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#include "nig1d_pad.h"
#include "pnl/pnl_fft.h"
#include "pnl/pnl_complex.h"
#include "pnl/pnl_vector.h"

#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2011+2) //The "#els
static int CHK_OPT(FFT_NIG_FloatingLookback)(void *Opt, void *Mod)
{
    return NONACTIVE;
}
int CALC(FFT_NIG_FloatingLookback)(void *Opt, void *Mod, PricingMethod *Met)
{
    return AVAILABLE_IN_FULL_PREMIA;
}
#else

// "resultat takes the product of a circulant matrix M(c) and a vector x
static void circulante(PnlVectComplex *resultat, PnlVectComplex *c, PnlVectComplex *x)
{
    PnlVectComplex *temp;
    int i, n;
    n = x->size;
    temp = pnl_vect_complex_create(n);

    pnl_fft(c, temp);
    pnl_fft(x, resultat);
    for (i = 0; i < n; i++)
    {
        pnl_vect_complex_set(temp, i, Cmul(pnl_vect_complex_get(temp, i), pnl_vect_complex_get(resultat, i)));
    }
    pnl_ifft(temp, resultat);
    pnl_vect_complex_free(&temp);
}

// "r" takes the product of the toeplitz matrix N(v,w) with holes and a vector x
static void toep(PnlVectComplex *v, PnlVectComplex *w, PnlVectComplex *x, PnlVectComplex *r)
{
    int M, i;
    PnlVectComplex *temp;

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PnlVectComplex *temp2;
PnlVectComplex *x2;
M = v->size;
temp = pnl_vect_complex_create(4 * M);
temp2 = pnl_vect_complex_create(4 * M);
x2 = pnl_vect_complex_create(4 * M);
pnl_vect_complex_set(temp, 0, CRmul(CONE, 0.5));
for (i = 1; i < 2 * M + 1; i = i + 2)
{
    pnl_vect_complex_set(temp, i, pnl_vect_complex_get(v, (i - 1) / 2));
    pnl_vect_complex_set(temp, i + 1, CZERO);
}
for (i = 2 * M + 1; i < 4 * M - 1; i = i + 2)
{
    pnl_vect_complex_set(temp, i, pnl_vect_complex_get(w, (M - 1) - ((i - 1) -
    pnl_vect_complex_set(temp, i + 1, CZERO);
}
pnl_vect_complex_set(temp, i, pnl_vect_complex_get(w, (M - 1) - ((4 * M - 1 -
for (i = 0; i < 2 * M + 1; i++)
    pnl_vect_complex_set(x2, i, pnl_vect_complex_get(x, i));
for (i = 2 * M + 1; i < 4 * M; i++)
    pnl_vect_complex_set(x2, i, CZERO);
circulante(temp2, temp, x2);
for (i = 0; i < 2 * M + 1; i++)
    pnl_vect_complex_set(r, i, pnl_vect_complex_get(temp2, i));

pnl_vect_complex_free(& temp);
pnl_vect_complex_free(& temp2);
pnl_vect_complex_free(& x2);
}

// the characteristic function of the NIG model
static dcomplex fi_NIG(double t, double drift, double delta, double alpha, doubl
{
    dcomplex temp1, u;
    u = CRmul(w, (double)signe);
    temp1 = RCMul(delta, CRsub(Csqrt(RCsub(pow(alpha, 2) , Cpow_real(CRadd(Cmul(CI
    temp1 = Csub(temp1, CRmul(Cmul(CI, u), drift));
    temp1 = CRmul(temp1, (-t)); //-t*delta* [sqrt(alphaÃš-(beta+iw)Ãš)-sqrt(alphaÃš
    temp1 = Cexp(temp1); //temp1=temp1.expon();

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    return temp1;
}
// the characteristic function of the NIG model after the Esscher transformation
static dcomplex fi_NIG_star(double t, double drift, double delta, double alpha,
{
    dcomplex b;
    dcomplex a;
    dcomplex c;
    a = CRmul(CI, -1);
    c = fi_NIG(t, drift, delta, alpha, beta, Cadd(u, CRmul(a, x)), signe);
    b = fi_NIG(t, drift, delta, alpha, beta, CRmul(a, x) , signe);
    a = Cdiv(c, b);

    return a;
}
//The diagonal matrix which attributes the corresponding coefficients to the calc
static void F_diag-fi_NIG(PnlVectComplex *v, double t, double drift, double del
{
    int com;

    for (com = 0; com < 2 * M + 1; com++)
        pnl_vect_complex_set(v, com, Cmul(pnl_vect_complex_get(v, com), fi_NIG_star(
}

//The diagonal matrix which attributes the corresponding coefficients to the calc
static void G_diag-fi_NIG(PnlVectComplex *v, double t, double drift, double delt
{
    int i;

    for (i = 0; i < 2 * M + 1; i++)
        pnl_vect_complex_set(v, i, Cmul(pnl_vect_complex_get(v, i), fi_NIG_star(t, d
}

// the estimation's algorithm in the NIG model with "n_point" maximum observat
static dcomplex estiation_NIG(double Xmaxmin, PnlVectComplex *G, double t, doubl
{
    int i, j;
    double Xmax;
    dcomplex C, cte, a, k;
    PnlVectComplex *v, *w, *F, *tempg, *tempf;
    F = pnl_vect_complex_create(2 * M + 1);

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v = pnl_vect_complex_create(M); //the first column vector of the Hilbert's
w = pnl_vect_complex_create(M); //the first line vector of the Hilbert's ma
tempg = pnl_vect_complex_create(2 * M + 1);
tempf = pnl_vect_complex_create(2 * M + 1);
//initialisation of v and w
cte = CONE;
C = CRmul(CI, M_1_PI); // 1/pi
for (i = 0; i < M; i = i + 1)
    pnl_vect_complex_set(v, i, CRdiv(C, (double)(2 * i + 1)));
for (i = 0; i < M; i = i + 1)
    pnl_vect_complex_set(w, i, CRdiv(C, (double)(-(2 * i + 1))));
//intialisation of G_1, F_1 and Cte_1
Xmax = MAX(Xmaxmin, 0);
for (i = 0; i < 2 * M + 1; i++)
{
    pnl_vect_complex_set(F, i, Cexp(Cmul(CRmul(CRmul(h, (double)(i - M)) , Xma
    pnl_vect_complex_set(G, i, Cexp(CRmul(CRadd(Cmul(CRmul(h, (double)(i - M))
}
F_diag_fi_NIG(F, t, drift, delta, alpha, beta, h, x, M, signe); //G=( fi_NIG(1)
toep(v, w, F, tempf);
pnl_vect_complex_clone(F, tempf);

cte = CRmul(CRsub(pnl_vect_complex_get(F, M), 1.0), -1); //1-f(0)

G_diag_fi_NIG(G, t, drift, delta, alpha, beta, h, x, M, signe); //G=( fi_NIG(1)
toep(v, w, G, tempg); //temp=C(H)*G
pnl_vect_complex_clone(G, tempg);

for (j = 1; j < n_points; j++)
{
    for (i = 0; i < 2 * M + 1; i++)
    {
        pnl_vect_complex_set(F, i, Cadd(cte, pnl_vect_complex_get(F, i))); //F
        pnl_vect_complex_set(G, i, Cadd(cte, pnl_vect_complex_get(G, i))); //G
    }
    F_diag_fi_NIG(F, t, drift, delta, alpha, beta, h, x, M, signe); //G=( fi_NI
    toep(v, w, F, tempf); //
    pnl_vect_complex_clone(F, tempf); //F=temp=H.Df*F

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    G_diag_fi_NIG(G, t, drift, delta, alpha, beta, h, x, M, signe); //G=( fi_N
    toep(v, w, G, tempg); //temp=C(H)*G
    pnl_vect_complex_clone(G, tempg); //G=temp=H.Dg*G

    cte = CRmul(CRadd(pnl_vect_complex_get(F, M), -1), -1);

}

k = RCmul(-1, CI);
a = fi_NIG(n_points * t, drift, delta, alpha, beta, CRmul(k, x), signe);

pnl_vect_complex_set(G, M, Cmul(Cadd(pnl_vect_complex_get(G, M), cte), a));

pnl_vect_complex_free(&v);
pnl_vect_complex_free(&w);
pnl_vect_complex_free(&tempf);
pnl_vect_complex_free(&tempg);
pnl_vect_complex_free(&F);

return pnl_vect_complex_get(G, M);
}
int fft_NIG_lookbackfloating(double s_maxmin, NumFunc_2 *P, double S0, double T,
{
    double pas, d, c, drift, nu, h_temp, x_maxmin, signe, alpha, beta, delta;
    dcomplex h, res;
    PnlVectComplex *G;

    alpha = sqrt(theta * theta + sigma * sigma / kappa) / (sigma * sigma);
    beta = theta / (sigma * sigma);
    delta = sigma / sqrt(kappa);
    pas = T / n_points;
    //the width of the estimation's strip
    d = MIN(fabs(beta - alpha), fabs(beta + alpha));
    // the optimal h: h(M)//
    nu = 1;
    c = delta;
    h_temp = pow(((M_PI * d) / (pas * c)), 1.0 / (1 + nu)) * pow((double)M, -nu /
    h = CRmul(CONE, h_temp);
    //condition martingale//
    drift = r - divid + delta * (sqrt((pow(alpha, 2) - pow((1 + beta), 2))) - sqrt
    G = pnl_vect_complex_create(2 * M + 1);

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//CALL
if ((P->Compute) == &Call_StrikeSpot2)
{
    signe = -1;
    x_maxmin = signe * log((s_maxmin / S0));
    res = estiation_NIG(x_maxmin, G, pas, drift, delta, alpha, beta, h, signe);
    res = CRmul(CRsub(CRmul(res, exp(-r * T)), exp(-divid * T)), -S0);
}
//PUT
if ((P->Compute) == &Put_StrikeSpot2)
{
    signe = 1;
    x_maxmin = log((s_maxmin / S0));
    res = estiation_NIG(x_maxmin, G, pas, drift, delta, alpha, beta, h, signe);
    res = CRmul(CRsub(CRmul(res, exp(-r * T)), exp(-divid * T)), S0);
}
*ptprice = Creal(res);

pnl_vect_complex_free(&G);

return OK;
}
int CALC(FFT_NIG_FloatingLookback)(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 fft_NIG_lookbackfloating((ptOpt->PathDep.Val.V_NUMFUNC_2)->Par[4].Val.
}

static int CHK_OPT(FFT_NIG_FloatingLookback)(void *Opt, void *Mod)
{
    if ((strcmp(((Option *)Opt)->Name, "LookBackCallFloatingEuro") == 0) || (strcmp
        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->HelpFilenameHint = "ap_nig_lookbackfloating_fft";
        Met->Par[0].Val.V_PINT = 252;
        Met->Par[1].Val.V_LONG = 4096;
    }
    return OK;
}

PricingMethod MET(FFT_NIG_FloatingLookback) =
{
    "FFT_NIG_LookbackFloating",
    {{"Number of discretization steps", LONG, {100}, ALLOW}, {"N Truncation level",
    CALC(FFT_NIG_FloatingLookback),
    {"Price", DOUBLE, {100}, FORBID}, {" ", PREMIA_NULLTYPE, {0}, FORBID}},
    CHK_OPT(FFT_NIG_FloatingLookback),
    CHK_ok,
    MET(Init)
} ;
```