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tr_producttr

Input parameters:

- StepNumber N

Output parameters:

- Price
- Delta1
- Delta2

Exemples of that kind of two-dimensional trees maybe found in [1].
This is a 4-node tree whith a state space which is a product of two Euler one-dimensional trees (cf Routine tr_euler_bs.c), which is a binomial tree where the driving Brownian motion of the Black Scholes model is replaced by the symmetric random walk in a natural manner. In particular the weight of the two sons nodes are $\frac{1}{2}$. In the no correlation case case the product tree gives equal weight $\frac{1}{4}$ to the 4 nodes. Otherwise the probabilities are chosen so that the two projected trees in each direction remain Euler trees, and so that Kushner's local consistency condition is in force (cf Convergence result for Tree methods in finance), which grants convergence. The calculations are detailed there.

/*2D Price Array allocation*/

/*Up and Down factors*/

Here $u1 = e^{\left(r - diviv_1 - \frac{\sigma_1^2}{2}\right)h + \sigma_1\sqrt{h}}$, $d1 = e^{\left(r - diviv_1 - \frac{\sigma_1^2}{2}\right)h - \sigma_1\sqrt{h}}$, $u2 = e^{\left(r - diviv_2 - \frac{\sigma_2^2}{2}\right)h + \sigma_2\sqrt{h}}$, $d2 = e^{\left(r - diviv_2 - \frac{\sigma_2^2}{2}\right)h - \sigma_2\sqrt{h}}$, in each direction the grid is that of a standard Euler tree. Notice that in general this is not a flat tree (ie $u1 * d1 = 1$ and $u2 * d2 = 1$ does not hold).

/*Risk-Neutral probabilities*/
These are discounted as you can see.

/*Terminal prices*/

/*Backward scheme*/
We try to minimize the times operation, whence
`P[i][j]=puu*(P[i][j]+P[i+1][j+1])+pud*(P[i+1][j]+P[i][j+1])`
Notice also that we need to recompute the values of the underlying (S_1, S_2) at each node in order to compute the intrinsic value-also recomputed at each node, in order to handle the american case. This tree is therefore much costly in computation time than a flat one.

/*Deltas*/
We call a function which computes the two deltas in a finite-difference manner in bs2d_std2d.h.

/*First Time Step*/

/*Price*/

/*2D Price Array desallocation*/

References

[1] H.KUSHNER P.G.DUPUIS. *Numerical Methods for Stochastic Control Problems in Continous Time*. Springer-Verlag, 1992. 1