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#include <stdlib.h>
#include "bs1d_lim.h"
#include "error_msg.h"

static int RogersStapleton_UpOut_97(int am, double S, NumFunc_1 *p, double T, d
{

    double *P;
    double pu, pd;
    int Eta0, npts = 0, i, j, m, n, npts;
    double Eta, pulim, pdlim, G, Prix;
    double mu, c, B1, B2, B3, C1, C2, y, alpha3;
    double stock, lower;
    double moy, v, u, d, x1, x2, Q, Delta;
    double U1, U2, W1, W2, pr, pro1, pro2, disc;

    /*Up and Down probabilities*/
    u = step_space;
    d = -u;
    mu = (r - divid) - ((sigma * sigma) / 2.);
    c = mu / (sigma * sigma);
    pu = (exp(2.*c * u) - 1.) / (exp(2.*c * u) - exp(-2.*c * u));
    pd = 1. - pu;

    Eta = (log(up / S)) / u;
    Eta0 = (int) floor(Eta);
    x1 = log(S) + (Eta0 * u);
    x2 = log(up);

    if (Eta0 == Eta)
        pdlim = 0.;
    else
        pdlim = (exp(-2.*c * x1) - exp(-2.*c * x2)) / (exp(-2.*c * (x1 - u)) - exp(-

    pulim = 1. - pdlim;

    /*moments of tau1*/

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moy = (u / mu) * tanh(c * u);
v = ((sigma / mu) * (sigma / mu) * moy) - ((u / mu) * (u / mu)) + (moy * moy);
v = sqrt(v);

B1 = 12.*c * u * (-exp(-4.*c * u) - exp(-2.*c * u));
B2 = 8.*c * c * u * u * (-exp(-2.*c * u) + exp(-4.*c * u));
B3 = 3.*(1 - exp(-2.*c * u) + exp(-4.*c * u) - exp(-6.*c * u));
C1 = u * (B1 + B2 - B3);
y = (-exp(-2.*c * u) - 1.);
C2 = pow(c, 5.) * pow(sigma, 6.) * pow(y, 3.);
alpha3 = C1 / C2;

/*Initialization*/
U2 = (T - moy) / v;
W2 = ((1. - U2 * U2) * exp(-U2 * U2 / 2.)) / sqrt(72.*M_PI);
Q = 0.0;
Prix = 0.;
Delta = 0.;
n = 1;

/*recursion on the number of time-steps*/

do /*computation of the probability of nu=n*/
{
    U1 = U2;
    W1 = W2;
    U2 = (T - (double)(n + 1) * moy) / (v * sqrt((double)(n + 1)));
    W2 = ((1 - U2 * U2) * exp(-U2 * U2 / 2)) / sqrt(72 * M_PI * (double)(n + 1));

    pro1 = cdf_nor(U1);
    pro2 = cdf_nor(U2);

    pr = (pro1 - pro2) + alpha3 * (W1 - W2);

    if (pr < 0.000005)
    {
        Q += pr;
    }
}

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        n++;
    }

else
{
    /*contribution for a fixed number of time-steps*/

    Q = Q + pr;
    disc = exp(-r * T / (double)n);

    if (n >= Eta0) /*Barrier hit*/
    {

        lower = S * exp((double)n * d);
        stock = lower;

        m = (int) floor((n - Eta0) / 2);
        npoints = Eta0 + m;
        npts = n - Eta0;

        if (Eta0 == 0) npts = n - 1;

        /*Price, intrinsic value arrays*/
        P = malloc((npoints + 1) * sizeof(double));
        if (P == NULL)
            return MEMORY_ALLOCATION_FAILURE;

        for (i = 0; i <= npoints; i++)
        {
            P[i] = (p->Compute)(p->Par, stock);
            stock = stock * exp(2.*u);
        }

        /*Terminal Values*/
        if ((n - Eta0) % 2 == 0)
        {
            npoints--;
            for (i = 1; i <= npts; i++)
            {
                if (i % 2 == 0)

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        {
            for (j = 0; j < npoints; j++)
                P[j] = disc * (pd * P[j] + pu * P[j + 1]);

            P[npoints] = disc * (pulim * rebate + pdlim * P[npoint
npoints--];
        }
    else
    {
        for (j = 0; j <= npoints; j++)
            P[j] = disc * (pd * P[j] + pu * P[j + 1]);

        }
    }
}

else
{
    for (i = 1; i <= npts; i++)
    {
        if (i % 2 == 0)
        {
            for (j = 0; j <= npoints; j++)
                P[j] = disc * (pd * P[j] + pu * P[j + 1]);
        }
        else
        {
            for (j = 0; j < npoints; j++)
                P[j] = disc * (pd * P[j] + pu * P[j + 1]);

            P[npoints] = disc * (pulim * rebate + pdlim * P[npoint
npoints--];
        }
    }
}

for (i = 1; i < Eta0; i++)
{
    for (j = 0; j <= Eta0 - i; j++)
        P[j] = disc * (pd * P[j] + pu * P[j + 1]);
}

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/*Price*/
if (Eta0 == 0)
{
    G = disc * (pulim * rebate + pdlim * P[0]);
    Delta = Delta + (G - P[0]) * pr / (S * (exp(u) - 1));
    P[0] = disc * (pulim * rebate + pdlim * P[0]);
}
else
{
    Delta = Delta + (P[1] - P[0]) * pr / (S * (exp(u) - exp(d)));
    P[0] = disc * (pu * P[0] + pd * P[1]);
}

P[0] = P[0] * pr;
}

else /*Barrier not hit*/
{

/*Terminal Values*/
lower = S * exp((double)n * d);

stock = lower;
/*Price, intrinsic value arrays*/
P = malloc((npoints + 1) * sizeof(double));
if (P == NULL)
    return MEMORY_ALLOCATION_FAILURE;
for (i = 0; i <= n; i++)
{
    P[i] = (p->Compute)(p->Par, stock);
    stock = stock * exp(2.*u);
}

/*Backward Resolution*/

for (i = 1; i < n; i++)
{
    for (j = 0; j <= n - i; j++)
        P[j] = disc * (pd * P[j] + pu * P[j + 1]);
}

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        /*Price*/
        Delta = Delta + (P[1] - P[0]) * pr / (S * (exp(u) - exp(d)));
        P[0] = disc * (pd * P[0] + pu * P[1]);
        P[0] = P[0] * pr;

    }
    Prix = Prix + P[0];

    /*Memory Desallocation*/
    free(P);

    n++;
}

}
/*end of the recursion*/
while (Q < 0.99999);

/*Price and Delta*/

*ptprice = Prix;
*ptdelta = Delta;

return OK;
}

int CALC(TR_RogersStapleton_UpOut)(void *Opt, void *Mod, PricingMethod *Met)
{
    TYPEOPT *ptOpt = (TYPEOPT *)Opt;
    TYPEMOD *ptMod = (TYPEMOD *)Mod;
    double r, divid, limit, rebate;

    r = log(1. + ptMod->R.Val.V_DOUBLE / 100.);
    divid = log(1. + ptMod->Divid.Val.V_DOUBLE / 100.);
    limit = ((ptOpt->Limit.Val.V_NUMFUNC_1)->Compute)((ptOpt->Limit.Val.V_NUMFUNC_1)->Compute);
    rebate = ((ptOpt->Rebate.Val.V_NUMFUNC_1)->Compute)((ptOpt->Rebate.Val.V_NUMFUNC_1)->Compute);

    return RogersStapleton_UpOut_97(ptOpt->EuOrAm.Val.V_BOOL, ptMod->S0.Val.V_PDOUT);
}

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    ptOpt->PayOff.Val.V_NUMFUNC_1, ptOpt->Maturity
    r, divid, ptMod->Sigma.Val.V_PDDOUBLE, Met->Par
    &(Met->Res[0].Val.V_DOUBLE), &(Met->Res[1].Val
}

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static int CHK_OPT(TR_RogersStapleton_UpOut)(void *Opt, void *Mod)
{
    Option *ptOpt = (Option *)Opt;
    TYPEOPT *opt = (TYPEOPT *) (ptOpt->TypeOpt);

    if ((opt->EuOrAm).Val.V_BOOL == EURO)
        if ((opt->OutOrIn).Val.V_BOOL == OUT)
            if ((opt->DownOrUp).Val.V_BOOL == UP)
                if ((opt->Parisian).Val.V_BOOL == FALSE)
                    return OK;

    return WRONG;
}

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static int MET(Init)(PricingMethod *Met, Option *Opt)
{
    if (Met->init == 0)
    {
        Met->init = 1;
        Met->Par[0].Val.V_DOUBLE = 0.01;

    }

    return OK;
}

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PricingMethod MET(TR_RogersStapleton_UpOut) =
{
    "TR_RogersStapleton_UpOut",
    {"Space Step", DOUBLE, {100}, ALLOW}, {" ", PREMIA_NULLTYPE, {0}, FORBID}},
    CALC(TR_RogersStapleton_UpOut),
    {"Price", DOUBLE, {100}, FORBID}, {"Delta", DOUBLE, {100}, FORBID} , {" ", PR
    CHK_OPT(TR_RogersStapleton_UpOut),
    CHK_tree,
    MET(Init)
}

```

};