

[Help](#)

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/* F. Dubois et T. Lelievre */
/* revu par T. Lelievre décembre 2003 */
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#include <stdlib.h>
#include "bs1d_pad.h"

#include <stdio.h>
#include <math.h>
#include "error_msg.h"

#define EPSILON_RODSHI 1.e-10
/* Inversion LU matrice tridiagonale */

void Initinv_Crout(double *A_inf, double *A_diag, double *A_up, int n_0 , int di
{

    int i;

    L_diag[0] = A_diag[n_0 + 0];
    U_up[0] = A_up[n_0 + 0] / L_diag[0];

    for (i = 1; i <= dim - 2; i++)
    {
        L_inf[i - 1] = A_inf[n_0 + i];
        L_diag[i] = A_diag[n_0 + i] - L_inf[i - 1] * U_up[i - 1];
        U_up[i] = A_up[n_0 + i] / L_diag[i];
    }
    L_inf[dim - 2] = A_inf[n_0 + dim - 1];
    L_diag[dim - 1] = A_diag[n_0 + dim - 1] - L_inf[dim - 2] * U_up[dim - 2];
}

void inv_Crout(double *v, double *sol, double *A_inf, double *A_diag, double *A_
{

    int i;
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Initinv_Crout(A_inf, A_diag, A_up, n_0, dim, L_inf, L_diag, U_diag, U_up);

/* On resout d'abord L sol = v */
/* descente */
sol[n_0] = v[n_0] / L_diag[0];
for (i = 1; i < dim; i++)
    sol[n_0 + i] = (v[n_0 + i] - L_inf[i - 1] * sol[n_0 + i - 1]) / L_diag[i];

/* Puis on resout U sol(new) = sol */
/* remontee */
for (i = dim - 2; i >= 0; i--)
    sol[n_0 + i] = (sol[n_0 + i] - U_up[i] * sol[n_0 + i + 1]);
}

/* Construction des matrices au temps t_n */
void Construit_Matrices_CN(int n, double *Mn_inf, double *Mn_diag, double *Mn_up)
{
    double val1, val2, facmul;
    int i;

    /* Initialisation des matrices */

    /*
        ( - Id / dt + 0.5 * A(t_n) + 0.5 * B_{t_n} )
        ( - Id / dt - 0.5 * A(t_n) - 0.5 * B_{t_n} )
        En fait, ce n'est pas exactement Id : il y a un 0.5 en bas
    */

    /* Mn */
    for (i = n + 1; i <= N + J; i++)
    {
        Mn_inf[i] = 0.;
        Mn_diag[i] = 0.;
        Mn_up[i] = 0.;
    }

    /* M(n+1) */
    for (i = n + 1; i <= N + J; i++)
    {

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    Mn_plus_1_inf[i] = 0.;
    Mn_plus_1_diag[i] = 0.;
    Mn_plus_1_up[i] = 0.;
}

/* Mn */
facmul = 0.5 * (sigma * sigma / 2);
for (i = n + 1; i < N + J; i++)
{
    val1 = facmul * (i - 0.5 - n) * (i - 0.5 - n);
    val2 = facmul * (i + 0.5 - n) * (i + 0.5 - n);
    Mn_inf[i] += val1;
    Mn_diag[i] += -val2 - val1;
    Mn_up[i] += val2;
}
val1 = facmul * (N + J - 0.5 - n) * (N + J - 0.5 - n);
val2 = facmul * (N + J + 0.5 - n) * (N + J + 0.5 - n);
Mn_inf[N + J] += val1;
Mn_diag[N + J] += -val1;

/* M(n+1) */
facmul = -0.5 * (sigma * sigma / 2);
for (i = n + 1; i < N + J; i++)
{
    val1 = facmul * (i - 0.5 - (n + 1)) * (i - 0.5 - (n + 1));
    val2 = facmul * (i + 0.5 - (n + 1)) * (i + 0.5 - (n + 1));
    Mn_plus_1_inf[i] += val1;
    Mn_plus_1_diag[i] += -val2 - val1;
    Mn_plus_1_up[i] += val2;
}
val1 = facmul * (N + J - 0.5 - (n + 1)) * (N + J - 0.5 - (n + 1));
val2 = facmul * (N + J + 0.5 - (n + 1)) * (N + J + 0.5 - (n + 1));
Mn_plus_1_inf[N + J] += val1;
Mn_plus_1_diag[N + J] += -val1;

/* Mn */
facmul = 0.5 * (-(r + sigma * sigma) / 2);
for (i = n + 1; i < N + J; i++)
{
    val1 = facmul * (i - 0.5 - n);
    val2 = facmul * (i + 0.5 - n);

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        Mn_inf[i] += -val1;
        Mn_diag[i] += -facmul;
        Mn_up[i] += val2;
    }
    val1 = facmul * (N + J - 0.5 - n);
    val2 = facmul * (N + J + 0.5 - n);
    Mn_inf[N + J] += -val1;
    Mn_diag[N + J] += val1;

    /* M(n+1) */
    facmul = -0.5 * (-(r + sigma * sigma) / 2);
    for (i = n + 1; i < N + J; i++)
    {
        val1 = facmul * (i - 0.5 - (n + 1));
        val2 = facmul * (i + 0.5 - (n + 1));
        Mn_plus_1_inf[i] += -val1;
        Mn_plus_1_diag[i] += -facmul;
        Mn_plus_1_up[i] += val2;
    }
    val1 = facmul * (N + J - 0.5 - (n + 1));
    val2 = facmul * (N + J + 0.5 - (n + 1));
    Mn_plus_1_inf[N + J] += -val1;
    Mn_plus_1_diag[N + J] += val1;

    /* Mn et M(n+1) */
    for (i = n + 1; i < N + J; i++)
    {
        Mn_diag[i] += -1. / dt;
        Mn_plus_1_diag[i] += -1. / dt;

    }
    Mn_diag[N + J] += -0.5 / dt;
    Mn_plus_1_diag[N + J] += -0.5 / dt;
}

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static int Fixed_RodgerShi_2(double pseudo_stock, double pseudo_strike, NumFunc_
{
    /* Matrices */
    double *Mn_inf, * Mn_diag, * Mn_up;
    double *Mn_plus_1_inf, * Mn_plus_1_diag, * Mn_plus_1_up;

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double *L_diag, * L_inf, * U_up, *U_diag;

/* Vecteur */
double *Fold, * Fnew;
double *scd_membre;

/* Parametres financiers */
double T = maturite;
double r = taux_d_interet - divid;
double S0 = pseudo_stock;
double K = pseudo_strike;

/* Parametres numeriques */

int N = nt; /* nbre de pas de temps */
int J = N / 2; /* nbre de pas d'espaces en plus (à droite de 1) */
double dt = T / N;
double dx = dt / T;
/* double xmax=(N+J)*dx;*/

/* dans les itérations en temps */
int timestep;
double t;
double CL;
int n_0, dim;

/* Calcul du prix */
double x;
int i;
double a, b, c, d;
double aprime, bprime, cprime, dprime;

/* cas d'un taux d'interet nul */
int divid_zero = 0;
if (fabs(r) < EPSILON_RODSHI)
    divid_zero = 1;

/*Memory Allocation*/
L_diag = malloc((N + J + 1) * sizeof(double));
if (L_diag == NULL)
    return MEMORY_ALLOCATION_FAILURE;
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L_inf = malloc((N + J + 1) * sizeof(double));
if (L_inf == NULL)
    return MEMORY_ALLOCATION_FAILURE;

U_diag = malloc((N + J + 1) * sizeof(double));
if (U_diag == NULL)
    return MEMORY_ALLOCATION_FAILURE;
U_up = malloc((N + J + 1) * sizeof(double));
if (U_up == NULL)
    return MEMORY_ALLOCATION_FAILURE;
Mn_inf = malloc((N + J + 1) * sizeof(double));
if (Mn_inf == NULL)
    return MEMORY_ALLOCATION_FAILURE;
Mn_diag = malloc((N + J + 1) * sizeof(double));
if (Mn_diag == NULL)
    return MEMORY_ALLOCATION_FAILURE;
Mn_up = malloc((N + J + 1) * sizeof(double));
if (Mn_up == NULL)
    return MEMORY_ALLOCATION_FAILURE;
Mn_plus_1_inf = malloc((N + J + 1) * sizeof(double));
if (Mn_plus_1_inf == NULL)
    return MEMORY_ALLOCATION_FAILURE;
Mn_plus_1_diag = malloc((N + J + 1) * sizeof(double));
if (Mn_plus_1_diag == NULL)
    return MEMORY_ALLOCATION_FAILURE;
Mn_plus_1_up = malloc((N + J + 1) * sizeof(double));
if (Mn_plus_1_up == NULL)
    return MEMORY_ALLOCATION_FAILURE;
Fold = malloc((N + J + 1) * sizeof(double));
if (Fold == NULL)
    return MEMORY_ALLOCATION_FAILURE;
Fnew = malloc((N + J + 1) * sizeof(double));
if (Fnew == NULL)
    return MEMORY_ALLOCATION_FAILURE;
scd_membre = malloc((N + J + 1) * sizeof(double));
if (scd_membre == NULL)
    return MEMORY_ALLOCATION_FAILURE;

/* Condition finale : nulle */

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for (i = 0; i <= N + J; i++)
    Fold[i] = MAX(0, (1 - i * dx));

/* Iterations en temps */

for (timestep = N - 1; timestep >= 0; timestep--)
{
    t = timestep * dt;

    n_0 = timestep + 1; /* première coordonnée inconnue */
    dim = N + J - timestep; /* dimension du système à résoudre */

    /* Construction des matrices */
    Construit_Matrices_CN(timestep, Mn_inf, Mn_diag, Mn_up, Mn_plus_1_inf, Mn_
    /* second membre */
    for (i = n_0; i < N + J; i++)
        scd_membre[i] = Fold[i - 1] * Mn_plus_1_inf[i] + Fold[i] * Mn_plus_1_dia
    scd_membre[N + J] = Fold[N + J - 1] * Mn_plus_1_inf[N + J] + Fold[N + J] *
    /* Definition de la condition aux limites de Dirichlet (à gauche) */
    if (!divid_zero)
        CL = (1 / (r * T)) * (1 - exp(-r * (T - t)));
    else
        CL = (T - t) / T;
    scd_membre[n_0] -= CL * Mn_inf[n_0];

    /* calcul de la valeur au temps tn */
    inv_Crout(scd_membre, Fnew, Mn_inf, Mn_diag, Mn_up, n_0, dim, L_inf, L_dia

    /* On passe à la suite et on complète à gauche */
    if (!divid_zero)
        for (i = 0; i <= timestep; i++)
            Fold[i] = (1 / (r * T)) * (1 - exp(-r * (T - t))) - (i * dx - t / T) *
    else
        for (i = 0; i <= timestep; i++)
            Fold[i] = (T - t) / T - (i * dx - t / T);

    for (i = n_0; i <= N + J; i++)
        Fold[i] = Fnew[i];
}

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/* Calcul du prix et du delta */
for (i = 0; i <= N + J; i++)
    Fnew[i] = Fold[i];

x = K / S0;
i = (int)floor((K / S0) / dx);

/* Interpolation d'ordre 1 */
/*
a=((i+1)*dx-x)/dx;
b=(x-i*dx)/dx;

if ((p->Compute) == &Call_OverSpot2)
*ptprice=exp(-divid*T)*S0*(a*Fnew[i]+b*Fnew[i+1]);
else
if (!divid_zero)
*ptprice=exp(-divid*T)*S0*(a*Fnew[i]+b*Fnew[i+1])-exp(-divid*T)*exp(-r*T)*((
else
*ptprice=exp(-divid*T)*S0*(a*Fnew[i]+b*Fnew[i+1])-exp(-divid*T)*(S0-K);

if ((p->Compute) == &Call_OverSpot2)
*ptdelta=exp(-divid*T)*((a*Fnew[i]+b*Fnew[i+1])-(K/S0)*(Fnew[i+1]-Fnew[i]))/(
else
if (!divid_zero)
*ptdelta=exp(-divid*T)*((a*Fnew[i]+b*Fnew[i+1])-(K/S0)*(Fnew[i+1]-Fnew[i]))/(
else
*ptdelta=exp(-divid*T)*((a*Fnew[i]+b*Fnew[i+1])-(K/S0)*(Fnew[i+1]-Fnew[i]))/(
*/

/* Interpolation d'ordre 3 */

a = (i * dx - x) * ((i + 1) * dx - x) * ((i + 2) * dx - x) / (dx * 2 * dx * 3
b = (x - (i - 1) * dx) * ((i + 1) * dx - x) * ((i + 2) * dx - x) / (dx * dx *
c = (x - (i - 1) * dx) * (x - i * dx) * ((i + 2) * dx - x) / (2 * dx * dx * dx
d = (x - (i - 1) * dx) * (x - i * dx) * (x - (i + 1) * dx) / (3 * dx * 2 * dx

aprime = ((-1.) * ((i + 1) * dx - x) * ((i + 2) * dx - x) + (i * dx - x) * (-1
bprime = ((1.) * ((i + 1) * dx - x) * ((i + 2) * dx - x) + (x - (i - 1) * dx)
cprime = ((1.) * (x - i * dx) * ((i + 2) * dx - x) + (x - (i - 1) * dx) * (1.)
dprime = ((1.) * (x - i * dx) * (x - (i + 1) * dx) + (x - (i - 1) * dx) * (1.)

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    if ((p->Compute) == &Call_OverSpot2)
        *ptprice = exp(-divid * T) * S0 * (a * Fnew[i - 1] + b * Fnew[i] + c * Fnew[i + 1])
    else if (!divid_zero)
        *ptprice = exp(-divid * T) * S0 * (a * Fnew[i - 1] + b * Fnew[i] + c * Fnew[i + 1])
    else
        *ptprice = exp(-divid * T) * S0 * (a * Fnew[i - 1] + b * Fnew[i] + c * Fnew[i + 1])

    if ((p->Compute) == &Call_OverSpot2)
        *ptdelta = exp(-divid * T) * ((a * Fnew[i - 1] + b * Fnew[i] + c * Fnew[i + 1]) - (a * Fnew[i - 2] + b * Fnew[i - 1] + c * Fnew[i]))
    else if (!divid_zero)
        *ptdelta = exp(-divid * T) * ((a * Fnew[i - 1] + b * Fnew[i] + c * Fnew[i + 1]) - (a * Fnew[i - 2] + b * Fnew[i - 1] + c * Fnew[i]))
    else
        *ptdelta = exp(-divid * T) * ((a * Fnew[i - 1] + b * Fnew[i] + c * Fnew[i + 1]) - (a * Fnew[i - 2] + b * Fnew[i - 1] + c * Fnew[i]))

    /*Memory Desallocation*/

    free(L_diag);
    free(L_inf);
    free(U_diag);
    free(U_up);
    free(Mn_inf);
    free(Mn_diag);
    free(Mn_up);
    free(Mn_plus_1_inf);
    free(Mn_plus_1_diag);
    free(Mn_plus_1_up);
    free(Fold);
    free(Fnew);
    free(scd_membre);

    return OK;
}
int CALC(FD_FixedAsian_RodgerShi2)(void *Opt, void *Mod, PricingMethod *Met)
{
    TYPEOPT *ptOpt = (TYPEOPT *)Opt;
    TYPEMOD *ptMod = (TYPEMOD *)Mod;

    int return_value;
    double r, divid, time_spent, pseudo_spot, pseudo_strike;
    double t_0, T_0;

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

T_0 = ptMod->T.Val.V_DATE;
t_0 = (ptOpt->PathDep.Val.V_NUMFUNC_2)->Par[0].Val.V_PDOUBLE;

if (T_0 < t_0)
{
    Fprintf(TOSCREEN, "T_0 < t_0, untreated case\ n\ n\ n");
    return_value = WRONG;
}
/* Case t_0 <= T_0 */
else
{
    time_spent = (ptMod->T.Val.V_DATE - (ptOpt->PathDep.Val.V_NUMFUNC_2)->Par[0].Val.V_DATE - (ptOpt->Maturity.Val.V_DATE - (ptOpt->PathDep.Val.V_NUMFUNC_2)->Par[0].Val.V_DATE) / 360.);
    pseudo_spot = (1. - time_spent) * ptMod->S0.Val.V_PDOUBLE;
    pseudo_strike = (ptOpt->PayOff.Val.V_NUMFUNC_2)->Par[0].Val.V_PDOUBLE - ti

    if (pseudo_strike <= 0.)
    {
        Fprintf(TOSCREEN, "ANALYTIC FORMULA\ n\ n\ n");
        return_value = Analytic_KemnaVorst(pseudo_spot, pseudo_strike, time_spent);
    }
    else
    {
        return_value = Fixed_RodgerShi_2(pseudo_spot, pseudo_strike, ptOpt->PayOff.Val.V_NUMFUNC_2)->Par[0].Val.V_PDOUBLE;
    }
    return return_value;
}

static int CHK_OPT(FD_FixedAsian_RodgerShi2)(void *Opt, void *Mod)
{
    if ((strcmp(((Option *)Opt)->Name, "AsianCallFixedEuro") == 0) || (strcmp(((Option *)Opt)->Name, "AsianPutFixedEuro") == 0))
        return OK;
    return WRONG;
}

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

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{
    Met->init = 1;
    Met->Par[0].Val.V_INT2 = 500;
    Met->HelpFilenameHint = "FD_FixedAsian_RodgerShi2";
}

return OK;
}

PricingMethod MET(FD_FixedAsian_RodgerShi2) =
{
    "FD_FixedAsian_RodgerShi2",
    { {"TimeStepNumber", INT2, {1000}, ALLOW},
      {" ", PREMIA_NULLTYPE, {0}, FORBID}
    },
    CALC(FD_FixedAsian_RodgerShi2),
    { {"Price", DOUBLE, {100}, FORBID},
      {"Delta", DOUBLE, {100}, FORBID} ,
      {" ", PREMIA_NULLTYPE, {0}, FORBID}
    },
    CHK_OPT(FD_FixedAsian_RodgerShi2),
    CHK_ok,
    MET(Init)
};
```