MA374-Financial Engineering Laboratory
Assignment 9

Sourav Bikash
11012338

April 1, 2014

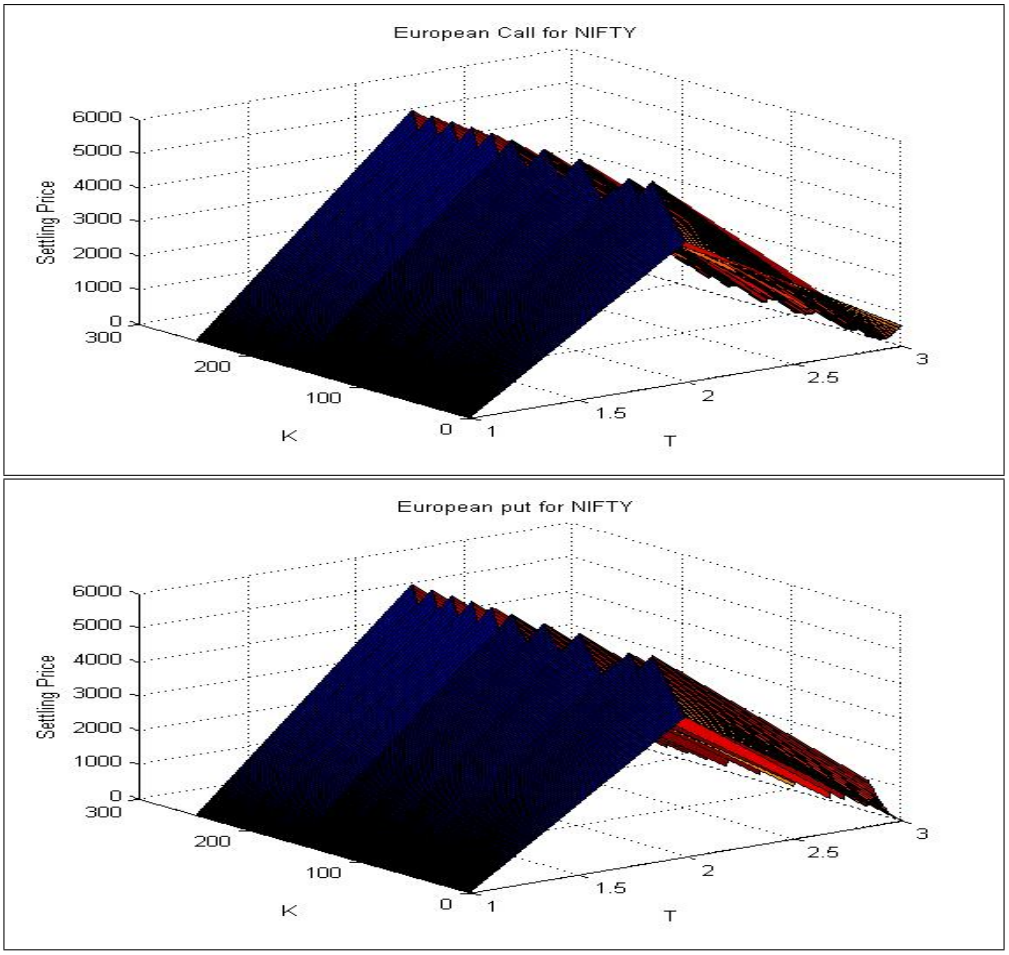
Contents

1 Section-A

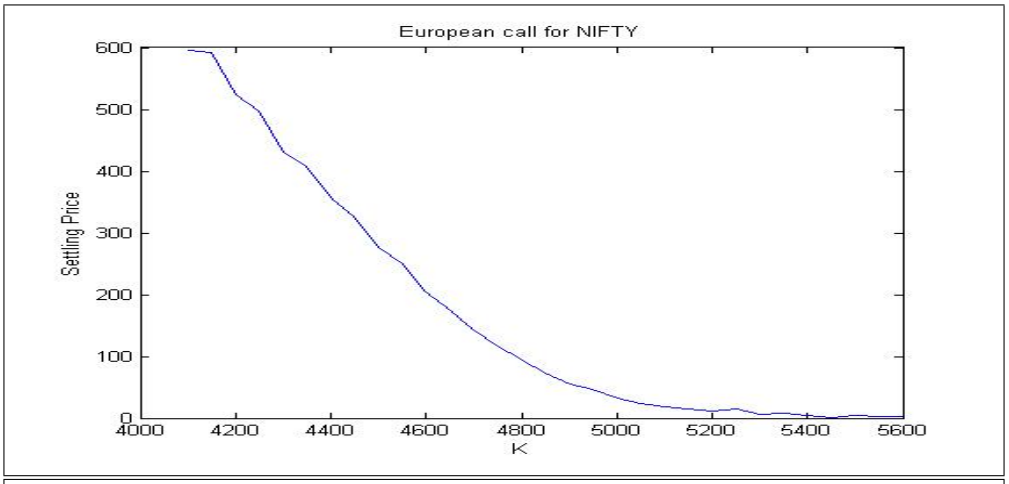
2 Question 1

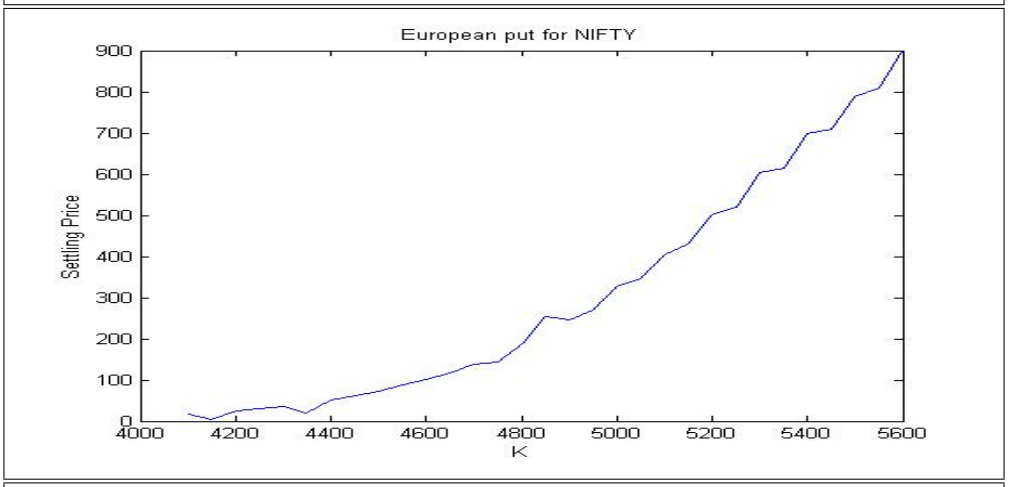
The data has been enclosed in xlxs format.

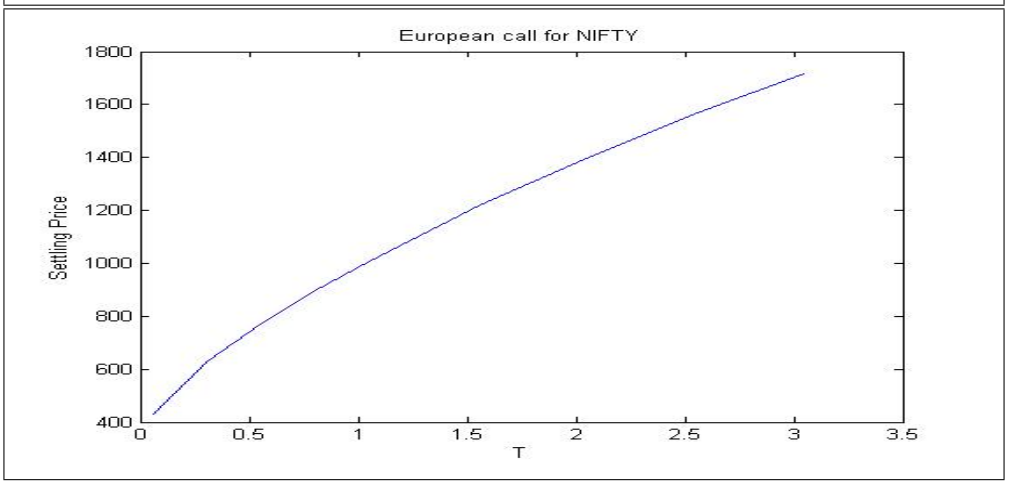
2.1 Option Price Plot in 3D

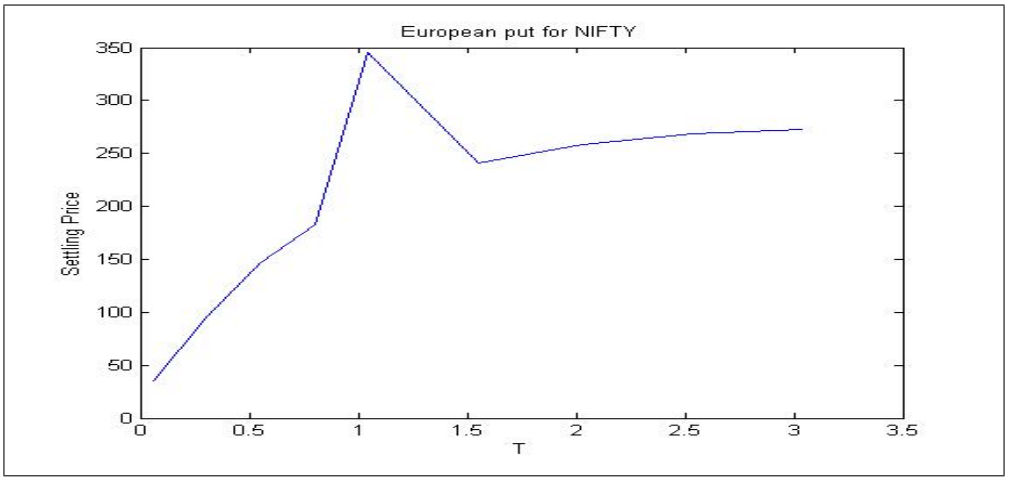


2.2 2D Analysis





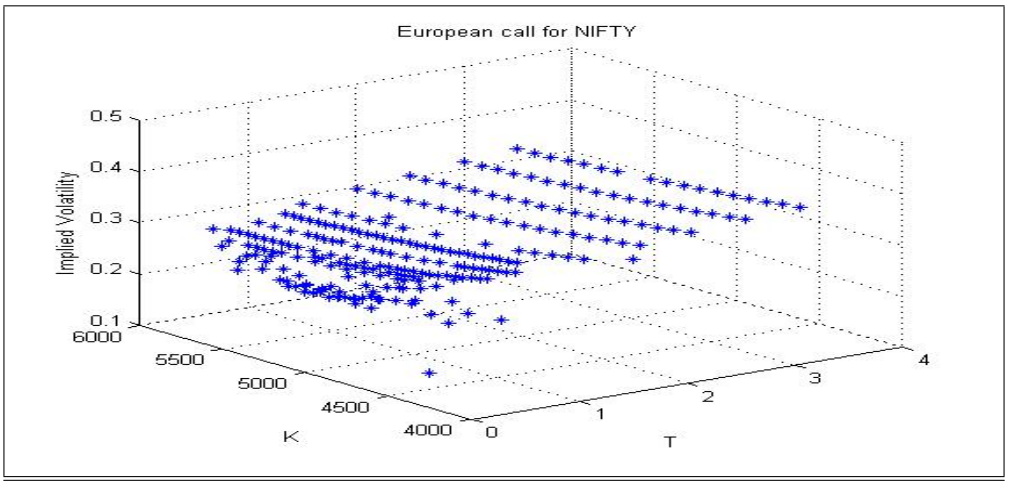


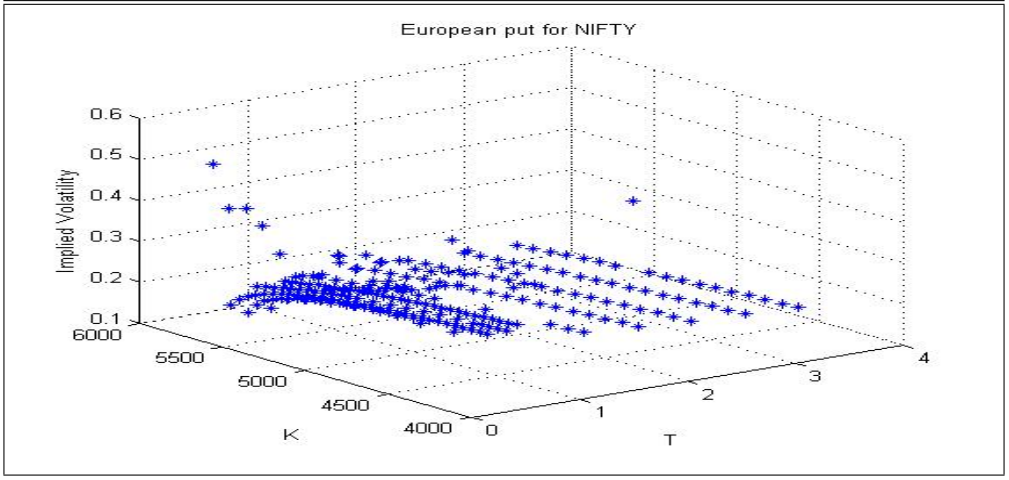

European put for NIFTY
Settling Price
T
0
50
100
150
200
250
300
350
0
0.5
1
1.5
2
2.5
3
3.5

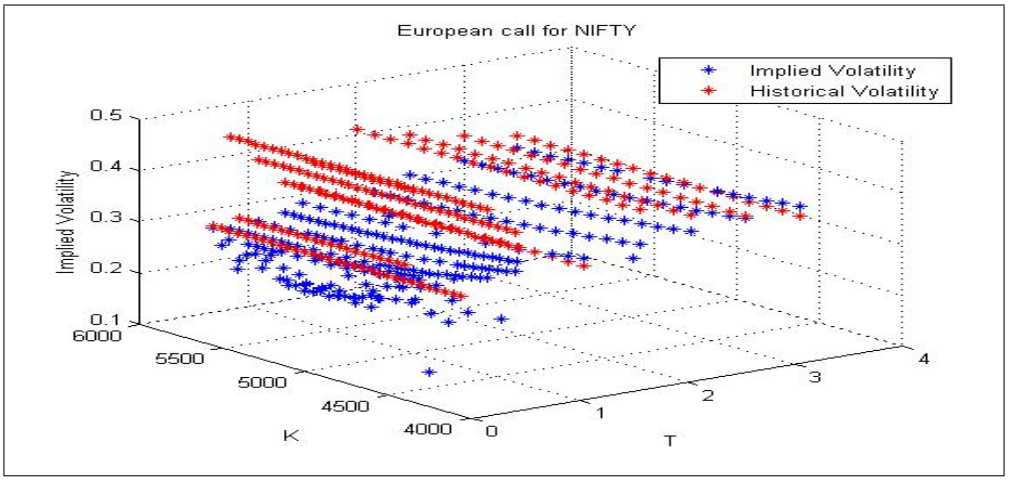
3 Question 2

.

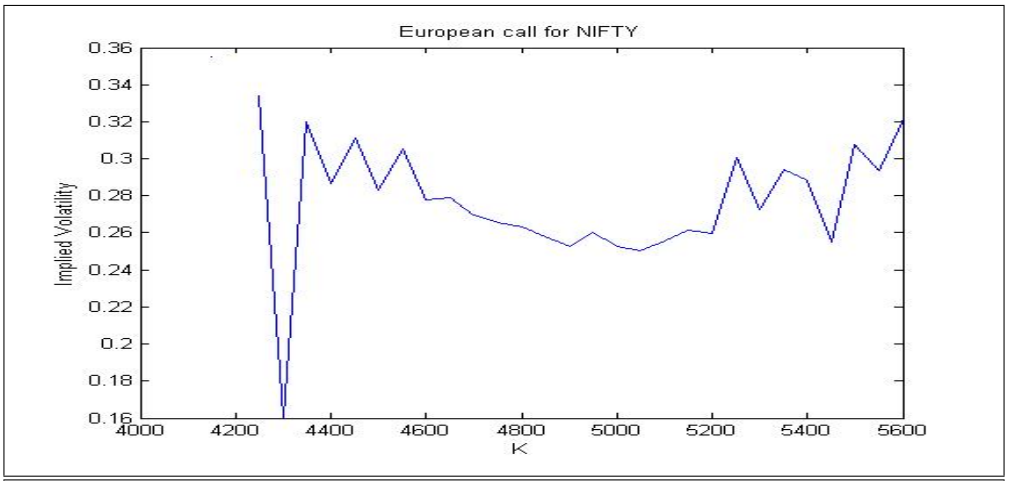
3.1 Implied Volatility 3D plot

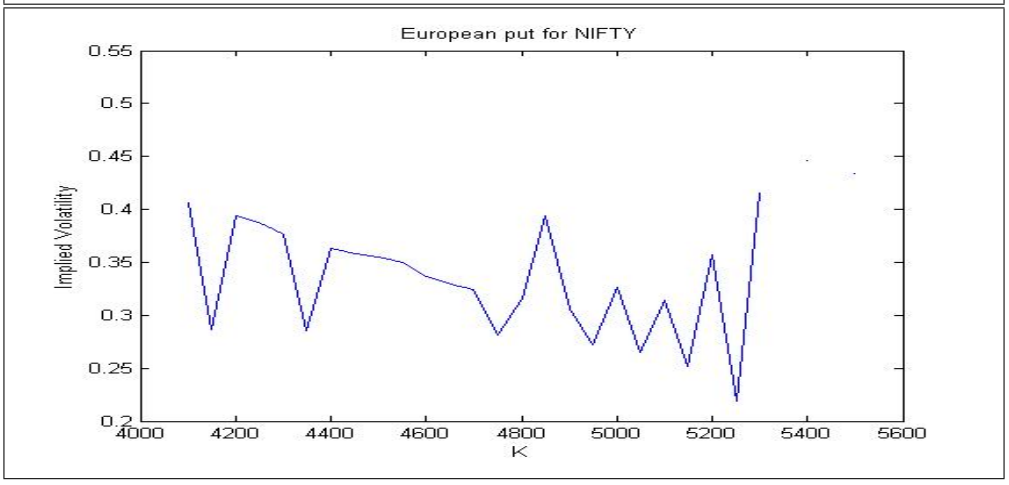


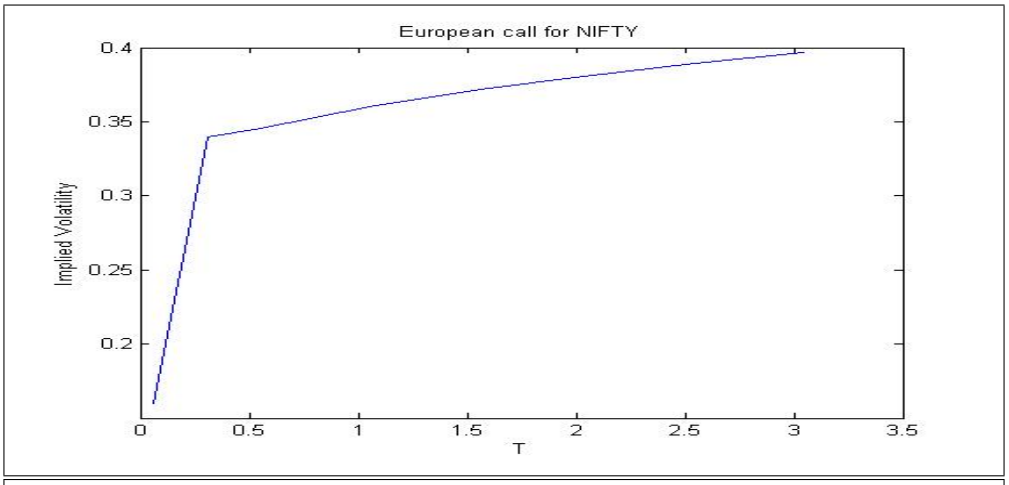


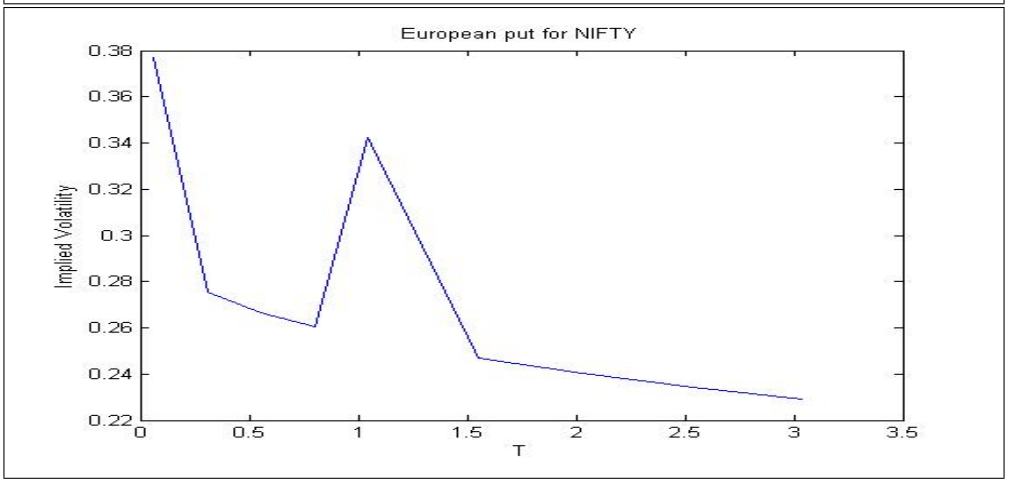


3.2 2D Analysis





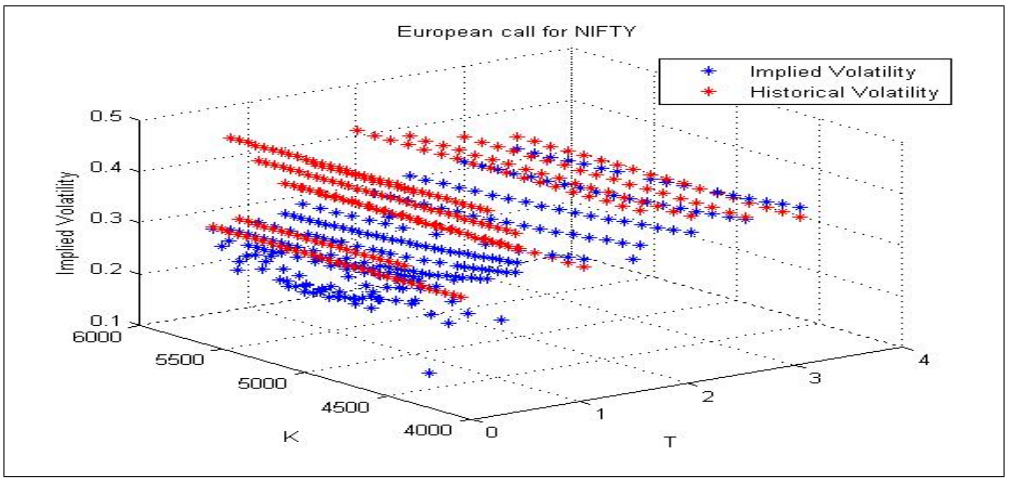

European call for NIFTY
Implied Volatility
T
0.4
0.35
0.3
0.25
0.2
0
0.5
1
1.5
2
2.5
3
3.5


European put for NIFTY
Implied Volatility
T
0.38
0.36
0.34
0.32
0.3
0.28
0.26
0.24
0.22
0
0.5
1
1.5
2
2.5
3
3.5

4 Question 3

.

4.1 Historical Volatility

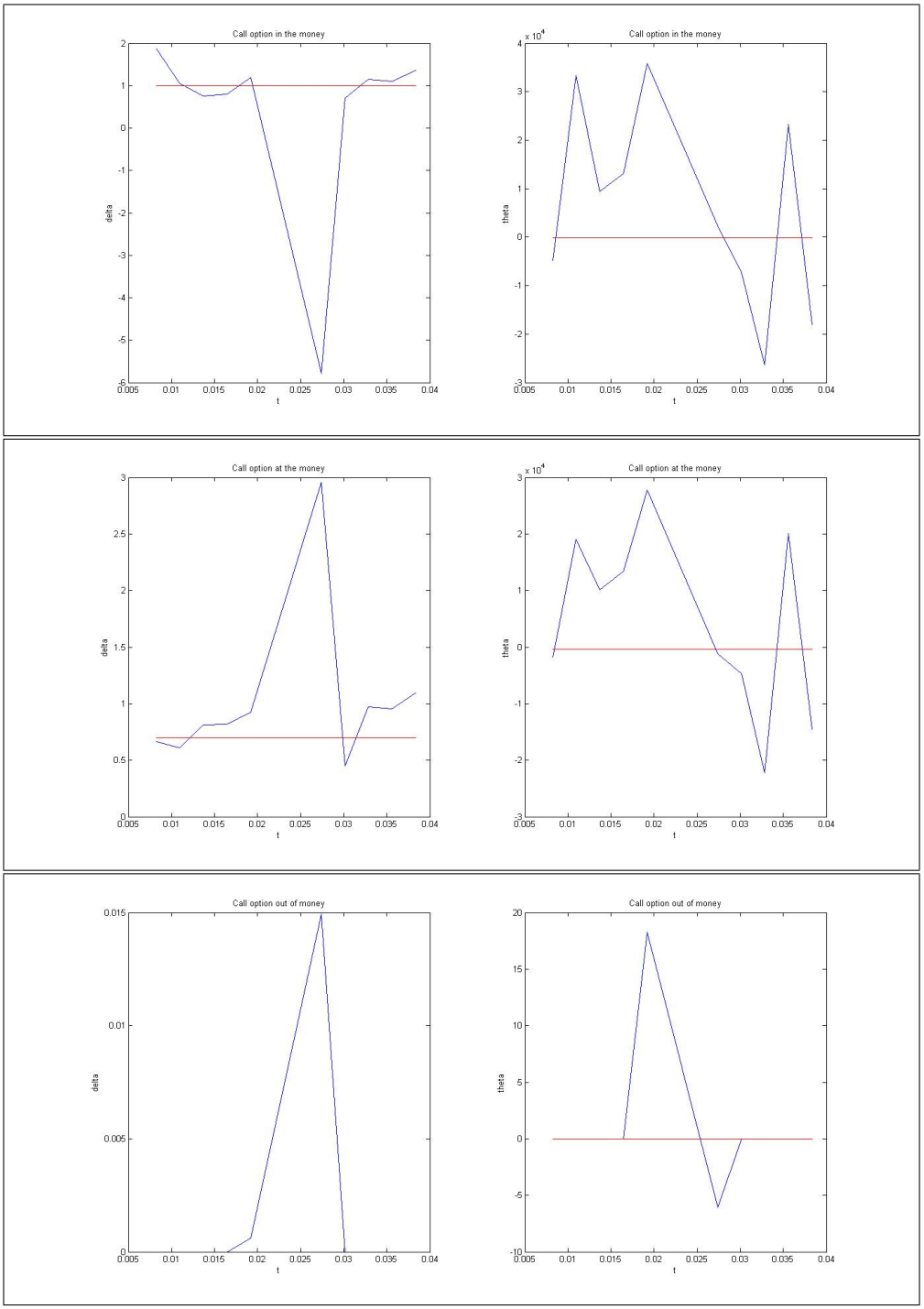


4.2 Comparision of implied and Historical Volatility

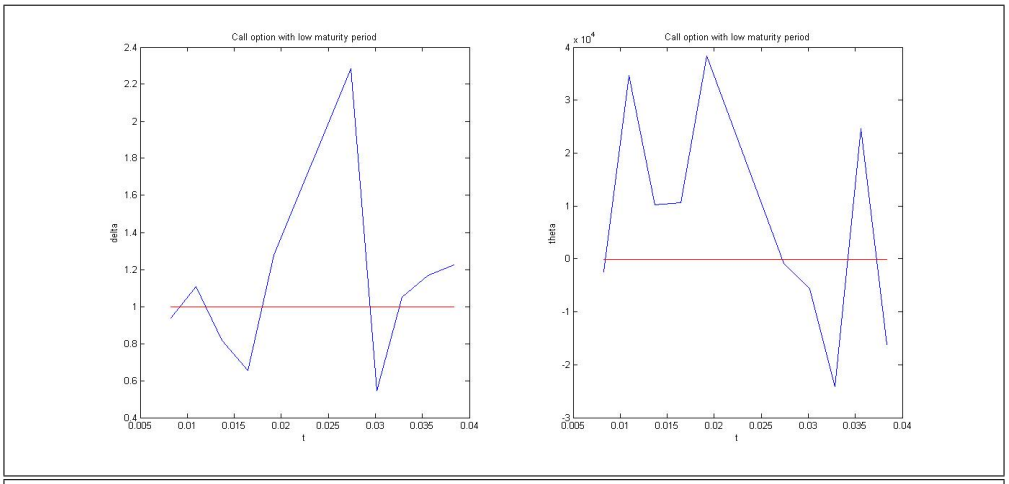
The values can be found in the attached in the excel files.

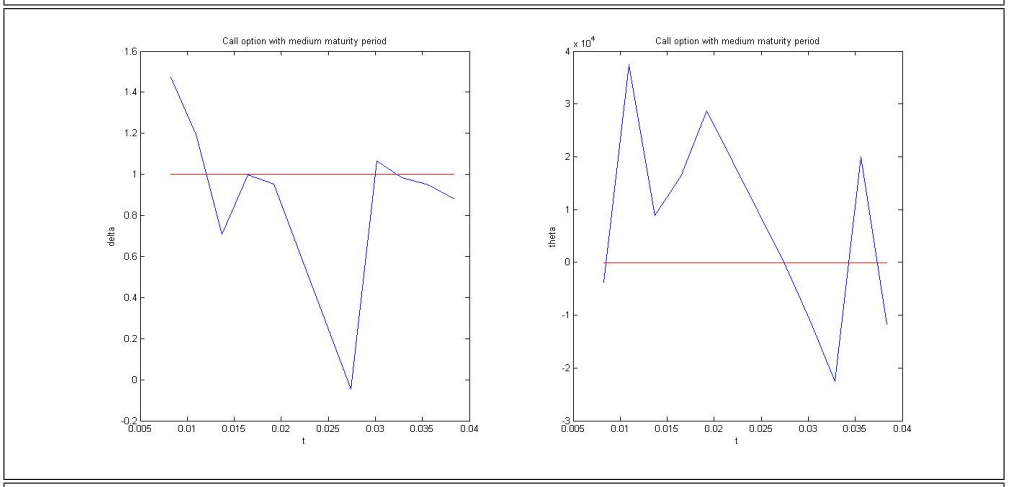
5 Section-B

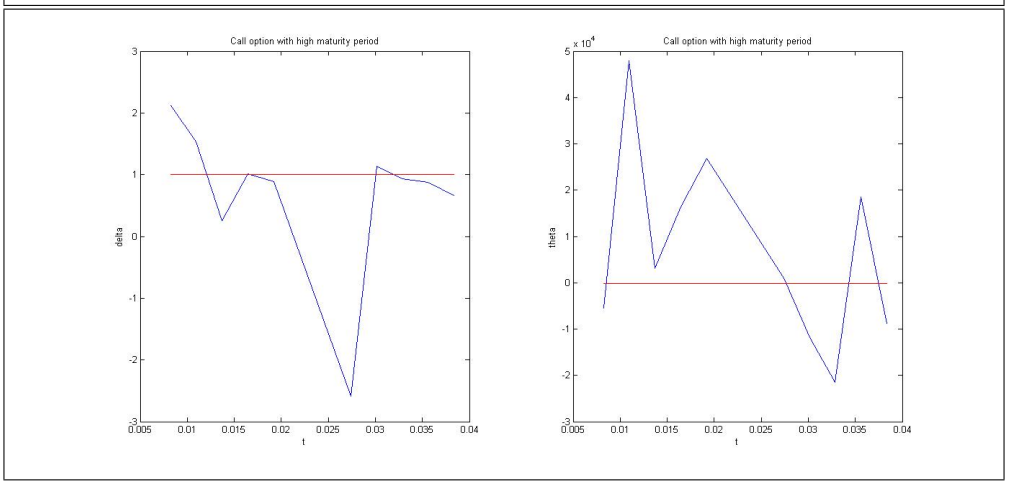
6 Question 1



7 Question 2


Call option with low maturity period
delta
t
Call option with low maturity period
x 10^-4
theta
t


Call option with medium maturity period
delta
t
Call option with medium maturity period
x 10^-4
theta
t


Call option with high maturity period
delta
t
Call option with high maturity period
x 10^-4
theta
t

8 Matlab Codes

8.1 Question 1

```
close all;
clear;
clc;

[num]=xlsread('NSEoptiondata.xlsx',1);
surf(num);
xlabel('T');
ylabel('K');
zlabel('Settling Price');
title('European Call for NIFTY');

figure();
[num]=xlsread('NSEoptiondata.xlsx',2);
surf(num);
xlabel('T');
ylabel('K');
zlabel('Settling Price');
title('European put for NIFTY');

figure();
[num]=xlsread('NSEoptiondata.xlsx',3);
plot(num(:,1),num(:,2));
xlabel('K');
ylabel('Settling Price');
title('European call for NIFTY');

figure();
[num]=xlsread('NSEoptiondata.xlsx',4);
plot(num(:,1),num(:,2));
xlabel('K');
ylabel('Settling Price');
title('European put for NIFTY');

figure();
[num]=xlsread('NSEoptiondata.xlsx',5);
plot(num(:,1),num(:,2));
xlabel('T');
ylabel('Settling Price');
title('European call for NIFTY');
```

```
figure();
[num]=xlsread('NSEoptiondata.xlsx',6);
plot(num(:,1),num(:,2));
xlabel('T');
ylabel('Settling Price');
title('European put for NIFTY');
```

8.2 Question 2

```
close all;
clear;
clc;

s=4715.90;
r=0.05;
tol=10^-3;
MAXIT=100;
[num]=xlsread('NSEoptiondata.xlsx',1);
for i=1:length(num)
    T=num(i,1);
    k=num(i,2);
    sig=0.5;
    for j=1:MAXIT
        d1=(log(s/k)+(r+0.5*sig*sig)*T)/(sig*sqrt(T));
        d2=(log(s/k)+(r-0.5*sig*sig)*T)/(sig*sqrt(T));
        f=normcdf(d1)*s-normcdf(d2)*k*exp(-r*T)-num(i,3);
        df=s*sqrt(T)*normpdf(d1);
        dx=f/df;
        sig=sig-dx;
        if(abs(dx)<tol)
            v(i)=sig;
            break;
        elseif(j==MAXIT)
            v(i)=NaN;
        end
    end
end
scatter3(num(:,1),num(:,2),v(:),'*');
xlabel('T');
ylabel('K');
zlabel('Implied Volatility');
title('European call for NIFTY');
```

```
clear;
s=4715.90;
r=0.05;
tol=10^-3;
MAXIT=100;
figure();
[num]=xlsread('NSEoptiondata.xlsx',2);
for i=1:length(num)
    T=num(i,1);
    k=num(i,2);
    sig=0.5;
    for j=1:MAXIT
        d1=(log(s/k)+(r+0.5*sig*sig)*T)/(sig*sqrt(T));
        d2=(log(s/k)+(r-0.5*sig*sig)*T)/(sig*sqrt(T));
        f=normcdf(-d2)*k*exp(-r*T)-normcdf(-d1)*s-num(i,3);
        df=s*sqrt(T)*normpdf(d1);
        dx=f/df;
        sig=sig-dx;
        if(abs(dx)<tol)
            v(i)=sig;
            break;
        elseif(j==MAXIT)
            v(i)=NaN;
        end
    end
end
scatter3(num(:,1),num(:,2),v(:),'*');
xlabel('T');
ylabel('K');
zlabel('Implied Volatility');
title('European put for NIFTY');

clear;
s=4715.90;
r=0.05;
tol=10^-3;
MAXIT=100;
figure();
[num]=xlsread('NSEoptiondata.xlsx',3);
for i=1:length(num)
    T=num(i,1);
    k=num(i,2);
    sig=0.5;
```

```
    for j=1:MAXIT
        d1=(log(s/k)+(r+0.5*sig*sig)*T)/(sig*sqrt(T));
        d2=(log(s/k)+(r-0.5*sig*sig)*T)/(sig*sqrt(T));
        f=normcdf(d1)*s-normcdf(d2)*k*exp(-r*T)-num(i,3);
        df=s*sqrt(T)*normpdf(d1);
        dx=f/df;
        sig=sig-dx;
        if(abs(dx)<tol)
            v(i)=sig;
            break;
        elseif(j==MAXIT)
            v(i)=NaN;
        end
    end
end
plot(num(:,2),v(:));
xlabel('K');
ylabel('Implied Volatility');
title('European call for NIFTY');

clear;
s=4715.90;
r=0.05;
tol=10^-3;
MAXIT=100;
figure();
[num]=xlsread('NSEoptiondata.xlsx',4);
for i=1:length(num)
    T=num(i,1);
    k=num(i,2);
    sig=0.5;
    for j=1:MAXIT
        d1=(log(s/k)+(r+0.5*sig*sig)*T)/(sig*sqrt(T));
        d2=(log(s/k)+(r-0.5*sig*sig)*T)/(sig*sqrt(T));
        f=normcdf(-d2)*k*exp(-r*T)-normcdf(-d1)*s-num(i,3);
        df=s*sqrt(T)*normpdf(d1);
        dx=f/df;
        sig=sig-dx;
        if(abs(dx)<tol)
            v(i)=sig;
            break;
        elseif(j==MAXIT)
            v(i)=NaN;
```

```
        end
    end
end
plot(num(:,2),v(:));
xlabel('K');
ylabel('Implied Volatility');
title('European put for NIFTY');

clear;
s=4715.90;
r=0.05;
tol=10^-3;
MAXIT=100;
figure();
[num]=xlsread('NSEoptiondata.xlsx',5);
for i=1:length(num)
    k=num(i,1);
    T=num(i,2);
    sig=0.5;
    for j=1:MAXIT
        d1=(log(s/k)+(r+0.5*sig*sig)*T)/(sig*sqrt(T));
        d2=(log(s/k)+(r-0.5*sig*sig)*T)/(sig*sqrt(T));
        f=normcdf(d1)*s-normcdf(d2)*k*exp(-r*T)-num(i,3);
        df=s*sqrt(T)*normpdf(d1);
        dx=f/df;
        sig=sig-dx;
        if(abs(dx)<tol)
            v(i)=sig;
            break;
        elseif(j==MAXIT)
            v(i)=NaN;
        end
    end
end
plot(num(:,2),v(:));
xlabel('T');
ylabel('Implied Volatility');
title('European call for NIFTY');

clear;
s=4715.90;
r=0.05;
tol=10^-3;
```

```
MAXIT=100;
figure();
[num]=xlsread('NSEoptiondata.xlsx',6);
for i=1:length(num)
    k=num(i,1);
    T=num(i,2);
    sig=0.5;
    for j=1:MAXIT
        d1=(log(s/k)+(r+0.5*sig*sig)*T)/(sig*sqrt(T));
        d2=(log(s/k)+(r-0.5*sig*sig)*T)/(sig*sqrt(T));
        f=normcdf(-d2)*k*exp(-r*T)-normcdf(-d1)*s-num(i,3);
        df=s*sqrt(T)*normpdf(d1);
        dx=f/df;
        sig=sig-dx;
        if(abs(dx)<tol)
            v(i)=sig;
            break;
        elseif(j==MAXIT)
            v(i)=NaN;
        end
    end
end
plot(num(:,2),v(:));
xlabel('T');
ylabel('Implied Volatility');
title('European put for NIFTY');
```

8.3 Question 3

```
close all;
clear;
clc;

s=4715.90;
r=0.05;
tol=10^-3;
MAXIT=100;
[num1]=xlsread('NSEoptiondata.xlsx',1);
[num2]=xlsread('NSEdata.xlsx');
n=length(num2);
ret=price2ret(num2,[],'Periodic');
n=n-1;
for i=1:length(num1)
    T=num1(i,1);
```

```
    k=num1(i,2);
    sig=0.5;
    for j=1:MAXIT
        d1=(log(s/k)+(r+0.5*sig*sig)*T)/(sig*sqrt(T));
        d2=(log(s/k)+(r-0.5*sig*sig)*T)/(sig*sqrt(T));
        f=normcdf(d1)*s-normcdf(d2)*k*exp(-r*T)-num1(i,3);
        df=s*sqrt(T)*normpdf(d1);
        dx=f/df;
        sig=sig-dx;
        if(abs(dx)<tol)
            v(i,1)=sig;
            break;
        elseif(j==MAXIT)
            v(i,1)=NaN;
        end
    end
    ret_new=ret(floor(n-T*252+1):n);
    v(i,2)=sqrt(252*var(ret_new));
end
scatter3(num1(:,1),num1(:,2),v(:,1),'*');
xlabel('T');
ylabel('K');
zlabel('Implied Volatility');
title('European call for NIFTY');
hold on;
scatter3(num1(:,1),num1(:,2),v(:,2),'r*');

colhead={'Implied Volatility','Historical Volatility'};
xlswrite('comparison_sigma.xlsx',colhead,'A1:B1');
xlswrite('comparison_sigma.xlsx',v,'A2:B249');
legend('Implied Volatility','Historical Volatility');
```

8.4 Question 1 B

```
close all;
clear;
clc;

[num,text]=xlsread('NIFTYoptiondata.xlsx',1);
r=0.05;
sig=sqrt(252)*std(price2ret(unique(num(:,5)),[],'periodic'));

j=1;
for i=1:length(num)
```

```
    if(num(i,9)~=max(num(:,9)))
        temp(j)=i;
        j=j+1;
    end
end
num(temp,:)=[];
text(temp+1,:)=[];

K=min(num(:,2));
for i=1:length(num)
    if(num(i,2)==K)
        T=text(i+1,7);
        break;
    end
end

j=0;
for i=1:length(num)
    if(num(i,2)==K && strcmp(text(i+1,7),T))
        j=j+1;
        p(j,:)=num(i,1:5);
    end
end

d1=(log(p(1,5)/K)+(r+0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
d2=(log(p(1,5)/K)+(r-0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
delta_bsm=normcdf(d1);
theta_bsm=((-0.5*p(1,5)*normpdf(d1)*sig)/(sqrt(p(1,4))))-(r*K*
   exp(-r*p(1,4))*normcdf(d2));
delta=diff(p(:,3))./diff(p(:,5));
theta=diff(p(:,3))./diff(p(:,1));

subplot(1,2,1);
plot(p(2:length(p)),delta);
hold on;
plot(p(2:length(p)),delta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('delta');
title('Call option in the money');
hold off;
subplot(1,2,2);
plot(p(2:length(p)),theta);
hold on;
```

```
plot(p(2:length(p)),theta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('theta');
title('Call option in the money');
hold off;

K=median(num(:,2));
for i=1:length(num)
    if(num(i,2)==K)
        T=text(i+1,7);
        break;
    end
end

j=0;
for i=1:length(num)
    if(num(i,2)==K && strcmp(text(i+1,7),T))
        j=j+1;
        p(j,:)=num(i,1:5);
    end
end

d1=(log(p(1,5)/K)+(r+0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
d2=(log(p(1,5)/K)+(r-0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
delta_bsm=normcdf(d1);
theta_bsm=((-0.5*p(1,5)*normpdf(d1)*sig)/(sqrt(p(1,4))))-(r*K*
   exp(-r*p(1,4))*normcdf(d2));
delta=diff(p(:,3))./diff(p(:,5));
theta=diff(p(:,3))./diff(p(:,1));

figure();
subplot(1,2,1);
plot(p(2:length(p)),delta);
hold on;
plot(p(2:length(p)),delta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('delta');
title('Call option at the money');
hold off;
subplot(1,2,2);
plot(p(2:length(p)),theta);
hold on;
plot(p(2:length(p)),theta_bsm*ones(length(p)-1));
```

```
xlabel('t');
ylabel('theta');
title('Call option at the money');
hold off;

K=max(num(:,2));
for i=1:length(num)
    if(num(i,2)==K)
        T=text(i+1,7);
        break;
    end
end

j=0;
for i=1:length(num)
    if(num(i,2)==K && strcmp(text(i+1,7),T))
        j=j+1;
        p(j,:)=num(i,1:5);
    end
end

d1=(log(p(1,5)/K)+(r+0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
d2=(log(p(1,5)/K)+(r-0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
delta_bsm=normcdf(d1);
theta_bsm=((-0.5*p(1,5)*normpdf(d1)*sig)/(sqrt(p(1,4))))-(r*K*
    exp(-r*p(1,4))*normcdf(d2));
delta=diff(p(:,3))./diff(p(:,5));
theta=diff(p(:,3))./diff(p(:,1));

figure();
subplot(1,2,1);
plot(p(2:length(p)),delta);
hold on;
plot(p(2:length(p)),delta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('delta');
title('Call option out of money');
hold off;
subplot(1,2,2);
plot(p(2:length(p)),theta);
hold on;
plot(p(2:length(p)),theta_bsm*ones(length(p)-1));
xlabel('t');
```

```
ylabel('theta');
title('Call option out of money');
hold off;
```

8.5 Question 2 B

```
close all;
clear;
clc;

[num,text]=xlsread('NIFTYoptiondata.xlsx',1);
r=0.05;
sig=sqrt(252)*std(price2ret(unique(num(:,5)),[],'periodic'));

j=1;
for i=1:length(num)
    if(num(i,9)~=max(num(:,9)))
        temp(j)=i;
        j=j+1;
    end
end
num(temp,:)=[];
text(temp+1,:)=[];

j=0;
for i=1:length(num)
    if(num(i,1)==0)
        j=j+1;
        q(j,:)=num(i,1:5);
    end
end

for i=1:length(num)
    if(num(i,4)==min(q(:,4)))
        K=num(i,2);
        T=text(i+1,7);
        break;
    end
end

j=0;
for i=1:length(num)
    if(num(i,2)==K && strcmp(text(i+1,7),T))
        j=j+1;
```

```
        p(j,:)=num(i,1:5);
    end
end

d1=(log(p(1,5)/K)+(r+0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
d2=(log(p(1,5)/K)+(r-0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
delta_bsm=normcdf(d1);
theta_bsm=((-0.5*p(1,5)*normpdf(d1)*sig)/(sqrt(p(1,4))))-(r*K*
    exp(-r*p(1,4))*normcdf(d2));
delta=diff(p(:,3))./diff(p(:,5));
theta=diff(p(:,3))./diff(p(:,1));

subplot(1,2,1);
plot(p(2:length(p)),delta);
hold on;
plot(p(2:length(p)),delta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('delta');
title('Call option with low maturity period');
hold off;
subplot(1,2,2);
plot(p(2:length(p)),theta);
hold on;
plot(p(2:length(p)),theta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('theta');
title('Call option with low maturity period');
hold off;

for i=1:length(num)
    if(num(i,4)==median(q(:,4)))
        K=num(i,2);
        T=text(i+1,7);
        break;
    end
end

j=0;
for i=1:length(num)
    if(num(i,2)==K && strcmp(text(i+1,7),T))
        j=j+1;
        p(j,:)=num(i,1:5);
    end
```

```
end

d1=(log(p(1,5)/K)+(r+0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
d2=(log(p(1,5)/K)+(r-0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
delta_bsm=normcdf(d1);
theta_bsm=((-0.5*p(1,5)*normpdf(d1)*sig)/(sqrt(p(1,4))))-(r*K*
    exp(-r*p(1,4))*normcdf(d2));
delta=diff(p(:,3))./diff(p(:,5));
theta=diff(p(:,3))./diff(p(:,1));

figure();
subplot(1,2,1);
plot(p(2:length(p)),delta);
hold on;
plot(p(2:length(p)),delta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('delta');
title('Call option with medium maturity period');
hold off;
subplot(1,2,2);
plot(p(2:length(p)),theta);
hold on;
plot(p(2:length(p)),theta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('theta');
title('Call option with medium maturity period');
hold off;

for i=1:length(num)
    if(num(i,4)==max(q(:,4)))
        K=num(i,2);
        T=text(i+1,7);
        break;
    end
end

j=0;
for i=1:length(num)
    if(num(i,2)==K && strcmp(text(i+1,7),T))
        j=j+1;
        p(j,:)=num(i,1:5);
    end
end
```

```
d1=(log(p(1,5)/K)+(r+0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
d2=(log(p(1,5)/K)+(r-0.5*sig*sig)*p(1,4))/(sig*sqrt(p(1,4)));
delta_bsm=normcdf(d1);
theta_bsm=((-0.5*p(1,5)*normpdf(d1)*sig)/(sqrt(p(1,4))))-(r*K*
    exp(-r*p(1,4))*normcdf(d2));
delta=diff(p(:,3))./diff(p(:,5));
theta=diff(p(:,3))./diff(p(:,1));

figure();
subplot(1,2,1);
plot(p(2:length(p)),delta);
hold on;
plot(p(2:length(p)),delta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('delta');
title('Call option with high maturity period');
hold off;
subplot(1,2,2);
plot(p(2:length(p)),theta);
hold on;
plot(p(2:length(p)),theta_bsm*ones(length(p)-1));
xlabel('t');
ylabel('theta');
title('Call option with high maturity period');
hold off;
```

9 References

- www.bseindia.com
- www.nseindia.com
- wikipedia...