

[Help](#)

```
#include "
href../../../../mod/bs2d/bs2d_std2d/bs2d_std2d_h_src.pdfbs2d_std2d.h"
#include "
href../../../../common/error_msg_h_src.pdferror_msg.h"

static int VFExplicit(int am, double s1, double s2, NumFunc_2 *payoff, double K
{
    int i, j, I, II1, II2, JJ2;
    double temps, hg, ee, l, la, lb, w, p, k1, k2, t1, t2, bb1, bb2, bb3, bb4, bb5
        c0, c00, c1, c2, c3, aaa, bbb, ccc, ddd, eee, fff, ggg, hhh;
    double *u, *uap, *psi;
    double u1, u2, loc, sig1, sig2;
    double a2, c, s, b1, b2, b3, v1, v2, h, g, dt, alpha, c22, theta, k3;
    double delta1, delta2;

    /*Memory Allocation*/
    u = (double *)calloc(N * N, sizeof(double));
    if (u == NULL)
        return MEMORY_ALLOCATION_FAILURE;
    uap = (double *)calloc(N * N, sizeof(double));
    if (uap == NULL)
        return MEMORY_ALLOCATION_FAILURE;
    psi = (double *)calloc(N * N, sizeof(double));
    if (psi == NULL)
        return MEMORY_ALLOCATION_FAILURE;

    /* Initialisations */
    sig1 = sigma1 * sigma1;
    sig2 = sigma2 * sigma2;
    u1 = log(s1);
    u2 = log(s2);

    /*Space Localization*/
    p = 0.2316419;
    bb1 = 0.319381530;
    bb2 = -0.356563782;
    bb3 = 1.781477937;
```

```

bb4 = -1.821255978;
bb5 = 1.330274429;

la = 0;
lb = 10 * K;
w = 0;
for (j = 0; j < 20; j++)
{
    for (i = 0; i < 200; i++)
    {
        /*Homogeneous Discretization of [la,lb]*/
        l = la + i * (lb - la) * 0.005;

        k1 = (1 - fabs(t * (r - divid1 - 0.5 * sigma1 * sigma1))) / (sqrt(t) *
        k2 = (1 - fabs(t * (r - divid2 - 0.5 * sigma2 * sigma2))) / (sqrt(t) *

        t1 = 1 / (1 + p * k1);
        t2 = 1 / (1 + p * k2);

        /*Put Minimum*/
        if ((payoff->Compute) == &PutMin)
            k3 = 4 * K;
        /*Call Maximum*/
        else if ((payoff->Compute) == &CallMax)
            k3 = 1000 * 64 * (exp(u1 + fabs(r - divid1) * t + sig1 * t) + exp(u2
            (exp(u1 + fabs(r - divid1) * t + sig1 * t) + exp(u2 + fabs(r -
        /*Exchange option*/
        else /*if((payoff->Compute)==&Exchange)*/
            k3 = 1000 * 64 * exp(2 * u1 + 2 * fabs(r - divid1) * t + 2 * sig1 *

        /*Precision of 1/1000*/
        w = 1 / (2.506628274631) *
            (exp(-0.5 * k1 * k1) *
                (bb1 * t1 + bb2 * t1 * t1 + bb3 * t1 * t1 * t1 + bb4 * t1 * t1 *
            exp(-0.5 * k2 * k2) *
                (bb1 * t2 + bb2 * t2 * t2 + bb3 * t2 * t2 * t2 + bb4 * t2 * t2 *

```

```

        if (w < 0)
        {
            break;
        }
    }
    /*[la,lb] contains the solution w(l)=0 */
    la = 1 - (lb - la) * 0.005;
    lb = 1;
    /*Frame of the solution*/
    if (lb - la < 0.00001) break;
}
loc = 1;

/* Rotation */

if (sig1 == sig2)
{

    theta = atan(1);
    alpha = sig1 * 0.5 * (1 + rho);
    a2 = sig2 * 0.5 * (1 - rho);

    c = cos(theta);
    s = sin(theta);

    b1 = (r - divid1 - sig1 * 0.5) * c + (r - divid2 - sig2 * 0.5) * s;
    b2 = (r - divid2 - sig2 * 0.5) * c - (r - divid1 - sig1 * 0.5) * s ;
}
else
{
    theta = atan(2 * rho * sigma1 * sigma2 / (sig1 - sig2)) / 2;

    c = cos(theta);
    c2 = cos(2 * theta);
    s = sin(theta);

    alpha = ((sig1 + sig2) * c2 + sig1 - sig2) / (4 * c2);
    a2 = ((sig1 + sig2) * c2 + sig2 - sig1) / (4 * c2);
    b1 = (r - divid1 - sig1 * 0.5) * c + (r - divid2 - sig2 * 0.5) * s;
}

```

```

        b2 = (r - divid2 - sig2 * 0.5) * c - (r - divid1 - sig1 * 0.5) * s ;

    }

/*homothetie*/

b3 = sqrt(alpha / a2);

/*Space steps*/
h = (double)(2.0 * loc / ((double)1.0 * N));
g = (double)(2.0 * b3 * loc / ((double)1.0 * N));
hg = h * g;

/*Localization after rotation and homothetie*/

v1 = u1 * c + u2 * s;
v2 = (u2 * c - u1 * s) * b3;

/*Stability Condition*/

/* if(2*a1 < (h,g)*MAX(fabs(b1),fabs(b2*b3))) */
/*Pechlet Condition*/
if (2 * alpha - MAX(h * fabs(b1), g * fabs(b2 * b3)) < 0)
{
    /*Upwind Scheme*/

    /*Stability Condition Time Step*/
    dt = hg / (r * hg + 3 * alpha * (h / g + g / h) + g * fabs(b1) + h * fabs(b2));
    /*Constants*/
    c0 = alpha * dt / (h * h);
    c00 = alpha * dt / (g * g);
    c1 = b1 * dt / h;
    c22 = b2 * b3 * dt / g;
    c3 = r * dt;
    aaa = 1 - 2 * (c0 + c00) - c3 - (fabs(c1) + fabs(c22));
    bbb = c0 + MAX(-c1, 0);
    ccc = c0 + MAX(c1, 0);
    ddd = c00 + MAX(-c22, 0);
    eee = c00 + MAX(c22, 0);
}

```

```

    fff = aaa - c00;
    ggg = aaa - c0;
    hhh = aaa - c0 - c00;

}
else
{

    /*Central Scheme*/

    /*Stability Condition Time Step*/

    dt = hg / (0.5 * r * hg + (h / g + g / h) * 2 * alpha + 0.5 * (g * fabs(b1
/*Constants*/
    c0 = alpha * dt / (h * h);
    c00 = alpha * dt / (g * g);
    c1 = 0.5 * b1 * dt / h;
    c22 = 0.5 * b2 * b3 * dt / g;
    c3 = r * dt;
    aaa = 1 - 2 * (c0 + c00) - c3;
    bbb = c0 - c1;
    ccc = c0 + c1; /*Deltas*/
    ddd = c00 - c22;
    eee = c00 + c22;
    fff = 1 - 2 * c0 - 3 * c00 - c3;
    ggg = 1 - 3 * c0 - 2 * c00 - c3;
    hhh = 1 - 3 * (c0 + c00) - c3;

}

/*Maturity Conditions*/
ee = N * 0.5;
for (j = 0; j < N; j++)
{
    for (i = 0; i < N; i++)
    {
        I = i * N + j;

        aa = v1 + i * h - h * ee;

```

```

        bb = v2 + j * g - g * ee;
        psi[I] = (payoff->Compute)(payoff->Par, exp(aa * c - bb * s / b3), exp
/*psi[I] = Payoff(aa*c-bb*s/b3,aa*s+bb*c/b3,K,mu);*/

        uap[I] = psi[I];
        u[I] = psi[I];

    }
}

/*Explicit Finite Difference Cycle*/
temps = 0;
while (temps < t)
{
    temps += dt;
    for (i = 1; i < N - 1; i++)
    {
        for (j = 1; j < N - 1; j++)
        {
            I = i * N + j;
            u[I] = uap[I] * aaa + uap[I - N] * bbb + uap[I + N] * ccc +
                uap[I - 1] * ddd + uap[I + 1] * eee;

        }
    }
}

/*Homogeneous Dirichlet Conditions*/
for (i = 1; i < N - 1; i++)
{
    II1 = i * N;
    II2 = i * N + (N - 1);
    JJ2 = (N - 1) * N + i;

    u[II1] = uap[II1] * fff + uap[II1 - N] * bbb + uap[II1 + N] * ccc +
        uap[II1 + 1] * eee;

    u[II2] = uap[II2] * fff + uap[II2 - N] * bbb + uap[II2 + N] * ccc + ua

```

```

        u[i] = uap[i] * ggg + uap[i + N] * ccc + uap[i - 1] * ddd + uap[i + 1] * eee;
        u[JJ2] = uap[JJ2] * ggg + uap[JJ2 - N] * bbb + uap[JJ2 - 1] * ddd + uap[JJ2 + 1] * eee;
    }

    u[0] = uap[0] * hhh + uap[N] * ccc + uap[1] * eee;

    u[N - 1] = uap[N - 1] * hhh + uap[N + N - 1] * ccc +
        uap[N - 2] * ddd;

    u[(N - 1)*N + (N - 1)] = uap[(N - 1) * N + (N - 1)] *
        hhh + uap[(N - 2) * N + (N - 1)] * bbb +
        uap[(N - 1) * N + (N - 2)] * ddd;

    u[(N - 1)*N] = uap[(N - 1) * N] * hhh +
        uap[(N - 2) * N] * bbb + uap[(N - 1) * N + 1] * eee;

    for (i = 0; i < N; i++)
    {
        for (j = 0; j < N; j++)
        {
            I = i * N + j;
            /*Splitting for the american case*/
            uap[I] = MAX(u[I], psi[I]);
        }
    }
}

/*Price*/
i = ((int)(N / 2)) * N + (int)(N / 2);
*ptprice = uap[i];

/*Deltas*/
delta1 = (uap[i + N] - uap[i - N]) / (2 * h);
delta2 = (uap[i + 1] - uap[i - 1]) / (2 * g);
*ptdelta1 = (delta1 * c - delta2 * s * b3) * exp(-u1);
*ptdelta2 = (delta2 * b3 * c + delta1 * s) * exp(-u2);

```

```

/*Memory desallocation*/
free(u);
free(uap);
free(psi);

return OK;
}

int CALC(FD_VFExplicit)(void *Opt, void *Mod, PricingMethod *Met)
{
    TYPEOPT *ptOpt = (TYPEOPT *)Opt;
    TYPEMOD *ptMod = (TYPEMOD *)Mod;
    double r, divid1, divid2;

    r = log(1. + ptMod->R.Val.V_DOUBLE / 100.);
    divid1 = log(1. + ptMod->Divid1.Val.V_DOUBLE / 100.);
    divid2 = log(1. + ptMod->Divid2.Val.V_DOUBLE / 100.);

    return VFExplicit(ptOpt->EuOrAm.Val.V_BOOL, ptMod->S01.Val.V_PDOUBLE,
                      ptMod->S02.Val.V_PDOUBLE, ptOpt->PayOff.Val.V_NUMFUNC_2, (pt
                      ptOpt->Maturity.Val.V_DATE - ptMod->T.Val.V_DATE,
                      r, divid1, divid2, ptMod->Sigma1.Val.V_PDOUBLE, ptMod->Sigma
                      Met->Par[0].Val.V_INT,
                      &(Met->Res[0].Val.V_DOUBLE), &(Met->Res[1].Val.V_DOUBLE), &(
}

static int CHK_OPT(FD_VFExplicit)(void *Opt, void *Mod)
{
    if ((strcmp(((Option *)Opt)->Name, "PutMinimumAmer") == 0)
        || (strcmp(((Option *)Opt)->Name, "CallMaximumAmer") == 0)
        || (strcmp(((Option *)Opt)->Name, "ExchangeAmer") == 0))
        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;

    }

    return OK;
}

PricingMethod MET(FD_VFExplicit) =
{
    "FD_FVExpl",
    {"StepNumber", INT2, {100}, ALLOW}, {" ", PREMIA_NULLTYPE, {0}, FORBID}},
    CALC(FD_VFExplicit),
    { {"Price", DOUBLE, {100}, FORBID}, {"Delta1", DOUBLE, {100}, FORBID} ,
      {"Delta2", DOUBLE, {100}, FORBID} ,
      {" ", PREMIA_NULLTYPE, {0}, FORBID}
    },
    CHK_OPT(FD_VFExplicit),
    CHK_ok,
    MET(Init)
};

```