

[Help](#)

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#include <stdlib.h>
#include "bs1d_limdisc.h"

static int fd_call_down_out(int am, double t, NumFunc_1 *p, double r, double di
{

    double K, theta, s;
    int i, TimeIndex, j, M;
    double sigma2;
    double x_min, x_max;
    double *alpha_l, *beta_l, *gamma_l, *alpha_r, *beta_r, *gamma_r, *vect_t;
    double *vect_s, *V, *Vp, *beta_p, *Price, *Obst, *monit_date, *Old_Price;
    double a, b, c, a1, b1, c1;
    double hi, hip, xis, xips, xims, boundary_inf, boundary_sup;
    double INC_DELTA = 0.0001;
    double price_l, price_r, rebate, barrier_down;
    int down_index;

    K = p->Par[0].Val.V_PDOUBLE;
    theta = 0.5;
    s = x / K;
    sigma2 = SQR(sigma);
    rebate = 0. / K;
    barrier_down = limit / K;

    /*Time Step number*/
    M = 20 * nb_mon_date;

    /*Memory Allocation*/
    alpha_l = malloc((N + 1) * sizeof(double));
    beta_l = malloc((N + 1) * sizeof(double));
    gamma_l = malloc((N + 1) * sizeof(double));
    alpha_r = malloc((N + 1) * sizeof(double));
    beta_r = malloc((N + 1) * sizeof(double));
    gamma_r = malloc((N + 1) * sizeof(double));
    vect_t = malloc((M + 1) * sizeof(double));
    monit_date = malloc((M + 1) * sizeof(double));
    vect_s = malloc((N + 1) * sizeof(double));
    V = malloc((N + 1) * sizeof(double));

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Vp = malloc((N + 1) * sizeof(double));
beta_p = malloc((N + 1) * sizeof(double));
Price = malloc((N + 1) * sizeof(double));
Old_Price = malloc((N + 1) * sizeof(double));
Obst = malloc((N + 2) * sizeof(double));

/*Space Localisation*/
x_min = 0.;
x_max = 2.*s;

/*Time Discretisation*/
for (i = 0; i <= M; i++)
    vect_t[i] = ((double)i) * (t) / (double)M;

/*Monitoring Dates*/
for (i = 1; i <= nb_mon_date; i++)
    monit_date[i] = ((double)i) * (t) / (double)nb_mon_date;

/*Mesh Points*/
for (i = 0; i <= N; i++)
{
    vect_s[i] = x_min + ((double)i) * (x_max - x_min) / (double)N;
}

/*Compute barrier level*/
i = 0;
while (vect_s[i] < barrier_down) i++;
down_index = i;

/*Terminal Values*/
for (i = 0; i <= N; i++)
{
    if (i <= down_index)
        Price[i] = rebate;
    else
        Price[i] = MAX(0., vect_s[i] - 1.);

    Obst[i] = Price[i];
}

/*Finite Difference Cycle*/

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for (TimeIndex = 1; TimeIndex <= M; TimeIndex++)
{
    for (j = 1; j < nb_mon_date; j++)

        if (vect_t[TimeIndex] == monit_date[j])
        {
            if ((am == 1) && (rebate == 0.))
                for (i = 0; i <= down_index; i++)
                    Price[i] = MAX(0, vect_s[i] - 1);
            else
                for (i = 0; i <= down_index; i++)
                    Price[i] = rebate;
        }

    boundary_inf = rebate;
    boundary_sup = x_max * exp(-divid * (vect_t[TimeIndex])) - exp(-r * (vect_

a = (1. + r * (vect_t[TimeIndex] - vect_t[TimeIndex - 1]) * theta) / 2.;
b = theta * (vect_t[TimeIndex] - vect_t[TimeIndex - 1]) / 4.;
c = theta * (vect_t[TimeIndex] - vect_t[TimeIndex - 1]) / 2.;

a1 = (1. - r * (vect_t[TimeIndex] - vect_t[TimeIndex - 1]) * (1. - theta))
b1 = (1. - theta) * (vect_t[TimeIndex] - vect_t[TimeIndex - 1]) / 4.;
c1 = (1. - theta) * (vect_t[TimeIndex] - vect_t[TimeIndex - 1]) / 2.;

for (i = 1; i < N; i++)
{
    hi = vect_s[i] - vect_s[i - 1];
    hip = vect_s[i + 1] - vect_s[i];

    xis = vect_s[i] * vect_s[i];
    xips = vect_s[i + 1] * vect_s[i + 1];
    xims = vect_s[i - 1] * vect_s[i - 1];

    /*Computation of Lhs coefficients*/
    alpha_l[i] = -b * sigma2 * (xis + xims) / hi - c * (sigma2 * vect_s[i]
    beta_l[i] = a * (hi + hip) +
                b * (sigma2 * (xis + xims) / hi + sigma2 * (xips + xis) /
    gamma_l[i] = -b * sigma2 * (xips + xis) / hip + c * (sigma2 * vect_s[i]

    /*Computation of Rhs coefficients*/

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        alpha_r[i] = b1 * sigma2 * (xis + xims) / hi + c1 * (sigma2 * vect_s[i]
        beta_r[i] = a1 * (hi + hip) -
                    b1 * (sigma2 * (xis + xims) / hi + sigma2 * (xips + xis) /
        gamma_r[i] = b1 * sigma2 * (xips + xis) / hip - c1 * (sigma2 * vect_s
    }
    /*Compute Rhs*/
    V[1] = alpha_r[1] * Price[0] + beta_r[1] * Price[1] + gamma_r[1] * Price[
    for (i = 2; i < N - 1; i++)
        V[i] = alpha_r[i] * Price[i - 1] + beta_r[i] * Price[i] + gamma_r[i] *

    V[N - 1] = alpha_r[N - 1] * Price[N - 2] + beta_r[N - 1] * Price[N - 1] +

    Price[0] = boundary_inf;
    Price[N] = boundary_sup;

    /*Gauss pivoting*/
    Vp[N - 1] = V[N - 1];
    beta_p[N - 1] = beta_l[N - 1];

    for (i = N - 2; i >= 1; i--)
    {
        beta_p[i] = beta_l[i] - gamma_l[i] * alpha_l[i + 1] / beta_p[i + 1];
        Vp[i] = V[i] - gamma_l[i] * Vp[i + 1] / beta_p[i + 1];
    }

    Price[1] = Vp[1] / beta_p[1];

    for (i = 2; i <= N - 1; i++)
    {
        Price[i] = (Vp[i] - alpha_l[i] * Price[i - 1]) / beta_p[i];
    }

    if (am)
        for (i = 1; i <= N - 1; i++)
        {
            Price[i] = MAX(Price[i], Obst[i]);
        }

    }
    /*End of Time Cycle*/

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    /*Price*/
    i = 0;
    while (vect_s[i] < s) i++;

    i = 0;
    while (vect_s[i] < s * (1. + INC_DELTA)) i++;
    price_r = (Price[i] + (Price[i] - Price[i - 1]) * (s * (1. + INC_DELTA) - vect_s[i])) / (s * (1. + INC_DELTA));

    i = 0;
    while (vect_s[i] < s * (1. - INC_DELTA)) i++;
    price_l = (Price[i] + (Price[i] - Price[i - 1]) * (s * (1. - INC_DELTA) - vect_s[i])) / (s * (1. - INC_DELTA));

    /*Price*/
    *pt_price = K * (Price[i] + (Price[i] - Price[i - 1]) * (s - vect_s[i])) / (s - vect_s[i]);

    /*Delta*/
    *pt_delta = (price_r - price_l) / (2.*s * INC_DELTA);

    /*Memory Desallocation*/
    free(alpha_r);
    free(beta_r);
    free(gamma_r);
    free(alpha_l);
    free(beta_l);
    free(gamma_l);
    free(vect_t);
    free(monit_date);
    free(vect_s);
    free(V);
    free(Vp);
    free(beta_p);
    free(Price);
    free(Old_Price);
    free(Obst);

    return OK;
}

int CALC(FD_LimDisc)(void *Opt, void *Mod, PricingMethod *Met)
{
    TYPEOPT *ptOpt = (TYPEOPT *)Opt;

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    TYPEMOD *ptMod = (TYPEMOD *)Mod;
    double r, divid, limit, sd;
    int return_value;

    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)->Par[0].Val.V_DATE);
    sd = (ptOpt->Limit.Val.V_NUMFUNC_1)->Par[0].Val.V_DATE;

    if (sd != ptMod->T.Val.V_DATE)
    {
        Fprintf(TOSCREEN, " StartingDate=!t0, untreated case\ n\ n\ n");
        return_value = WRONG;
    }
    else
        return_value = fd_call_down_out(ptOpt->EuOrAm.Val.V_BOOL, ptOpt->Maturity.Val.V_DATE, ptMod->R.Val.V_DOUBLE, ptMod->Divid.Val.V_DOUBLE, ptMod->T.Val.V_DATE, ptMod->Limit.Val.V_NUMFUNC_1, ptMod->Limit.Val.V_NUMFUNC_2, ptMod->Limit.Val.V_NUMFUNC_3, ptMod->Limit.Val.V_NUMFUNC_4, ptMod->Limit.Val.V_NUMFUNC_5, ptMod->Limit.Val.V_NUMFUNC_6, ptMod->Limit.Val.V_NUMFUNC_7, ptMod->Limit.Val.V_NUMFUNC_8, ptMod->Limit.Val.V_NUMFUNC_9, ptMod->Limit.Val.V_NUMFUNC_10, ptMod->Limit.Val.V_NUMFUNC_11, ptMod->Limit.Val.V_NUMFUNC_12, ptMod->Limit.Val.V_NUMFUNC_13, ptMod->Limit.Val.V_NUMFUNC_14, ptMod->Limit.Val.V_NUMFUNC_15, ptMod->Limit.Val.V_NUMFUNC_16, ptMod->Limit.Val.V_NUMFUNC_17, ptMod->Limit.Val.V_NUMFUNC_18, ptMod->Limit.Val.V_NUMFUNC_19, ptMod->Limit.Val.V_NUMFUNC_20, ptMod->Limit.Val.V_NUMFUNC_21, ptMod->Limit.Val.V_NUMFUNC_22, ptMod->Limit.Val.V_NUMFUNC_23, ptMod->Limit.Val.V_NUMFUNC_24, ptMod->Limit.Val.V_NUMFUNC_25, ptMod->Limit.Val.V_NUMFUNC_26, ptMod->Limit.Val.V_NUMFUNC_27, ptMod->Limit.Val.V_NUMFUNC_28, ptMod->Limit.Val.V_NUMFUNC_29, ptMod->Limit.Val.V_NUMFUNC_30, ptMod->Limit.Val.V_NUMFUNC_31, ptMod->Limit.Val.V_NUMFUNC_32, ptMod->Limit.Val.V_NUMFUNC_33, ptMod->Limit.Val.V_NUMFUNC_34, ptMod->Limit.Val.V_NUMFUNC_35, ptMod->Limit.Val.V_NUMFUNC_36, ptMod->Limit.Val.V_NUMFUNC_37, ptMod->Limit.Val.V_NUMFUNC_38, ptMod->Limit.Val.V_NUMFUNC_39, ptMod->Limit.Val.V_NUMFUNC_40, ptMod->Limit.Val.V_NUMFUNC_41, ptMod->Limit.Val.V_NUMFUNC_42, ptMod->Limit.Val.V_NUMFUNC_43, ptMod->Limit.Val.V_NUMFUNC_44, ptMod->Limit.Val.V_NUMFUNC_45, ptMod->Limit.Val.V_NUMFUNC_46, ptMod->Limit.Val.V_NUMFUNC_47, ptMod->Limit.Val.V_NUMFUNC_48, ptMod->Limit.Val.V_NUMFUNC_49, ptMod->Limit.Val.V_NUMFUNC_50, ptMod->Limit.Val.V_NUMFUNC_51, ptMod->Limit.Val.V_NUMFUNC_52, ptMod->Limit.Val.V_NUMFUNC_53, ptMod->Limit.Val.V_NUMFUNC_54, ptMod->Limit.Val.V_NUMFUNC_55, ptMod->Limit.Val.V_NUMFUNC_56, ptMod->Limit.Val.V_NUMFUNC_57, ptMod->Limit.Val.V_NUMFUNC_58, ptMod->Limit.Val.V_NUMFUNC_59, ptMod->Limit.Val.V_NUMFUNC_60, ptMod->Limit.Val.V_NUMFUNC_61, ptMod->Limit.Val.V_NUMFUNC_62, ptMod->Limit.Val.V_NUMFUNC_63, ptMod->Limit.Val.V_NUMFUNC_64, ptMod->Limit.Val.V_NUMFUNC_65, ptMod->Limit.Val.V_NUMFUNC_66, ptMod->Limit.Val.V_NUMFUNC_67, ptMod->Limit.Val.V_NUMFUNC_68, ptMod->Limit.Val.V_NUMFUNC_69, ptMod->Limit.Val.V_NUMFUNC_70, ptMod->Limit.Val.V_NUMFUNC_71, ptMod->Limit.Val.V_NUMFUNC_72, ptMod->Limit.Val.V_NUMFUNC_73, ptMod->Limit.Val.V_NUMFUNC_74, ptMod->Limit.Val.V_NUMFUNC_75, ptMod->Limit.Val.V_NUMFUNC_76, ptMod->Limit.Val.V_NUMFUNC_77, ptMod->Limit.Val.V_NUMFUNC_78, ptMod->Limit.Val.V_NUMFUNC_79, ptMod->Limit.Val.V_NUMFUNC_80, ptMod->Limit.Val.V_NUMFUNC_81, ptMod->Limit.Val.V_NUMFUNC_82, ptMod->Limit.Val.V_NUMFUNC_83, ptMod->Limit.Val.V_NUMFUNC_84, ptMod->Limit.Val.V_NUMFUNC_85, ptMod->Limit.Val.V_NUMFUNC_86, ptMod->Limit.Val.V_NUMFUNC_87, ptMod->Limit.Val.V_NUMFUNC_88, ptMod->Limit.Val.V_NUMFUNC_89, ptMod->Limit.Val.V_NUMFUNC_90, ptMod->Limit.Val.V_NUMFUNC_91, ptMod->Limit.Val.V_NUMFUNC_92, ptMod->Limit.Val.V_NUMFUNC_93, ptMod->Limit.Val.V_NUMFUNC_94, ptMod->Limit.Val.V_NUMFUNC_95, ptMod->Limit.Val.V_NUMFUNC_96, ptMod->Limit.Val.V_NUMFUNC_97, ptMod->Limit.Val.V_NUMFUNC_98, ptMod->Limit.Val.V_NUMFUNC_99, ptMod->Limit.Val.V_NUMFUNC_100);

    return return_value;
}

static int CHK_OPT(FD_LimDisc)(void *Opt, void *Mod)
{
    return strcmp(((Option *)Opt)->Name, "CallDownOutDiscEuro");
}

static int MET(Init)(PricingMethod *Met, Option *Opt)
{
    if (Met->init == 0)
    {
        Met->init = 1;

        Met->Par[0].Val.V_INT2 = 1000;

    }

    return OK;
}

PricingMethod MET(FD_LimDisc) =
{

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"FD_LimDisc",  
{{"SpaceStepNumber", INT2, {100}, ALLOW}, {" ", PREMIA_NULLTYPE, {0}, FORBID}}  
CALC(FD_LimDisc),  
{{"Price", DOUBLE, {100}, FORBID}, {"Delta", DOUBLE, {100}, FORBID} , {" ", PR  
CHK_OPT(FD_LimDisc),  
CHK_ok,  
MET(Init)  
} ;
```