Nonstandard Finite Difference Methods Applied to Financial Problems

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2024

Summary:

This thesis explores the application of Nonstandard Finite Difference (NSFD) methods to financial problems, particularly in the pricing of European and Asian options. It begins by reviewing the fundamental concepts in financial markets and explores the limitations of traditional numerical methods, such as the centered-in-space and upwind finite difference schemes, which often face challenges in stability and accuracy under convection-dominated conditions characterized by high Péclet numbers.

NSFD methods are presented as a powerful alternative, designed to preserve the qualitative properties of the underlying partial differential equations, such as positivity, stability, and monotonicity. The effectiveness of NSFD methods is demonstrated through numerical experiments, where they overcome standard methods in solving convection-diffusion equations and pricing options with non-smooth payoff structures. These results confirm that NSFD schemes reduce numerical dissipation and convection errors while maintaining solution positivity and stability.

The thesis concludes that NSFD methods offer significant advantages in financial modeling.