HW3

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1. 估計以下的模型：

ln(wage) = β0 + β1educ + β2exper + β3tenure + β4married+ β5black + β6south + β7urban + u

並解釋 $\beta\hat{}1$ 與 $\beta\hat{}2$ 的意義。

Code :

```
library(wooldridge)
data("wage2")
model_1 <- lm( log(wage)~educ+exper+tenure+married+black+south+urban, data = wage2)
summary(model_1)
```

估計結果 ：

```
Call:
lm(formula = log(wage) ~ educ + exper + tenure + married + black +
    south + urban, data = wage2)

Residuals:
     Min       1Q   Median       3Q      Max
-1.98069 -0.21996  0.00707  0.24288  1.22822

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  5.395497   0.113225  47.653  < 2e-16 ***
educ         0.065431   0.006250  10.468  < 2e-16 ***
exper        0.014043   0.003185   4.409 1.16e-05 ***
tenure       0.011747   0.002453   4.789 1.95e-06 ***
married      0.199417   0.039050   5.107 3.98e-07 ***
black       -0.188350   0.037667  -5.000 6.84e-07 ***
south       -0.090904   0.026249  -3.463 0.000558 ***
urban        0.183912   0.026958   6.822 1.62e-11 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3655 on 927 degrees of freedom
Multiple R-squared:  0.2526,    Adjusted R-squared:  0.2469
F-statistic: 44.75 on 7 and 927 DF,  p-value: < 2.2e-16
```

β^0 = 5.395497

β^1 = 0.065431

β^2 = 0.014043

β^3 = 0.011747

β^4 = 0.199417

β^5 = -0.188350

β^6 = -0.090904

β^7 = 0.183912

β^1 = 0.065431 : 代表控制其他變數不變，當受教育的年份每增加一年，每月收入平均增加 6.5431%

β^2 = 0.014043 : 代表控制其他變數不變，工作年資每增加一年，每月收入平均增加 1.4043%

2. 承上題，$\beta\hat{}1$ 與 $\beta\hat{}2$ 的正負號是否合理？並解釋合理或不合理的原因。

Ans : 我認為兩者的正負號均合理。因通常受教育的年份較長代表其教育程度較高，因此專業性較高，薪水收入較高是合理的。而工作年資越長代表越有經驗，收入較高亦合理。

3. 控制其他解釋變數的值不變，估計 black 與 nonblack 的月薪資差異為何？此差異在統計上是否顯著？(僅需寫出虛無假設、對立假設、p-value 與決策結果，α = 0.05)

Model : ln(wage) = β0 + β1educ + β2exper + β3tenure + β4married+ β5black + β6south + β7urban + u

- H0 : β^5 = 0; H1 : β^5≠0
- β^5 = -0.188350
  →代表在其他解釋變數值不變的情況下，black 的月薪資平均比 nonblack 低 18.835%
- p-value = $6.84*10^{-7}$ < α = 0.05 →拒絕虛無假設→此差異在= 0.05 下顯著

4. 回到第一小題，在模型中加入 black 與 married 的交乘項：

ln(wage) = γ0 + γ1educ + γ2exper + γ3tenure + γ4married+ γ5black + γ6black ∗ married + γ7south + γ8urban + u, 交乘項在統計上是否顯著 (僅需寫出虛無假設、對立假設、p-value 與決策結果，α = 0.05)？根據此模型，估計 married blacks 與 married nonblacks 的月薪資差異為何？

Code :

```
model_2 <- lm(log(wage)~educ + exper + tenure + married+ black + black*married + south + urban, data = wage2)
summary(model_2)
```

```
Call:
lm(formula = log(wage) ~ educ + exper + tenure + married + black +
    black * married + south + urban, data = wage2)

Residuals:
     Min       1Q   Median       3Q      Max
-1.98013 -0.21780  0.01057  0.24219  1.22889

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)    5.403793   0.114122  47.351  < 2e-16 ***
educ           0.065475   0.006253  10.471  < 2e-16 ***
exper          0.014146   0.003191   4.433 1.04e-05 ***
tenure         0.011663   0.002458   4.745 2.41e-06 ***
married        0.188915   0.042878   4.406 1.18e-05 ***
black         -0.240820   0.096023  -2.508 0.012314 *
south         -0.091989   0.026321  -3.495 0.000497 ***
urban          0.184350   0.026978   6.833 1.50e-11 ***
married:black  0.061354   0.103275   0.594 0.552602
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3656 on 926 degrees of freedom
Multiple R-squared:  0.2528,    Adjusted R-squared:  0.2464
F-statistic: 39.17 on 8 and 926 DF,  p-value: < 2.2e-16
```

- H0 : γ^6 = 0 ; H1 : γ^6≠0
- p-value = 0.552602 > α = 0.05 → 接受虛無假設、交乘項不顯著
- married blacks 與 married nonblacks 的月薪資差異:
  當其他變數不變的情況下且α = 0.05 下，由於交乘項不顯著，因此只須考慮 married 的係數。
  married black 與 married non-blacks 的月薪資差異為 100*(-0.24082)% = -24.082%，平均而言，married black 的月薪資比 married non-black 低 24.082%

5. 使用 stargazer 函數，將第一題與第四題的結果輸出為表格 (係數的顯著性設定為 *p < 0.05, **p < 0.01, ***p < 0.001)。

Code :

```
library(stargazer)
stargazer(model_1, model_2, type = "text", title = "Results",star.cutoffs = c(0.05, 0.01, 0.001))
```

Results

	Dependent variable:	
	log(wage)	
	(1)	(2)
educ	0.065***	0.065***
	(0.006)	(0.006)
exper	0.014***	0.014***
	(0.003)	(0.003)
tenure	0.012***	0.012***
	(0.002)	(0.002)
married	0.199***	0.189***
	(0.039)	(0.043)
black	-0.188***	-0.241*
	(0.038)	(0.096)
south	-0.091***	-0.092***
	(0.026)	(0.026)
urban	0.184***	0.184***
	(0.027)	(0.027)
married:black		0.061
		(0.103)
Constant	5.395***	5.404***
	(0.113)	(0.114)
Observations	935	935
R2	0.253	0.253
Adjusted R2	0.247	0.246
Residual Std. Error	0.365 (df = 927)	0.366 (df = 926)
F Statistic	44.747*** (df = 7; 927)	39.170*** (df = 8; 926)
Note:		*p<0.05; **p<0.01; ***p<0.001