[Example8-2] Heteroskedasticity-Robust SE

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```
load("~/計量経済学演習/R data sets for 5e/gpa3.RData")
gpa3<-data

library(lmtest); library(car) #lmtest for coeftest,car for linearHypothesis

## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric

## Loading required package: carData
```

Estimate model (*only for spring data*)

```
reg <- lm(cumgpa~sat+hsperc+tothrs+female+black+white,
                                      data=gpa3, subset=(spring==1))
```

t-test with usual SE (impose the assumption of homoskedasticity)

```
coeftest(reg)

##
## t test of coefficients:
##
##                Estimate  Std. Error t value  Pr(>|t|)
## (Intercept)  1.47006477  0.22980308  6.3971 4.942e-10 ***
## sat          0.00114073  0.00017856  6.3885 5.197e-10 ***
## hsperc      -0.00856636  0.00124042 -6.9060 2.275e-11 ***
## tothrs       0.00250400  0.00073099  3.4255 0.0006847 ***
## female       0.30343329  0.05902033  5.1412 4.497e-07 ***
## black       -0.12828368  0.14737012 -0.8705 0.3846164
## white       -0.05872173  0.14098956 -0.4165 0.6772953
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

with Refined White heteroscedasticity-robust SE

```
coeftest(reg, vcov=hccm)
```

```
##
## t test of coefficients:
##
##                Estimate  Std. Error t value  Pr(>|t|)
## (Intercept)  1.47006477  0.22938036  6.4089 4.611e-10 ***
## sat          0.00114073  0.00019532  5.8402 1.169e-08 ***
## hsperc      -0.00856636  0.00144359 -5.9341 6.963e-09 ***
## tothrs       0.00250400  0.00074930  3.3418   0.00092 ***
## female       0.30343329  0.06003964  5.0539 6.911e-07 ***
## black       -0.12828368  0.12818828 -1.0007   0.31762
## white       -0.05872173  0.12043522 -0.4876   0.62615
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

sat など variable in interest の coef の se は大きくなっているので t-stat 小さくなり p-value は大きくなるので若干 reject しづらくなるがいずれにしろ 1% significant であることは変わらない。

F-Tests using different variance-covariance formulas

```
myH0 <- c("black","white")
```

①Ususal VCOV(u is homoskedastic in black and white)

```
linearHypothesis(reg, myH0)
```

```
## Linear hypothesis test
##
## Hypothesis:
## black = 0
## white = 0
##
## Model 1: restricted model
## Model 2: cumgpa ~ sat + hsperc + tothrs + female + black + white
##
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1    361 79.362
## 2    359 79.062  2   0.29934 0.6796 0.5075
```

②Refined White VCOV

```
linearHypothesis(reg, myH0, vcov=hccm)
```

```
## Linear hypothesis test
##
## Hypothesis:
## black = 0
## white = 0
##
```

```
## Model 1: restricted model
## Model 2: cumgpa ~ sat + hsperc + tothrs + female + black + white
##
## Note: Coefficient covariance matrix supplied.
##
##   Res.Df Df      F Pr(>F)
## 1    361
## 2    359  2 0.6725 0.5111
```

③Classical White VCOV

```
linearHypothesis(reg, myH0, vcov=hccm(reg,type="hc0"))
```

```
## Linear hypothesis test
##
## Hypothesis:
## black = 0
## white = 0
##
## Model 1: restricted model
## Model 2: cumgpa ~ sat + hsperc + tothrs + female + black + white
##
## Note: Coefficient covariance matrix supplied.
##
##   Res.Df Df      F Pr(>F)
## 1    361
## 2    359  2 0.7478 0.4741
```

どれも対して結果変わらんので heteroskedastidity に対する sensitivity は高くはないって感じ