CH5Q6 (a)

$$L = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} \qquad C = B_2 = 0 \qquad b = \begin{bmatrix} 2 \\ 3 \\ -1 \end{bmatrix} \qquad df = 63-3 = 60$$

$$t = \frac{L^T b - C}{\sqrt{L^T \operatorname{cov}(b) L}} = \frac{3-0}{\sqrt{[0,1,0]\begin{bmatrix} 3 & -2 & 1 \\ -2 & 4 & 0 \\ 1 & 0 & 3 \end{bmatrix}\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}}} = \frac{3}{\sqrt{4}} = 1.5$$

$t_{0.05}(60) = 2 \qquad 1.5 < 2$ 不拒絕 H0，沒證據表明 $B_2 \neq 0$

(b) $L = [1,2,0]^T \qquad C = 5$

$$t = \frac{L^T b - C}{\sqrt{L^T \operatorname{cov}(b) L}} = \frac{8-5}{\sqrt{[1,2,0]\begin{bmatrix} 3 & -2 & 1 \\ -2 & 4 & 0 \\ 1 & 0 & 3 \end{bmatrix}\begin{bmatrix} 1 \\ 2 \\ 0 \end{bmatrix}}} = \frac{3}{\sqrt{11}}$$

$\frac{3}{\sqrt{11}} < 2$ 不拒絕 H0，沒證據表明 $B_1 + 2B_2 \neq 5$

(c) $L = [1,-1,1]^T \qquad C = 4$

$$t = \frac{L^T b - C}{\sqrt{L^T \operatorname{cov}(b) L}} = \frac{-2-4}{\sqrt{[1,-1,1]\begin{bmatrix} 3 & -2 & 1 \\ -2 & 4 & 0 \\ 1 & 0 & 3 \end{bmatrix}\begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}}} = \frac{-6}{\sqrt{16}} = -1.5$$

$-1.5 > -2$ 不拒絕 H0，沒證據表明 $B_1 - B_2 + B_3 \neq 4$

CH5 Q31 (a)

$Time = 20.8701 + 0.3681 \times depart + 1.5219 \times reds + 3.0237 \times trains$

B_1：Bill在6:30出門且沒遇到紅綠燈 or 火車時所需花費 20.8701 分鐘

B_2：每晚1分鐘出門，通勤時間增加 0.3681分鐘

B_3：每多1個紅燈，通勤時間增加 1.5219分鐘

B_4：每遇到1班火車，通勤時間增加 3.0237分鐘

(b)

depart 和 reds 區間較窄，不確定性小，準確度高

trains 區間較寬，不確定性較大，但仍具意義

(c)

$H0: B_3 \geq 2$

$H1: B_3 < 2$

$a = 0.05$

$df = 245$

$$t = \frac{1.5219-2}{\sqrt{0.185}} = -2.5843$$

$$t_{0.05}(245) = -1.6511$$

$-1.6511 > -2.5843$ 拒絕 H0

在 5%的水準下，有足夠證據表明每個紅燈預期增加的時間 <2分鐘

(d)

H0 : $B_4 = 3$

H1 : $B_4 \neq 3$

$\alpha = 0.1$

$$t = \frac{3.0237 - 3}{\sqrt{0.643}} = 0.0374$$

$$t_{0.1}(245) = 1.6511$$

$-1.6511 < 0.0374 < 1.6511$　不拒絕 H0

沒足夠的證據表明 $B_4 \neq 3$，有可能=3分鐘

(e)

H0 : $30B_2 \geq 10 \Rightarrow B_2 \geq \frac{1}{3}$

H1 : $30B_2 < 10 \Rightarrow B_2 < \frac{1}{3}$

$\alpha = 0.05$

$$t = \frac{\frac{1}{3} - 0.3681}{\sqrt{0.0351}} = -0.9915$$

$-0.9915 > -1.6511$

不拒絕 H0，所以可能會增加10分鐘

(f)

H0 : $B_4 \geq 3B_3 \Rightarrow B_4 - 3B_3 \geq 0$

H1 : $B_4 < 3B_3 \quad B_4 < 3B_3 < 0$

$\alpha = 0.05$

$$SE = \sqrt{0.634^2 + 9 \times 0.185^2} = 0.842$$

$$t = \frac{3.0237 - 3 \times 1.5219}{0.842} = -1.831$$

$-1.831 < -1.6511$　拒絕 H0

火車延誤的時間 < 紅綠燈的3倍

(g) Time = 20.8701 + 0.3681 × 30 + 1.5219 × 6 + 3.0237 = 44.0682

H0: E(time) ≤ 45

H1: E(time) > 45

$\alpha = 0.05$

$45.131 - 44.069 = 1.062$ $t_{0.05}(245) = 1.6511$

$1.062 = 1.97 \times SE$ $SE = 0.539$

$$t = \frac{44.069 - 45}{0.539} = -1.727$$

$-1.727 < 1.6511$ 不拒絕 H0

沒足夠證據表明 Bill 會遲到

(h)

H0: E(time) > 45

H1: E(time) ≤ 45

$\alpha = 0.05$

$-1.727 < -1.6511$

拒絕 H0，有足夠證據說明 Bill 會在 7:45 分前到，結論不變

CH5 Q33 (a)

除了 $EDUC^2$ 以外，其餘在 1% 水準下均顯著

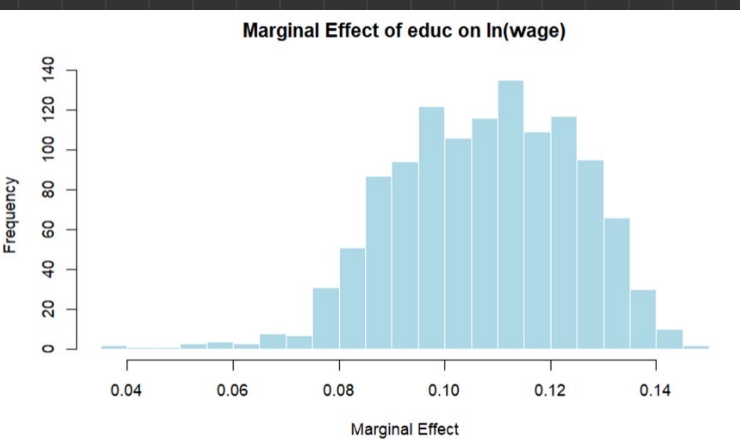
(b)

$$\frac{\partial \ln(wage)}{\partial EDUC} = \beta_2 + 2\beta_3 \times EDUC + \beta_6 EXPER = 0.08954 + 2\times 0.01458EDUC - 0.00101EXPER$$

$\beta_3 = 0.01458$ 受教育程度提升，薪增也會增加

$\beta_4 = -0.00101$ 經驗增加時，教育程度對工資的影響減弱

(c)




```
Median marginal effect:  0.1084313
> cat("5th percentile: ", percentile_5, "\n")
5th percentile:  0.08008187
> cat("95th percentile: ", percentile_95, "\n")
95th percentile:  0.1336188
>
```

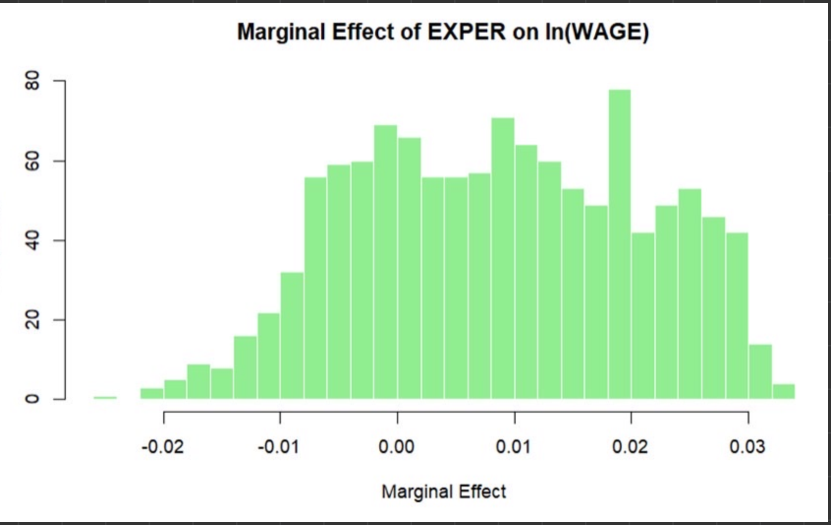
(d) $\frac{\partial E(\ln(wage))}{\partial EXPER} = \beta_4 + 2\beta_5 \times EXPER + \beta_6 \times EDUC$

$= 0.04488 - 0.000936\,EXPER - 0.00101\,EDUC$

經驗增加，邊際報酬遞減（薪資）

教育也是

(e)




```
> cat("Median marginal effect: ", median_effect, "\n")
Median marginal effect:  0.008418878
> cat("5th percentile: ", percentile_5, "\n")
5th percentile:  -0.01037621
> cat("95th percentile: ", percentile_95, "\n")
95th percentile:  0.02793115
```

(f)

$$\mu_D = 1.038 + 0.08954 \times 17 + 0.001458 \times 17^2 + 0.04488 \times 8 - 0.000468 \times 8^2 - 0.00101 \times 17 \times 8$$

$$= 3.174$$

$$\mu_S = 1.038 + 0.08954 \times 16 + 0.001458 \times 16^2 + 0.04488 \times 18 - 0.000468 \times 18^2 - 0.00101 \times 16 \times 18$$

$$= 3.209$$

$H0: \ \mu_D \le \mu_S \Rightarrow \mu_D - \mu_S \le 0$

$H1: \ \mu_D > \mu_S \Rightarrow \mu_D - \mu_S > 0$

$\alpha = 0.05$

```
NA> qt(0.05,1194)
[1] -1.646131
```

$$t = \frac{-0.03588}{0.0215} = -1.6688 \qquad -1.6688 < 1.696$$

不拒絕 H0 ，沒有足夠的證據表明 David的預期薪資高於 Svetlana

(g)

$$u_D = 1.038 + 0.08954\times 17 + 0.001458\times 17^2 + 0.04488\times 16 - 0.000468\times 16^2 - 0.00101\times 17\times 16$$

$$u_S = 1.038 + 0.08954\times 16 + 0.001458\times 16^2 + 0.04488\times 18 - 0.000468\times 26^2 - 0.00101\times 16\times 26$$

$H0: u_S - u_D \geq 0$

$H1: u_S - u_D < 0$

$\alpha = 0.05$

$$t = \frac{0.031}{0.015} = \frac{31}{15} \qquad \frac{31}{15} > 1.646$$

拒絕H0，足夠證據表明8年後 David 的薪資高於 Svetlana

(h)

$H0$: 相等 : $B_4 + 34B_5 + 12B_6 = B_4 + 22B_5 + 16B_6 \qquad 12B_5 - 4B_6 = 0 \qquad 3B_5 - B_6 = 0$

$H1$: 不等 : $B_4 + 34B_5 + 12B_6 \neq B_4 + 22B_5 + 16B_6 \qquad 3B_5 - B_6 \neq 0$

$\alpha = 0.05$

$t = -1.0273 \qquad -1.0273 > -1.96$ 不拒絕H0，沒顯著差異

(i)

$$\frac{\partial E(\ln(WAGE))}{\partial EXPER} = \beta_3 + 2\beta_4 x + \beta_5 \times 16 = 0$$

$$x = \frac{-(\beta_3 + 16\beta_5)}{2\beta_4} = \frac{-0.02872}{-0.000936} = 30.7 \qquad 30.7 - 11 = \underline{19.7}$$

$$g(\beta) = \frac{-\beta_3 - 16\beta_5}{2\beta_4} \qquad \frac{\partial g}{\partial \beta_3} = \frac{-1}{2\beta_4} \qquad \frac{\partial g}{\partial \beta_4} = \frac{\beta_3 + 16\beta_5}{2\beta_4^2} \qquad \frac{\partial g}{\partial \beta_5} = \frac{-16}{2\beta_4}$$

$$Var(x) = \left(\frac{-1}{2\beta_4}\right)^2 Var(\beta_3) + \left(\frac{\beta_3 + 16\beta_5}{2\beta_4^2}\right)^2 Var(\beta_4) + \left(\frac{-16}{2\beta_4}\right)^2 Var(\beta_5)$$

$$+ 2\left[\left(\frac{-1}{2\beta_4}\right)\left(\frac{\beta_3 + 16\beta_5}{2\beta_4^2}\right) Cov(\beta_3, \beta_4) + \left(\frac{-1}{2\beta_4}\right)\left(\frac{-16}{2\beta_4}\right) Cov(\beta_3, \beta_5) + \left(\frac{\beta_3 + 16\beta_5}{2\beta_4^2}\right)\left(\frac{-16}{2\beta_4}\right) Cov(\beta_4, \beta_5) \right.$$

$\Rightarrow$ 1.896

$$19.7 \pm 1.896 \times 1.96 = [15.984, \ 23.416]$$