

[Help](#)

```
#include "lmm_heston1d_std.h"
#include "math/lmm/lmm_libor.h"
#include "math/lmm/lmm_products.h"
#include "math/lmm/lmm_volatility.h"
#include "math/lmm/lmm_numerical.h"
#include "math/lmm/lmm_zero_bond.h"
#include "pnl/pnl_complex.h"
#include "math/integral.h"

#if defined(PremiaCurrentVersion) && PremiaCurrentVersion < (2007+2) //The "#els
static int CHK_OPT(AP_WZ)(void *Opt, void *Mod)
{
    return NONACTIVE;
}
int CALC(AP_WZ)(void *Opt, void *Mod, PricingMethod *Met)
{
    return AVAILABLE_IN_FULL_PREMIA;
}
#else

static Volatility *ptVol;
static Libor *ptLib;
static Swaption *ptSwpt;
//static Caplet* ptCplt;

// stochastic volatility variables
static double epsilon;
static double kappa;
static double theta;
static double V0;
static double rho1_lmm;
static double rho2_lmm;
static double rho3_lmm;

static int *initlog ;
static int *bk ;
static dcomplex dlk;
static dcomplex *lk_1;
```

```

static int *initSqrt;
static int *sk;
//static dcomplex dsk;
static dcomplex *sk_1;

//static double *f1;
//static double *f2;
/* static int indicegene=0; */
/* static int* branch; */

// global variables

static double *ptCor = NULL;
static double *omega = NULL;
static double *alpha = NULL;
static dcomplex *A = NULL ;
static dcomplex *g = NULL ;
static dcomplex *a = NULL ;
static dcomplex *d = NULL ;
static dcomplex *B = NULL ;
static double *lambda = NULL;
static double *zeta = NULL;
static double *beta = NULL;

static int nb_time, int_type;
static double spot, strike , T;

static int compute_a(dcomplex *a, dcomplex z, double *beta , double *zeta, int
static int compute_d(dcomplex *d , dcomplex *a, dcomplex z, double *lambda, int
static int compute_B(dcomplex *B , dcomplex *g , dcomplex *a, dcomplex *d , int
static int compute_A(dcomplex *A , dcomplex *g , dcomplex *a, dcomplex *d , int

static int compute_price(double t, Swaption *ptSwpt, double sigma);

static double func(double u);
static double compute_beta_swaption(double t , Swaption *ptSwpt , double *alpha,
static double compute_zeta_swaption(double t, Swaption *ptSwpt, double sigma);
static double compute_lambda_swaption(double t , Swaption *ptSwpt , double *ome

```

```

static void init_log(int nbpoints);
static void free_log();
static dcomplex characteristic_function(double x, double V, dcomplex z, double

static int build_correlation(double **ptCr, int number_of_corr);
static int check_parameters(double period , int number_of_factors , double swapt

static void init_log(int nbpoints)
{
    int i;

    initlog = (int *)malloc(sizeof(int) * nbpoints);
    initSqrt = (int *)malloc(sizeof(int) * nbpoints);

    bk = (int *)malloc(sizeof(int) * nbpoints);
    lk_1 = (dcomplex *)malloc(sizeof(dcomplex) * nbpoints);
    sk = (int *)malloc(sizeof(int) * nbpoints);
    sk_1 = (dcomplex *)malloc(sizeof(dcomplex) * nbpoints);
    for (i = 0; i < nbpoints; i++)
    {
        initlog[i] = 0;
        initSqrt[i] = 0;
        bk[i] = 0;
        sk[i] = 0;
    }
}

static void free_log()
{
    free(initlog);
    initlog = NULL;
    free(initSqrt);
    initSqrt = NULL;
    free(bk);
    bk = NULL;
    free(lk_1);
    lk_1 = NULL;
    free(sk);
    sk = NULL;
}

```

```

    free(sk_1);
    sk_1 = NULL;
}

static double lmm_swaption_payer_stoVol_pricer(double period , int number_of_factors , double swap_maturity , double swap_maturity , double priceVal , double percent_of_ATM_strike , double sigma)
{
    double tenor = period;
    int number_of_dates;
    double priceVal = 0.25;
    double price;
    double percent_of_ATM_strike;

    percent_of_ATM_strike = -20.;
    check_parameters(period , number_of_factors , swaption_maturity , swap_maturity , priceVal , percent_of_ATM_strike , sigma);
    number_of_dates = (int)(swap_maturity / period) + 2;
    mallocLibor(&ptLib , number_of_dates , tenor, 10);
    mallocVolatility(&ptVol , number_of_factors , sigma);

    //s=(int)(swaption_maturity/tenor);
    //M=(int)(swap_maturity/tenor);
    //atm_Strike=(computeZeroCoupon(ptLib,0,s) - computeZeroCoupon(ptLib,0,M))/computeZeroCoupon(ptLib,0,M);
    /*atm_Strike*=(1 + percent_of_ATM_strike/100.);*/
    /*strike=atm_Strike;*/

    mallocSwaption(&ptSwpt , swaption_maturity , swap_maturity , priceVal , percent_of_ATM_strike , sigma);

    omega = (double *)malloc(sizeof(double) * ptSwpt->numberOfDates);
    alpha = (double *)malloc(sizeof(double) * ptSwpt->numberOfDates);

    // build the correlation structure
    build_correlation(&ptCor, number_of_factors);
    compute_price(0.0 , ptSwpt, sigma);
    price = ptSwpt->price;

    // free memory
    free(ptCor);
    ptCor = NULL;
    free(omega);
    omega = NULL;
    free(alpha);
}

```

```
alpha = NULL;
freeSwaption(&ptSwpt);
ptSwpt = NULL;
freeLibor(&ptLib);
ptLib = NULL;
freeVolatility(&ptVol);
ptVol = NULL;
```

```
return (price);
}
```

```
static int check_parameters(double period , int number_of_factors , double swapt
{
```

```
    // this function checks the consistency of the parameters
```

```
double s;
double M;
```

```
if (swaption_maturity >= swap_maturity)
{
    printf(" swaption maturity must be lower than swap maturity !\ n");
    exit(-1);
}
```

```
if (number_of_factors > 3)
{
    printf("number of factors must be lower or equal to 3 \ n");
}
```

```
s = (int)(swaption_maturity / period);
if (fabs(swaption_maturity - s * period) > 0.0)
{
    printf(" swaption maturity must be a multiple of period\ n");
    exit(-1);
}
```

```
M = (int)(swap_maturity / period);
if (fabs(swap_maturity - M * period) > 0.0)
{
    printf(" swap maturity must be a multiple of period\ n");
    exit(-1);
}
```

```
if ((int)(number_of_factors > 3))
{
```

```

        printf("number of factors must be lower or equal to 3 \ n");
        exit(-1);
    }
    /*if((percent_of_ATM_strike<-40.) || (percent_of_ATM_strike>40.))
    {
        printf("percent of the ATM strike must be within the range [-40\ % ; 40\
        exit(-1);
    }*/

    return (1);
}

static int build_correlation(double **ptCorrel , int number_of_factors)
{
    if (number_of_factors > 3)
    {
        printf("Only three factors allowed!!!\ n");
        exit(-1);
    }
    else
    {
        *ptCorrel = (double *)malloc(sizeof(double) * number_of_factors);
        switch (number_of_factors)
        {
            case 1:
                (*ptCorrel)[0] = rho1_lmm;
                break;
            case 2:
                (*ptCorrel)[0] = rho1_lmm ;
                (*ptCorrel)[1] = rho2_lmm;
                break;
            case 3:
                (*ptCorrel)[0] = rho1_lmm ;
                (*ptCorrel)[1] = rho2_lmm;
                (*ptCorrel)[2] = rho3_lmm;
                break;
            default:
                exit(-1);
                break;
        }
    }
}

```

```

    }
    return (1);
}

```

```

/*****

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*   functions needed for the computation of the characteristic function of the

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*****/

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```

static int compute_a(dcomplex *a, dcomplex z, double *beta , double *zeta, int
{

```

```

    int j;

```

```

    dcomplex b0;

```

```

    for (j = 0; j < nb_time; j++)

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```

    {

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```

        a[j] = RCmul(-zeta[j] * epsilon, z);

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```

        b0 = Complex(kappa * beta[j] , 0.0);

```

```

        a[j] = Cadd(a[j], b0);

```

```

    }

```

```

    return (1);

```

```

}

```

```

static int compute_d(dcomplex *d , dcomplex *a, dcomplex z, double *lambda, int
{

```

```

    int j;

```

```

    dcomplex b0, b1, b2, slk;

```

```

    b0 = Cmul(z, z);

```

```

    b0 = Csub(b0, z);

```

```

    for (j = 0; j < nb_time; j++)

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```

    {

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```

        b1 = RCmul(pow(lambda[j] * epsilon, 2) , b0);

```

```

        b2 = Cmul(a[j] , a[j]);

```

```

    d[j] = Csub(b2 , b1);
    d[j] = Clog(d[j]);

    // Test for Sqrt
    if (initSqrt[j] > 0)
    {
        slk = Csub(d[j], sk_1[j]);
        if (slk.i < -M_PI)
        {

            sk[j] = sk[j] + 1;

        }
        else if (slk.i > M_PI)
        {
            sk[j] = sk[j] - 1;
        }

        sk_1[j] = d[j];
    }
    else
    {
        initSqrt[j]++;
        sk_1[j] = d[j];
    }
    //
    d[j] = Cadd(d[j], Complex(0., 2 * M_PI * sk[j]));
    d[j] = RCmul(0.5, d[j]);
    d[j] = Cexp(d[j]);

}
return (1);
}

```

```

static int compute_B(dcomplex *B , dcomplex *g , dcomplex *a, dcomplex *d , int
{
    dcomplex b1, b0, b2, b4, b3;
    double tau = ptLib->tenor;
    int j;

    B[ nb_time - 1 ] = Complex(0.0 , 0.0);

```

```

g[ nb_time - 1 ] = Cdiv(Cadd(a[ nb_time - 1 ], d[ nb_time - 1 ]) , Csub(a[ nb_

for (j = nb_time - 1 ; j >= 0 ; j--)
{

    if (j == (nb_time - 1))
    {
        g[j] = Cdiv(Cadd(a[j], d[j])    , Csub(a[j], d[j]));
        b4 = Complex(0.0, 0.0);
    }
    else
    {
        g[j] = Cdiv(Csub(Cadd(a[j], d[j]), RCmul(epsilon * epsilon, B[j + 1]))
        b4 = RCmul(epsilon * epsilon, B[j + 1]);
    }

    b1 = RCmul(tau , d[j]);
    b1 = Cexp(b1);

    b0 = Complex(1.0, 0.0);
    b0 = Csub(b0, b1);

    b1 = Cmul(g[j], b1);
    b3 = Complex(1.0, 0.0);
    b3 = Csub(b3, b1);
    b3 = RCmul(epsilon * epsilon, b3);

    b2 = Cadd(a[j], d[j]);
    b2 = Csub(b2, b4);
    b2 = Cmul(b2, b0);

    b2 = Cdiv(b2, b3);

    if (j == (nb_time - 1))
    {
        B[j] = b2;
    }
    else
    {
        B[j] = Cadd(B[j + 1], b2);
    }
}

```

```

    }
}
return (1);
}

```

```

static int compute_A(dcomplex *A , dcomplex *g , dcomplex *a, dcomplex *d , int
{
    dcomplex b0, b1, b2, b3, b4;
    int j;
    double tau = ptLib->tenor;

    for (j = nb_time - 1 ; j >= 0 ; j--)
    {
        b1 = RCmul(tau , d[j]);
        b1 = Cexp(b1);
        b3 = Cmul(g[j], b1);

        b0 = Complex(1.0, 0.0);
        b0 = Csub(b0, b3);

        b2 = Complex(1.0, 0.0);
        b2 = Csub(b2, g[j]);

        b2 = Cdiv(b0, b2);
        b2 = Clog(b2);

        // Test for the log function
        if (initlog[j] > 0)
        {
            dlk = Csub(b2, lk_1[j]);
            if (dlk.i < -M_PI)
            {
                bk[j] = bk[j] + 1;
            }
            else if (dlk.i > M_PI)
            {
                bk[j] = bk[j] - 1;
            }
        }
    }
}

```

```

        }

        lk_1[j] = b2;
    }
    else
    {
        initlog[j]++;
        lk_1[j] = b2;
    }

    b2 = Cadd(b2, Complex(0., 2 * M_PI * bk[j]));
    b2 = RCmul(2., b2);

    b4 = Cadd(a[j], d[j]);
    b4 = RCmul(tau, b4);
    b4 = Csub(b4, b2);
    b4 = RCmul(kappa * theta / pow(epsilon, 2), b4);

    if (j == (nb_time - 1))
    {
        A[j] = b4 ;
    }
    else
    {
        A[j] = Cadd(A[j + 1], b4);
    }
}

return (1);
}

/*****
*
*  swaption
*
*****/

static int build_beta_swaption(double *beta, Swaption *ptSwpt, double sigma)
{

```

```

double t;
int i;
int nb_time;

nb_time = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

for (i = 0; i < nb_time; i++)
{
    t = i * ptLib->tenor;
    beta[i] = compute_beta_swaption(t , ptSwpt , alpha, sigma);
}
return (1);
}

```

```

static int build_lambda_swaption(double *lambda , Swaption *ptSwpt , Libor *ptLi
{
    double t;
    int i, nb_time;

    nb_time = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

    for (i = 0; i < nb_time; i++)
    {
        t = i * ptLib->tenor;
        lambda[i] = compute_lambda_swaption(t , ptSwpt , omega, sigma);
    }
    return (1);
}

```

```

static int build_zeta_swaption(double *zeta , Swaption *ptSwpt , Libor *ptLib, d
{
    double t;
    int i, nb_time;

    nb_time = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

    for (i = 0; i < nb_time; i++)
    {
        t = i * ptLib->tenor;
        zeta[i] = compute_zeta_swaption(t, ptSwpt, sigma);
    }
}

```

```

    return (1);
}

```

```

static double compute_beta_swaption(double t , Swaption *ptSwpt , double *alpha,
{
    int i, j, l;
    float v;
    float sum = 0.0;
    int M, s;
    double Ti;
    double epsj;

    M = (int)(ptSwpt->swapMaturity / ptSwpt->tenor);
    s = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

    sum = 0.0;
    for (j = s; j < M; j++)
    {

        epsj = 0.0;
        for (i = 1; i <= j; i++)
        {
            Ti = GET(ptLib->maturity, i);
            v = 0.0;
            for (l = 0; l < ptVol->numberOfFactors; l++)
            {
                v += evalVolatility(ptVol, l, t, Ti) * ptCor[l];
            }

            v *= (ptLib->tenor * GET(ptLib->libor, i)) / (1 + ptLib->tenor * GET(p
            epsj += v;
        }
        epsj *= alpha[j] * epsilon / kappa;
        sum += epsj;
    }

    sum += 1.;
    return (sum);
}

```

```

static double compute_zeta_swaption(double t, Swaption *ptSwpt, double sigma)
{
    int j, l;
    double sum, Tj;
    int M, s;
    double v;

    M = (int)(ptSwpt->swapMaturity / ptSwpt->tenor);
    s = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

    sum = 0.0;

    for (j = s; j < M; j++)
    {
        Tj = GET(ptLib->maturity, j);
        v = 0.0;
        for (l = 0; l < ptVol->numberOfFactors; l++)
        {
            v += evalVolatility(ptVol, l, t, Tj) * ptCor[l];
        }
        sum += (v * omega[j]);
    }
    return (sum);
}

```

```

static double compute_lambda_swaption(double t , Swaption *ptSwpt , double *ome
{

    int l, i1, i2;
    double sum = 0.0;
    int M, s;
    double Ti1, Ti2;

    M = (int)(ptSwpt->swapMaturity / ptSwpt->tenor);
    s = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

    for (l = 0; l < ptVol->numberOfFactors; l++)
    {

```

```

    for (i1 = s; i1 < M; i1++)
    {
        for (i2 = s; i2 < M; i2++)
        {

            Ti1 = GET(ptLib->maturity, i1);
            Ti2 = GET(ptLib->maturity, i2);
            sum += omega[i1] * omega[i2] * evalVolatility(ptVol, 1, t, Ti1) *

        }
    }
    return (sqrt(sum));
}

```

```

static int compute_Omega(Libor *ptLib, Swaption *ptSwpt , double *omega)
{
    int j;
    double BT_M, BT_s, sumZc;
    int s, M;

    M = (int)(ptSwpt->swapMaturity / ptSwpt->tenor);
    s = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

    BT_M = computeZeroCoupon(ptLib, 0, M);
    BT_s = computeZeroCoupon(ptLib, 0, s);
    sumZc = computeZeroCouponSum(ptLib, 0, s + 1, M);

    for (j = 0; j < M; j++)
    {
        omega[j] = 0.0;
    }

    for (j = s; j < M; j++)
    {
        omega[j] = (ptLib->tenor * GET(ptLib->libor, j) / (1 + ptLib->tenor * GET(
    }
}

```

```

    return (1);

}

static int compute_alpha(Libor *ptLib, Swaption *ptSwpt , double *alpha)
{
    int j;
    int M, s;

    M = (int)(ptSwpt->swapMaturity / ptSwpt->tenor);
    s = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

    for (j = 0; j < M; j++)
    {
        alpha[j] = 0.0;
    }

    for (j = s; j < M; j++)
    {
        alpha[j] = (ptLib->tenor * computeZeroCoupon(ptLib, 0, j + 1)) / computeZe

    }

    return (1);
}

/*****/

static dcomplex characteristic_function(double x, double V, dcomplex z, double
{

    dcomplex resu;

    compute_a(a, z, beta , zeta, nb_time);
    compute_d(d , a, z, lambda, nb_time);
    compute_B(B , g , a, d , nb_time);
    compute_A(A , g , a, d , nb_time);

```

```

    resu = Cexp(Cadd(A[0], RCmul(V, B[0])));

    return (resu);

}

```

```

static double func(double u)
{

    dcomplex uc1, uc2, uc3;

    if (int_type == 1)
    {
        uc1 = Complex(0.0, u);
    }
    else
    {
        uc1 = Complex(1. , u);
    }
    uc3 = characteristic_function(0.0 , V0 , uc1 , T , beta , zeta , lambda , A ,
    uc2 = Cexp(Complex(0.0, -u * log(strike / spot)));
    uc3 = Cmul(uc2 , uc3);
    return (uc3.i / u) ;
}

```

```

int compute_price(double t, Swaption *ptSwpt, double sigma)
{

    int i, M, s;
    double BT_M, BT_s, sumZc;
    double w;
    double price;
    int ngauss = 10. , N = 1000;
    double ai, b, h = 1., tol = 1.e-12, tpi, tp3, tp1, tp2;

    nb_time = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);

    beta = (double *)malloc(nb_time * sizeof(double));

```

```

zeta = (double *)malloc(nb_time * sizeof(double));
lambda = (double *)malloc(nb_time * sizeof(double));

A = (dcomplex *)malloc(nb_time * sizeof(dcomplex)) ;
g = (dcomplex *)malloc(nb_time * sizeof(dcomplex)) ;
a = (dcomplex *)malloc(nb_time * sizeof(dcomplex)) ;
d = (dcomplex *)malloc(nb_time * sizeof(dcomplex)) ;
B = (dcomplex *)malloc(nb_time * sizeof(dcomplex)) ;

M = (int)(ptSwpt->swapMaturity / ptSwpt->tenor);
s = (int)(ptSwpt->swaptionMaturity / ptSwpt->tenor);
BT_M = computeZeroCoupon(ptLib, 0, M);
BT_s = computeZeroCoupon(ptLib, 0, s);
sumZc = computeZeroCouponSum(ptLib, 0, s + 1, M);
spot = (BT_s - BT_M) / sumZc;
w = BT_s - BT_M;
strike = ptSwpt->strike;
compute_Omega(ptLib, ptSwpt , omega);
compute_alpha(ptLib, ptSwpt , alpha);
build_beta_swaption(beta, ptSwpt, sigma);
build_lambda_swaption(lambda , ptSwpt , ptLib , omega, sigma);
build_zeta_swaption(zeta, ptSwpt , ptLib, sigma);

int_type = 1;
init_gauss(ngauss);
init_log(nb_time);
//
//=====
tp3 = 0.;
tpi = 1.;
i = 0;
while ((fabs(tpi) > tol) && (i < N))
{
    ai = i * h;
    b = ai + h;
    tpi = integrale_gauss(func, ai, b);

    tp3 += tpi;
    i++;
}
if (fabs(tpi) > tol) printf("tpi %f= \ n", tpi);

```

```

tp1 = tp3 / M_PI;
tp1 += 0.5;
//=====
//
free_gauss();
free_log();

int_type = 2;
init_gauss(ngauss);
init_log(nb_time);
//
//=====
tp3 = 0.;
tpi = 1.;
i = 0;
while ((fabs(tpi) > tol) && (i < N))
{
    ai = i * h;
    b = ai + h;
    tpi = integrale_gauss(func, ai, b);
    tp3 += tpi;
    i++;
}
if (fabs(tpi) > tol) printf("tpi %f= \ n", tpi);

tp2 = tp3 / M_PI;
tp2 += 0.5;
//=====
//
free_gauss();
free_log();

price = w * (tp2 - strike / spot * tp1) ;
ptSwpt->price = price;

// free
free(beta);
beta = NULL;

```

```
    free(zeta);
    zeta = NULL;
    free(lambda);
    lambda = NULL;
    free(A);
    A = NULL;
    free(g);
    g = NULL;
    free(a);
    a = NULL;
    free(d);
    d = NULL;
    free(B);
    B = NULL;

    return (1);
}
```

```
static int ap_wuzhang_lmm_heston1d(double epsilon_lmm, double kappa_lmm, double
{
    int numMat;
    double *maturities;
    double swaption_price;

    epsilon = epsilon_lmm;

    kappa = kappa_lmm;
    theta = theta_lmm;
    V0 = V0_lmm;
    rho1_lmm = rho1;
    rho2_lmm = rho2;
    rho2_lmm = 0.;

    swap_maturity = swap_maturity - t0;
    swap_maturity = swap_maturity - t0;

    numMat = (int)(swap_maturity / tenor);
    maturities = (double *)malloc(numMat * sizeof(double));
```

```

/* if ((p->Compute)==&Put) */
/*   payer_or_receiver=1; */
/* else */
/*   if ((p->Compute)==&Call) */
/*     payer_or_receiver=0; */

swaption_price = lmm_swaption_payer_stoVol_pricer(tenor, nb_factors, swaption_

*price = Nominal * swaption_price;

free(maturities);

return OK;
}

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

    return ap_wuzhang_lmm_heston1d(ptMod->Sigma2.Val.V_PDOUBLE,
                                   ptMod->MeanReversion.Val.V_PDOUBLE,
                                   ptMod->LongRunVariance.Val.V_PDOUBLE,
                                   ptMod->Sigma0.Val.V_PDOUBLE,
                                   ptMod->Rho1.Val.V_PDOUBLE,
                                   ptMod->Rho2.Val.V_PDOUBLE,
                                   ptOpt->PayOff.Val.V_NUMFUNC_1, ptMod->l0.Val.V_
                                   ptMod->T.Val.V_DATE,
                                   ptMod->Sigma.Val.V_PDOUBLE,
                                   ptMod->NbFactors.Val.V_ENUM.value,
                                   ptOpt->BMaturity.Val.V_DATE,
                                   ptOpt->OMaturity.Val.V_DATE,
                                   ptOpt->EuOrAm.Val.V_BOOL,
                                   ptOpt->Nominal.Val.V_PDOUBLE,
                                   ptOpt->FixedRate.Val.V_PDOUBLE,
                                   ptOpt->ResetPeriod.Val.V_DATE,
                                   &(Met->Res[0].Val.V_DOUBLE));
}

static int CHK_OPT(AP_WZ)(void *Opt, void *Mod)

```

```

{

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

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

    return OK;
}

PricingMethod MET(AP_WZ) =
{
    "AP_WuZhang_LMMHeston",
    {
        {" ", PREMIA_NULLTYPE, {0}, FORBID}
    },
    CALC(AP_WZ),
    {"Price", DOUBLE, {100}, FORBID}/*,{"Delta",DOUBLE,{100},FORBID}*/ , {" ", PR
    CHK_OPT(AP_WZ),
    CHK_ok,
    MET(Init)
} ;

```