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/* Standard Monte Carlo simulation for a Call - Put - CallSpread or
Digit option.
In the case of Monte Carlo simulation, the program provides estimations for p
In the case of Quasi-Monte Carlo simulation, the program just provides estima

For a Call, the implementation is based on the Call-Put Parity
relationship. */

#include "bs1d_std.h"
#include "enums.h"
static double reg_put(double eps, double s, double H)
{
    if (s <= H - eps)
        return 1.;
    else
    {
        if ((s > H - eps) && (s <= H + eps))
            return (-s + H + eps) / 2 * eps;
        else
            return 0.0;
    }
}

static double F_reg_put(double eps, double s, double H)
{
    if (s <= H - eps)
        return 0.0;
    else
    {
        if ((s >= H - eps) && (s < H))
            return H - s - (SQR(-s + H + eps)) / (4.*eps);
        else
        {
            if ((s >= H) && (s < H + eps))
                return 0.0 - (SQR(-s + H + eps)) / (4.*eps);
            else
                return 0.0;
        }
    }
}
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static double reg_call(double eps, double s, double H)
{
    if (s <= H - eps)
        return 0.;
    else
    {
        if ((s > H - eps) && (s <= H + eps))
            return (s - H + eps) / 2 * eps;
        else
            return 1.0;
    }
}

static double F_reg_call(double eps, double s, double H)
{
    if (s <= H - eps)
        return 0.0;
    else
    {
        if ((s >= H - eps) && (s < H))
            return 0.0 - (SQR(s - H + eps)) / (4.*eps);
        else
        {
            if ((s >= H) && (s < H + eps))
                return s - H - (SQR(s - H + eps)) / (4.*eps);
            else
                return 0.0;
        }
    }
}

static double regular(double eps, double s)
{
    if ((s > -eps) && (s <= 0))
        return 0.5 * SQR(1 + s / eps);
    else if ((s < eps) && (s > 0)) return (1 - 0.5 * SQR(1 - s / eps));
    else if (s > eps) return 1;
    else return 0.;
}

static double der_regular(double eps, double s)
{

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    if ((s > -eps) && (s <= 0))
        return (1 + s / eps) * 1. / eps;
    else if ((s < eps) && (s > 0)) return (1 - s / eps) * 1. / eps;
    else return 0.;
}

static int MCStandard(double s, NumFunc_1 *p, double t, double r, double divid,
{
    int flag;
    long i;
    double mean_price, mean_delta, var_price, var_delta, forward, forward_stock,
        exp_sigmaxwt, S_T, U_T, price_sample, delta_sample = 0.,
        s_plus, s_minus, K1, K2, sigma_sq;

    double g;
    int init_mc;
    int simulation_dim = 1;
    double alpha, z_alpha;
    double g_reg, g_reg_der, eps = 1.0;

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

    /*Initialisation*/
    flag = 0;
    s_plus = s * (1. + inc);
    s_minus = s * (1. - inc);
    mean_price = 0.0;
    mean_delta = 0.0;
    var_price = 0.0;
    var_delta = 0.0;

    /* CallSpread */ /*For digit option K2 is the rebate*/
    K1 = p->Par[0].Val.V_PDOUBLE;
    K2 = p->Par[1].Val.V_PDOUBLE;

    /*Median forward stock and delta values*/
    sigma_sqrt = sigma * sqrt(t);
    forward = exp(((r - divid) - SQR(sigma) / 2.0) * t);
    forward_stock = s * forward;

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/* Change a Call into a Put to apply the Call-Put parity */
if ((p->Compute) == &Call)
{
    (p->Compute) = &Put;
    flag = 1;
}

/*MC sampling*/
init_mc = pnl_rand_init(generator, simulation_dim, N);

/* Test after initialization for the generator */
if (init_mc == OK)
{

    /* Begin N iterations */
    for (i = 1 ; i <= N ; i++)
    {
        /* Simulation of a gaussian variable according to the generator type,
           that is Monte Carlo or Quasi Monte Carlo. */
        g = pnl_rand_normal(generator);

        exp_sigmaxwt = exp(sigma_sqrt * g);
        S_T = forward_stock * exp_sigmaxwt;
        U_T = forward * exp_sigmaxwt;

        /*Price*/
        price_sample = (p->Compute)(p->Par, S_T);

        /*Delta*/

        /*Digit*/
        if ((p->Compute) == &Digit)
        {
            if (delta_met == 1)
                delta_sample = ((p->Compute)(p->Par, U_T * s_plus) -
                                (p->Compute)(p->Par, U_T * s_minus)) / (2.*s * i);
            if (delta_met == 2)
                /*Malliavin Global*/
                delta_sample = (price_sample * g * sqrt(t)) / (s * sigma * t);
            if (delta_met == 3)

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    {
        /*Malliavin Local*/
        g_reg = K2 * exp(-r * t) * regular(eps, S_T - K1);
        g_reg_der = K2 * exp(-r * t) * der_regular(eps, S_T - K1);
        //f_loc=price_sample-g_reg;
        delta_sample = ((price_sample - g_reg) * g * sqrt(t)) / (s * s
    }
}

/* CallSpread */
else if ((p->Compute) == &CallSpread)
{
    if (delta_met == 1)
    {
        delta_sample = 0;
        if (S_T > K1)
            delta_sample += U_T;
        if (S_T > K2)
            delta_sample -= U_T;
    }
    if (delta_met == 2)
        /*Malliavin Global*/
        delta_sample = (price_sample * g * sqrt(t)) / (s * sigma * t);
    if (delta_met == 3)
    {
        delta_sample = 0.0;
        g_reg = reg_call(eps, S_T, K1);
        g_reg_der = exp(-r * t) * F_reg_call(eps, S_T, K1);
        delta_sample += g_reg * U_T + g_reg_der * sqrt(t) * g / (s * s
        g_reg = reg_call(eps, S_T, K2);
        g_reg_der = exp(-r * t) * F_reg_call(eps, S_T, K2);
        delta_sample -= g_reg * U_T + g_reg_der * sqrt(t) * g / (s * s
    }
}

/*Call-Put*/
else if ((p->Compute) == &Put)
{
    if (delta_met == 1)
    {
        if (price_sample > 0.)

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        delta_sample = -U_T;
    else
        delta_sample = 0.0;
    }
    if (delta_met == 2)
        /*Malliavin Global*/
        delta_sample = (price_sample * g * sqrt(t)) / (s * sigma * t);
    if (delta_met == 3)
    {
        /*Malliavin Local*/
        g_reg = reg_put(eps, S_T, K1);
        g_reg_der = exp(-r * t) * F_reg_put(eps, S_T, K1);
        //f_loc=price_sample-g_reg;
        delta_sample = -(g_reg * U_T) + g_reg_der * g * sqrt(t) / (s *
    }

    }

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

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

/* Price */
*ptprice = exp(-r * t) * (mean_price / (double) N);
*pterror_price = sqrt(exp(-2.0 * r * t) * var_price / (double)N - SQR(*ptp

/*Delta*/
*ptdelta = exp(-r * t) * mean_delta / (double) N;
*pterror_delta = sqrt(exp(-2.0 * r * t) * (var_delta / (double)N - SQR(*pt

/* Call Price and Delta with the Call Put Parity */
if (flag == 1)
{
    *ptprice += s * exp(-divid * t) - p->Par[0].Val.V_DOUBLE * exp(-r * t)

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        *ptdelta += exp(-divid * t);
        (p->Compute) = &Call;
        flag = 0;
    }

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

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

int CALC(MC_Standard)(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 MCStandard(ptMod->S0.Val.V_PDOUBLE,
        ptOpt->PayOff.Val.V_NUMFUNC_1,
        ptOpt->Maturity.Val.V_DATE - ptMod->T.Val.V_DATE,
        r,
        divid,
        ptMod->Sigma.Val.V_PDOUBLE,
        Met->Par[0].Val.V_LONG,
        Met->Par[1].Val.V_ENUM.value,
        Met->Par[2].Val.V_PDOUBLE,
        Met->Par[3].Val.V_DOUBLE,
        Met->Par[4].Val.V_ENUM.value,
        &(Met->Res[0].Val.V_DOUBLE),
        &(Met->Res[1].Val.V_DOUBLE),
        &(Met->Res[2].Val.V_DOUBLE),

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        &(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));

}

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

    if ((opt->EuOrAm).Val.V_BOOL == EURO)
        return OK;

    return WRONG;
}

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_ENUM.value = 0;
        Met->Par[1].Val.V_ENUM.members = &PremiaEnumRNGs;
        Met->Par[2].Val.V_PDOUBLE = 0.01;
        Met->Par[3].Val.V_DOUBLE = 0.95;
        Met->Par[4].Val.V_ENUM.value = 2;
        Met->Par[4].Val.V_ENUM.members = &PremiaEnumDeltaMC;

    }

    type_generator = Met->Par[1].Val.V_ENUM.value;

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if (pnl_rand_or_quasi(type_generator) == PNL_QMC)
{
    Met->Res[2].Viter = IRRELEVANT;
    Met->Res[3].Viter = IRRELEVANT;
    Met->Res[4].Viter = IRRELEVANT;
    Met->Res[5].Viter = IRRELEVANT;
    Met->Res[6].Viter = IRRELEVANT;
    Met->Res[7].Viter = IRRELEVANT;

}
else
{
    Met->Res[2].Viter = ALLOW;
    Met->Res[3].Viter = ALLOW;
    Met->Res[4].Viter = ALLOW;
    Met->Res[5].Viter = ALLOW;
    Met->Res[6].Viter = ALLOW;
    Met->Res[7].Viter = ALLOW;
}
return OK;
}

PricingMethod MET(MC_Standard) =
{
    "MC_Standard",
    { {"N iterations", LONG, {100}, ALLOW},
      {"RandomGenerator", ENUM, {100}, ALLOW},
      {"Delta Increment Rel (Digit)", PDOUBLE, {100}, ALLOW},
      {"Confidence Value", DOUBLE, {100}, ALLOW},
      {"Delta Method", ENUM, {100}, ALLOW},
      {" ", PREMIA_NULLTYPE, {0}, FORBID}
    },
    CALC(MC_Standard),
    { {"Price", DOUBLE, {100}, FORBID},
      {"Delta", DOUBLE, {100}, FORBID} ,
      {"Error Price", DOUBLE, {100}, FORBID},
      {"Error Delta", DOUBLE, {100}, FORBID} ,
      {"Inf Price", DOUBLE, {100}, FORBID},

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