Empirical Methods in Financial Econometrics:Project 5

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Exercise 1

A

The figures are below:

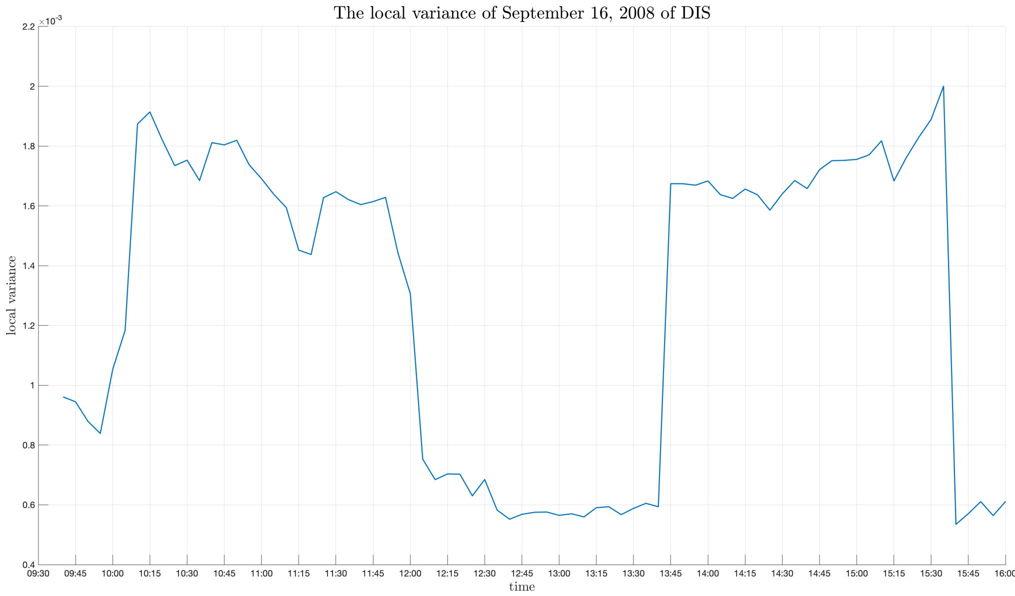

Figure 1: The local variance of September 16, 2008 of DIS

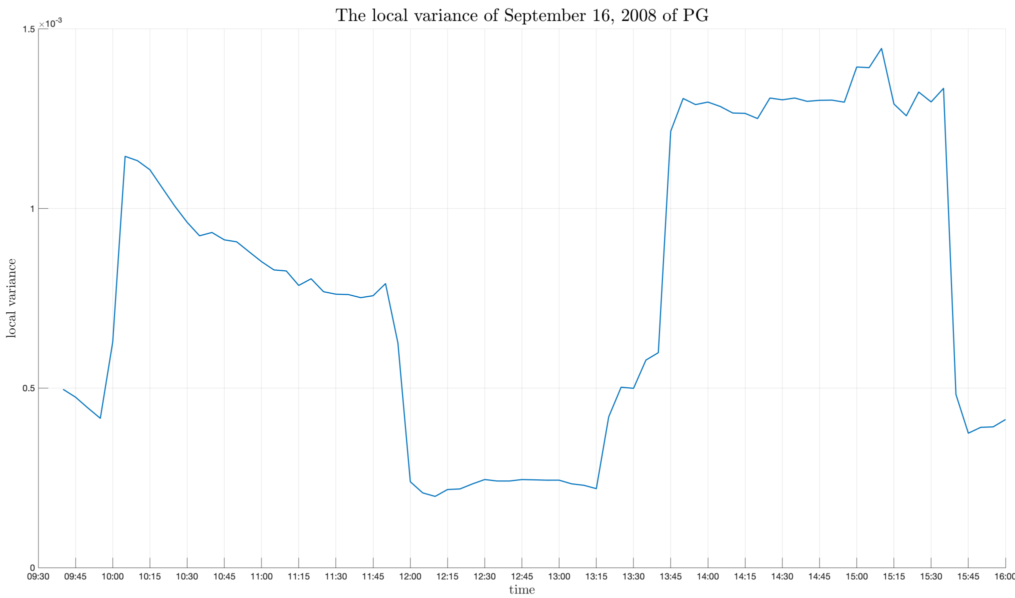

Figure 2: The local variance of September 16, 2008 of PG

Interpret: The local variance of DIS on September 16, 2008 shows a clear trend, which is like two mountain peaks. Specifically, the local variance rose sharply from 9:30 to 10:15 to 1.9×10^{-3}. Then, it fluctuated between 10:15 and 11:50, and dropped sharply to around 0.7×10^{-3} after 11:50, and continued stable to 13:40, sharply rising to around 1.7×10^{-3}. Next, it fluctuated from 13:45 to 15:35 until the highest point of 2×10^{-3}, and then drastically dropped to around 0.5×10^{-3} until the end.

The local variance of PG on September 16, 2008 also shows a clear trend, which is like two mountain peaks. Specifically, the local variance rose sharply from 9:30 to 10:05 to 1.2×10^{-3}. Then, it almost kept dropping between 10:05 and 11:50, and dropped sharply to around 0.2×10^{-3} after 11:50, and continued stable to 13:15, sharply rising to around 1.3×10^{-3}. Next, it fluctuated from 13:45 to 15:45 until the highest point of 1.4×10^{-3}, and then drastically dropped to around 0.4×10^{-3} until the end.

B

The figures are below:

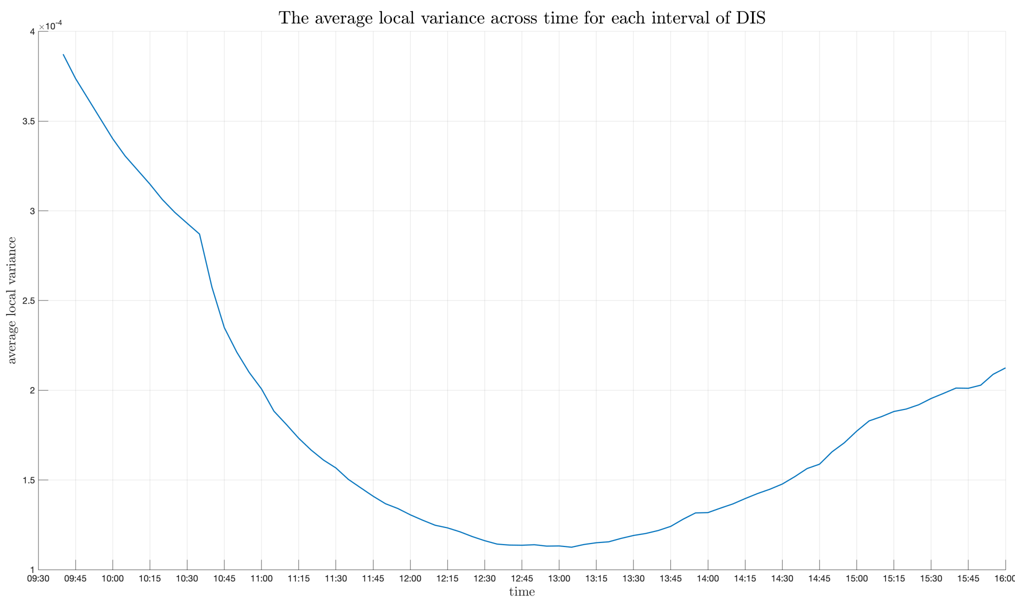

Figure 3: The average local variance across time for each interval of DIS

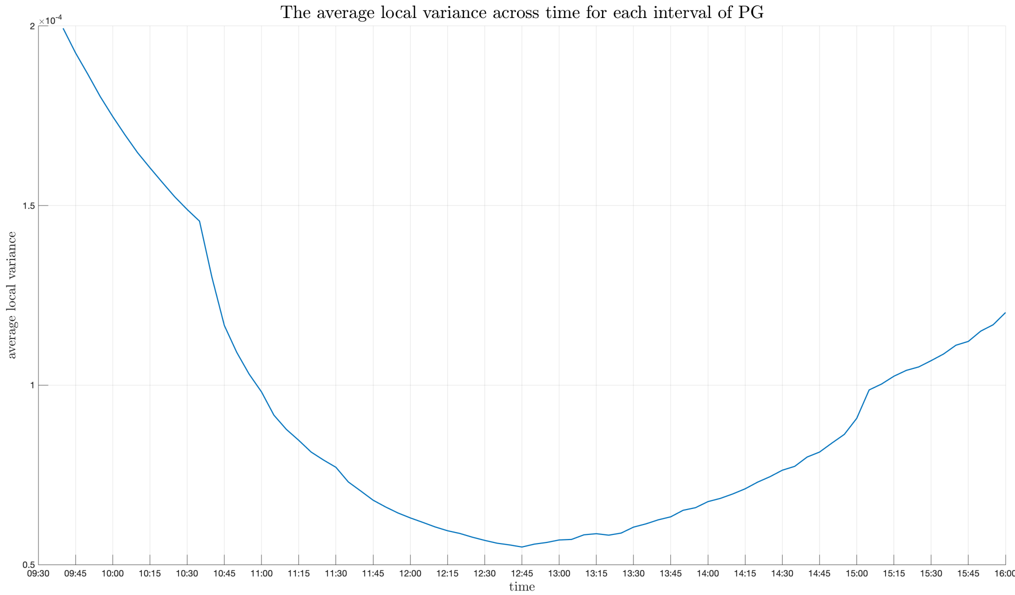

Figure 4: The average local variance across time for each interval of PG

Interpret: I can clearly find out the average local variance across time in the figures of DIS and PG are like "U" shape, which decremented from 9:30 to 12:50, incremented from 12:50 to 16:00, but didn't increment to the original point of 9:30, so it is higher on the left than on the right.

The plot of the time of day factor is also like a "U" shape. Because the time of the day factor is the weight of variance. It is easy to understand that the bigger the local variance is, the bigger the weight of variance, so they have similar shape.

Exercise 2

A

The figures are below:

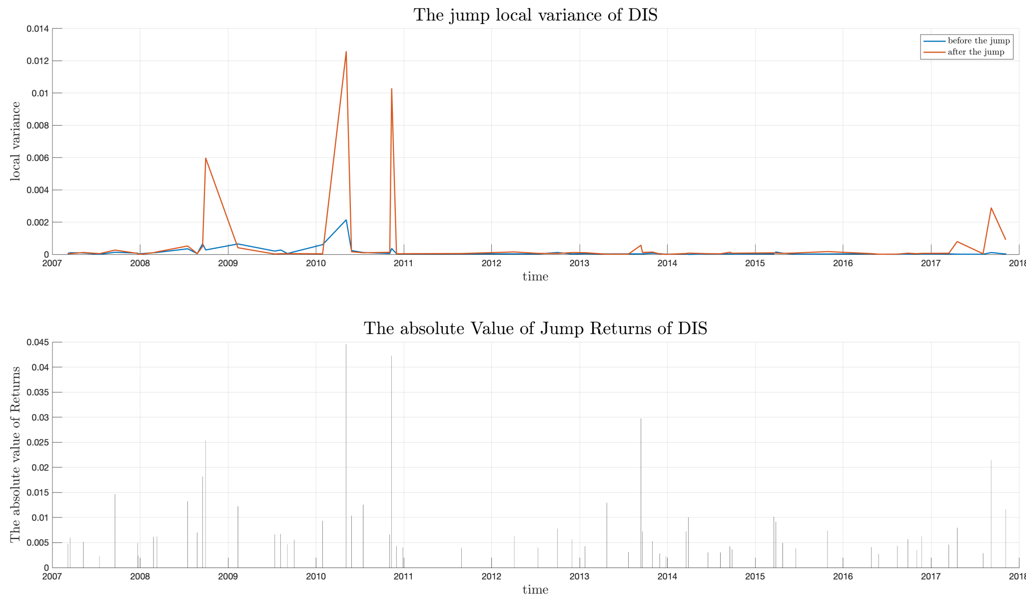

Figure 5: The jump local variance and the absolute value of jump returns of DIS

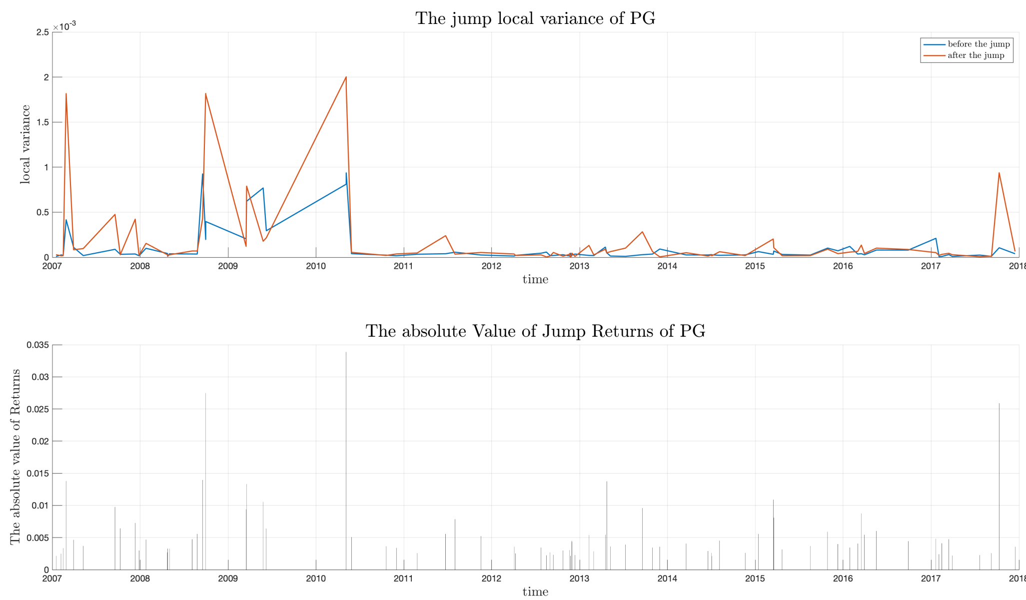

Figure 6: The jump local variance and the absolute value of jump returns of PG

Interpret: According to the two figures above, it can be seen that when there are jumps in returns, there is indication that the volatility will jump. For example, the plots of 2009, 2010, 2011 and 2017 can clearly show this. Another question can also be explained by these plots, which is there is relation between the moves in the volatility and the magnitude of the jump returns. The bigger the magnitude of the jump returns are, the bigger the moves in the volatility.

Exercise 3

A

The jumps per year of SPY:

years	jumps
2007	11
2008	5
2009	7
2010	8
2011	4
2012	17
2013	9
2014	14
2015	8
2016	18
2017	15

The average magnitude of the jumps per year of SPY:

years	jumps
2007	0.0047
2008	0.0095
2009	0.0063
2010	0.0037
2011	0.0067
2012	0.0034
2013	0.0024
2014	0.0024
2015	0.0040
2016	0.0027
2017	0.0019

B

The figures are below:

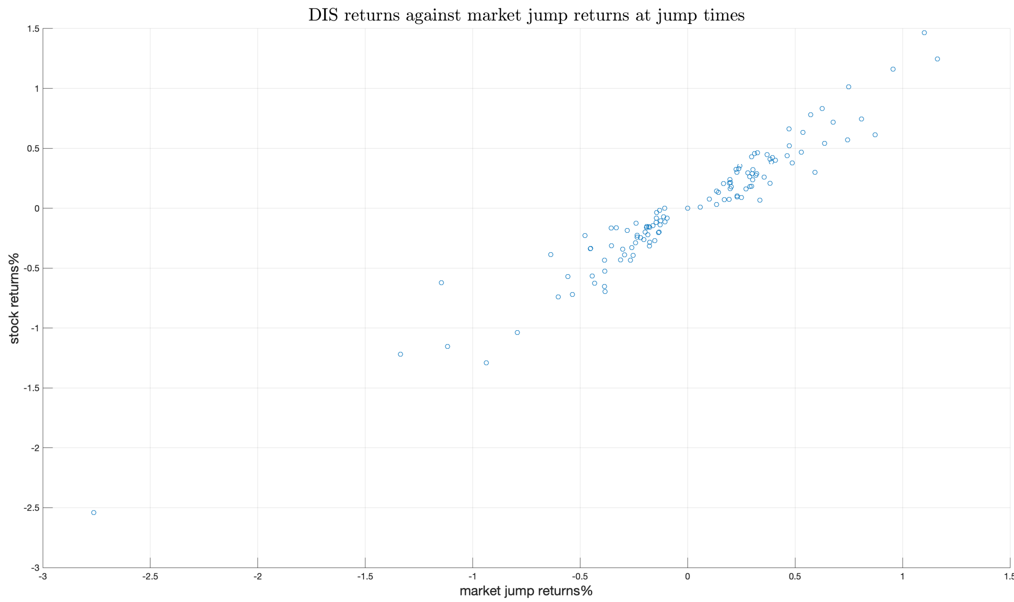

Figure 7: DIS returns against market jump returns at jump times

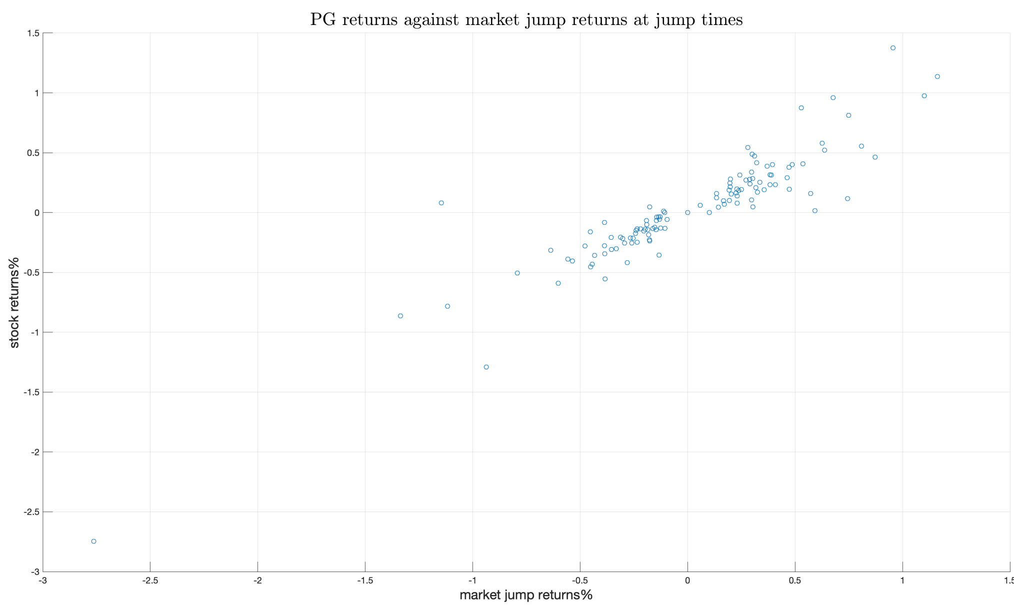

Figure 8: PG returns against market jump returns at jump times

Interpret: Based on the two figures above, I think a liner regression is plausible, because the scatters showed a tendency to gather near a line, and this line is increasing from left to right.

C

The OLS jump beta for DIS is 0.9942

The OLS jump beta for PG is 0.8269

Interpret: The OLS jump beta means that the jump returns of the market increases by one unit, and the jump returns of the specific stock will increase the jump beta units. Specifically, for DIS, the jump returns of the market increases by one unit, and the jump returns of it will increase 0.9942 units; for PG, the jump returns of it will increase 0.8269 units

D

The figures are below:

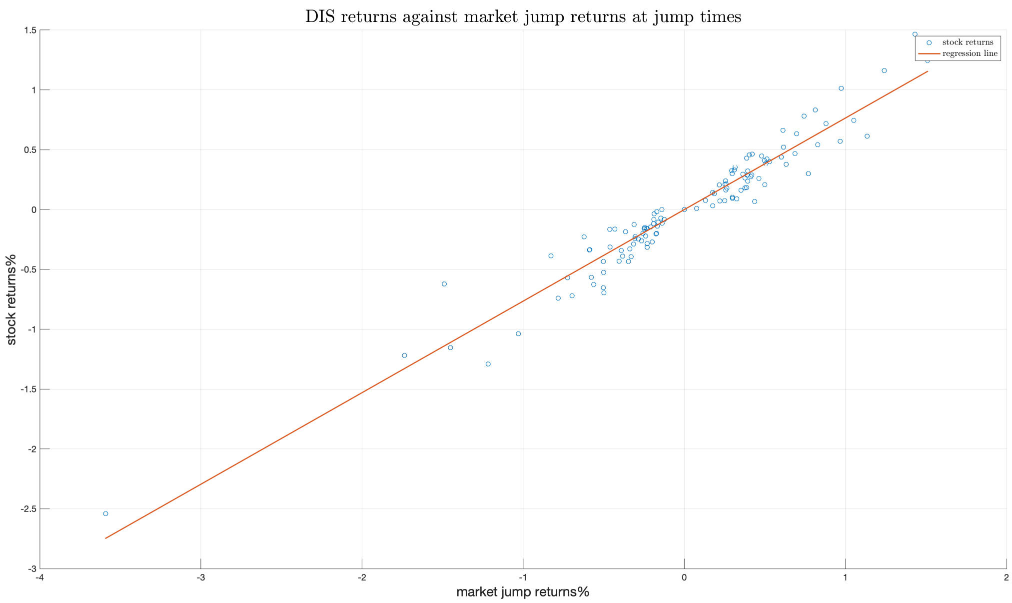

Figure 9: DIS returns against market jump returns at jump times with a regression line

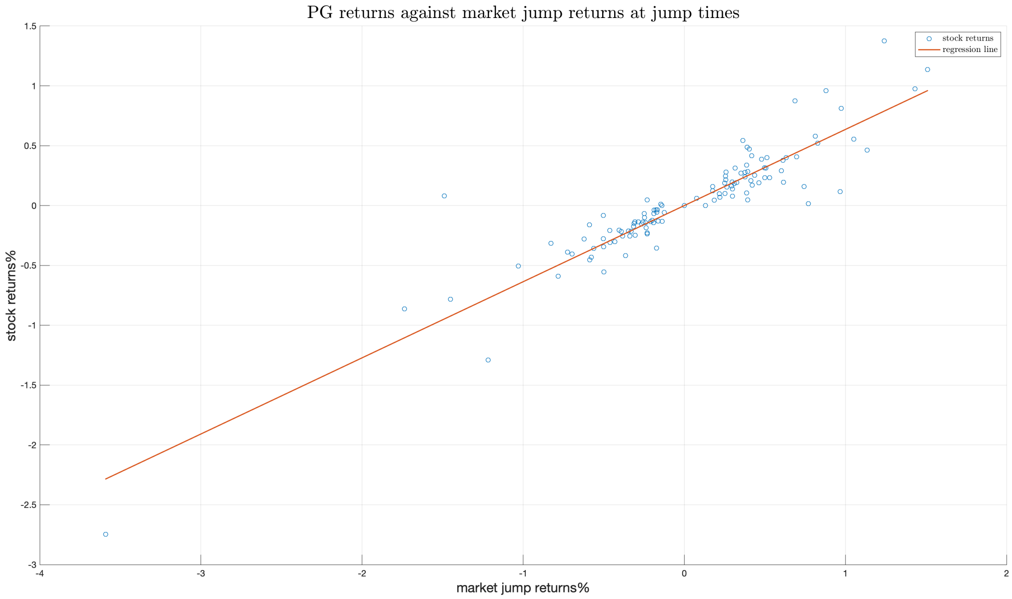

Figure 10: PG returns against market jump returns at jump times with a regression line

E

The value of $\sqrt{\Delta_n \hat{V}_\beta}$ of DIS is 0.0512

The value of $\sqrt{\Delta_n \hat{V}_\beta}$ of PG is 0.0421

F

The confidence interval for the jump betas:

DIS:[0.8937;1.0946]

PG:[0.7443;0.9094]

G

I can hedge my position by short selling the market index futures(SPY futures). Specifically, when I have 200 million DIS, I need to short sell 198.8345 million SPY futures; when I have 200 million PG, I need to short sell 165.3727 million SPY futures.

Based on the confidence intervals, the range of values I need to short sell for DIS is [178.7461;218.9228](million), for PG, is [148.8583;181.8870] (million)in order to hedge my position.

H

For DIS:

$\hat{\beta}_1$ is 0.9586

$\hat{\beta}_2$ is 1.0710

$\hat{V}_{\beta_1}$ is 0.4102

$\hat{V}_{\beta_2}$ is 0.0567

For PG:

$\hat{\beta}_1$ is 0.7713

$\hat{\beta}_2$ is 0.9468

$\hat{V}_{\beta_1}$ is 0.2849

$\hat{V}_{\beta_2}$ is 0.0822

I

The confidence interval for the difference of the jump betas:

DIS:[-0.2651;0.0401]

PG:[-0.3108;-0.0401]

Interpret: The confidence interval of DIS contain the number 0, and the confidence interval of PG don't contain the number 0. The reason could be the jump beta of the period 1 and the period 2 of DIS could be the same, so there is 0 in the confidence interval, while the jump betas of the period 1 and the period 2 of PG can not be the same, so the underlying assumption which is the jump beta is constant is not always true.

Code

The code is below:

Listing 1: ex_1.m

```
% question A
[dates, prices] = load_stock('DIS.csv');
[dates_return,deltax] = log_returns(dates, prices);
[n,T] = size(deltax);

zoom_end_916 = find(dates_return==datenum(2008,9,16,16,00,0))/n;
deltax_zoom_916 = deltax(:,zoom_end_916);

kn = 11;
```

```

c_hat_916 = local_variance(deltax_zoom_916,1,n,kn);

f = figure(1);
set(f,'units','normalized','outerposition',[0 0 1 1]);
plot(dates_return(:,1),c_hat_916)
datetick('x','HH:MM');
title('The local variance of September 16, 2008 of DIS');
box off; grid on;
xlabel('time');
ylabel('local variance');
print(f,'-dpng','-r200','figures/1A1');
close(f);

% question B
c_hat = local_variance(deltax,T,n,kn);
average_c_hat = sum(c_hat,2)/T;

f = figure(2);
set(f,'units','normalized','outerposition',[0 0 1 1]);
plot(dates_return(:,1),average_c_hat)
datetick('x','HH:MM');
title('The average local variance across time for each interval of DIS');
box off; grid on;
xlabel('time');
ylabel('average local variance');
print(f,'-dpng','-r200','figures/1B1');
close(f);
```

Listing 2: ex_2.m

```
% question A
[dates, prices] = load_stock('DIS.csv');
[dates_return,deltax] = log_returns(dates, prices);
[n,T] = size(deltax);
deltan = 1/n;

```

```
tau = tau_f(deltax);
BV = bipower_var(deltax);
alpha = 5;
cutoff = alpha*deltan^0.49*sqrt(tau*BV);

rc = deltax;
rc(abs(deltax)>cutoff)=0;
rd = deltax;
rd(abs(deltax)<=cutoff)=0;

kn = 11;
[c_hat_minus,c_hat_plus,dates_j,rd_j] = local_variance_j(dates_return,rc,
    rd,n,T,kn);

f = figure(5);
subplot(2,1,1);
set(f,'units','normalized','outerposition',[0 0 1 1]);
plot(dates_j,c_hat_minus);
hold on
plot(dates_j,c_hat_plus);
hold off
datetick('x','yyyy');
legend('before the jump','after the jump')
title('The jump local variance of DIS');
box off; grid on;
xlabel('time');
ylabel('local variance');

subplot(2,1,2);
bar(dates_j,abs(rd_j));
datetick('x','yyyy');
box off; grid on;
xlabel('time')
ylabel('The absolute value of Returns')
title('The absolute Value of Jump Returns of DIS');

```

```
print(f,'-dpng','-r200','figures/2A1');
close(f);
```

Listing 3: ex_3.m

```
% question A
[dates_m, prices_m] = load_stock('SPY.csv');
[dates_return_m,deltax_m] = log_returns(dates_m, prices_m);
[n,T] = size(deltax_m);
deltan = 1/n;

tau_m = tau_f(deltax_m);
BV_m = bipower_var(deltax_m);
alpha = 5;
cutoff_m = alpha*deltan^0.49*sqrt(tau_m*BV_m);

rd_m = deltax_m;
rd_m(abs(deltax_m)<=cutoff_m)=0;

jumps = sum(rd_m~=0);
y = zeros(12,1);
[yyyy,mm,dd]= ymd_f('SPY.csv');
for i = 1:11
    y(i+1) = sum(ismember(yyyy,2006+i));
end
jumps_y = zeros(11,1);
for i = 1:11
    jumps_y(i) = sum(jumps(1,(sum(y(1:i))+1):sum(y(1:i+1))));
end
sum_jumps_y = sum(jumps_y);

rd_m_y = sum(rd_m);
mag_rd_y = zeros(11,1);
for i = 1:11
    mag_rd_y(i) = sum(abs(rd_m_y(1,(sum(y(1:i))+1):sum(y(1:i+1)))));
end
av_mag_rd_y = mag_rd_y./jumps_y;
```

```
% question B
[dates_1, prices_1] = load_stock('DIS.csv');
[dates_return_1,deltax_1] = log_returns(dates_1, prices_1);

j_m = (rd_m ~=0);
rd_j_1 = j_m .* deltax_1;

f = figure(7);
set(f,'units','normalized','outerposition',[0 0 1 1]);
scatter(rd_m(:)*100,rd_j_1(:)*100)
title('DIS returns against market jump returns at jump times');
box off; grid on;
xlabel('market jump returns%');
ylabel('stock returns%');
print(f,'-dpng','-r200','figures/3B1');
close(f);

[dates_2, prices_2] = load_stock('PG.csv');
[dates_return_2,deltax_2] = log_returns(dates_2, prices_2);

rd_j_2 = j_m .* deltax_2;

f = figure(8);
set(f,'units','normalized','outerposition',[0 0 1 1]);
scatter(rd_m(:)*100,rd_j_2(:)*100)
title('PG returns against market jump returns at jump times');
box off; grid on;
xlabel('market jump returns%');
ylabel('stock returns%');
print(f,'-dpng','-r200','figures/3B2');
close(f);

% queation C
betaj_1 = jump_beta(rd_m,deltax_1);

```

```
betaj_2 = jump_beta(rd_m,deltax_2);

% question D
x = rd_m(:) * 100 * 1.3;

f = figure(9);
set(f,'units','normalized','outerposition',[0 0 1 1]);
scatter(x,rd_j_1(:)*100);
hold on
plot(x,rd_m(:)*100 * betaj_1);
hold off
title('DIS returns against market jump returns at jump times')
box off; grid on;
xlabel('market jump returns%')
ylabel('stock returns%')
legend('stock returns','regression line')
print(f,'-dpng','-r200','figures/3D1');
close(f);

f = figure(10);
set(f,'units','normalized','outerposition',[0 0 1 1]);
scatter(x,rd_j_2(:)*100);
hold on
plot(x,rd_m(:)*100 * betaj_2);
hold off
title('PG returns against market jump returns at jump times')
box off; grid on;
xlabel('market jump returns%')
ylabel('stock returns%')
legend('stock returns','regression line')
print(f,'-dpng','-r200','figures/3D2');
close(f);

% question E
V_beta_hat_1 = V_beta(deltax_1,betaj_1,deltax_m,rd_m,n,T);
std_1 = sqrt(deltan*V_beta_hat_1);
```

```

V_beta_hat_2 = V_beta(deltax_2,betaj_2,deltax_m,rd_m,n,T);
std_2 = sqrt(deltan*V_beta_hat_2);

% question F
ci_betaj_1 = ci_f(0.05,betaj_1,std_1);

ci_betaj_2 = ci_f(0.05,betaj_2,std_2);

% question G
hedge_1 = 200 * betaj_1;
hedge_2 = 200 * betaj_2;
hedge_1_r = 200 * ci_betaj_1;
hedge_2_r = 200 * ci_betaj_2;

% question H
zoom_start_11 = find(dates_return_1==datenum(2007,1,3,16,0,0))/n;
zoom_end_11 = find(dates_return_1==datenum(2011,12,30,16,0,0))/n;
rd_m_1 = rd_m(:,zoom_start_11:zoom_end_11);
deltax_1_1 = deltax_1(:,zoom_start_11:zoom_end_11);
deltax_m_1 = deltax_m(:,zoom_start_11:zoom_end_11);

zoom_start_12= find(dates_return_1==datenum(2012,1,3,16,0,0))/n;
zoom_end_12 = find(dates_return_1==datenum(2017,12,29,16,0,0))/n;
rd_m_2 = rd_m(:,zoom_start_12:zoom_end_12);
deltax_1_2 = deltax_1(:,zoom_start_12:zoom_end_12);
deltax_m_2 = deltax_m(:,zoom_start_12:zoom_end_12);

betaj_1_1 = jump_beta(rd_m_1,deltax_1_1);
betaj_1_2 = jump_beta(rd_m_2,deltax_1_2);
V_beta_hat_1_1 = V_beta(deltax_1_1,betaj_1_1,deltax_m_1,rd_m_1,n,1260);
V_beta_hat_1_2 = V_beta(deltax_1_2,betaj_1_2,deltax_m_2,rd_m_2,n,1509);

zoom_start_21 = find(dates_return_2==datenum(2007,1,3,16,0,0))/n;
zoom_end_21 = find(dates_return_2==datenum(2011,12,30,16,0,0))/n;
rd_m_1 = rd_m(:,zoom_start_21:zoom_end_21);
```

```
deltax_2_1 = deltax_2(:,zoom_start_21:zoom_end_21);
deltax_m_1 = deltax_m(:,zoom_start_21:zoom_end_21);

zoom_start_22 = find(dates_return_2==datenum(2012,1,3,16,0,0))/n;
zoom_end_22 = find(dates_return_2==datenum(2017,12,29,16,0,0))/n;
rd_m_2 = rd_m(:,zoom_start_22:zoom_end_22);
deltax_2_2 = deltax_2(:,zoom_start_22:zoom_end_22);
deltax_m_2 = deltax_m(:,zoom_start_22:zoom_end_22);

betaj_2_1 = jump_beta(rd_m_1,deltax_2_1);
betaj_2_2 = jump_beta(rd_m_2,deltax_2_2);
V_beta_hat_2_1 = V_beta(deltax_2_1,betaj_2_1,deltax_m_1,rd_m_1,n,1260);
V_beta_hat_2_2 = V_beta(deltax_2_2,betaj_2_2,deltax_m_2,rd_m_2,n,1509);

% question I
std_11 = sqrt(deltan*(V_beta_hat_1_1 + V_beta_hat_1_2));
ci_betaj_11 = ci_f(0.05,betaj_1_1-betaj_1_2,std_11);

std_22 = sqrt(deltan*(V_beta_hat_2_1 + V_beta_hat_2_2));
ci_betaj_22 = ci_f(0.05,betaj_2_1-betaj_2_2,std_22);
```