

[Help](#)

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#include <stdlib.h>
#include "hes1d_std.h"
#include "enums.h"

#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2015+2) //The "#els
static int CHK_OPT(MC_BaldiPisani_Heston)(void *Opt, void *Mod)
{
    return NONACTIVE;
}
int CALC(MC_BaldiPisani_Heston)(void *Opt, void *Mod, PricingMethod *Met)
{
    return AVAILABLE_IN_FULL_PREMIA;
}
#else

// Function that will be used in L2
static double psi_function(double h, double k)
{
    if (k == 0) return h;
    else return (1. - exp(-k * h)) / k;
}

// Simulation according to the generator L_1
static double L1(double x, double h, int n, double a, double sigma)
{
    double x_new;
    x_new = x + (a - (double)n * sigma * sigma / 4.) * h;
    return x_new;
}

// Simulation according to the generator L_2
static double L2(double x, double h, int n, double sigma, double k, int generat
{
    double *Y, *Z, psi, x_new = 0.;
    int i;

    Y = malloc(n * sizeof(double *));
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Z = malloc(n * sizeof(double *));

Y[0] = sqrt(x);

for (i = 1; i < n; i++)
{
    Y[i] = 0.;
}

psi = psi_function(h, k);

for (i = 0; i < n; i++)
{
    Z[i] = Y[i] * exp(-k * 0.5 * h) + sigma * 0.5 * sqrt(psi) * pnl_rand_normal;
}

for (i = 0; i < n; i++)
{
    x_new = x_new + Z[i] * Z[i];
}

free(Y);
free(Z);

return x_new;
}

//Simulation CIR at time t_i+1 starting from a simulation at time t_i
//following the composition rule p_2(t/2)*p_1(t)*p_2(t/2)
//that is according to the scheme q_2 in the paper
static double CIR(double x, double h, int n, double a, double k, double sigma, int generator)
{
    double x_new, x_tmp1, x_tmp2;
    x_tmp1 = L2(x, h * 0.5, n, sigma, k, generator);
    x_tmp2 = L1(x_tmp1, h, n, a, sigma);
    x_new = L2(x_tmp2, h * 0.5, n, sigma, k, generator);
    return x_new;
}

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//Function associated to the generator W in [Alfonsi] paper
static void HW(double *x1, double *x2, double *x3, double *x4, double *delta_x1,
{
    double app;
    app = CIR(*x1, h, n, a, k, sigma, generator);
    (*delta_x1) = -(*x1) + app; //here I "save" the value x1[i+1]-x[i]
    (*x2) = (*x2) + (*x1 + 0.5 * (*delta_x1)) * h;
    (*x4) = (*x4) + 0.5 * (*x3) * h;
    (*x3) = (*x3) * exp((r - divid - rho * a / sigma) * h + rho * (*delta_x1) / si
    (*x4) = (*x4) + 0.5 * (*x3) * h;
    (*x1) = (*x1) + (*delta_x1);
}

//Function associated to the generator Z in [Alfonsi] paper
static void Zgenerator( double *x1, double *x3, double h,double rho,int generato
{
    (*x3) = (*x3) * exp(sqrt((1. - rho * rho) * (*x1) * h) * pnl_rand_normal(gener
}

int MCBaldiPisani(double S_0, NumFunc_1 *p, double T, double r, double divid, d
{
    long i, ipath;
    double price_sample, delta_sample, mean_price, mean_delta, var_price, var_delt
    int init_mc;
    int simulation_dim;
    double alpha, z_alpha;
    double x1, x2, x3, x4, delta_x1, S_T;
    double h;
    double a;
    int n;

    //Time Step
    h = T / nn;

    a = theta * k;
    n = floor(4.*a / (sigma * sigma));

    /* Value to construct the confidence interval */
    alpha = (1. - confidence) / 2.;
    z_alpha = pnl_inv_cdfnor(1. - alpha);

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/*Initialisation*/
mean_price = 0.0;
mean_delta = 0.0;
var_price = 0.0;
var_delta = 0.0;

/* Size of the random vector we need in the simulation */
simulation_dim = nn;

/* MC sampling */
init_mc = pnl_rand_init(generator, simulation_dim, nb);
/* Test after initialization for the generator */
if (init_mc == OK)
{
    for (ipath = 1; ipath <= nb; ipath++)
    {
        //initialization
        x1 = v_0;
        x2 = 0.;
        x3 = S_0;
        x4 = 0.;

        //simulation of X_T
        for (i = 0; i < nn; i++)
        {
            if (pnl_rand_uni(generator) < 0.5)
            {
                HW(&x1, &x2, &x3, &x4, &delta_x1, h, n, a, r, divid, k, sigma,
                    Zgenerator(&x1, &x3, h, rho, generator));
            }
            else
            {
                Zgenerator(&x1, &x3, h, rho, generator);
                HW(&x1, &x2, &x3, &x4, &delta_x1, h, n, a, r, divid, k, sigma,
                    Zgenerator(&x1, &x3, h, rho, generator));
            }
        }

        /*Price*/
    }
}

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    S_T = x3;
    price_sample = (p->Compute)(p->Par, x3);

    /* Delta */
    if (price_sample > 0.0)
        delta_sample = (S_T / S_0);
    else delta_sample = 0.;

    /* Sum */
    mean_price += price_sample;
    mean_delta += delta_sample;

    /* Sum of squares */
    var_price += SQR(price_sample);
    var_delta += SQR(delta_sample);
}
/* End of the N iterations */

/* Price estimator */
*ptprice = (mean_price / (double)nb);
*pterror_price = exp(-r * T) * sqrt(var_price / (double)nb - SQR(*ptprice));
*ptprice = exp(-r * T) * (*ptprice);

/* Price Confidence Interval */
*inf_price = *ptprice - z_alpha * (*pterror_price);
*sup_price = *ptprice + z_alpha * (*pterror_price);

/* Delta estimator */
*ptdelta = exp(-r * T) * (mean_delta / (double)nb);
if ((p->Compute) == &Put)
    *ptdelta *= (-1);
*pterror_delta = sqrt(exp(-2.0 * r * T) * (var_delta / (double)nb - SQR(*ptdelta)));

/* Delta Confidence Interval */
*inf_delta = *ptdelta - z_alpha * (*pterror_delta);
*sup_delta = *ptdelta + z_alpha * (*pterror_delta);
}

return init_mc;
}

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int CALC(MC_BaldiPisani_Heston)(void *Opt, void *Mod, PricingMethod *Met)
{
    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 MCBaldiPisani(ptMod->S0.Val.V_PDOUBLE,
                        ptOpt->PayOff.Val.V_NUMFUNC_1,
                        ptOpt->Maturity.Val.V_DATE - ptMod->T.Val.V_DATE,
                        r,
                        divid, ptMod->Sigma0.Val.V_PDOUBLE
                        , ptMod->MeanReversion.Val.V_PDOUBLE,
                        ptMod->LongRunVariance.Val.V_PDOUBLE,
                        ptMod->Sigma.Val.V_PDOUBLE,
                        ptMod->Rho.Val.V_PDOUBLE,
                        Met->Par[0].Val.V_LONG,
                        Met->Par[1].Val.V_INT,
                        Met->Par[2].Val.V_ENUM.value,
                        Met->Par[3].Val.V_PDOUBLE,
                        &(Met->Res[0].Val.V_DOUBLE),
                        &(Met->Res[1].Val.V_DOUBLE),
                        &(Met->Res[2].Val.V_DOUBLE),
                        &(Met->Res[3].Val.V_DOUBLE),
                        &(Met->Res[4].Val.V_DOUBLE),
                        &(Met->Res[5].Val.V_DOUBLE),
                        &(Met->Res[6].Val.V_DOUBLE),
                        &(Met->Res[7].Val.V_DOUBLE));
}

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

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    return WRONG;
}
#endif //PremiaCurrentVersion

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

        Met->Par[0].Val.V_LONG = 100000;
        Met->Par[1].Val.V_INT = 20;
        Met->Par[2].Val.V_ENUM.value = 0;
        Met->Par[2].Val.V_ENUM.members = &PremiaEnumMCRNGs;
        Met->Par[3].Val.V_DOUBLE = 0.95;
    }

    return OK;
}

PricingMethod MET(MC_BaldiPisani_Heston) =
{
    "MC_BaldiPisani",
    { {"N iterations", LONG, {100}, ALLOW},
      {"TimeStepNumber", LONG, {100}, ALLOW},
      {"RandomGenerator", ENUM, {100}, ALLOW},
      {"Confidence Value", DOUBLE, {100}, ALLOW},
      {" ", PREMIA_NULLTYPE, {0}, FORBID}
    },
    CALC(MC_BaldiPisani_Heston),
    { {"Price", DOUBLE, {100}, FORBID},
      {"Delta", DOUBLE, {100}, FORBID} ,
      {"Error Price", DOUBLE, {100}, FORBID},
      {"Error Delta", DOUBLE, {100}, FORBID} ,
      {"Inf Price", DOUBLE, {100}, FORBID},
      {"Sup Price", DOUBLE, {100}, FORBID} ,
      {"Inf Delta", DOUBLE, {100}, FORBID},
    }
}

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    {"Sup Delta", DOUBLE, {100}, FORBID} ,  
    {" ", PREMIA_NULLTYPE, {0}, FORBID}  
},  
CHK_OPT(MC_BaldiPisani_Heston),  
CHK_mc,  
MET(Init)  
};
```