Help

```
#include <stdlib.h>
#include  "vasicek1d_stdi.h"

/*Product*/
static double dt,dr,r_min,r_max;
static double *r_vect,*disc,**Ps,**Option_Price;
static double *pu,*pm,*pd;
static long Ns;

/*Memory Allocation*/
static void memory_allocation(long Nt)
{
  int i;

  if((r_vect = malloc(sizeof(double)*(Ns+1)))==NULL)
    {
      printf("Allocation error");
      exit(1);
    }
  if((disc = malloc(sizeof(double)*(Ns+1)))==NULL)
    {
      printf("Allocation error");
      exit(1);
    }
  if((pu = malloc(sizeof(double)*(Ns+1)))==NULL)
    {
      printf("Allocation error");
      exit(1);
    }
  if((pm = malloc(sizeof(double)*(Ns+1)))==NULL)
    {
      printf("Allocation error");
      exit(1);
    }if((pd = malloc(sizeof(double)*(Ns+1)))==NULL)
       {
   printf("Allocation error");
   exit(1);
       }
  if ((Ps = malloc(sizeof(double *)*(Nt+1))) ==NULL)
    {
```

```
      printf("Allocation error");
      exit(1);
    }
  for(i=0;i<=Nt;i++){
    Ps[i] = malloc(sizeof(double)*(Ns+1));
  }
  if ((Option_Price = malloc(sizeof(double *)*(Nt+1))) ==
    NULL)
    {
      printf("Allocation error");
      exit(1);
    }
  for(i=0;i<=Nt;i++){
    Option_Price[i] = malloc(sizeof(double)*(Ns+1));
  }

  return;
}

/*Memory Desallocation*/
static void free_memory(long Nt)
{
  int i;

  free(r_vect);
  free(pu);
  free(pm);
  free(pd);
  free(disc);

  for (i=0;i<Nt+1;i++)
    free(Ps[i]);
  free(Ps);

  for (i=0;i<Nt+1;i++)
    free(Option_Price[i]);
  free(Option_Price);

  return;
}
```

```
/*Compute probabilities*/
static int init_prob(double k,double sigma,double theta,
    double T,double t0,long Nt)
{
  double df;
  int j;

  /*Time and Space Step*/
  dt=(T-t0)/(double)Nt;
  dr=sigma*sqrt(3.*dt);

  /*Localization*/
  r_min=theta-dr/(2.*k*dt);
  r_max=theta+dr/(2.*k*dt);
  Ns=(int)ceil((r_max-r_min)/dr);
  memory_allocation(Nt);

  /*Compute probabilities*/
  for(j=0;j<=Ns;j++)
    {
      r_vect[j]=r_min+(double)j*dr;
      df=k*(theta-r_vect[j])*dt/dr;
      disc[j]=exp(-r_vect[j]*dt);
      /*Boundary*/
      if(j==0)
        {
    pu[j]=1./6.+(SQR(df)-df)/2.;
    pm[j]=df-2.*pu[j];
    pd[j]=1.-pu[j]-pm[j];
        }
      else if(j==Ns)
        {
    pd[j]=1./6.+(SQR(df)+df)/2.;
    pm[j]=-df-2.*pd[j];
    pu[j]=1.-pd[j]-pm[j];
  }
      /*Not Boundary*/
      else
        {
    pu[j]=1./6.+(SQR(df)+df)/2.;
```

```
    pd[j]=pu[j]-df;
    pm[j]=1.-pu[j]-pd[j];
        }
    }

  return OK;
}

/*Zero Coupon Bond*/
static int zcb_vasicek(long Nt)
{
  int i,j;

  /*Maturity conditions for pure discount Bond*/
  for(j=0;j<=Ns;j++)
    Ps[Nt][j]=1.;

  /*Dynamic Programming*/
  for(i=Nt-1;i>=0;i--)
    for(j=0;j<=Ns;j++)
      {
  if(j==0)
    Ps[i][j]=disc[j]*(pu[j]*Ps[i+1][j+2]+pm[j]*Ps[i+1][j+1
    ]+pd[j]*Ps[i+1][j]);
  else
    if(j==Ns)
      Ps[i][j]=disc[j]*(pd[j]*Ps[i+1][j-2]+pm[j]*Ps[i+1][
    j-1]+pu[j]*Ps[i+1][j]);
    else
      Ps[i][j]=disc[j]*(pu[j]*Ps[i+1][j+1]+pm[j]*Ps[i+1][
    j]+pd[j]*Ps[i+1][j-1]);
      }
  return 1.;
}


/*Cap,Floor=Portfolio of zero-bond options*/
static int capfloor_vasicek1d(double r0,double k,double t0,
     double sigma,double theta,double first_payement,double
    Nominal,double K,double periodicity,NumFunc_1 *p,double T,
    long NtY,double *price)
```

```
{
  int i,j,z,Nt,NsY,NtO,nb_payement;
  double val,val1,tmp,sum;

  /*Number of maximal steps*/
  Nt=NtY*(long)((T-t0)/periodicity);

  /*Compute probabilities*/
  init_prob(k,sigma,theta,T,t0,Nt);

  /*Compute Cap or Floor*/
  nb_payement=(int)((T-first_payement)/periodicity);
  sum=0.;
  NsY=Nt;
  tmp=p->Par[0].Val.V_DOUBLE;
  p->Par[0].Val.V_DOUBLE=1./(1.+K*periodicity);
  for(z=nb_payement;z>0;z--)
    {
      /*Number of steps for generic caplet/flooret*/
      NsY=Nt-(nb_payement-z)*NtY;

      /*Compute Zero Coupon Prices*/
      zcb_vasicek(NsY);

      /*Compute Caplet or Flooret*/
      /*Maturity conditions*/
      NtO=NsY-NtY;

      for(j=0;j<=Ns;j++)
  Option_Price[NtO][j]=(p->Compute)(p->Par,Ps[NtO][j]);

      /*Explicit Finite Difference Cycle*/
      for(i=NtO-1;i>=0;i--)
  for(j=0;j<=Ns;j++)
    {
      /*Boundary*/
      if(j==0)
        Option_Price[i][j]=disc[j]*(pu[j]*Option_Price[i+1
    ][j+2]+pm[j]*Option_Price[i+1][j+1]+pd[j]*Option_Price[i+1
    ][j]);
      else
```

```
        if(j==Ns)
    Option_Price[i][j]=disc[j]*(pd[j]*Option_Price[i+1][
    j-2]+pm[j]*Option_Price[i+1][j-1]+pu[j]*Option_Price[i+1][
    j]);
      /*Not Boundary*/
        else
    Option_Price[i][j]=disc[j]*(pu[j]*Option_Price[i+1][
    j+1]+pm[j]*Option_Price[i+1][j]+pd[j]*Option_Price[i+1][j-1
    ]);
    }

      /*Linear Interpolation*/
      j=0;
      while(r_vect[j]<r0)
  j++;
      val= Option_Price[0][j];
      val1= Option_Price[0][j-1];

      /*Sum*/
      sum+=(1.+K*periodicity)*(val+(val-val1)*(r0-r_vect[j]
    )/dr);

    }

  /*Price*/
  *price=Nominal*sum;

  /*Memory Disallocation*/
  p->Par[0].Val.V_DOUBLE=tmp;
  free_memory(Nt);


  return OK;
}

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

```
  return capfloor_vasicek1d(ptMod->r0.Val.V_PDOUBLE,ptMod->
    k.Val.V_DOUBLE,ptMod->T.Val.V_DATE,ptMod->Sigma.Val.V_PDOUB
    LE,
          ptMod->theta.Val.V_PDOUBLE,ptOpt->FirstResetD
    ate.Val.V_DATE,ptOpt->Nominal.Val.V_PDOUBLE,ptOpt->FixedRa
    te.Val.V_PDOUBLE,ptOpt->ResetPeriod.Val.V_DATE,ptOpt->PayO
    ff.Val.V_NUMFUNC_1,ptOpt->BMaturity.Val.V_DATE,Met->Par[0].
    Val.V_LONG,&(Met->Res[0].Val.V_DOUBLE));
}


static int CHK_OPT(FD_CAPFLOOR)(void *Opt, void *Mod)
{

  if ((strcmp(((Option*)Opt)->Name,"Cap")==0)|| (strcmp(((
    Option*)Opt)->Name,"Floor")==0))
    return OK;
  else
    return WRONG;
}

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

      Met->Par[0].Val.V_LONG=10;


    }
  return OK;
}

PricingMethod MET(FD_CAPFLOOR)=
{
  "FD_Explicit_Vasicek1d_CapFloor",
  {{"TimeStepNumber for Period",LONG,{100},ALLOW},
   {" ",PREMIA_NULLTYPE,{0},FORBID}},
  CALC(FD_CAPFLOOR),
  {{"Price",DOUBLE,{100},FORBID},{" ",PREMIA_NULLTYPE,{0},
```

```
    FORBID}},
  CHK_OPT(FD_CAPFLOOR),
  CHK_ok,
  MET(Init)
} ;
```

References