

[Help](#)

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#include<stdlib.h>
#include<math.h>
#include"pnl/pnl_random.h"
#include"pnl/pnl_specfun.h"
#include"pnl/pnl_mathtools.h"
#include "nig1d_pad.h"

#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2011+2) //The "#els
static int CHK_OPT(MC_NIG_FixedAsian)(void *Opt, void *Mod)
{
    return NONACTIVE;
}
int CALC(MC_NIG_FixedAsian)(void *Opt, void *Mod, PricingMethod *Met)
{
    return AVAILABLE_IN_FULL_PREMIA;
}
#else
//Compute the positive or negative jump size between the smallest and the bigges
static double jump_generator_NIG(double *cdf_jump_vect, double *cdf_jump_points,
{
    double z, v, y;
    int test, temp, l, j, q;
    test = 0;
    v = pnl_rand_uni(generator);
    y = cdf_jump_vect[cdf_jump_vect_size] * v;
    l = cdf_jump_vect_size / 2;
    j = cdf_jump_vect_size;
    z = 0;
    if (cdf_jump_vect[l] > y)
    {
        l = 0;
        j = cdf_jump_vect_size / 2;
    }
    if (v == 1)
    {
        z = cdf_jump_points[cdf_jump_vect_size];
    }
    if (v == 0)
    {

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        z = cdf_jump_points[0];
    }
    if (v != 1 && v != 0)
    {
        while (test == 0)
        {
            if (cdf_jump_vect[l + 1] > y)
            {
                q = l;
                test = 1;
            }
            else
            {
                temp = (j - l - 1) / 2 + 1;
                if (cdf_jump_vect[temp] > y)
                {
                    j = temp;
                    l = l + 1;
                }
                else
                {
                    l = temp * (temp > 1) + (l + 1) * (temp <= 1);
                }
            }
        }
        z = pow(1. / cdf_jump_points[q] - (y - cdf_jump_vect[q]) * exp(-beta * cdf_jump_points[q]), 1 / beta);
    }
    return z;
}

//(exp(x)-1)/x
static double p_func(double x)
{
    double s;
    int i, n;
    n = 1;
    s = 0;
    for (i = 0; i <= n; i++)
        s += pow(x, i) / pnl_fact(i + 1);

    return s;
}

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}

//(4exp(x)+(2x-3)exp(2x)-1)/x^3
static double var_func(double x)
{
    double s;
    int i, n;
    n = 1;
    s = 0;
    for (i = 0; i <= n; i++)
        s += 4 * pow(x, i) / pnl_fact(i + 3) - 3 * pow(2., i + 3) * pow(x, i) / pnl_

    return s;
}

//exp(x)/x-(exp(x)-1)/x^2
static double cov_func(double x)
{
    double s;
    int i, n;
    n = 1;
    s = 0;
    for (i = 0; i <= n; i++)
        s += pow(x, i) * (1. / pnl_fact(i + 1) - 1. / pnl_fact(i + 2));

    return s;
}

static int NIG_Mc_FixedAsian(NumFunc_2 *P, double S0, double
                                T, double r, double divid, double sigma, double the
{
    double eps, s, s1, s2, s3, s4, s5, s6, payoff, dpayoff, control, discount, w1,
    double lambda_p, control_expec, lambda_m, cdf_jump_bound, pas, cov_payoff_cont
    double cor_payoff_control, control_coef, var_dpayoff, *cdf_jump_points, *cdf_j
    double *cdf_jump_vect_m, *Xg, *Xd, tau, *jump_time_vect, *jump_time_vect_p, *j
    double alpha, beta, delta, var_temp, cov_temp, *vect_temp, g_temp, K;
    int i, j, k, jump_number_p, jump_number_m, jump_number, m1, m2, cdf_jump_vect_
    K = P->Par[0].Val.V_DOUBLE;
    n_int = 10000;
    discount = exp(-r * T);
    err = 1E-16;

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eps = 0.1;
cdf_jump_vect_size = 100000;
if (r - divid != 0)
    control_expec = S0 * (exp((r - divid) * T) - 1) / ((r - divid) * T);
else
    control_expec = S0;
s = 0;
s1 = 0;
s2 = 0;
s3 = 0;
s4 = 0;
s5 = 0;
s6 = 0;
alpha = sqrt(theta * theta + sigma * sigma / kappa) / (sigma * sigma);
beta = theta / (sigma * sigma);
delta = sigma / sqrt(kappa);
if (alpha - fabs(beta) < 1)
{
    printf("Function NIG_Mc_FixedAsian: invalid parameters. We must have sqrt(
}
while (delta * exp(-fabs(beta)*eps) / (M_PI * eps) < 10)
    eps = eps * 0.9;
////////////////////////////////////
cdf_jump_bound = 1;
//Computation of the biggest jump that we tolerate
while (2 * sqrt(alpha / (2 * M_PI))*delta * exp(-(alpha - fabs(beta))*cdf_jump
    cdf_jump_bound++;
pas = (cdf_jump_bound - eps) / cdf_jump_vect_size;
cdf_jump_points = malloc((cdf_jump_vect_size + 1) * sizeof(double));
cdf_jump_vect_p = malloc((cdf_jump_vect_size + 1) * sizeof(double));
cdf_jump_vect_m = malloc((cdf_jump_vect_size + 1) * sizeof(double));
cdf_jump_points[0] = eps;
cdf_jump_vect_p[0] = 0;
cdf_jump_vect_m[0] = 0;
//computation of the cdf of the positive and negative jumps at some points
for (i = 1; i <= cdf_jump_vect_size; i++)
{
    cdf_jump_points[i] = i * pas + eps;
    cdf_jump_vect_p[i] = cdf_jump_vect_p[i - 1] + exp(beta * cdf_jump_points[i]
    cdf_jump_vect_m[i] = cdf_jump_vect_m[i - 1] + exp(-beta * cdf_jump_points[i]
}

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    lambda_p = cdf_jump_vect_p[cdf_jump_vect_size] * alpha * delta / M_PI;
    lambda_m = cdf_jump_vect_m[cdf_jump_vect_size] * alpha * delta / M_PI;
    //////////////////////////////////////
    sigma0 = 0;
    for (i = 1; i <= n_int; i++)
        sigma0 += (eps * i / n_int) * cosh(beta * i * eps / n_int) * pnl_bessel_k(1.
    sigma0 = sqrt(sigma0 * alpha * delta * 2 / M_PI);
    drift = 0;
    for (i = 1; i <= n_int; i++)
        drift += sinh(beta * i * eps / n_int) * pnl_bessel_k(1., alpha * i * eps / n
    drift = drift * alpha * delta * 2 / M_PI + (r - divid) - delta * (sqrt(alpha *
    //////////////////////////////////////
    m1 = (int)(1000 * lambda_p * T);
    m2 = (int)(1000 * lambda_m * T);
    jump_time_vect_p = malloc((m1) * sizeof(double));
    jump_time_vect_m = malloc((m2) * sizeof(double));
    jump_time_vect = malloc((m1 + m2) * sizeof(double));
    vect_temp = malloc((m1 + m2) * sizeof(double));
    jump_time_vect_p[0] = 0;
    jump_time_vect_m[0] = 0;
    jump_time_vect[0] = 0;
    vect_temp[0] = 0;
    Xg = malloc((m1 + m2) * sizeof(double)); //left value of X at jump times
    Xd = malloc((m1 + m2) * sizeof(double)); //right value of X at jump times
    Xg[0] = 0;
    Xd[0] = 0;
    //////////////////////////////////////
    pnl_rand_init(generator, 1, n_paths);
    /*Call Case*/
    if ((P->Compute) == &Call_OverSpot2)
    {
        for (i = 0; i < n_paths; i++)
        {
            //simulation of the positive jump times and number
            tau = -(1 / lambda_p) * log(pnl_rand_uni(generator));
            jump_number_p = 0;
            while (tau < T)
            {
                jump_number_p++;
                jump_time_vect_p[jump_number_p] = tau;
                tau += -1 / (lambda_p) * log(pnl_rand_uni(generator));
            }
        }
    }

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    }
    //simulation of the negative jump times and number
    tau = -(1 / lambda_m) * log(pnl_rand_uni(generator));
    jump_number_m = 0;
    while (tau < T)
    {
        jump_number_m++;
        jump_time_vect_m[jump_number_m] = tau;
        tau += -1 / (lambda_m) * log(pnl_rand_uni(generator));
    }
    jump_time_vect_p[jump_number_p + 1] = T;
    jump_time_vect_m[jump_number_m + 1] = T;
    jump_number = jump_number_p + jump_number_m;
    //////////////////////////////////////
    //computation of Xg and Xd
    k1 = 1;
    k2 = 1;
    u0 = 0;
    u = 0;
    for (k = 1; k <= jump_number; k++)
    {
        w1 = jump_time_vect_p[k1];
        w2 = jump_time_vect_m[k2];
        if (w1 < w2)
        {
            u = w1;
            k1++;
            z = jump_generator_NIG(cdf_jump_vect_p, cdf_jump_points, cdf_j
        }
        else
        {
            u = w2;
            k2++;
            z = -jump_generator_NIG(cdf_jump_vect_m, cdf_jump_points, cdf_
        }
        g_temp = pnl_rand_normal(generator);
        if (fabs(drift * (u - u0)) < 1e-4)
        {
            var_temp = (u - u0) * (u - u0) * (u - u0) * var_func(drift * (
            cov_temp = (u - u0) * (u - u0) * cov_func(drift * (u - u0));
        }
    }

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else
{
    var_temp = (4 * exp(drift * (u - u0)) + (2 * drift * (u - u0)
    cov_temp = (u - u0) * exp(drift * (u - u0)) / drift - (exp(dri
}
jump_time_vect[k] = u;
vect_temp[k] = cov_temp * g_temp / (sqrt(u - u0)) + sqrt(var_temp
Xg[k] = drift * (u - u0) + sigma0 * g_temp * sqrt(u - u0) + Xd[k -
Xd[k] = Xg[k] + z;
u0 = u;
}
g_temp = pnl_rand_normal(generator);
if (fabs(drift * (T - u0)) < 1e-4)
{
    var_temp = (T - u0) * (T - u0) * (T - u0) * var_func(drift * (T -
    cov_temp = (T - u0) * (T - u0) * cov_func(drift * (T - u0));
}
else
{
    var_temp = (4 * exp(drift * (T - u0)) + (2 * drift * (T - u0) - 3)
    cov_temp = (T - u0) * exp(drift * (T - u0)) / drift - (exp(drift *
}
jump_time_vect[jump_number + 1] = T;
vect_temp[jump_number + 1] = cov_temp * g_temp / (sqrt(T - u0)) + sqrt
Xg[jump_number + 1] = drift * (T - u0) + sigma0 * g_temp * sqrt(T - u0
Xd[jump_number + 1] = Xg[jump_number + 1];
////////////////////////////////////
//computation of the payoff
payoff = 0;
for (j = 1; j <= jump_number + 1; j++)
{
    if (fabs(drift * (jump_time_vect[j] - jump_time_vect[j - 1])) < 1e
        payoff += exp(Xd[j - 1]) * (p_func(drift * (jump_time_vect[j] -
    else
        payoff += exp(Xd[j - 1]) * ((exp(drift * (jump_time_vect[j] - ju
}
control = S0 * payoff / T;
dpayoff = -discount * (payoff / T) * (S0 * payoff / T < K);
payoff = discount * (K - S0 * payoff / T) * (S0 * payoff / T < K);
s1 += payoff;
s += payoff * payoff;

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        s2 += control;
        s3 += control * control;
        s4 += control * payoff;
        s5 += dpayoff;
        s6 += dpayoff * dpayoff;
    }
    cov_payoff_control = s4 / n_paths - s1 * s2 / ((double)n_paths * n_paths);
    var_payoff = (s - s1 * s1 / ((double)n_paths)) / (n_paths - 1);
    var_control = (s3 - s2 * s2 / ((double)n_paths)) / (n_paths - 1);
    cor_payoff_control = cov_payoff_control / (sqrt(var_payoff) * sqrt(var_control));
    control_coef = cov_payoff_control / var_control;
    var_dpayoff = (s6 - s5 * s5 / ((double)n_paths)) / (n_paths - 1);
    if (r != divid)
        *ptprice = (s1 / n_paths - control_coef * (s2 / n_paths - control_expect));
    else
        *ptprice = (s1 / n_paths - control_coef * (s2 / n_paths - control_expect));
    *priceerror = 1.96 * sqrt(var_payoff * (1 - cor_payoff_control * cor_payoff));
    if (r != divid)
        *ptdelta = s5 / (n_paths) + (exp(-divid * T) - exp(-r * T)) / ((r - divid));
    else
        *ptdelta = s5 / (n_paths) + exp(-r * T);
    *deltaerror = 1.96 * sqrt(var_dpayoff) / sqrt(n_paths);
}
/*Put case*/
if ((P->Compute) == &Put_OverSpot2)
{
    for (i = 0; i < n_paths; i++)
    {
        //simulation of the positive jump times and number
        tau = -(1 / lambda_p) * log(pnl_rand_uni(generator));
        jump_number_p = 0;
        while (tau < T)
        {
            jump_number_p++;
            jump_time_vect_p[jump_number_p] = tau;
            tau += -1 / (lambda_p) * log(pnl_rand_uni(generator));
        }
        //simulation of the negative jump times and number
        tau = -(1 / lambda_m) * log(pnl_rand_uni(generator));
        jump_number_m = 0;
        while (tau < T)

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{
    jump_number_m++;
    jump_time_vect_m[jump_number_m] = tau;
    tau += -1 / (lambda_m) * log(pnl_rand_uni(generator));
}
jump_time_vect_p[jump_number_p + 1] = T;
jump_time_vect_m[jump_number_m + 1] = T;
jump_number = jump_number_p + jump_number_m;
////////////////////////////////////
//computation of Xg and Xd
k1 = 1;
k2 = 1;
u0 = 0;
u = 0;
for (k = 1; k <= jump_number; k++)
{
    w1 = jump_time_vect_p[k1];
    w2 = jump_time_vect_m[k2];
    if (w1 < w2)
    {
        u = w1;
        k1++;
        z = jump_generator_NIG(cdf_jump_vect_p, cdf_jump_points, cdf_j
    }
    else
    {
        u = w2;
        k2++;
        z = -jump_generator_NIG(cdf_jump_vect_m, cdf_jump_points, cdf_
    }
    g_temp = pnl_rand_normal(generator);
    if (fabs(drift * (u - u0)) < 1e-4)
    {
        var_temp = (u - u0) * (u - u0) * (u - u0) * var_func(drift * (
        cov_temp = (u - u0) * (u - u0) * cov_func(drift * (u - u0));
    }
    else
    {
        var_temp = (4 * exp(drift * (u - u0)) + (2 * drift * (u - u0)
        cov_temp = (u - u0) * exp(drift * (u - u0)) / drift - (exp(dri
    }
}

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        jump_time_vect[k] = u;
        vect_temp[k] = cov_temp * g_temp / (sqrt(u - u0)) + sqrt(var_temp) * g_temp;
        Xg[k] = drift * (u - u0) + sigma0 * g_temp * sqrt(u - u0) + Xd[k] - drift * u;
        Xd[k] = Xg[k] + z;
        u0 = u;
    }
    g_temp = pnl_rand_normal(generator);
    if (fabs(drift * (T - u0)) < 1e-4)
    {
        var_temp = (T - u0) * (T - u0) * (T - u0) * var_func(drift * (T - u0));
        cov_temp = (T - u0) * (T - u0) * cov_func(drift * (T - u0));
    }
    else
    {
        var_temp = (4 * exp(drift * (T - u0)) + (2 * drift * (T - u0) - 3) * exp(drift * (T - u0))) * (T - u0);
        cov_temp = (T - u0) * exp(drift * (T - u0)) / drift - (exp(drift * (T - u0)) + 1) * (T - u0);
    }
    jump_time_vect[jump_number + 1] = T;
    vect_temp[jump_number + 1] = cov_temp * g_temp / (sqrt(T - u0)) + sqrt(var_temp) * g_temp;
    Xg[jump_number + 1] = drift * (T - u0) + sigma0 * g_temp * sqrt(T - u0) + Xd[jump_number] - drift * u;
    Xd[jump_number + 1] = Xg[jump_number + 1];
    //////////////////////////////////////
    //computation of the payoff
    payoff = 0;
    for (j = 1; j <= jump_number + 1; j++)
    {
        if (fabs(drift * (jump_time_vect[j] - jump_time_vect[j - 1])) < 1e-4)
            payoff += exp(Xd[j - 1]) * (p_func(drift * (jump_time_vect[j] - jump_time_vect[j - 1])) - 1);
        else
            payoff += exp(Xd[j - 1]) * ((exp(drift * (jump_time_vect[j] - jump_time_vect[j - 1])) - 1) / drift);
    }
    control = S0 * payoff / T;
    dpayoff = -discount * (payoff / T) * (S0 * payoff / T < K);
    payoff = discount * (K - S0 * payoff / T) * (S0 * payoff / T < K);
    s1 += payoff;
    s += payoff * payoff;
    s2 += control;
    s3 += control * control;
    s4 += control * payoff;
    s5 += dpayoff;
    s6 += dpayoff * dpayoff;

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    }
    cov_payoff_control = s4 / n_paths - s1 * s2 / ((double)n_paths * n_paths);
    var_payoff = (s - s1 * s1 / ((double)n_paths)) / (n_paths - 1);
    var_control = (s3 - s2 * s2 / ((double)n_paths)) / (n_paths - 1);
    cor_payoff_control = cov_payoff_control / (sqrt(var_payoff) * sqrt(var_con
    control_coef = cov_payoff_control / var_control;
    var_dpayoff = (s6 - s5 * s5 / ((double)n_paths)) / (n_paths - 1);
    *ptprice = (s1 / n_paths - control_coef * (s2 / n_paths - control_expec));
    *priceerror = 1.96 * sqrt(var_payoff * (1 - cor_payoff_control * cor_payof
    *ptdelta = s5 / (n_paths);
    *deltaerror = 1.96 * sqrt(var_dpayoff) / sqrt(n_paths);
}
free(Xd);
free(Xg);
free(cdf_jump_points);
free(cdf_jump_vect_p);
free(cdf_jump_vect_m);
free(jump_time_vect_p);
free(jump_time_vect_m);
free(jump_time_vect);
free(vect_temp);

return OK;
}
int CALC(MC_NIG_FixedAsian)(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 NIG_Mc_FixedAsian(ptOpt->PayOff.Val.V_NUMFUNC_2, ptMod->S0.Val.V_PDOUN
}

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

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}

#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_LONG = 100000;
    }
    return OK;
}

PricingMethod MET(MC_NIG_FixedAsian) =
{
    "MC_NIG_AsianFixed",
    {"RandomGenerator", ENUM, {100}, ALLOW}, {"N iterations", LONG, {100}, ALLOW},
    CALC(MC_NIG_FixedAsian),
    {"Price", DOUBLE, {100}, FORBID}, {"Delta", DOUBLE, {100}, FORBID}, {"Price E
    CHK_OPT(MC_NIG_FixedAsian),
    CHK_ok,
    MET(Init)
} ;

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