```
   Help
#include<stdlib.h>
#include<time.h>
#include"pnl/pnl_specfun.h"
#include "cgmy1d_pad.h"

#if defined(PremiaCurrentVersion) && PremiaCurrentVersion <
     (2011+2) //The "#else" part of the code will be freely av
    ailable after the (year of creation of this file + 2)
static int CHK_OPT(AP_CernyKyriakou_CGMY_FixedAsian)(void *
    Opt, void *Mod)
{
  return NONACTIVE;
}
int CALC(AP_CernyKyriakou_CGMY_FixedAsian)(void*Opt,void *
    Mod,PricingMethod *Met)
{
  return AVAILABLE_IN_FULL_PREMIA;
}
#else
//Laplace transform of CGMY process
static dcomplex CGMY_laplace_transform(dcomplex u,double t,
    double C,double G,double M,double Y,double drift)
{
  dcomplex temp;

  if(Y==1)
  {
    temp=RCmul(C,Cadd(Cmul(RCsub(M,u),Clog(RCsub(1,CRdiv(u,
    M)))),Cmul(RCadd(G,u),Clog(RCadd(1,CRdiv(u,G))))));
  }
  else
  {
    temp=RCmul(C*pnl_sf_gamma(-Y),Cadd(RCmul(POW(M,Y),Csub(
    Cpow_real(RCsub(1,CRdiv(u,M)),Y),RCsub(1,CRdiv(CRmul(u,Y),M)
    ))),RCmul(POW(G,Y),
    Csub(Cpow_real(RCadd(1,CRdiv(u,G)),Y),RCadd(1,CRdiv(CR
    mul(u,Y),G))))));
  }
  return Cexp(RCmul(t,Cadd(RCmul(drift,u),temp)));
}
```

```
//The generalized discrete Fourier transform (DFT) of a fro
    m x onto u
static void DFT(dcomplex *a,double *x,int n,double *u,int
    m,dcomplex* b)
{
  int j,k;

  for(k=0;k<=m;k++)
  {
    b[k]=CZERO;
    for(j=1;j<=n;j++)
      b[k]=Cadd(Cmul(a[j],CIexp(x[j]*u[k])),b[k]);
    b[k]=CRmul(b[k],fabs(x[1]-x[0]));
  }
}

int cgmy_ap_cernykyriakou_asianfixed(NumFunc_2*P,double S0,
    double T,double r,double divid,double C,double G,double M,
    double Y,int n_points,double *ptprice)
{
   double *lambda,drift,*L,*L_bar,*u,*U,*U_bar,rho,u_max,*x
    ,*y,x_step,y_step,time_step;
   double u_step,*u_minus,*h,*a,*b,exp_X,u_em,l_em,K,coef;
   int i,k,i_up,i_down,x_nb,y_nb,u_nb,i_temp,i_x,test;
   dcomplex *q,*p,*P_vect,*phi,*temp;
   k=0;
   rho=1e-6;
   time_step=T/n_points;
   u_nb=POW(2,10);
   x_nb=POW(2,10);
   y_nb=POW(2,10);
   i_x=0;
   coef=1;
   K=P->Par[0].Val.V_DOUBLE;
   lambda=malloc((n_points+1)*sizeof(double));
   a=malloc((n_points+1)*sizeof(double));
   b=malloc((n_points+1)*sizeof(double));
   L=malloc((n_points+1)*sizeof(double));
   U=malloc((n_points+1)*sizeof(double));
   L_bar=malloc((n_points+1)*sizeof(double));
   U_bar=malloc((n_points+1)*sizeof(double));
```

```
x=malloc((x_nb+1)*sizeof(double));
y=malloc((y_nb+1)*sizeof(double));
h=malloc((y_nb+1)*sizeof(double));
p=malloc((y_nb+1)*sizeof(dcomplex));
q=malloc((x_nb+1)*sizeof(dcomplex));
drift=(r-divid)-log(Creal(CGMY_laplace_transform(
 Complex(1,0),1,C,G,M,Y,0)));
u_max=5.;
while(Cabs(CGMY_laplace_transform(Complex(0,u_max),
 time_step,C,G,M,Y,drift))+Cabs(CGMY_laplace_transform(Complex(0
 ,-u_max),time_step,C,G,M,Y,drift))>rho)
{
  u_max+=5.;
}
u_step=2*u_max/u_nb;
if(u_step>0.125)
{
  u_nb=trunc(16*u_max);
  u_nb+=PNL_IS_ODD(u_nb);
  u_step=2*u_max/u_nb;
}
u=malloc((u_nb+1)*sizeof(double));
u_minus=malloc((u_nb+1)*sizeof(double));
P_vect=malloc((u_nb+1)*sizeof(dcomplex));
phi=malloc((u_nb+1)*sizeof(dcomplex));
temp=malloc((u_nb+1)*sizeof(dcomplex));
for(i=0;i<=u_nb;i++)
{
  u[i]=-u_max+i*u_step;
  u_minus[i]=-u[i];
  phi[i]=CGMY_laplace_transform(Complex(0,u[i]),time_s
 tep,C,G,M,Y,drift);
}
/*Call Case*/
lambda[0]=1./(n_points+1)-K/S0;
for(i=1;i<=n_points;i++)
  lambda[i]=1./(n_points+1);
do
{
  u_em=5*coef;
  l_em=-5*coef;
```

```
////////////////////////////////////////////////////////////
    ////////////////////
     a[n_points]=1;
     b[n_points]=lambda[0]*(lambda[0]>0);
     exp_X=Creal(CGMY_laplace_transform(Complex(1,0),time_s
    tep,C,G,M,Y,drift));
     for(i=n_points;i>0;i--)
     {
       a[i-1]=a[i]*exp_X;
       b[i-1]=b[i]+a[i-1]*lambda[n_points-i+1];
     }
////////////////////////////////////////////////////////////
    ////////////////////
     L_bar[0]=log(lambda[n_points]);
     U_bar[0]=log(lambda[n_points]);
     for(i=1;i<n_points;i++)
     {
       L[i]=L_bar[i-1]+l_em;
       U[i]=U_bar[i-1]+u_em;
       L_bar[i]=log(exp(L[i])+lambda[n_points-i]);
       U_bar[i]=log(exp(U[i])+lambda[n_points-i]);

     }
     L[n_points]=L_bar[n_points-1]+l_em;
     U[n_points]=U_bar[n_points-1]+u_em;
     y_step=(U[n_points]-L[n_points])/y_nb;
     for(i=0;i<=y_nb;i++)
     {
       y[i]=L[n_points]+i*y_step;
       p[i]=Complex((exp(y[i])+lambda[0])*(exp(y[i])+lambd
    a[0]>0),0);
     }
     coef*=0.95;
   }
   while(y[y_nb]>10);
   for(k=n_points;k>1;k--)
   {


     x_step=(U_bar[k-1]-L_bar[k-1])/x_nb;
     for(i=0;i<=x_nb;i++)
```

```
      {
        x[i]=L_bar[k-1]+i*x_step;
      }
      DFT(p,y,y_nb,u,u_nb,P_vect);
      for(i=0;i<=u_nb;i++)
      {
        temp[i]=Cmul(P_vect[i],Conj(phi[i]));
      }
      DFT(temp,u_minus,u_nb,x,x_nb,q);
      for(i=0;i<=x_nb;i++)
      {
        q[i]=CRdiv(q[i],2*M_PI);
      }
////////////////////////////////////////////////////////////
    //////////
      y_step=(U[k-1]-L[k-1])/y_nb;
      for(i=0;i<=y_nb;i++)
      {
        y[i]=L[k-1]+i*y_step;
        h[i]=log(exp(y[i])+lambda[n_points-(k-1)]);

        test=0;
        if(h[i]<=x[0])
        {
          i_x=0;
          test=1;
          p[i]=Cadd(q[i_x],CRmul(CRdiv(Csub(q[i_x+1],q[i_x])
    ,x[i_x+1]-x[i_x]),(h[i]-x[i_x])));
        }
        if(h[i]>=x[x_nb])
        {
          i_x=x_nb;
          test=1;
          p[i]=Cadd(q[i_x-1],CRmul(CRdiv(Csub(q[i_x],q[i_x-1
    ]),x[i_x]-x[i_x-1]),(h[i]-x[i_x-1])));
        }
        if((h[i]>x[0]) && (h[i]<x[x_nb]))
        {
          i_down=x_nb/2;
          i_up=x_nb;
          if(x[i_down]>h[i])
```

```
          {
            i_down=0;
            i_up=x_nb/2;
          }
          while(test==0)
          {
            if(x[i_down+1]>h[i])
            {
             i_x=i_down;
             test=1;
            }
            else
            {
              i_temp=(i_up-i_down-1)/2+i_down;
              if(x[i_temp]>h[i])
              {
                i_up=i_temp;
                i_down=i_down+1;
              }
              else
              {
                i_down=i_temp*(i_temp>i_down)+(i_down+1)*(i_
    temp<=i_down);
              }
            }
          }
          p[i]=Cadd(q[i_x],CRmul(CRdiv(Csub(q[i_x+1],q[i_x])
    ,x[i_x+1]-x[i_x]),(h[i]-x[i_x])));
        }
      }
////////////////////////////////////////////////////////
     ///////////////
   }
   x_step=(U_bar[0]-L_bar[0])/x_nb;
   for(i=0;i<=x_nb;i++)
   {
     x[i]=L_bar[0]+i*x_step;
   }
   DFT(p,y,y_nb,u,u_nb,P_vect);
   for(i=0;i<=u_nb;i++)
   {
```

```
    temp[i]=Cmul(P_vect[i],Conj(phi[i]));
  }
  DFT(temp,u_minus,u_nb,x,x_nb,q);
  for(i=0;i<=x_nb;i++)
  {
    q[i]=CRdiv(q[i],2*M_PI);
  }
  /*Call Case*/
  if((P->Compute)==&Call_OverSpot2)
  {
    *ptprice=S0*exp(-r*T)*Creal(q[0]);
  }
  /*Put case*/
  if((P->Compute)==&Put_OverSpot2)
  {
    if(r!=divid)
      *ptprice=S0*exp(-r*T)*Creal(q[0])+K*exp(-r*T)-S0*(
   exp(-divid*T)-exp(-r*T))/((r-divid)*T);
    else
      *ptprice=S0*exp(-r*T)*Creal(q[0])-(S0-K)*exp(-r*T);
  }
  free(lambda);
  free(L);
  free(U);
  free(L_bar);
  free(U_bar);
  free(u);
  free(u_minus);
  free(x);
  free(y);
  free(h);
  free(p);
  free(P_vect);
  free(phi);
  free(temp);
  free(q);
  free(a);
  free(b);

  return OK;
}
```

```
int CALC(AP_CernyKyriakou_CGMY_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  cgmy_ap_cernykyriakou_asianfixed(ptOpt->PayOff.
    Val.V_NUMFUNC_2,ptMod->S0.Val.V_PDOUBLE,ptOpt->Maturity.Val.
    V_DATE-ptMod->T.Val.V_DATE,r,divid,ptMod->C.Val.V_PDOUBLE,
    ptMod->G.Val.V_DOUBLE,ptMod->M.Val.V_SPDOUBLE,ptMod->Y.Val.
    V_PDOUBLE,Met->Par[0].Val.V_PINT,&(Met->Res[0].Val.V_
    DOUBLE));
}

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

#endif //PremiaCurrentVersion
static int MET(Init)(PricingMethod *Met,Option *Mod)
{
  if ( Met->init == 0)
    {
      Met->init=1;
       Met->HelpFilenameHint = "    ap_cernykyriakou_cgmy_asianfixed";
      Met->Par[0].Val.V_PINT=10;
    }
  return OK;
}

PricingMethod MET(AP_CernyKyriakou_CGMY_FixedAsian)=
```

```
{
  "AP_CernyKyriakou_CGMY_FixedAsian",
  {{"Number of discretization steps",LONG,{100},ALLOW},{" "
    ,PREMIA_NULLTYPE,{0},FORBID}},
  CALC(AP_CernyKyriakou_CGMY_FixedAsian),
  {{"Price",DOUBLE,{100},FORBID},{" ",PREMIA_NULLTYPE,{0},
    FORBID}},
  CHK_OPT(AP_CernyKyriakou_CGMY_FixedAsian),
  CHK_ok,
  MET(Init)
} ;
```

References