squares approach. *The Review of Financial Studies*, 14(1), 113-147.