Partial Differential Equations in Finance

Your Name

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Overview of Topics

- Charting theory and nature of boundary and initial conditions
- Explicit solutions, including original Black-Scholes formula
- Special problems arising when there are free boundaries

Key Questions in Financial PDEs

- Physical interpretation of the equations?
- Mathematical properties of the solution?
- Techniques for obtaining explicit solutions?

PDEs in finance:

- Fundamental equations (e.g., Black-Scholes)
- Linear vs. nonlinear problems

Considerations for PDEs in Finance

1. Does the equation make sense as a well-posed problem?
   - Appropriate boundary or initial/final conditions?
   - Nature of the mathematical problem?
   - Smooth or discontinuous solutions?
2. Can we develop analytical tools to solve the equation?
3. How should we solve the equation numerically if necessary?

Fundamental Approach

Analytical vs. Numerical Solutions

- Seek explicit solutions when possible (e.g., Black-Scholes formula)
- Understand limitations of analytical methods
- Develop numerical methods for more complex cases

Special Challenges

Free boundary problems require particular attention in financial applications