

[Help](#)

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#include "mer1d_pad.h"
#include "pnl/pnl_cdf.h"

#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2009+2) //The "#els
static int CHK_OPT(MC_Merton_FixedLookback)(void *Opt, void *Mod)
{
    return NONACTIVE;
}
int CALC(MC_Merton_FixedLookback)(void *Opt, void *Mod, PricingMethod *Met)
{
    return AVAILABLE_IN_FULL_PREMIA;
}
#else
static int Merton_Mc_FixedLookback(double s_maxmin, NumFunc_2 *P, double S0, dou
                                int generator, int n_points, long n_paths, do
{
    double *s, s1, s2, *s3, **s4, s5, s6;
    double pas, sup, inf, supw, infw, exp_sup, exp_inf, exp_supw, exp_infw, beta;
    double *t, *jump_size_vect, *jump_time_vect, sup0, temp, nu, discount, *cov_pa
    double cor_payoff_control, *coef_control, var_proba, determinant_control;
    double *X, *W, payoff, *control, proba, s0, s_shift, e1, e2, e3, expect_contro
    int i, j, k, l, jump_number, *N;
    K = P->Par[0].Val.V_DOUBLE;
    k = 0;
    beta = 0.5826;
    delta = sqrt(var);
    nu = (r - divid) - sigma * sigma / 2 - lambda * (exp(var / 2 - mean) - 1);
    discount = exp(-r * T);
    pas = T / n_points;
    X = malloc((n_points + 1) * sizeof(double));
    W = malloc((n_points + 1) * sizeof(double));
    t = malloc((n_points + 1) * sizeof(double));
    N = malloc((n_points + 1) * sizeof(int));
    s = malloc((2) * sizeof(double));
    s3 = malloc((2) * sizeof(double));
    control = malloc((2) * sizeof(double));
    var_control = (double **) malloc((2) * sizeof(double));
    s4 = (double **) malloc((2) * sizeof(double));

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for (i = 0; i <= 1; i++)
{
    var_control[i] = malloc((2) * sizeof(double));
    s4[i] = malloc((2) * sizeof(double));
}
cov_payoff_control = malloc((2) * sizeof(double));
coef_control = malloc((2) * sizeof(double));
jump_size_vect = malloc((int)(1000 * lambda * T) * sizeof(double));
jump_time_vect = malloc((int)(1000 * lambda * T) * sizeof(double));
X[0] = 0;
s[0] = 0;
s[1] = 0;
s3[0] = 0;
s3[1] = 0;
s4[0][0] = 0;
s4[0][1] = 0;
s4[1][0] = 0;
s4[1][1] = 0;
N[0] = 0;
s1 = 0;
s2 = 0;
s5 = 0;
s6 = 0;
for (k = 0; k <= n_points; k++)
{
    t[k] = k * pas;
}
pnl_rand_init(generator, 1, n_paths);
//Put options case
if ((P->Compute) == &Put_OverSpot2)
{
    s_maxmin = MIN(s_maxmin, K);
    s_shift = exp(beta * sigma * sqrt(T / n_points)) * s_maxmin;
    e1 = (log(s_maxmin / S0) * (S0 > s_maxmin) - (nu + sigma * sigma) * T) / (
    e2 = e1 + sigma * sqrt(T);
    e3 = (log(s_maxmin / S0) * (S0 > s_maxmin) + nu * T) / (sigma * sqrt(T));
    //first control variable's expected value : it's the exponential of the in
    if (S0 >= s_maxmin)
        expect_control_0 = exp(beta * sigma * sqrt(T / n_points)) * (discount *
    else
        expect_control_0 = exp(beta * sigma * sqrt(T / n_points)) * (S0 * exp(si

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for (i = 1; i <= n_paths; i++)
{
    jump_number = pnl_rand_poisson(lambda * T, generator); // number of jumps
    W[0] = 0;
    // simulation of the continuous part of the Levy process : Brownian motion
    for (j = 1; j <= n_points; j++)
    {
        W[j] = sigma * pnl_rand_normal(generator) * sqrt(pas) + nu * pas +
    }
    // simulation of the jump's times and the size of the jumps
    jump_time_vect[0] = 0;
    for (j = 1; j <= jump_number; j++)
    {
        jump_time_vect[j] = pnl_rand_uni_ab(0., T, generator);
        jump_size_vect[j] = delta * pnl_rand_normal(generator) + mean;
    }
    //rearranging jump's times in ascending order
    for (l = 0; l < jump_number; l++)
    {
        sup0 = jump_time_vect[0];
        for (j = 0; j < jump_number + 1 - l; j++)
        {
            if (jump_time_vect[j] > sup0)
            {
                sup0 = jump_time_vect[j];
                k = j;
            }
        }
        if (k != jump_number - l)
        {
            temp = jump_time_vect[jump_number - l];
            jump_time_vect[jump_number - l] = jump_time_vect[k];
            jump_time_vect[k] = temp;
        }
    }
    // simulation of one Levy path
    for (k = 1; k <= n_points; k++)
    {
        N[k] = 0;
        for (j = 1; j <= jump_number; j++)
        {

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        if (jump_time_vect[j] <= t[k])
            N[k]++;
    }
    s0 = 0;
    for (j = N[k - 1] + 1; j <= N[k]; j++)
        s0 += jump_size_vect[j];
    X[k] = X[k - 1] + (W[k] - W[k - 1]) + s0;
}
//computation of the supremum and the infimum of the Levy path and its
inf = X[0];
sup = X[0];
infw = W[0];
supw = W[0];
for (j = 1; j <= n_points; j++)
{
    if (inf > X[j])
        inf = X[j];
    if (sup < X[j])
        sup = X[j];
    if (infw > W[j])
        infw = W[j];
    if (supw < W[j])
        supw = W[j];
}
proba = 0;
exp_inf = S0 * exp(inf);
exp_infw = S0 * exp(infw);
if (exp_inf > s_shift)
{
    exp_inf = s_shift;
    proba = 1.;
}
if (exp_infw > s_shift)
{
    exp_infw = s_shift;
}
payoff = exp_inf;
control[0] = exp_infw;
exp_inf = S0 * exp(X[n_points] - sup); //antithetic variate associated
exp_infw = S0 * exp(W[n_points] - supw); //antithetic variate associat
if (exp_inf > s_shift)

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    {
        exp_inf = s_shift;
        proba += 1.;
    }
    if (exp_infw > s_shift)
    {
        exp_infw = s_shift;
    }
    proba = proba / 2;
    payoff = discount * (payoff + exp_inf) / 2;
    control[0] = discount * ((control[0] + exp_infw) / 2);
    control[1] = discount * S0 * exp(X[n_points]);
    s1 += payoff;
    s2 += payoff * payoff;
    for (j = 0; j <= 1; j++)
    {
        s[j] += control[j];
        s3[j] += control[j] * payoff;
        for (k = 0; k <= 1; k++)
            s4[j][k] += control[j] * control[k];
    }
    s5 += proba;
    s6 += proba * proba;
}
for (j = 0; j <= 1; j++)
{
    cov_payoff_control[j] = (s3[j] - s1 * s[j] / ((double)n_paths)) / (n_paths - 1);
    for (k = 0; k <= 1; k++)
    {
        var_control[j][k] = (s4[j][k] - s[j] * s[k] / ((double)n_paths)) / (n_paths - 1);
    }
}

determinant_control = var_control[0][0] * var_control[1][1] - var_control[0][1] * var_control[1][0];
coef_control[0] = (cov_payoff_control[0] * var_control[1][1] - cov_payoff_control[0][1] * var_control[1][0]) / determinant_control;
coef_control[1] = (cov_payoff_control[1] * var_control[0][0] - cov_payoff_control[0][1] * var_control[1][0]) / determinant_control;
var_payoff = (s2 - s1 * s1 / ((double)n_paths)) / (n_paths - 1);
cor_payoff_control = sqrt((coef_control[0] * cov_payoff_control[0] + coef_control[1] * cov_payoff_control[1] - 2 * coef_control[0] * coef_control[1] * var_payoff)) / sqrt(var_payoff);
var_proba = (s6 - s5 * s5 / ((double)n_paths)) / (n_paths - 1);
*ptprice = -exp(-beta * sigma * sqrt(T / n_points)) * (s1 / n_paths - coef_control[0] * var_payoff);
*priceerror = exp(-beta * sigma * sqrt(T / n_points)) * 1.96 * sqrt(var_payoff);
*ptdelta = (*ptprice + (S0 * exp(-divid * T) - K * exp(-r * T)) + discount

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        *deltaerror = (*priceerror + discount * s_maxmin * 1.96 * sqrt(var_proba)
    }
else//Call
    if ((P->Compute) == &Call_OverSpot2)
    {
        s_maxmin = MAX(s_maxmin, K);
        s_shift = exp(-beta * sigma * sqrt(T / n_points)) * s_maxmin;
        e1 = (log(S0 / s_maxmin) * (S0 < s_maxmin) + (nu + sigma * sigma) * T) /
        e2 = e1 - sigma * sqrt(T);
        e3 = (log(S0 / s_maxmin) * (S0 < s_maxmin) - nu * T) / (sigma * sqrt(T))
        //first control variable's expected value : it's the exponential of the
        if (S0 <= s_maxmin)
            expect_control_0 = exp(-beta * sigma * sqrt(T / n_points)) * (discount
        else
            expect_control_0 = exp(-beta * sigma * sqrt(T / n_points)) * (S0 * exp
        for (i = 0; i < n_paths; i++)
        {
            jump_number = pnl_rand_poisson(lambda * T, generator); // number of
            W[0] = 0;
            //simulation of the continuous part of the Levy : Brownian motion pa
            for (j = 1; j <= n_points; j++)
            {
                W[j] = sigma * pnl_rand_normal(generator) * sqrt(pas) + nu * pas
            }
            jump_time_vect[0] = 0;
            // simulation of the jump's times and the size of the jumps
            for (j = 1; j <= jump_number; j++)
            {
                jump_time_vect[j] = pnl_rand_uni_ab(0., T, generator);
                jump_size_vect[j] = delta * pnl_rand_normal(generator) + mean;
            }
            //rearranging jump's times in ascending order
            for (l = 0; l < jump_number; l++)
            {
                sup0 = jump_time_vect[0];
                for (j = 0; j < jump_number + 1 - l; j++)
                {
                    if (jump_time_vect[j] > sup0)
                    {
                        sup0 = jump_time_vect[j];
                        k = j;

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    }
  }
  if (k != jump_number - 1)
  {
    temp = jump_time_vect[jump_number - 1];
    jump_time_vect[jump_number - 1] = jump_time_vect[k];
    jump_time_vect[k] = temp;
  }
}
// simulation of one Levy path
for (k = 1; k <= n_points; k++)
{
  N[k] = 0;
  for (j = 1; j <= jump_number; j++)
  {
    if (jump_time_vect[j] <= t[k])
      N[k]++;
  }
  s0 = 0;
  for (j = N[k - 1] + 1; j <= N[k]; j++)
    s0 += jump_size_vect[j];
  X[k] = X[k - 1] + (W[k] - W[k - 1]) + s0;
}
//computation of the supremum and the infimum of the Levy path and i
sup = X[0];
inf = X[0];
infw = W[0];
supw = W[0];
for (j = 1; j <= n_points; j++)
{
  if (inf > X[j])
    inf = X[j];
  if (sup < X[j])
    sup = X[j];
  if (infw > W[j])
    infw = W[j];
  if (supw < W[j])
    supw = W[j];
}
proba = 0;
exp_sup = S0 * exp(sup);

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exp_supw = S0 * exp(supw);
if (exp_sup < s_shift)
{
    exp_sup = s_shift;
    proba = 1.;
}
if (exp_supw < s_shift)
{
    exp_supw = s_shift;
}
payoff = exp_sup;
control[0] = exp_supw;
exp_sup = S0 * exp(X[n_points] - inf); //antithetic variate associat
exp_supw = S0 * exp(W[n_points] - infw); //antithetic variate associ
if (exp_sup < s_shift)
{
    exp_sup = s_shift;
    proba += 1.;
}
if (exp_supw < s_shift)
{
    exp_supw = s_shift;
}
proba = proba / 2.;
payoff = discount * (payoff + exp_sup) / 2;
control[0] = discount * (control[0] + exp_supw) / 2;
control[1] = discount * S0 * exp(X[n_points]);
s1 += payoff;
s2 += payoff * payoff;
for (j = 0; j <= 1; j++)
{
    s[j] += control[j];
    s3[j] += control[j] * payoff;
    for (k = 0; k <= 1; k++)
        s4[j][k] += control[j] * control[k];
}
s5 += proba;
s6 += proba * proba;
}
for (j = 0; j <= 1; j++)
{

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        cov_payoff_control[j] = (s3[j] - s1 * s[j] / ((double)n_paths)) / (n_paths - 1);
        for (k = 0; k <= 1; k++)
        {
            var_control[j][k] = (s4[j][k] - s[j] * s[k] / ((double)n_paths)) / (n_paths - 1);
        }
    }
    determinant_control = var_control[0][0] * var_control[1][1] - var_control[0][1] * var_control[1][0];
    coef_control[0] = (cov_payoff_control[0] * var_control[1][1] - cov_payoff_control[1][0] * var_control[0][1]) / determinant_control;
    coef_control[1] = (cov_payoff_control[1] * var_control[0][0] - cov_payoff_control[0][1] * var_control[1][0]) / determinant_control;
    var_payoff = (s2 - s1 * s1 / ((double)n_paths)) / (n_paths - 1);
    cor_payoff_control = sqrt((coef_control[0] * cov_payoff_control[0] + coef_control[1] * cov_payoff_control[1]) / var_payoff);
    var_proba = (s6 - s5 * s5 / ((double)n_paths)) / (n_paths - 1);
    *ptprice = exp(beta * sigma * sqrt(T / n_points)) * (s1 / n_paths - coef_control[0] * var_payoff * cor_payoff_control);
    *priceerror = exp(beta * sigma * sqrt(T / n_points)) * 1.96 * sqrt(var_proba);
    *ptdelta = (*ptprice + (K * exp(-r * T) - S0 * exp(-divid * T)) - discount) / *priceerror;
    *deltaerror = (*priceerror + discount * s_maxmin * 1.96 * sqrt(var_proba));
}

free(X);
free(W);
free(t);
free(N);
free(coef_control);
free(control);
free(s);
free(s3);
free(cov_payoff_control);
for (i = 0; i <= 1; i++)
{
    free(var_control[i]);
    free(s4[i]);
}
free(var_control);
free(s4);
free(jump_time_vect);
free(jump_size_vect);
return OK;
}

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

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    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 Merton_Mc_FixedLookback((ptOpt->PathDep.Val.V_NUMFUNC_2)->Par[4].Val.V
                                   ptOpt->PayOff.Val.V_NUMFUNC_2,
                                   ptMod->S0.Val.V_PDOUBLE,
                                   ptOpt->Maturity.Val.V_DATE - ptMod->T.Val.V_DA
                                   r, divid, ptMod->Sigma.Val.V_PDOUBLE,
                                   ptMod->Lambda.Val.V_PDOUBLE, ptMod->Mean.Val.V
                                   Met->Par[0].Val.V_ENUM.value, Met->Par[1].Val.
                                   &(Met->Res[0].Val.V_DOUBLE), &(Met->Res[1].Val

}

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

#endif //PremiaCurrentVersion
static int MET(Init)(PricingMethod *Met, Option *Mod)
{
    if (Met->init == 0)
    {
        Met->init = 1;
        Met->Par[0].Val.V_ENUM.value = 0;
        Met->Par[0].Val.V_ENUM.members = &PremiaEnumMCRNGs;
        Met->Par[1].Val.V_PINT = 100;
        Met->Par[2].Val.V_LONG = 10000;
    }
    return OK;
}

PricingMethod MET(MC_Merton_FixedLookback) =
{
    "MC_Merton_FixedLookback",

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```
{ {"RandomGenerator", ENUM, {100}, ALLOW},
  {"Number of discretization steps", LONG, {100}, ALLOW}, {"N iterations", LONG, {100}, ALLOW},
},
CALC(MC_Merton_FixedLookback),
{{"Price", DOUBLE, {100}, FORBID}, {"Delta", DOUBLE, {100}, FORBID}, {"Price Elasticity", DOUBLE, {100}, FORBID}},
CHK_OPT(MC_Merton_FixedLookback),
CHK_ok,
MET(Init)
} ;
```