A Note on Black-Scholes Pricing Model for Theoretical Values of Stock Options

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Abstract. In this paper, we consider some conditions that transform the classical Black-Scholes Model for stock options valuation from its partial differential equation (PDE) form to an equivalent ordinary differential equation (ODE) form. In addition, we propose a relatively new semi-analytical method for the solution of the transformed Black-Scholes model. The obtained solutions via this method can be used to find the theoretical values of the stock options in relation to their fair prices. In considering the reliability and efficiency of the models, we test some cases and the results are in good agreement with the exact solution.

INTRODUCTION

Black-Scholes model is a fundamental tool for option valuation in financial mathematics [1]. Options play important roles in pricing theory, since they can be used for instance, to hedge asset and portfolios for the purpose of risk control, due to the movement of stock prices. This has been a great concern in finance, actuarial sciences, and other areas of applied sciences [2-4]. In recent years, many researchers have used various methods and approaches to find numerical and analytical solutions of the Black-Scholes pricing model [5-13]. The method of [14] can also be applied.

The Black-Scholes model with its assumptions has been considered by many researchers for various reasons, leading to some modifications [15-18].

In this work, the transformed form of the Black-Scholes model via some conditions is presented[19] and we give a proposition regarding the exact solution, and also, for reliability and efficiency, we propose a relatively new semi-analytical method for its numerical and exact solutions.

ANALYSIS OF DIFFERENTIAL TRANSFORMATION TECHNIQUE

Consider an arbitrary one dimensional function \(w(x)\) whose differential transform is defined as:

\[
W(k) = \frac{1}{k!} \left[ \frac{d^k w(x)}{dx^k} \right]_{x=0}
\]  

(1)

The Taylor series about a point \(x = 0\) is given as:

\[
w(k) = \sum_{k=0}^{\infty} \frac{x^k}{k!} \left[ \frac{d^k w(x)}{dx^k} \right]_{x=0}
\]  

(2)

The inverse differential transform is expressed as:

\[
w(x) = \sum_{k=0}^{\infty} x^k W(k)
\]  

(3)

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