Using the Sinc-Sandwich Estimator to Estimate Real Options Prices

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Abstract

In this paper, we introduce the Sinc-Sandwich estimator, a robust Bayesian estimation technique that leverages the interpolation properties of the Sinc function and the bounding guarantees of the Sandwich Theorem. We demonstrate its application to real options pricing, highlighting its advantages in handling model misspecification and uncertainty. Vector graphics are used to illustrate the estimator's mechanics and its impact on real options valuation.

The paper ends with "The End"

1 Introduction

Real options analysis extends financial option pricing techniques to investment decisions in real assets, capturing the value of managerial flexibility under uncertainty. Traditional models, such as Black-Scholes and binomial trees, often rely on strong assumptions and can be sensitive to model misspecification. Bayesian estimation offers a principled framework for incorporating uncertainty, but standard approaches may still be vulnerable to misspecification and computational challenges.

In this article, we present the **Sinc-Sandwich estimator**, which combines the Sinc function's optimal kernel properties with the bounding power of the Sandwich Theorem. This approach yields robust Bayesian estimators with improved convergence and variance properties, making it particularly suitable for real options pricing in complex, uncertain environments.

2 Background

2.1 Bayesian Estimation

Bayesian estimation treats parameters as random variables, updating their distributions via Bayes' theorem:

$$P(\theta|y) = \frac{P(y|\theta)P(\theta)}{P(y)}$$

where $P(\theta)$ is the prior, $P(y|\theta)$ is the likelihood, and $P(\theta|y)$ is the posterior [2].

2.2 The Sandwich Theorem

The Sandwich (Squeeze) Theorem states that if $g(x) \leq f(x) \leq h(x)$ for all x near a, and $\lim_{x\to a} g(x) = \lim_{x\to a} h(x) = L$, then $\lim_{x\to a} f(x) = L$ [1]. In estimation, this theorem is used to prove convergence by bounding estimators between two functions with known limits.

2.3 The Sinc Function

The Sinc function is defined as:

$$\operatorname{sinc}(x) = \begin{cases} 1 & \text{if } x = 0, \\ \frac{\sin(\pi x)}{\pi x} & \text{if } x \neq 0. \end{cases} \tag{1}$$

It is widely used as an interpolation kernel in signal processing and nonparametric density estimation due to its minimal mean integrated squared error [3].

3 The Sinc-Sandwich Estimator

The Sinc-Sandwich estimator integrates the Sinc function's kernel properties with the bounding guarantees of the Sandwich Theorem. This combination enables the construction of Bayesian estimators that are robust to model deviations and efficient in terms of variance, even under model misspecification [1].

3.1 Estimator Construction

Given observed data y and parameter θ, the Sinc-Sandwich estimator $\hat{\theta}_{SS}$ is constructed as:

$$\hat{\theta}_{SS} = \int \theta \cdot K_{\text{sinc}}(y, \theta)\, d\theta$$

where K_{sinc} is a Sinc-based kernel. The estimator is bounded above and below by functions whose limits are known, ensuring convergence via the Sandwich Theorem.

3.2 Advantages

- **Robustness:** Handles model misspecification effectively.
- **Efficiency:** Achieves low variance due to the optimality of the Sinc kernel.
- **Applicability:** Suitable for hierarchical models and time series, common in financial contexts.

4 Application to Real Options Pricing

Real options pricing involves valuing the flexibility to make investment decisions under uncertainty, such as the option to defer, expand, or abandon a project. Traditional models (e.g., Black-Scholes, binomial trees) may not adequately capture uncertainty or model risk.

The Sinc-Sandwich estimator can be applied to estimate the value of real options by:

1. Modeling the underlying asset (project value) dynamics.
2. Using the Sinc kernel to estimate the posterior distribution of option value.
3. Applying the Sandwich Theorem to ensure estimator convergence and robustness.

4.1 Illustrative Example: Sinc-Sandwich Estimator in Action

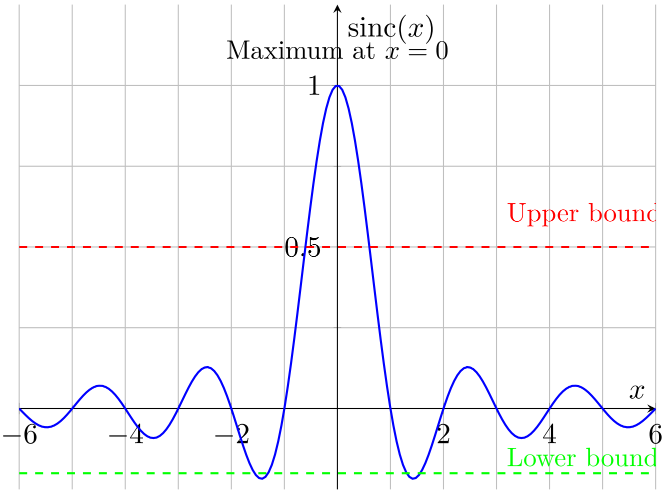

Figure 1: The Sinc function as a kernel, with bounding functions (Sandwich Theorem) ensuring estimator convergence.

4.2 Vector Field: Sinc-Sandwich Estimator's Effect on Option Value Surface

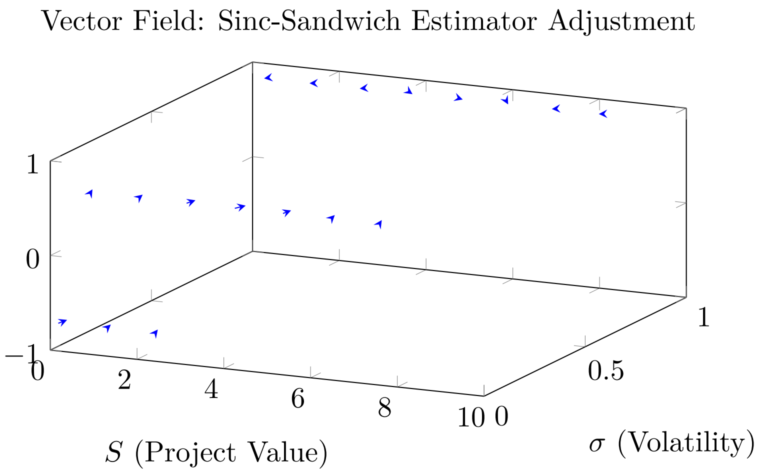

Figure 2: Vector field illustrating the adjustment of option value estimates by the Sinc-Sandwich estimator across project value (S) and volatility (σ).

5 Discussion

The Sinc-Sandwich estimator provides a principled, robust approach to real options pricing, particularly valuable when traditional models are prone to misspecification. Its kernel-based construction ensures efficient use of data, while the Sandwich Theorem guarantees convergence and robustness.

6 Conclusion

By integrating the Sinc function and the Sandwich Theorem, the Sinc-Sandwich estimator offers a powerful tool for real options valuation under uncertainty. Its robustness and efficiency make it a promising approach for practitioners and researchers in finance and economics.

References

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