Quantitative Finance > Computational Finance

Equivalence of interest rate models and lattice gases

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(Submitted on 4 Apr 2012)

We consider the class of short rate interest rate models for which the short rate is proportional to the exponential of a Gaussian Markov process x(t) in the terminal measure r(t) = a(t) exp(x(t)). These models include the Black, Derman, Toy and Black, Karasinski models in the terminal measure. We show that such interest rate models are equivalent with lattice gases with attractive two-body interaction V(t1,t2)= -Cov(x(t1),x(t2)). We consider in some detail the Black, Karasinski model with x(t) an Ornstein, Uhlenbeck process, and show that it is similar with a lattice gas model considered by Kac and Helfand, with attractive long-range two-body interactions V(x,y) = -\alpha (e^{-\gamma |x - y|} - e^{-\gamma (x + y)}). An explicit solution for the model is given as a sum over the states of the lattice gas, which is used to show that the model has a phase transition similar to that found previously in the Black, Derman, Toy model in the terminal measure.

Comments: 7 pages, 1 figure

Subjects: **Computational Finance (q-fin.CP)**; Statistical Mechanics (cond-mat.stat-mech); Mathematical Physics (math-ph)

Cite as: **arXiv:1204.0915v1 [q-fin.CP]**

Submission history

From: Dan Pirjol [view email]

[v1] Wed, 4 Apr 2012 10:35:09 GMT (176kb)

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