HW4.Rmd

(a) show the results from the function lm()

```
dataset4 <- read.csv("./data_for_homework_4.csv",header=TRUE)

percapitaEE <- dataset4$EE/dataset4$P
percapitaGDP <- dataset4$GDP/dataset4$P


lse4 <- lm(percapitaEE~percapitaGDP)
summary(lse4)
```

```
##
## Call:
## lm(formula = percapitaEE ~ percapitaGDP)
##
## Residuals:
##      Min      1Q   Median      3Q      Max
## -0.21682 -0.08804 -0.01401  0.06517  0.38156
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.124573   0.048523  -2.567   0.0151 *
## percapitaGDP   0.073173   0.005179  14.128 2.65e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1359 on 32 degrees of freedom
## Multiple R-squared:  0.8618, Adjusted R-squared:  0.8575
## F-statistic: 199.6 on 1 and 32 DF,  p-value: 2.65e-15
```

(b) Do the BP-test & White-test using the bptest()

H0 : Homoscedasticity is true

BP-test
```
BPtest4 <- bptest(lse4)
BPtest4
```

```
##
##  studentized Breusch-Pagan test
##
## data:  lse4
## BP = 7.3515, df = 1, p-value = 0.006701
#p-value = 0.006701 < 5% then we will reject H0 and there is Hetero.

###    BPtest
#BP4 <- lm(esq4~percapitaGDP)
#summary(BP4)
```

```
#LMBP4 <- 0.1609*n4 #5.4706
#pvchisq4 <- 1-pchisq(LMBP4,df=1)
#pvchisq4
# pvchisq4=0.01933899 <5%   then we will reject H0 and there is Hetero.
```

White-test

```
percapitaGDPsquare <- percapitaGDP^2
Wtest4 <- bptest(lse4,~percapitaGDP+percapitaGDPsquare)
Wtest4
```

```
##
##  studentized Breusch-Pagan test
##
## data:  lse4
## BP = 9.9615, df = 2, p-value = 0.006869
# Wtest4=0.006869 < 5% then we will reject H0 and there is Hetero.
```

(c) White's heteroscedasticity-consistent standard errors (sol1)

```
library(lmtest)
library(sandwich)

HCVCOV <- vcovHC(lse4)
HCresults4 <- coeftest(lse4, vcov=HCVCOV)
HCresults4
```

```
##
## t test of coefficients:
##
##              Estimate Std. Error t value  Pr(>|t|)
## (Intercept)  -0.1245728  0.0424400 -2.9353  0.006123 **
## percapitaGDP  0.0731732  0.0066033 11.0813 1.735e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(lse4)
```

```
##
## Call:
## lm(formula = percapitaEE ~ percapitaGDP)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.21682 -0.08804 -0.01401  0.06517  0.38156
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -0.124573   0.048523   -2.567   0.0151 *
## percapitaGDP  0.073173   0.005179   14.128 2.65e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

2

```
## Residual standard error: 0.1359 on 32 degrees of freedom
## Multiple R-squared:  0.8618, Adjusted R-squared:  0.8575
## F-statistic: 199.6 on 1 and 32 DF,  p-value: 2.65e-15
# beta2hat are the same and standard error is different.
```

(d) WLS (sol2)

```
percapitaEE_star <- percapitaEE/percapitaGDP^0.5
intercept_star <- 1/percapitaGDP^0.5
percapitaGDP_star <- percapitaGDP^0.5

wlse4 <- lm(percapitaEE_star~intercept_star+percapitaGDP_star-1)
summary(wlse4) #standard error of betahat2 = 0.004412
```

```
##
## Call:
## lm(formula = percapitaEE_star ~ intercept_star + percapitaGDP_star -
##     1)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.072028 -0.038561 -0.008488  0.027706  0.105415
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## intercept_star    -0.092921   0.028904  -3.215  0.00298 **
## percapitaGDP_star  0.069321   0.004412  15.713  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04451 on 32 degrees of freedom
## Multiple R-squared:  0.9381, Adjusted R-squared:  0.9342
## F-statistic: 242.5 on 2 and 32 DF,  p-value: < 2.2e-16
```
```
HCresults4 #standard error of betahat2 = 0.0066033
```

```
##
## t test of coefficients:
##
##                Estimate Std. Error t value  Pr(>|t|)
## (Intercept)  -0.1245728  0.0424400 -2.9353  0.006123 **
## percapitaGDP  0.0731732  0.0066033 11.0813 1.735e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```
```
summary(lse4) #standard error of betahat2 = 0.005179
```

```
##
## Call:
## lm(formula = percapitaEE ~ percapitaGDP)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.21682 -0.08804 -0.01401  0.06517  0.38156
```

```
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.124573   0.048523  -2.567   0.0151 *
## percapitaGDP 0.073173   0.005179  14.128 2.65e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1359 on 32 degrees of freedom
## Multiple R-squared:  0.8618, Adjusted R-squared:  0.8575
## F-statistic: 199.6 on 1 and 32 DF,  p-value: 2.65e-15
# the wlse's standard error of betahat2 is the smallest.
```

(e) F-test on 5% level in adjusted regression model

```
# We expect to not reject the H0:Homo after the WLS adjustment

wlse_residual <- as.matrix(residuals(wlse4))
wlse4_esq <- wlse_residual^2


lm(wlse4_esq~intercept_star+percapitaGDP_star) -> adjusted_Heterotest
summary(adjusted_Heterotest)

##
## Call:
## lm(formula = wlse4_esq ~ intercept_star + percapitaGDP_star)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -0.0022580 -0.0017390 -0.0005757  0.0004063  0.0087156
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       3.364e-03  8.608e-03   0.391    0.699
## intercept_star   -3.590e-03  9.576e-03  -0.375    0.710
## percapitaGDP_star -9.980e-06  1.739e-03  -0.006    0.995
##
## Residual standard error: 0.002465 on 31 degrees of freedom
## Multiple R-squared:  0.05016,    Adjusted R-squared:  -0.01112
## F-statistic: 0.8185 on 2 and 31 DF,  p-value: 0.4504
```

under(e)-BPtest again

```
# Multiple R-squared:  0.05016

adjusted_BP <- 0.05016*n4 #1.70544
adjusted_BP_pvchisq <- 1-pchisq(adjusted_BP, df=2) #df=2 because intercept_star & percapitaGDP_star
adjusted_BP_pvchisq #0.4262539 > 5% not rejected H0: Homo

## [1] 0.4262539
```