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## tr\_boyleevninegibbs

Input parameters:

- StepNumber  $N$

Output parameters:

- Price
- Delta1
- Delta2

This is taken from [2]. It is a 4-node tree which is a particular case ( $\lambda = 1$ ) of a 5-node tree designed later by Kamrad and Ritchken in [1] implemented in [Routine tr\\_kamradritchken.c](#).

/\*Memory Allocation\*/

/\*Up and Down factors\*/

Here  $u1 = e^{\sigma_1\sqrt{h}}$ ,  $d1 = e^{-\sigma_1\sqrt{h}}$ ,  $u2 = e^{\sigma_2\sqrt{h}}$ ,  $d2 = e^{-\sigma_2\sqrt{h}}$ : in each direction the grid is that of a standard CRR tree.

/\*Risk-Neutral Probabilities\*/

These are computed from the two first-moments matching condition, cf [Routine tr\\_kamradritchken.c](#).

/\*Terminal Values\*/

Nothing surprising here: at each *stock2* level (variable  $i$ ) we initialize the intrinsic values and then the price values in the *stock1* direction (variable  $j$ ). The indexing starts from below for *stock1*, above for *stock2* (why not?).

Since this is a flat tree (cf [Introduction to Tree methods in finance](#)), we store the intrinsic values in an array to avoid to recompute them at each node just like in

[Routine tr\\_coxrossrubinstein.c](#).

/\*Backward Cycle\*/

/\*Deltas\*/

We call a function which computes the two deltas in a finite-difference manner in [bs2d\\_std2d.h](#).

/\*First Time Step\*/

/\*Price\*/

/\*Memory desallocation\*/

## References

- [1] B.KAMRAD P.RITCHKEN. Multinomial approximating models for options with k state variables. *Management Science*, 37:1640–1652, 1991. 1
- [2] P.BOYLE J.EVNINE S.GIBBS. Numerical evaluation of multivariate contingent claims. *Review of Financial Studies*, (2):241–250, 1989. 1