

[Help](#)

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#include <stdlib.h>
#include "vasicek1d_std.h"

/*Product*/
static double dt, dr, r_min, r_max;
static double *r_vect, *disc, * *Option_Price, * *Ps;
static double *pu, *pm, *pd;
static long Ns, Nt0;

/*Memory Allocation*/
static void memory_allocation(long Nt)
{
    int i;

    if ((r_vect = malloc(sizeof(double) * (Ns + 1))) == NULL)
    {
        printf("Allocation error");
        exit(1);
    }
    if ((disc = malloc(sizeof(double) * (Ns + 1))) == NULL)
    {
        printf("Allocation error");
        exit(1);
    }
    if ((pu = malloc(sizeof(double) * (Ns + 1))) == NULL)
    {
        printf("Allocation error");
        exit(1);
    }
    if ((pm = malloc(sizeof(double) * (Ns + 1))) == NULL)
    {
        printf("Allocation error");
        exit(1);
    }
    if ((pd = malloc(sizeof(double) * (Ns + 1))) == NULL)
    {
        printf("Allocation error");
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        exit(1);
    }
    if ((Ps = malloc(sizeof(double *) * (Nt + 1))) == NULL)
    {
        printf("Allocation error");
        exit(1);
    }
    if ((Option_Price = malloc(sizeof(double *) * (Nt + 1))) == NULL)
    {
        printf("Allocation error");
        exit(1);
    }
    for (i = 0; i <= Nt; i++)
    {
        Option_Price[i] = malloc(sizeof(double) * (Ns + 1));
    }
    for (i = 0; i <= Nt; i++)
    {
        Ps[i] = malloc(sizeof(double) * (Ns + 1));
    }

    return;
}

/*Memory Desallocation*/
static void free_memory(long Nt)
{
    int i;

    free(r_vect);
    free(pu);
    free(pm);
    free(pd);
    free(disc);

    for (i = 0; i < Nt + 1; i++)
        free(Ps[i]);
    free(Ps);

    for (i = 0; i < Nt + 1; i++)
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    free(Option_Price[i]);
    free(Option_Price);

    return;
}

/*Compute probabilities*/
static int init_prob(double k, double sigma, double theta, double T, double t0,
{
    double df;
    int j;

    /*Time and Space Step*/
    dt = (T - t0) / (double)Nt;
    dr = sigma * sqrt(3.*dt);

    /*Localization*/
    r_min = theta - dr / (2.*k * dt);
    r_max = theta + dr / (2.*k * dt);
    Ns = (int)ceil((r_max - r_min) / dr);
    memory_allocation(Nt);

    /*Compute probabilities*/
    for (j = 0; j <= Ns; j++)
    {
        r_vect[j] = r_min + (double)j * dr;
        df = k * (theta - r_vect[j]) * dt / dr;
        disc[j] = exp(-r_vect[j] * dt);
        /*Boundary*/
        if (j == 0)
        {
            pu[j] = 1. / 6. + (SQR(df) - df) / 2.;
            pm[j] = df - 2.*pu[j];
            pd[j] = 1. - pu[j] - pm[j];
        }
        else if (j == Ns)
        {
            pd[j] = 1. / 6. + (SQR(df) + df) / 2.;
            pm[j] = -df - 2.*pd[j];
            pu[j] = 1. - pd[j] - pm[j];
        }
    }
}

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        /*Not Boundary*/
        else
        {
            pu[j] = 1. / 6. + (SQR(df) + df) / 2.;
            pd[j] = pu[j] - df;
            pm[j] = 1. - pu[j] - pd[j];
        }
    }

    return OK;
}

/*Compute Coupon Bearing*/
static int zcb_vasicek(long Nt, int Nt0, double K, double periodicity, double fi
{
    int i, j, z;

    /*Maturity condition*/
    for (j = 0; j <= Ns; j++)
        Ps[Nt][j] = 1. + K * periodicity;

    /*Dynamic Programming*/
    for (i = Nt - 1; i >= Nt0; i--)
        for (j = 0; j <= Ns; j++)
        {
            if (j == 0)
                Ps[i][j] = disc[j] * (pu[j] * Ps[i + 1][j + 2] + pm[j] * Ps[i + 1][j +
            else if (j == Ns)
                Ps[i][j] = disc[j] * (pd[j] * Ps[i + 1][j - 2] + pm[j] * Ps[i + 1][j -
            else
                Ps[i][j] = disc[j] * (pu[j] * Ps[i + 1][j + 1] + pm[j] * Ps[i + 1][j]

    /*Coupon adjustment*/
    for (z = 0; z < nb_coupon; z++)
    {
        if ((i != 0) && (fabs((double)i * dt - (first_payement + (double)z *
        {
            Ps[i][j] += K * periodicity;
        }
    }
}

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    }
    return 1.;
}

/*Swaption=Option on Coupon-Bearing Bond*/
static int swaption_vasicek1d(double r0, double k, double t0, double sigma, double theta, double T)
{
    int i, j, nb_coupon, Nt;
    double val, val1, tmp, first_payement;

    /*Compute probabilities*/
    Nt = NtY * (long)((T - t0) / periodicity);
    init_prob(k, sigma, theta, T, t0, Nt);

    /*Number of Step for the Option*/
    Nt0 = NtY * (long)((t - t0) / periodicity);

    /*Compute Coupon Bearing*/
    first_payement = t + periodicity;
    nb_coupon = (int)((T - first_payement) / periodicity);
    zcb_vasicek(Nt, Nt0, K, periodicity, first_payement, nb_coupon);

    /*Maturity conditions for the option*/
    tmp = p->Par[0].Val.V_DOUBLE;
    p->Par[0].Val.V_DOUBLE = 1.;
    for (j = 0; j <= Ns; j++)
        Option_Price[Nt0][j] = (p->Compute)(p->Par, Ps[Nt0][j]);

    /*Explicit Finite Difference Cycle*/
    for (i = Nt0 - 1; i >= 0; i--)
        for (j = 0; j <= Ns; j++)
        {
            /*Boundary*/
            if (j == 0)
                Option_Price[i][j] = disc[j] * (pu[j] * Option_Price[i + 1][j + 2] + p
            else if (j == Ns)
                Option_Price[i][j] = disc[j] * (pd[j] * Option_Price[i + 1][j - 2] + p
            /*Not Boundary*/
            else
                Option_Price[i][j] = disc[j] * (pu[j] * Option_Price[i + 1][j + 1] + p
            /*American Case*/

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        /*if(am)
            Option_Price[i][j]=MAX(Option_Price[i][j],(p->Compute)(p->Par,Ps[i][j]
        }

    /*Linear Interpolation*/
    j = 0;
    while (r_vect[j] < r0)
        j++;
    val = Option_Price[0][j];
    val1 = Option_Price[0][j - 1];

    /*Price*/
    *price = Nominal * (val + (val - val1) * (r0 - r_vect[j]) / dr);

    /*Memory Disallocation*/
    p->Par[0].Val.V_DOUBLE = tmp;
    free_memory(Nt);

    return OK;
}

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

    return swaption_vasicek1d(ptMod->r0.Val.V_PDOUBLE, ptMod->k.Val.V_DOUBLE, ptMo
        ptMod->theta.Val.V_PDOUBLE, ptOpt->BMaturity.Val.V_D
        ptOpt->EuOrAm.Val.V_BOOL, ptOpt->Nominal.Val.V_PDOUNB
}

static int CHK_OPT(FD_SWAPTION)(void *Opt, void *Mod)
{
    if ((strcmp(((Option *)Opt)->Name, "PayerSwaption") == 0) || (strcmp(((Option
        return OK;
    else

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        return WRONG;
    }

static int MET(Init)(PricingMethod *Met, Option *Opt)
{
    if (Met->init == 0)
    {
        Met->init = 1;
        Met->Par[0].Val.V_LONG = 30;

    }
    return OK;
}

PricingMethod MET(FD_SWAPTION) =
{
    "FD_Explicit_Vasicek1d_Swaption",
    { {"TimeStepNumber for Period", LONG, {100}, ALLOW},
      {" ", PREMIA_NULLTYPE, {0}, FORBID}
    },
    CALC(FD_SWAPTION),
    {{"Price", DOUBLE, {100}, FORBID}, {" ", PREMIA_NULLTYPE, {0}, FORBID}},
    CHK_OPT(FD_SWAPTION),
    CHK_ok,
    MET(Init)
} ;
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