Q2

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%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%   This code is to calculate prices of bond option for various yields    %
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    format long;

%   zero-coupon yields

    r0=0.018:0.0005:0.0475; %0.05*ones(60,1); %:0.0005:0.05;
    %r0=0.02:0.0005:0.0495;

%   Model parameters

    th=0.004; sig=0.01;

%   Option and bond parameters

    c=2; TC=5; TB=15; K=99;

%   Parameters for the tree

    dt=0.5; rdt=sqrt(dt);
    N=TB/dt;                % index for bond's maturity
    M=TC/dt;                % index for option's maturity

    P0=zeros(N,1);

    P0(1)=100/(1+dt*r0(1));
    for j=2:N
         P0(j)=100/(1+dt*r0(j))^(j);  %spot rate
%        P0(j)=P0(j-1)/(1+dt*r0(j));  %forward rate
    end

    r=zeros(N,N);
    q=zeros(N,1);
    r(1,1)=r0(1);

    for j=2:N
        for i=1:j-1
            r(i,j)=r(i,j-1)+th*dt-sig*rdt;
        end
        r(j,j)=r(j-1,j-1)+th*dt+sig*rdt;
    end

    OPTIONS=[];
    for j=2:N
        jj=j; q0=0.5;
        q1=get_q1(P0,r,q,jj,dt);
        q(j-1)=q1;
    end
    %plot(q); pause
```

```
B=zeros(N+1,N+1);
B(:,N+1)=100*ones(N+1,1);
for j=N:-1:M+1
    for i=1:j
        B(i,j)=(q(j)*B(i,j+1)+(1-q(j))*B(i+1,j+1)+c*dt)/(1+r(i,j)*dt);
    end
end

C=zeros(M+1,M+1);                          % option value tree

for i=1:M+1
    C(i,M+1)=max(B(i,M+1)-K,0);
end

for j=M:-1:1
    for i=1:j
        C(i,j)=(q(j)*C(i,j+1)+(1-q(j))*C(i+1,j+1))/(1+r(i,j)*dt);
    end
end
C(1,1)
```

```
ans =

   1.977174420034350
```

Q3

```
P=zeros(M+1,M+1);                          % option value tree

for i=1:M+1
    P(i,M+1)=max(K-B(i,M+1),0);
end

for j=M:-1:1
    for i=1:j
        P(i,j)=(q(j)*P(i,j+1)+(1-q(j))*P(i+1,j+1))/(1+r(i,j)*dt);
    end
end
P(1,1)
```

```
ans =

  13.798216999837658
```

Q4

```
f=0.02:0.0005:0.0495;
n=length(f);
O=zeros(n,1);
d=zeros(n,1);
d(1)=1/(1+0.02/2);
s=zeros(n,1);
```

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for k=2:n
    d(k)=d(k-1)/(1+f(k)/2);  %Q4a
end

for k=1:n
    s(k)=(1-d(k))/(1/2*sum(d(1:k)));  %Q4b
end

st = (d(10)-d(30))/(1/2*sum(d(11:30)));  %Q4c


%st = 0.029503653118719

%price the swap Q4c and Q5

%   Model parameters
    th=0.005; sig=0.01;
    TC=5; TB=15; K=100;

%   Parameters for the tree

    dt=0.5; rdt=sqrt(dt);
    N=TB/dt;                % index for bond's maturity
    M=TC/dt;                % index for option's maturity
    P0=zeros(N,1);
    P0(1)=100/(1+dt*f(1));
    for j=2:N
        P0(j)=P0(j-1)/(1+dt*f(j));
    end

%   Calculate the swap rate

    sum=0;
    for j=M+1:N
        sum=sum+P0(j);
    end
    c=2*(P0(M)-P0(N))/sum;
    c=c*100;
%   Build tree

    q=zeros(N,1);
    r=zeros(N,N);
    r(1,1)=f(1);

    for j=2:N
        for i=1:j-1
            r(i,j)=r(i,j-1)+th*dt-sig*rdt;
        end
        r(j,j)=r(j-1,j-1)+th*dt+sig*rdt;
    end
     for j=2:N
        jj=j; q0=0.5;
        q1=get_q1(P0,r,q,jj,dt);
```

```
    q(j-1)=q1;
end


%  Calculate bond price at option's maturity

P=zeros(N+1,N+1);
P(:,N+1)=100*ones(N+1,1);
for j=N:-1:M+1
     for i=1:j
         P(i,j)=(q(j)*P(i,j+1)+(1-q(j))*P(i+1,j+1)+c*dt)/(1+r(i,j)*dt);
     end
end

%  Calculate option's value (receiver's swap)

C=zeros(M+1,M+1);

for i=1:M+1
    C(i,M+1)=max(P(i,M+1)-K,0); %V_fix - V_float
end

for j=M:-1:1
    for i=1:j
        C(i,j)=(q(j)*C(i,j+1)+(1-q(j))*C(i+1,j+1))/(1+r(i,j)*dt);
    end
end

C(1,1) %receiver's swap value is 6.6887

%  Calculate option's value (payer's swap)

C2=zeros(M+1,M+1);

for i=1:M+1
    C2(i,M+1)=max(K-P(i,M+1),0); %V_float - V_fix
end

for j=M:-1:1
    for i=1:j
        C2(i,j)=(q(j)*C2(i,j+1)+(1-q(j))*C2(i+1,j+1))/(1+r(i,j)*dt);
    end
end

C2(1,1) payer's swap value is 6.6887
```