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Credit gap risk in a first passage time model with jumps

Natalie Packham, Lutz Schloegl & Wolfgang M. Schmidt

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Abstract

The payoff of many credit derivatives depends on the level of credit spreads. In particular, credit derivatives with a leverage component are subject to gap risk, a risk associated with the occurrence of jumps in the underlying credit default swap spreads. In the framework of first passage time models, we consider a model that addresses these issues. The principal idea is to model a credit quality process as an Itô integral with respect to a Brownian motion with a stochastic volatility. Using a representation of the credit quality process as a time-changed Brownian motion, one can derive formulas for conditional default probabilities and credit spreads. An example for a stochastic volatility process is the square root of a Lévy-driven Ornstein–Uhlenbeck process. The model can be implemented efficiently using a technique called Panjer recursion. Calibration to a wide range of dynamics is supported. We illustrate the effectiveness of the model by valuing a leveraged credit-linked note.

Keywords:

Gap risk
Credit spreads
Credit dynamics
First passage time models
Stochastic volatility
General Ornstein–Uhlenbeck processes

JEL Classification:

G13
C69

Notes

[1]Since 2009, following an initiative of the International Swaps and Derivatives Association to facilitate netting, credit default swaps are nowadays entered into with standardised premiums of 25, 100, 500 or 1000 basis points. As a consequence, entering into a CDS normally requires an upfront premium to be paid. In the analysis of our model, we neglect the changes in market quoting conventions, since the qualitative results on the spread dynamics are not affected.

[2]The term credit spread also refers to the yield spread, which is the yield difference of defaultable and default-free zero-coupon bonds of the same maturity. There are some subtle differences between yield spreads and CDS spreads, mainly due to factors such as liquidity of the underlying and restrictions regarding short-selling. However, we assume that stylised facts of the yield spread term structure that can be related to the credit risk component of the underlying entity apply to the CDS term structure as well.

[3]A credit-linked note (CLN) is a note or bond paying an enhanced coupon to an investor for bearing the credit risk of a reference entity; see Bielecki and Rutkowski (2002, section 1.3.3) for a general description.

[4]The requirement P–a.s. ensures that P–a.s., as will become clear later on.

[5]For notational simplicity we compute an matrix of default probabilities; other setups of time points and time-to-maturities are possible.

[6]Actually, the deterministic part need not be computed for every simulation, hence for efficiency the computation of Line 19 should take place outside the loop .

[7] If the initial hazard rate is not constant, then a calibration where the variance moves purely by jumps cannot be attained. This is due to the fact that the jump intensity of the variance's compound Poisson process is constant, whereas a non-constant, deterministic hazard rate requires the jump intensity to be non-constant and deterministic. The former can be incorporated by specifying the jump process as an additive process.

[8] Under a suitable metric on C, resp. D, the σ-algebra(C), resp. (D), corresponds to the σ-algebra generated by the open sets (with respect to the metric) of C, resp. D, see e.g. (1996, section II.§2) or Karatzas and Shreve (1998, sections 2.4 and 6.2).