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#include <stdlib.h>
#include "
href../../mod/bs1d/bs1d_doublim/bs1d_doublim_h_src.pdfbs1d_doublim.h"
#include "
href../../common/error_msg_h_src.pdferror_msg.h"

static int Gauss_In(int am, double s, NumFunc_1 *L, NumFunc_1 *U, NumFunc_1 *
{
    int      Index, PriceIndex, TimeIndex;
    double   k, vv, h, z, alpha, beta, gamma, y, alpha1, beta1, gamma1, down, u, l
    double   price1 = 0., price2, price3 = 0., price4, pricen1, pricen2, priceph;
    double   *Obst, *A, *B, *C, *P, *S;

    /*Memory Allocation*/
    Obst = malloc((N + 2) * sizeof(double));
    if (Obst == NULL)
        return MEMORY_ALLOCATION_FAILURE;
    A = malloc((N + 2) * sizeof(double));
    if (A == NULL)
        return MEMORY_ALLOCATION_FAILURE;
    B = malloc((N + 2) * sizeof(double));
    if (B == NULL)
        return MEMORY_ALLOCATION_FAILURE;
    C = malloc((N + 2) * sizeof(double));
    if (C == NULL)
        return MEMORY_ALLOCATION_FAILURE;
    P = malloc((N + 2) * sizeof(double));
    if (P == NULL)
        return MEMORY_ALLOCATION_FAILURE;
    S = malloc((N + 2) * sizeof(double));
    if (S == NULL)
        return MEMORY_ALLOCATION_FAILURE;

    /*Time Step*/
    k = t / (double)M;

    /*Space Step*/
    u = (U->Compute)(U->Par, 0);
    l = (L->Compute)(L->Par, 0);
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rebate = (Rebate->Compute)(Rebate->Par, 0);
y = log(s);
down = log(1);
up = log(u);
h = (up - down) / (double)(N + 1);

/*Coefficient of diffusion augmented*/
vv = 0.5 * SQR(sigma);
z = (r - divid) - vv;
if ((h * fabs(z)) <= vv)
    upwind_alphacoef = 0.5;
else
{
    if (z > 0.) upwind_alphacoef = 0.0;
    else upwind_alphacoef = 1.0;
}
vv -= z * h * (upwind_alphacoef - 0.5);

/*Lhs Factor of theta-schema*/
alpha = theta * k * (-vv / (h * h) + z / (2.0 * h));
beta = 1.0 + k * theta * (r + 2.*vv / (h * h));
gamma = k * theta * (-vv / (h * h) - z / (2.0 * h));

for (PriceIndex = 1; PriceIndex <= N; PriceIndex++)
{
    A[PriceIndex] = alpha;
    B[PriceIndex] = beta;
    C[PriceIndex] = gamma;
}

/*Rhs Factor of theta-schema*/
alpha1 = k * (1.0 - theta) * (vv / (h * h) - z / (2.0 * h));
beta1 = 1.0 - k * (1.0 - theta) * (r + 2.*vv / (h * h));
gamma1 = k * (1.0 - theta) * (vv / (h * h) + z / (2.0 * h));

/*Set Up Gauss*/
for (PriceIndex = N - 1; PriceIndex >= 1; PriceIndex--)
    B[PriceIndex] = B[PriceIndex] - C[PriceIndex] * A[PriceIndex + 1] / B[PriceIndex + 1];
for (PriceIndex = 1; PriceIndex <= N; PriceIndex++)
    A[PriceIndex] = A[PriceIndex] / B[PriceIndex];
for (PriceIndex = 1; PriceIndex < N; PriceIndex++)
    C[PriceIndex] = C[PriceIndex] / B[PriceIndex + 1];

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/*Terminal Values*/
for (PriceIndex = 1; PriceIndex <= N; PriceIndex++)
{
    Obst[PriceIndex] = (p->Compute)(p->Par, exp(down + (double)PriceIndex * h)
    P[PriceIndex] = rebate;
}
price2 = (p->Compute)(p->Par, l);
price4 = (p->Compute)(p->Par, u);

/*Finite Difference Cycle*/
for (TimeIndex = 1; TimeIndex <= M; TimeIndex++)
{
    /*Set Rhs*/
    price1 = Boundary(l, p, (double)TimeIndex * k, r, divid, sigma);
    S[1] = beta1 * P[1] + gamma1 * P[2] + alpha1 * price2 - alpha * price1;
    price2 = price1;

    for (PriceIndex = 2; PriceIndex <= N - 1; PriceIndex++)
        S[PriceIndex] = alpha1 * P[PriceIndex - 1] + beta1 * P[PriceIndex] +
            gamma1 * P[PriceIndex + 1];

    price3 = Boundary(u, p, (double)TimeIndex * k, r, divid, sigma);
    S[N] = alpha1 * P[N - 1] + beta1 * P[N] + gamma1 * price4 - gamma * price3;
    price4 = price3;

    /*Solve the system*/
    for (PriceIndex = N - 1; PriceIndex >= 1; PriceIndex--)
        S[PriceIndex] = S[PriceIndex] - C[PriceIndex] * S[PriceIndex + 1];

    P[1] = S[1] / B[1];

    for (PriceIndex = 2; PriceIndex <= N; PriceIndex++)
        P[PriceIndex] = S[PriceIndex] / B[PriceIndex] - A[PriceIndex] * P[PriceIndex - 1];

    /*Splitting for the american case*/
    if (am)
        for (PriceIndex = 1; PriceIndex <= N; PriceIndex++)
            P[PriceIndex] = MAX(Obst[PriceIndex], P[PriceIndex]);
}

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Index = (int)floor((y - down) / h);

/*Price*/
P[0] = price1;
P[N + 1] = price3;

if ((y == up) && (y == down))
    *ptprice = P[0];
else
    *ptprice = P[Index] + (P[Index + 1] - P[Index]) * (exp(y) - exp(down + Index));

/*Delta*/
if ((y == up) && (y == down))
    *ptdelta = 0.0;
else
{
    pricenh = P[Index + 1] + (P[Index + 2] - P[Index + 1]) * (exp(y + h) - exp(down + Index + h));
    if (Index > 0)
    {
        priceph = P[Index - 1] + (P[Index] - P[Index - 1]) * (exp(y - h) - exp(down + Index - h));
        *ptdelta = (pricenh - priceph) / (2 * s * h);
    }
    else
    {
        pricen2h = P[Index + 2] + (P[Index + 3] - P[Index + 2]) * (exp(y + 2 * h) - exp(down + Index + 2 * h));
        *ptdelta = (4 * pricenh - pricen2h - 3 * (*ptprice)) / (2 * s * h);
    }
}

/*Memory Desallocation*/
free(Obst);
free(A);
free(B);
free(C);
free(P);
free(S);

return OK;
}

int CALC(FD_Gauss_In)(void *Opt, void *Mod, PricingMethod *Met)

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{
    TYPEOPT *ptOpt = (TYPEOPT *)Opt;
    TYPEMOD *ptMod = (TYPEMOD *)Mod;
    double r, divid;

    r = log(1. + ptMod->R.Val.V_DOUBLE / 100.);
    divid = log(1. + ptMod->Divid.Val.V_DOUBLE / 100.);

    return Gauss_In(ptOpt->EuOrAm.Val.V_BOOL, ptMod->S0.Val.V_PDOUBLE,
                    ptOpt->LowerLimit.Val.V_NUMFUNC_1, ptOpt->UpperLimit.Val.V_NUM,
                    ptOpt->Maturity.Val.V_DATE - ptMod->T.Val.V_DATE, r, divid, ptMod->T.Val.V_DATE,
                    Met->Par[0].Val.V_INT, Met->Par[1].Val.V_INT, Met->Par[2].Val.V_DOUBLE,
                    &(Met->Res[0].Val.V_DOUBLE), &(Met->Res[1].Val.V_DOUBLE));
}

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

    if ((opt->TwoDoubleStep).Val.V_BOOL == FALSE)
        if ((opt->Parisian).Val.V_BOOL == FALSE)
            if ((opt->OutOrIn).Val.V_BOOL == IN)
                return OK;

    return WRONG;
}

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

        Met->Par[0].Val.V_INT2 = 100;
        Met->Par[1].Val.V_INT2 = 100;
        Met->Par[2].Val.V_RGDOUBLE = 1.0;
    }

    return OK;
}

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}

PricingMethod MET(FD_Gauss_In) =
{
    "FD_Gauss_In",
    { {"SpaceStepNumber", INT2, {100}, ALLOW    }, {"TimeStepNumber", INT2, {100},
        {"Theta", RGDOUBLE051, {100}, ALLOW}, {" " ", PREMIA_NULLTYPE, {0}, FORBID}
    },
    CALC(FD_Gauss_In),
    {{"Price", DOUBLE, {100}, FORBID}, {"Delta", DOUBLE, {100}, FORBID} , {" " ", PR
    CHK_OPT(FD_Gauss_In),
    CHK_split,
    MET(Init)
};

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