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extern "C" {
#include "variancegamma1d_stda.h"
#include "enums.h"
#include "pnl/pnl_finance.h"
}
#include "math/levy.h"
#include "math/fft.h"

extern "C" {

#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2014+2) //The "#els
    static int CHK_OPT(AP_GAP_VARIANCEGAMMA)(void *Opt, void *Mod)
    {
        return NONACTIVE;
    }
    int CALC(AP_GAP_VARIANCEGAMMA)(void *Opt, void *Mod, PricingMethod *Met)
    {
        return AVAILABLE_IN_FULL_PREMIA;
    }
#else

    static int Ap_Gap_Variancegamma(double S0, NumFunc_1 *p, int numberperiod, do
    {
        /* Declarations */
        // Integration parameters
        int Nlimit = 2048; // Number of integral discretization steps
        double logstrikestep;
        double k0; // log-moneyness strike
        double h; // Integral discretization step
        double A; // Integration domain is (-A/2,A/2)
        double vn;
        double weight; // Simpson's rule weights

        // Black-Scholes formula
        double sigmaBS;
        double d1;
        double d2;
        double CallBS;
        double DeltaBS;
```

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// Array and variables for integration
std::vector<double> x(Nlimit), x_img(Nlimit), y(Nlimit), y_img(Nlimit), z(Nlimit);
complex<double> dphi;
complex<double> dzeta;

double price;
double delta;
double cdf;
int n;
double strike;
double betagap, deltagap;

strike = p->Par[0].Val.V_DOUBLE;
if ((S0 < strike))
{
    return GAP_SHOULD_BE_NEGATIVE;
}
deltagap = T / (double)numberperiod;
betagap = log(alpha_gap);

/* Compute simultaneously the put part and the CDF. */

S0 *= exp(-divid * deltagap); // Taking account of dividends

Nlimit = 2048; // Number of integral discretization steps
logstrikestep = 0.01;
k0 = log(strike / S0);
h = 2 * M_PI / Nlimit / logstrikestep; // Integral discretization step
A = (Nlimit - 1) * h; // Integration domain is (-A/2,A/2)

// Black-Scholes formula
sigmaBS = 0.2;
d1 = (log(S0 / strike) + (r + sigmaBS * sigmaBS / 2) * deltagap) / sigmaBS;
d2 = d1 - sigmaBS * sqrt(deltagap);
CallBS = S0 * normCDF(d1) - strike * exp(-r * deltagap) * normCDF(d2);
DeltaBS = normCDF(d1);

// Construction of the model
VG_measure measure(theta, sigma, kappa, 0.1);

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vn = -A / 2;
weight = 1. / 3; //Simpson's rule weights

dphi = -exp(-I * vn * betagap) * (measure.cf(deltagap, vn)
                                   - exp(-sigmaBS * sigmaBS / 2.*vn * vn)) /
dzeta = exp(I * vn * (r * deltagap - k0)) * (measure.cf(deltagap, vn - I)
        - exp(-deltagap * sigmaBS * sigmaBS / 2.*(vn - I) * vn)) / (I * vn);
// cdf
x[0] = weight * real(dphi);
x_img[0] = weight * imag(dphi);
// price
y[0] = weight * real(dzeta / (1. + I * vn));
y_img[0] = weight * imag(dzeta / (1. + I * vn));
// delta
z[0] = weight * real(dzeta);
z_img[0] = weight * imag(dzeta);

for (n = 1; n < Nlimit - 1; n++)
{
    vn += h;
    weight = (weight < 1) ? 4. / 3 : 2. / 3; //Simpson's rule weights

    dphi = -exp(-I * vn * betagap) * (measure.cf(deltagap, vn)
                                        - exp(-sigmaBS * sigmaBS / 2.*vn * vn))
dzeta = exp(I * vn * (r * deltagap - k0)) * (measure.cf(deltagap, vn - I)
        - exp(-deltagap * sigmaBS * sigmaBS / 2.*(vn - I) * vn)) / (I *
// cdf
x[n] = weight * real(dphi);
x_img[n] = weight * imag(dphi);
// price
y[n] = weight * real(dzeta / (1. + I * vn));
y_img[n] = weight * imag(dzeta / (1. + I * vn));
// delta
z[n] = weight * real(dzeta);
z_img[n] = weight * imag(dzeta);
}
vn += h;
weight = 2. / 3; //Simpson's rule weights

dphi = -exp(-I * vn * betagap) * (measure.cf(deltagap, vn)
                                   - exp(-sigmaBS * sigmaBS / 2.*vn * vn)) /

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dzeta = exp(I * vn * (r * deltagap - k0)) * (measure.cf(deltagap, vn - I)
        - exp(-deltagap * sigmaBS * sigmaBS / 2.*(vn - I) * vn)) / (I * vn);
// cdf
x[Nlimit - 1] = weight * real(dphi);
x_img[Nlimit - 1] = weight * imag(dphi);
// price
y[Nlimit - 1] = weight * real(dzeta / (1. + I * vn));
y_img[Nlimit - 1] = weight * imag(dzeta / (1. + I * vn));
// delta
z[Nlimit - 1] = weight * real(dzeta);
z_img[Nlimit - 1] = weight * imag(dzeta);

fft1d(&x[0], &x_img[0], Nlimit, -1);
fft1d(&y[0], &y_img[0], Nlimit, -1);
fft1d(&z[0], &z_img[0], Nlimit, -1);

// Compute call
price = CallBS + S0 * A / 2. / M_PI / (Nlimit - 1) * y[0];
delta = exp(-divid * deltagap) * (DeltaBS + A / 2. / M_PI / (Nlimit - 1) * z
// Compute Put via parity
price = price - S0 + strike * exp(-r * deltagap);
delta = delta - exp(-divid * deltagap);
// Compute CDF
cdf = normCDF(betagap) + A / 2. / M_PI / (Nlimit - 1) * x[0];

/* Compute the gap option price. */
*ptprice = exp(-r * deltagap) * price * (1. - exp(-r * T) *
        std::pow(1. - cdf, numberperiod)) / (1. - exp(-r * deltagap) * (1
*ptdelta = exp(-r * deltagap) * delta * (1. - exp(-r * T) *
        std::pow(1. - cdf, numberperiod)) / (1. - exp(-r * deltagap) * (1

return OK;
}

int CALC(AP_GAP_VARIANCEGAMMA)(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.);

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        divid = log(1. + ptMod->Divid.Val.V_DOUBLE / 100.);

        return Ap_Gap_Variancegamma(ptMod->S0.Val.V_PDOUBLE, ptOpt->PayOff.Val.V_NUM
    }

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

#endif //PremiaCurrentVersion

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

PricingMethod MET(AP_GAP_VARIANCEGAMMA) =
{
    "AP_GAP_VARIANCEGAMMA",
    {" ", PREMIA_NULLTYPE, {0}, FORBID}},
    CALC(AP_GAP_VARIANCEGAMMA),
    {"Price", DOUBLE, {100}, FORBID}, {"Delta", DOUBLE, {100}, FORBID}, {" ", P
    CHK_OPT(AP_GAP_VARIANCEGAMMA),
    CHK_split,
    MET(Init)
};
}

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