Help

```
#include  "
href../../../mod/hhw4d/hhw4d_stdx/hhw4d_stdx_h_src.pdfhhw4d_stdx.h"
#include <
href../../../common/math/cdo/cdo_math_h_src.pdfmath.h>
#include "pnl/pnl_vector.h"
#include "pnl/pnl_complex.h"
#include "pnl/pnl_fft.h"
#include "pnl/pnl_mathtools.h"
#include "pnl/pnl_matrix.h"
#include "pnl/pnl_integration.h"

#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2013+2) //The "#els
static int CHK_OPT(AP_HHW4D)(void *Opt, void *Mod)
{
  return NONACTIVE;
}
int CALC(AP_HHW4D)(void *Opt, void *Mod, PricingMethod *Met)
{
  return AVAILABLE_IN_FULL_PREMIA;
}
#else

static double u0, kappa0, vbar0, rho120, rho130, rho140, rho340, gammav0, rho230
dcomplex fd0, fg0;

void static funcB(double u, dcomplex *result)
{
  *result = CRmul(CI, u);
}
void static funcd(double u, double kappa, double gamma, double rho12, dcomplex *
{
  if (kappa == 0.0 || gamma == 0.0)      *result = CZERO;
  else    *result = Csqrt(Csub(Cpow_real(CRsub(CRmul(CI, rho12 * gamma * u), kap
}
void static funcg(double u, double kappa, double gamma, double rho12, dcomplex f
{
  if (Cimag(fd) == 0.0 && Creal(fd) == 0.0)   *result = CONE;
  else    *result = Cdiv(Csub(RCsub(kappa, RCmul(gamma * rho12 * u, CI)), fd), C
```

```
}
void static funcC(double u, dcomplex fd, dcomplex fg, double tau, double kappa,
{
  *result = Cmul(Cdiv(RCsub(1., Cexp(RCmul(-tau, fd))), RCmul(gamma * gamma, RCs
}
void static funcC1(double kappa, double gamma, double *result)
{
  if (kappa == 0.0 || gamma == 0.0) *result = 0.0;
  else *result = gamma * gamma * (1. - exp(-kappa)) / (4.*kappa);
}
void static funcLambda(double kappa, double v0, double gamma, double *result)
{
  if (kappa == 0.0 || gamma == 0.0) *result = 0.0;
  else *result = 4.*kappa * v0 * exp(-kappa) / (gamma * gamma * (1. - exp(-kappa
}
void static funcD1(double kappa, double vbar, double gamma, double *result)
{
  if (kappa == 0.0 || gamma == 0.0) *result = 0.0;
  else *result = 4.*kappa * vbar / (gamma * gamma);
}
void static fLambda1(double fC1, double fLambda, double fD1, double *result)
{
  if (fD1 == 0.0 || fLambda == 0.0) *result = 0.0;
  else *result = sqrt(fC1 * (fLambda - 1.) + fC1 * fD1 + fC1 * fD1 / (2.*(fD1 +
}
void static funcbeta1(double kappa, double vbar, double gamma, double *result)
{
  if (vbar - gamma * gamma / 8. / kappa < 0.0)
    {
      *result = 0.0;
      printf("Invalid parameter for vbar, gammav, kappa!\ n");
    }
  else if (kappa == 0.0 || gamma == 0.0) *result = 0.0;
  else *result = sqrt(vbar - gamma * gamma / 8. / kappa);
}
void static funcbeta2(double v0, double beta1, double *result)
{
  *result = sqrt(v0) - beta1;
}
void static funcbeta3(double beta1, double beta2, double Lambda1, double *result
{
```

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  if (beta2 == 0.0 || (Lambda1 - beta1) == 0.0) *result = 0.0;
  else *result = -log((Lambda1 - beta1) / beta2);
}
static double intgf1r(double x, void *p)
{
  dcomplex fC;
  funcC(u0, fd0, fg0, x, kappa0, gammav0, rho120, &fC);
  return (kappa0 * vbar0 + rho230 * gammav0 * etad0 * (beta10 + beta20 * exp(-be
}
static double intgf2r(double x, void *p)
{
  dcomplex fC;
  funcC(u0, fd0, fg0, x, kappa0, gammav0, rho120, &fC);
  return rho230 * etad0 * gammav0 * (beta10 + beta20 * exp(-beta30 * x)) * (exp(
}
static double intgf3r(double x, void *p)
{
  dcomplex fC;
  funcC(u0, fd0, fg0, x, kappa0, gammav0, rho120, &fC);
  return rho240 * gammav0 * etaf0 * (beta10 + beta20 * exp(-beta30 * x)) * (exp(
}
static double intgf1i(double x, void *p)
{
  dcomplex fC;
  funcC(u0, fd0, fg0, x, kappa0, gammav0, rho120, &fC);
  return (kappa0 * vbar0 + rho230 * gammav0 * etad0 * (beta10 + beta20 * exp(-be
}
static double intgf2i(double x, void *p)
{
  dcomplex fC;
  funcC(u0, fd0, fg0, x, kappa0, gammav0, rho120, &fC);
  return rho230 * etad0 * gammav0 * (beta10 + beta20 * exp(-beta30 * x)) * (exp(
}
static double intgf3i(double x, void *p)
{
  dcomplex fC;
  funcC(u0, fd0, fg0, x, kappa0, gammav0, rho120, &fC);
  return rho240 * gammav0 * etaf0 * (beta10 + beta20 * exp(-beta30 * x)) * (exp(
}
static double intgfzeta(double x, void *p)
{
```

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  return (rho130 * etad0 * (exp(-lambdad0 * (T0 - x)) - 1.) / lambdad0 - rho140
}
void static funcA(double u, double v0, double kappa, double vbar, double gammav,
{
  double intg1r = 0., intg2r = 0., intg3r = 0., intg1i = 0., intg2i = 0., intg3i
  double fC1, fLambda, fD1, Lambda1, beta1, beta2, beta3;
  dcomplex fd, fg;
  PnlFunc func1r, func2r, func3r, func1i, func2i, func3i, funczeta;
  int n = 50;
  funcd(u, kappa, gammav, rho12, &fd);
  funcg(u, kappa, gammav, rho12, fd, &fg);
  funcbeta1(kappa, vbar, gammav, &beta1);
  funcbeta2(v0, beta1, &beta2);
  funcC1(kappa, gammav, &fC1);
  funcLambda(kappa, v0, gammav, &fLambda);
  funcD1(kappa, vbar, gammav, &fD1);
  fLambda1(fC1, fLambda, fD1, &Lambda1);
  funcbeta3(beta1, beta2, Lambda1, &beta3);
  fd0 = fd;
  fg0 = fg;
  u0 = u;
  kappa0 = kappa;
  vbar0 = vbar;
  rho120 = rho12;
  rho130 = rho13;
  rho140 = rho14;
  rho340 = rho34;
  gammav0 = gammav;
  rho230 = rho23;
  etad0 = etad;
  lambdad0 = lambdad;
  rho240 = rho24;
  etaf0 = etaf;
  lambdaf0 = lambdaf;
  beta10 = beta1;
  beta20 = beta2;
  beta30 = beta3;
  T0 = T;
  func1r.F = intgf1r;
  func2r.F = intgf2r;
  func3r.F = intgf3r;
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```
  func1i.F = intgf1i;
  func2i.F = intgf2i;
  func3i.F = intgf3i;
  funczeta.F = intgfzeta;
  intg1r = pnl_integration(&func1r, 0.0, T, n, "simpson");
  intg2r = pnl_integration(&func2r, 0.0, T, n, "simpson");
  intg3r = pnl_integration(&func3r, 0.0, T, n, "simpson");
  intg1i = pnl_integration(&func1i, 0.0, T, n, "simpson");
  intg2i = pnl_integration(&func2i, 0.0, T, n, "simpson");
  intg3i = pnl_integration(&func3i, 0.0, T, n, "simpson");
  intgzeta = pnl_integration(&funczeta, 0.0, T, n, "simpson");
  *result = Cadd(RCadd(intg1r + u * intg2i - u * intg3i, RCmul(intg1i - u * intg
}
void static chf(double u, double v0, double kappa, double vbar, double gammav, d
{
  dcomplex fb, fd, fg, fc, fa, expon;
  funcB(u, &fb);
  funcd(u, kappa, gammav, rho12, &fd);
  funcg(u, kappa, gammav, rho12, fd, &fg);
  funcC(u, fd, fg, T, kappa, gammav, rho12, &fc);
  funcA(u, v0, kappa, vbar, gammav, rho12, rho13, rho14, rho23, rho24, rho34, et
  expon = Cadd(Cadd(fa, RCmul(v0, fc)) , RCmul(-0.1 * delta_n * sqrt(T), fb));
  *result = Cexp(expon);
}

//COSINE method to calculate inverse fourier integral
double cosine_function_xi(double d, double c, double dma, double cma, double fnp
{
  double res = 1. / (1 + fnpi * fnpi) * ((cos(dma) + fnpi * sin(dma)) * exp(d) -
  return res;
}
double cosine_function_psi(double d, double c, double dma, double cma, double fn
{
  double res = (fnpi == 0.) ? (d - c) : (sin(dma) - sin(cma)) / fnpi;
  return res;
}
double cosine_Vk(double K, double a, double b, double fnpi)
{
  double cma = -a * fnpi;
  double bma = (b - a) * fnpi;
  double result = 2. / (b - a) * K * (cosine_function_xi(b, 0, bma, cma, fnpi) -
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```
  return result;
}


void static cosine_bound(double L, double csi0, double pd0, double pf0, double d
{
  double c1, zeta, fC1, fLambda, Lambda1, fD1, beta1, beta2, beta3;
  funcbeta1(kappa, vbar, gammav, &beta1);
  funcbeta2(v0, beta1, &beta2);
  funcC1(kappa, gammav, &fC1);
  funcLambda(kappa, v0, gammav, &fLambda);
  funcD1(kappa, vbar, gammav, &fD1);
  fLambda1(fC1, fLambda, fD1, &Lambda1);
  funcbeta3(beta1, beta2, Lambda1, &beta3);

  zeta = etad * etad * log(exp(-lambdad * T)) * pow(lambdad, -0.3e1) / 0.2e1 + r

  c1 = csi0 * exp(-pf0 * T) / exp(-pd0 * T) + v0 / 2. / kappa * (exp(-kappa * T)

  *a = c1 - L + (-0.1 * delta_n * sqrt(T));
  *b = c1 + L + (-0.1 * delta_n * sqrt(T));
}


static int ap_hhw4d(NumFunc_1 *p, double T, PnlVect *r, PnlVect *x0, double vbar
{
  double csi0, v0;
  double  gammav, etad, etaf;
  double kappa, lambdad, lambdaf;
  double rho12, rho13, rho14, rho23, rho24, rho34;
  double pd0, pf0;
  double delta_n;
  double rd, rf;

  double sum = 0, a, b;
  double K;
  double invbma = 0.0;
  double fnpi = 0.0;
  dcomplex phi = CZERO;
  int i;
  int N;
```

```
//----------------------Initialisation of variable
csi0 = GET(x0, 0);
v0 = GET(x0, 1);

rd = GET(r, 0);
rf = GET(r, 1);

pd0 = exp(-rd * T);
pf0 = exp(-rf * T);

kappa = GET(kappa_v, 0);
lambdad = GET(kappa_v, 1);
lambdaf = GET(kappa_v, 2);

gammav = GET(sigma, 0);
etad = GET(sigma, 1);
etaf = GET(sigma, 2);

rho12 = GET(rho, 0);
rho13 = GET(rho, 1);
rho14 = GET(rho, 2);
rho23 = GET(rho, 3);
rho24 = GET(rho, 4);
rho34 = GET(rho, 5);

//Strike computation
delta_n = p->Par[0].Val.V_PDOUBLE;
K = csi0 * pf0 / pd0 * exp(0.1 * delta_n * sqrt(T));

N = pow(2, 9.);
cosine_bound(10, csi0, rd, rf, delta_n,  v0, kappa, vbar,  gammav, etad,  lamb
invbma = M_PI / (b - a);
chf(fnpi, v0, kappa, vbar, gammav, rd, etad, lambdad, rf, etaf, lambdaf, rho12
sum = 0.5 * phi.r * cosine_Vk(K, a, b, fnpi);
for (i = 1; i < N; i++)
  {
    fnpi += invbma;
    chf(fnpi, v0, kappa, vbar, gammav, rd, etad, lambdad, rf, etaf, lambdaf, r
    sum += (phi.r * cos(fnpi * (-a)) - phi.i * sin(fnpi * (-a))) * cosine_Vk(K
  }
```

```
  *ptprice = sum * exp(-rd * T);
  return OK;
}

int CALC(AP_HHW4D)(void *Opt, void *Mod, PricingMethod *Met)
{
  TYPEOPT *ptOpt = (TYPEOPT *)Opt;
  TYPEMOD *ptMod = (TYPEMOD *)Mod;


  return ap_hhw4d(ptOpt->PayOff.Val.V_NUMFUNC_1,   ptOpt->Maturity.Val.V_DATE -
                  ptMod->x0.Val.V_PNLVECT, ptMod->MeanReversion.Val.V_DOUBLE,
                  ptMod->kappa.Val.V_PNLVECT,
                  ptMod->sigma.Val.V_PNLVECT,
                  ptMod->rho.Val.V_PNLVECT,
                  &(Met->Res[0].Val.V_DOUBLE)
                 );
}

static int CHK_OPT(AP_HHW4D)(void *Opt, void *Mod)
{
  if ((strcmp(((Option *)Opt)->Name, "CallFX") == 0))
    return OK;
  return  WRONG;
}

#endif //PremiaCurrentVersion

static int MET(Init)(PricingMethod *Met, Option *Opt)
{
  //int type_generator;
  if (Met->init == 0)
    {
      Met->init = 1;
      Met->HelpFilenameHint = "ap_grzlek";
    }

  return OK;
}

PricingMethod MET(AP_HHW4D) =
```

```
{
  "AP_HHW4D",
  {{" ", PREMIA_NULLTYPE, {0}, FORBID}},
  CALC(AP_HHW4D),
  { {"Price", DOUBLE, {100}, FORBID},
    {" ", PREMIA_NULLTYPE, {0}, FORBID}
  },
  CHK_OPT(AP_HHW4D),
  CHK_ok,
  MET(Init)
};
```