Abstract and Figures

In this paper, we consider a new corporate bond-pricing model with credit-rating migration risks and a stochastic interest rate. In the new model, the criterion for rating change is based on a predetermined ratio of the corporation's total asset and debt. Moreover, the rating changes are allowed to happen a finite number of times during the life-span of the bond. The volatility of a corporate bond price may have a jump when a credit rating for the bond is changed. Moreover, the volatility of the bond is also assumed to depend on the interest rate. This new model improves the previous existing bond models in which the rating change is only allowed to occur once with an interest-dependent volatility or multi-ratings with constant interest rate. By using a Feynman-Kac formula, we obtain a free boundary problem. Global existence and uniqueness are established when the interest rate follows a Vasicek's stochastic process. Calibration of the model parameters and some numerical calculations are shown.

Bond-Value Function Φ vs....

. The values, credit ratings,...

Multi Migration Free Surfaces.

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On a New Corporate Bond Pricing Model with Potential Credit Rating Change and Stochastic Interest Rate

Hong-Ming Yin [1,*], Jin Liang [2] and Yuan Wu [3]

[1] Department of Mathematics and Statistics, Washington State University, Pullman, WA 99164, USA
[2] Department of Mathematics, Tongji University, Shanghai 200092, China; liang_jin@Tongji.edu.cn
[3] School of Statistics and Mathematics, Shanghai Lixin University of Accounting and Finance, Shanghai 201209, China; wuyuan@lixin.edu.cn
* Correspondence: hyin@wsu.edu

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Abstract: In this paper, we consider a new corporate bond-pricing model with credit-rating migration risks and a stochastic interest rate. In the new model, the criterion for rating change is based on a predetermined ratio of the corporation's total asset and debt. Moreover, the rating changes are allowed to happen a finite number of times during the life-span of the bond. The volatility of a corporate bond price may have a jump when a credit rating for the bond is changed. Moreover, the volatility of the bond is also assumed to depend on the interest rate. This new model improves the previous existing bond models in which the rating change is only allowed to occur once with an interest-dependent volatility or multi-ratings with constant interest rate. By using a Feynman-Kac formula, we obtain a free boundary problem. Global existence and uniqueness are established when the interest rate follows a Vasicek's stochastic process. Calibration of the model parameters and some numerical calculations are shown.

Keywords: corporate bond-pricing model; multi credit rating migration; jump volatility; stochastic interest rate

1. Introduction

The study for bond-pricing models is always an attractive topic in financial research fields,

as bonds and their derivatives are the largest capital markets in the financial industry Richelson and Richelson (2011). For a for-profit corporation, the price of a bond plays an essential role in determining the valuation of the corporation. This is particularly true for a corporation that requires a large capital such as corporations in mining industry. One of those examples is a corporation conducting crude-oil exploration and production. A corporation's financial stress very much depends on the bond price of the corporation. It is a challenge in the financial markets to develop a comprehensive and dynamic bond-pricing model when an interest rate is uncertain.

There are two important factors that affect a bond price for a corporation. The first is the credit rating given by various rating agencies, which apply on their own measures. The second is the interest rate. For a long time, credit risks were mainly considered default risks, while credit-rating migration risks were usually neglected. After the financial crisis in 2008 and late the European sovereign debt crisis, researchers and bond traders realized the importance of credit-rating migration. One of the main factors for a dramatic change of a bond price is the credit-rating migration including default (see, for examples, Elton et al. (2001); Bessembinder et al. (2018)). The inflection and the liquidity risks in a corporate bond model are the other important factors (see, for examples, Kariya et al. (2016) and Kang and Pflueger (2015)). We would like to point out that the tax is another important factor in bond modelling (see, for example, Kenneth et al. (2018)). However, we will not consider this factor in this paper.

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Citations (12) References (31)

... Wang et al. [32] presented some theoretical results by showing that the asymptotic traveling wave solution obtained in Liang et al. [21] persists in the free boundary problem with multiple free boundaries. By considering stochastic interest rate in reality [19,24,29], Yin et al. [37] improved the model by replacing the constant interest rate with a stochastic version. This improved model covers the previous works where only two credit ratings are involved with an interest-dependent volatility [22] or multiple credit ratings migration with constant interest rate [32,34]. ...

... Hence, motivated by these existing works on the effect of credit rating migration risk when valuating a corporate bond, in this paper, we devote to studying a pricing model for a defaultable corporate bond with both multiple credit rating migration risk and stochastic interest rate. Our work extends the existing works [12, 37] , where the multiplicity of credit rating and stochasticity of interest rate are involved in their models, by inserting the default risk. Meanwhile, we improve the results of Wu et al. [35], who considered default risk in pricing the corporate bond with only one credit rating migration boundary and constant interest rate, to fit the effects of multiple credit ratings and stochastic interest rate. ...

Free boundary problem pricing defaultable corporate bonds with multiple credit rating migration risk and stochastic interest rate

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... We also help add to a burgeoning literature that focuses on the pricing of corporate bonds (Bai et al. 2019;Goldberg and Nozawa 2021;Goldstein et al. 2019;Lin et al. 2020; Yin et al. 2018) , and on the effects of corporate events on bondholders (Fang-Klingler 2019), or on the joint reaction of all stakeholders (Back and Crotty 2014;Kapadia and Pu 2012). This literature has expanded following the advent of the TRACE bond price reporting system that began in 2004 and the seminal papers by Bessembinder et al. (2006) and Bessembinder et al. (2009) which described the best ways to make use of the new data. ...

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... Later, Fu, Chen, and Liang [16] provided more mathematical analysis and detailed description of the free migration boundary. More extension of this model is considered in [30, 42, 39,40]. Recently, Chen and Liang [8] also considered the case where upgrade and downgrade boundaries are different. ...

Double free boundary problem for defaultable corporate bond with credit rating migration risks and their asymptotic behaviors

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... Corporate liabilities have been widely priced under the framework of stochastic DEs (Eissa and Elsayed, 2022; Yin et al., 2018; Black and Scholes, 1973). Black and Scholes (1973) illustrated how the B-S model can be used in the pricing of corporate liabilities. ...

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... Further, Hu et al 5 turned to considering the liability-asset ratio as a driving factor for the credit rating migration and deduced the migration boundary as a free boundary. With further research, the extensions of the structural model to more general cases are discussed and more theoretical and empirical results are obtained (see previous works [6] [7] [8] [9][10]. ...

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... Subsequently, Liang et al. [22] incorporated a risk discount factor, which measures the sensibility of credit rating migration to the proportion of the debt and asset value, into the model and showed a profile of an asymptotic traveling wave exists in the free boundary problem. Liang et al. [42] and Yin et al. [43] considered the situations of the time-varying risk-free interest rate [44,45]. Wu and Liang [46] provided some numerical results for multiple credit rating migration problems. ...

mathematics Utility Indifference Valuation for Defaultable Corporate Bond with Credit Rating Migration

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... The authors further demonstrate that the GZ index contains valuable information for future corporate bond returns over and beyond that embedded in macroeconomic and policy uncertainty variables. Yin et al. (2018) proposes a new corporate bond pricing model including both credit rating migration risks and stochastic interest rates. Unlike existing bond models, in which credit rating change is only allowed to occur once with an interest dependent volatility or multiple rating changes with constant interest rate, this model allows volatility to depend on both interest rates and credit rating changes, which can happen multiple times during the life of a bond and are only determined by the issuer's debt-to-asset ratio. ...

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