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Pricing European vanilla options under a jump-to-default threshold diffusion model

Yiming Jiang,[1] Shiyu Song,[2†] and Yongjin Wang[3]

Abstract

In this paper, we study option prices under a feasible threshold diffusion model subject to jump-to-default risk where the default intensity takes a negative power of the underlying stock price. The model incorporates the regime switches endogenously by assuming the volatility to shift from one regime to another when the stock price crosses the pre-specified threshold level. This threshold can be understood as the psychological price barrier. Using the probabilistic approach, we obtain the Laplace-transform-based analytical solutions to the pricing problem of European vanilla options. Numerical analysis in the end examines the option-related quantities using the derived results and shows the impact of jump-to-default risk and threshold effect.

Key Words: Option pricing; Jump-to-default risk; Threshold effect; Laplace transform; Green's function; First hitting time.

2010 Mathematics Subject Classification: 60G07; 91G20.

1. Introduction

The jump-to-default pricing model has prevailed in the field of financial derivative pricing over the past decade, since it consists with the existing empirical evidence on the linkage between default risk and equity prices, and thus unifies the valuation of credit derivatives and equity derivatives. Allowing for the possibility of default by the issuer of the stock, the critical point of such models is to incorporate default intensities into the price dynamics of the underlying prior to default, for the purpose of insuring the expected rate of return equal to the risk-free interest rate in the risk-neutral economy. We mention some representative works include the jump-to-default extended CEV model in Carr and Linetsky (2006) and Mendoza-Arriaga and Linetsky (2011), the jump-to-default extended geometric Brownian motion model in Linetsky (2006), the jump-to-default exponential Lévy model in Yamazaki (2013), and the jump-to-default time-changed Markov model in Hurd (2009) and Mendoza-Arriaga, Carr and Linetsky (2010).

[1]School of Mathematical Sciences, Nankai University, Tianjin 300071, P.R. China.
[2†]Corresponding author. School of Mathematics, Tianjin University, Tianjin 300354, P.R. China.
Email:shiyu.song@tju.edu.cn
[3]School of Business, Nankai University, Tianjin 300071, P.R. China.