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Polynomial stability of exact solution and a numerical method for stochastic differential equations with time-dependent delay *

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Abstract

We consider a stochastic differential equations with time-dependent delay in this paper. We first obtain the existence, uniqueness and polynomial stability of exact solution to this equation under suitable conditions. Then for the numerical method of the corresponding SDDE, we present a so called modified truncated Euler-Maruyama(MTEM) method and consider the almost sure and mean square polynomial stability of this numerical method. By using the well known discrete semimartingale convergence theorem, sufficient conditions are obtained for both bounded and unbounded delay δ to ensure the polynomial stability of the corresponding numerical approximation. Results suggest that the MTEM method replicates the polynomial stability of given SDDE under suitable conditions. Examples are presented to illustrate the conclusion.

MSC 2010: 60H10, 65C30.

Key words: SDEs with time-dependent delay, non explosion, MTEM method, almost sure polynomial stability, mean square polynomial stability.

1 Introduction

Asymptotic stability of stochastic differential delay equations has attracted more and more attention in recent years, see Kloden and Platen[5], Liu and Chen [10], Mao [13]. Since the exact solution is usually difficult to obtain, properties of the corresponding numerical simulations become more and more hot topics. There are plenty of papers devoted to the exponential stability of the different types of numerical solutions. For example, in 2010, Wu, Mao and Szpruch [20] considered the almost sure exponential stability of Euler and backward Euler methods for stochastic delay differential equations, Cao and Zhang [1] investigated exponential mean-square stability of two-step Maruyama methods for stochastic delay differential equations, [19] studied delay-dependent exponential stability of the backward Euler method for nonlinear stochastic delay differential equations. Recently, Lan [6]

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