Assignment 4

From the data set `assign4.dta`:

The study on bankruptcy firm employs the following regression model.

$$z_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} \quad (1)$$

The log-likelihood function of this model is as follows:

$$\ln L = \begin{cases} \ln \Phi(z_i) \; if \; y_i = 1 \\ \ln \Phi(-z_i) \; if \; y_i = 0 \end{cases} \quad (2)$$

where: y_i = 1 for bankruptcy firm and 0 otherwise.

x_{1i} = Debt coverage ratio of firm i

x_{2i} = Liquidity ratio of firm i

x_{3i} = Profitability index of firm i

x_{4i} = Solidity ratio of firm i

Let Φ(.) = Logistic probability distribution function. $\Phi(z_i) = \frac{1}{1+e^{-z_i}}$

From the given data set (`assig8-2.dta`):

a. Estimate the above models using MLE with Newton-Ralphson algorithm.
b. Perform hypothesis testing whether $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ using LR-test and Wald test.
c. Estimate the above models using MLE with BHHH algorithm, make comparison of the estimated result with the result from (1), and give explanation why are they different?

Let Φ(.) = Cumulation standard normal probability distribution function and

$$z_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} \quad (3)$$

d. Estimate the models using MLE with Newton-Ralphson algorithm.

Assume that there exists heteroskedasticity in the model as: $\sigma_i^2 = \exp(\gamma x_{4i})^2$, then,
Φ(.) = Cumulation standard normal probability distribution function $\Phi \; z_i / \exp(\gamma x_{4i})$

e. Estimate the models with heteroskedasticity using MLE with Newton-Ralphson algorithm. Perform LR-test whether there exists significant heteroskedasticity.

(a).

$z = -1.400447 + .4835128 X_1 + 1.454009 X_2 + 2.173186 X_3 + 1.855464 X_4$

(.5531237) (.1686119) (.5001373) (.7757021) (.7138855)

$n = 130$, Wald $chi^2(4) = 22.79$, $Prob > chi^2 = 0.0001$

(b). $chi^2(4) = 22.79$ LR $chi^2(4) = 63.00$

$Prob > chi^2 = 0.0001$ $Prob > chi^2 = 0.0000$

(c).

$z = -1.400063 + .4833318 X_1 + 1.453275 X_2 + 2.172641 X_3 + 1.854961 X_4$

(.5625155) (.1542635) (.597925) (.8589781) (.7142729)

$n = 130$, Wald $chi^2(4) = 16.34$, $Prob > chi^2 = 0.0026$

if use bhhh method, S.e. is higher but the parameters all are still significant. As bhhh applied, Hessian matrix is not used for calculation of Δ_t, only Gradient matrix is used. So this can lead to a different result of parameters estimation.

(d). $z = -.7729211 + .3592444 X_1 + 1.139607 X_2$

(.2765064) (.0871351) (.3224845)

$n = 130$, Wald $chi^2 = 22.61$, $Prob > chi^2 = 0.0000$

(e). 1. $z = -.6388431 + .2921402 X_1 + .9417319 X_2$

(.2144267) (.0773776) (.280057)

2. $z = 1.183929 X_4$

(.5851991)

$n = 130$, Wald $chi^2(2) = 16.42$

$Prob > chi^2 = 0.0003$

LR $chi^2(2) = 21.14$

$Prob > chi^2 = 0.0000$

```
                                                      ___  ____  ____  ____  ____(R)
                                                     /__    /   ____/   /   ____/
                                                    ___/   /   /___/   /   /___/
                                                      Statistics/Data Analysis


  ___  ____  ____  ____  ____ (R)
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Notes:
      1.  Unicode is supported; see help unicode_advice.
      2.  More than 2 billion observations are allowed; see help obs_advice.
      3.  Maximum number of variables is set to 5000; see help set_maxvar.

1 . use "C:\Users\a\Downloads\assign4.dta"

2 . log using "C:\Users\a\Desktop\426-a4.smcl", replace
-------------------------------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\a\Desktop\426-a4.smcl
  log type:  smcl
 opened on:  18 Feb 2021, 00:07:40

3 . do "C:\Users\a\AppData\Local\Temp\STD2e00_000000.tmp"

4 . program ml_logit
  1.  args lnf theta
  2.  quietly replace `lnf'=ln(1/(1+exp(-`theta'))) if $ML_y1==1
  3.  quietly replace `lnf'=ln(1-(1/(1+exp(-`theta')))) if $ML_y1==0
  4. end

5 .
end of do-file

6 . ml model lf ml_logit (y=x1 x2 x3 x4)

7 . ml max

initial:       log likelihood = -90.109133
alternative:   log likelihood = -86.130008
rescale:       log likelihood = -86.130008
Iteration 0:   log likelihood = -86.130008
Iteration 1:   log likelihood = -66.355929
Iteration 2:   log likelihood = -63.355226
Iteration 3:   log likelihood = -57.763041
Iteration 4:   log likelihood = -55.063873
Iteration 5:   log likelihood = -54.628535
Iteration 6:   log likelihood = -54.627603
Iteration 7:   log likelihood = -54.627603

                                                Number of obs     =        130
                                                Wald chi2(4)      =      22.79
Log likelihood = -54.627603                     Prob > chi2       =     0.0001
```

y	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
x1	.4835128	.1686119	2.87	0.004	.1530395	.813986
x2	1.454009	.5001373	2.91	0.004	.4737578	2.43426
x3	2.173186	.7757021	2.80	0.005	.652838	3.693535
x4	1.855464	.7138855	2.60	0.009	.4562739	3.254653
_cons	-1.400447	.5531237	-2.53	0.011	-2.484549	-.316344

```
 8 . test (x1=0) (x2=0) (x3=0) (x4=0)

   ( 1)  [eq1]x1 = 0
   ( 2)  [eq1]x2 = 0
   ( 3)  [eq1]x3 = 0
   ( 4)  [eq1]x4 = 0

           chi2(  4) =   22.79
         Prob > chi2 =    0.0001

 9 . est store ur

10 . ml model lf ml_logit (y=)

11 . ml max

   initial:       log likelihood = -90.109133
   alternative:   log likelihood = -86.130008
   rescale:       log likelihood = -86.130008
   Iteration 0:   log likelihood = -86.130008
   Iteration 1:   log likelihood = -86.129902
   Iteration 2:   log likelihood = -86.129902

                                                 Number of obs     =        130
                                                 Wald chi2(0)      =          .
   Log likelihood = -86.129902                   Prob > chi2       =          .
```

y	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_cons	.5026289	.1809802	2.78	0.005	.1479141	.8573436

```
12 . est store res

13 . lrtest ur res

   Likelihood-ratio test                                 LR chi2(4)  =     63.00
   (Assumption: res nested in ur)                        Prob > chi2 =    0.0000

14 . ml model lf ml_logit (y=x*), tech(bhhh)

15 . ml max
```

```
initial:       log likelihood = -90.109133
alternative:   log likelihood = -86.130008
rescale:       log likelihood = -86.130008
Iteration 0:   log likelihood = -86.130008
Iteration 1:   log likelihood = -64.805009
Iteration 2:   log likelihood = -58.076419
Iteration 3:   log likelihood = -55.104476
Iteration 4:   log likelihood = -54.737891
Iteration 5:   log likelihood = -54.673222
Iteration 6:   log likelihood = -54.653417
Iteration 7:   log likelihood = -54.641919
Iteration 8:   log likelihood = -54.636424
Iteration 9:   log likelihood = -54.632812
Iteration 10:  log likelihood = -54.630848
Iteration 11:  log likelihood = -54.629561
Iteration 12:  log likelihood = -54.628821
Iteration 13:  log likelihood = -54.628345
Iteration 14:  log likelihood = -54.628063
Iteration 15:  log likelihood = -54.627885
Iteration 16:  log likelihood = -54.627777
Iteration 17:  log likelihood =  -54.62771
Iteration 18:  log likelihood = -54.627669
Iteration 19:  log likelihood = -54.627644
Iteration 20:  log likelihood = -54.627628
Iteration 21:  log likelihood = -54.627618
Iteration 22:  log likelihood = -54.627612
Iteration 23:  log likelihood = -54.627609
Iteration 24:  log likelihood = -54.627607
Iteration 25:  log likelihood = -54.627605

                                                Number of obs     =        130
                                                Wald chi2(4)      =      16.34
Log likelihood = -54.627605                     Prob > chi2       =     0.0026
```

y	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
x1	.4833318	.1542635	3.13	0.002	.180981	.7856827
x2	1.453275	.597925	2.43	0.015	.2813639	2.625187
x3	2.172641	.8589781	2.53	0.011	.489075	3.856207
x4	1.854961	.7142729	2.60	0.009	.4550117	3.25491
_cons	-1.400063	.5625155	-2.49	0.013	-2.502573	-.2975527

```
16 . do "C:\Users\a\AppData\Local\Temp\STD2e00_000000.tmp"

17 . program ml_probit
     1.  args lnf theta
     2.  tempvar z
     3.  quietly g double `z'=`theta'
     4.  quietly replace `lnf'=ln(normal(`z')) if $ML_y1==1
     5.  quietly replace `lnf'=ln(1-normal(`z')) if $ML_y1==0
     6. end
```

```
18 .
   end of do-file

19 .
20 . . ml model lf ml_probit (y= x1 x2)

21 . ml max

   initial:       log likelihood = -90.109133
   alternative:   log likelihood = -87.504336
   rescale:       log likelihood = -86.291737
   Iteration 0:   log likelihood = -86.291737
   Iteration 1:   log likelihood = -78.555778
   Iteration 2:   log likelihood = -65.283096
   Iteration 3:   log likelihood =  -60.75495
   Iteration 4:   log likelihood = -60.695531
   Iteration 5:   log likelihood = -60.695503
   Iteration 6:   log likelihood = -60.695503

                                                 Number of obs     =        130
                                                 Wald chi2(2)      =      22.61
   Log likelihood = -60.695503                   Prob > chi2       =     0.0000

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          x1 |   .3592444   .0871351     4.12   0.000     .1884627    .5300262
          x2 |   1.139607   .3224845     3.53   0.000     .5075491    1.771665
       _cons |  -.7729211   .2765064    -2.80   0.005    -1.314864   -.2309785
------------------------------------------------------------------------------

22 . do "C:\Users\a\AppData\Local\Temp\STD2e00_000000.tmp"

23 . program ml_probit_het
     1.  args lnf theta sigma
     2.  tempvar z s
     3.  quietly g double `s'=exp(`sigma')
     4.  quietly g double `z'=`theta'/`s'
     5.  quietly replace `lnf'=ln(normal(`z')) if $ML_y1==1
     6.  quietly replace `lnf'=ln(1-normal(`z')) if $ML_y1==0
     7. end

24 .
   end of do-file

25 . ml model lf ml_probit_het (y=x1 x2) (x4, noconstant)

26 . ml max

   initial:       log likelihood = -90.109133
   alternative:   log likelihood = -83.932039
   rescale:       log likelihood = -83.932039
   rescale eq:    log likelihood =  -70.42663
   Iteration 0:   log likelihood =  -70.42663
   Iteration 1:   log likelihood = -69.416378
   Iteration 2:   log likelihood = -67.899365
   Iteration 3:   log likelihood = -64.594892
   Iteration 4:   log likelihood = -62.956299
   Iteration 5:   log likelihood = -61.359985
   Iteration 6:   log likelihood = -59.838297
   Iteration 7:   log likelihood = -59.474018
   Iteration 8:   log likelihood = -59.404563
   Iteration 9:   log likelihood = -59.404451
   Iteration 10:  log likelihood = -59.404451
```

```
                                                Number of obs     =        130
                                                Wald chi2(2)      =      16.42
Log likelihood = -59.404451                     Prob > chi2       =     0.0003
```

y	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
eq1						
x1	.2921402	.0773776	3.78	0.000	.140483	.4437975
x2	.9417319	.280057	3.36	0.001	.3928302	1.490634
_cons	-.6388431	.2144267	-2.98	0.003	-1.059112	-.2185746
eq2						
x4	1.183929	.5851991	2.02	0.043	.0369599	2.330898

```
27 . est store ur_het

28 . ml model lf ml_probit_het (y=) (x4, noconstant)

29 . ml max

initial:       log likelihood = -90.109133
alternative:   log likelihood = -83.932039
rescale:       log likelihood = -83.932039
rescale eq:    log likelihood =  -70.42663
Iteration 0:   log likelihood =  -70.42663
Iteration 1:   log likelihood = -69.976275
Iteration 2:   log likelihood = -69.973883
Iteration 3:   log likelihood = -69.973882

                                                Number of obs     =        130
                                                Wald chi2(0)      =          .
Log likelihood = -69.973882                     Prob > chi2       =          .
```

y	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
eq1						
_cons	.6158099	.2005698	3.07	0.002	.2227003	1.008919
eq2						
x4	-8.17863	3.212406	-2.55	0.011	-14.47483	-1.882429

```
30 . est store res

31 . est store res_het

32 . lrtest ur_het res_het

Likelihood-ratio test                                 LR chi2(2)  =     21.14
(Assumption: res_het nested in ur_het)                Prob > chi2 =    0.0000

33 . log close
      name:  <unnamed>
       log:  C:\Users\a\Desktop\426-a4.smcl
  log type:  smcl
 closed on:  18 Feb 2021, 00:16:37
```

```
34 .
```