Q18

(a)總共有16.33%的家庭父母皆有大學學歷(教育程度超過12年)

```
Percentage of parents with some college education: 16.33 %
```

(b)教育程度與父母是否有大學學歷之相關係數矩陣，COLL變數為dummy variable，比較可能跟誤差項無關，更符合工具變數的定義。

```
                educ mothercoll fathercoll
educ       1.0000000  0.3370171  0.3193212
mothercoll 0.3370171  1.0000000  0.3674532
fathercoll 0.3193212  0.3674532  1.0000000
```

(c)Example10.5之迴歸

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.1327561  0.4965325  -0.267  0.78932
exper        0.0433444  0.0134135   3.231  0.00133 **
I(exper^2)  -0.0008711  0.0004017  -2.169  0.03066 *
educ         0.0760180  0.0394077   1.929  0.05440 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6703 on 424 degrees of freedom
Multiple R-Squared: 0.147,      Adjusted R-squared: 0.1409
Wald test:   8.2 on 3 and 424 DF,  p-value: 2.569e-05
```

```
> confint(iv_model, level = 0.95)["educ", ]
       2.5 %       97.5 %
-0.001219763  0.153255678
```

(d)p 值 < 0.05 且 F > 10，MOTHERCOLL是強工具變數

```
Linear hypothesis test:
mothercoll = 0

Model 1: restricted model
Model 2: educ ~ exper + I(exper^2) + mothercoll

  Res.Df    RSS Df Sum of Sq      F    Pr(>F)
1    750 3846.2
2    749 3405.3  1    440.91 96.979 < 2.2e-16 ***
```

(e)

```
Residuals:
     Min       1Q   Median       3Q      Max
-3.07797 -0.32128  0.03418  0.37648  2.36183

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.2790819  0.3922213  -0.712  0.47714
exper        0.0426761  0.0132950   3.210  0.00143 **
I(exper^2)  -0.0008486  0.0003976  -2.135  0.03337 *
educ         0.0878477  0.0307808   2.854  0.00453 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

> # 取出 EDUC 的 95% 信賴區間
> confint(iv_model_2, level = 0.95)["educ", ]
     2.5 %     97.5 %
0.02751845 0.14817686
```

(f)MOTHERCOLL、FATHERCOLL皆為強工具變數

```
Linear hypothesis test:
mothercoll = 0
fathercoll = 0

Model 1: restricted model
Model 2: educ ~ exper + I(exper^2) + mothercoll + fathercoll

  Res.Df    RSS Df Sum of Sq      F    Pr(>F)
1    750 3846.2
2    748 3231.0  2    615.15 71.204 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(g)使用兩個工具變數(MOTHERCOLL、FATHRCOLL)來估計單一自變數(EDUC)，可能有過度便是(overidentified)的問題。

Q20

(a)MSFT的beta約1.2，相較市場組合更有些許風險

```
Residuals:
     Min       1Q   Median       3Q      Max
-0.27424 -0.04744 -0.00820  0.03869  0.35801

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.003250   0.006036   0.538    0.591
x           1.201840   0.122152   9.839   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08083 on 178 degrees of freedom
Multiple R-squared:  0.3523,    Adjusted R-squared:  0.3486
F-statistic:  96.8 on 1 and 178 DF,  p-value: < 2.2e-16
```

(b)RANK與市場溢酬正相關，可能是個強IV

```
Residuals:
      Min        1Q    Median        3Q       Max
-0.110497 -0.006308  0.001497  0.009433  0.029513

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -7.903e-02  2.195e-03   -36.0   <2e-16 ***
RANK         9.067e-04  2.104e-05    43.1   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.01467 on 178 degrees of freedom
Multiple R-squared:  0.9126,    Adjusted R-squared:  0.9121
F-statistic:  1858 on 1 and 178 DF,  p-value: < 2.2e-16
```

(c)在99%信心水準之下，一階回歸的殘差係數與0無異，市場報酬可能是外生變數

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.003018   0.005984   0.504   0.6146
mkt_excess   1.278318   0.126749  10.085   <2e-16 ***
v           -0.874599   0.428626  -2.040   0.0428 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.08012 on 177 degrees of freedom
Multiple R-squared:  0.3672,    Adjusted R-squared:   0.36
F-statistic: 51.34 on 2 and 177 DF,  p-value: < 2.2e-16
```

(d)係數與OLS結果相差約0.07，驗證OLS可能是有效的

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.003018   0.006044   0.499    0.618
mkt_excess  1.278318   0.128011   9.986   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.08092 on 178 degrees of freedom
Multiple R-Squared: 0.3508,     Adjusted R-squared: 0.3472
Wald test: 99.72 on 1 and 178 DF,  p-value: < 2.2e-16
```

(e)POS、RANK可能都是強工具變數

```
Linear hypothesis test:
RANK = 0
POS = 0

Model 1: restricted model
Model 2: mkt_excess ~ RANK + POS

  Res.Df     RSS Df Sum of Sq      F    Pr(>F)
1    179 0.43784
2    177 0.03727  2   0.40057 951.26 < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

(f)Hausmen Test，F檢定p-value<0.01，v_2應與誤差項無關聯。

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.003004   0.005972   0.503   0.6157
mkt_excess   1.283118   0.126344  10.156   <2e-16 ***
v_2         -0.954918   0.433062  -2.205   0.0287 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.07996 on 177 degrees of freedom
Multiple R-squared:  0.3696,    Adjusted R-squared:  0.3625
F-statistic: 51.88 on 2 and 177 DF,  p-value: < 2.2e-16
```

(g)使用POS+RANK的2SLS係數與PLS相差0.08，R平方相差無幾，OLS可能是可信的

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.003004   0.006044   0.497     0.62
mkt_excess  1.283118   0.127866  10.035   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.08093 on 178 degrees of freedom
Multiple R-Squared: 0.3507,     Adjusted R-squared: 0.347
Wald test: 100.7 on 1 and 178 DF,  p-value: < 2.2e-16
```

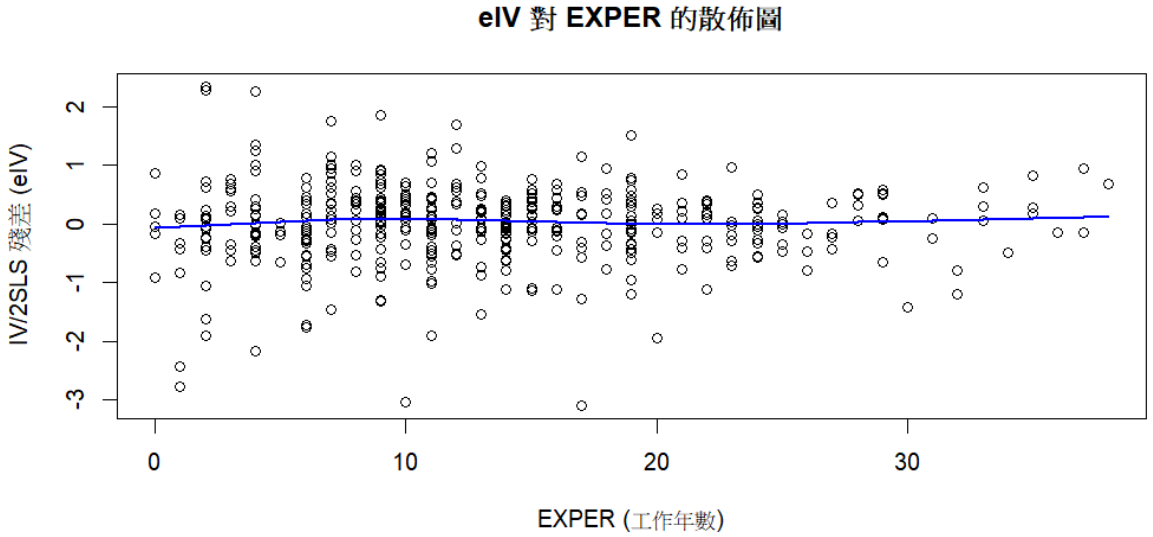
(h)不拒絕H0，代表IV與誤差項沒有相關性

```
> cat("Sargan J-statistic:", J_stat, "\n")
Sargan J-statistic: 0.5584634
> cat("Degrees of freedom:", df, "\n")
Degrees of freedom: 1
> cat("P-value:", p_value, "\n")
P-value: 0.45488
```

Q24

(a)在工作經驗較少時，殘差明顯變異較大。異質變異(heteroskedasticity)存在

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.0481003  0.4003281   0.120  0.90442
exper        0.0441704  0.0134325   3.288  0.00109 **
I(exper^2)  -0.0008990  0.0004017  -2.238  0.02574 *
educ         0.0613966  0.0314367   1.953  0.05147 .
```



(b)NR2 Test，P-value<0.01，存在異質變異(heteroskedasticity)

```
> p_value <- pchisq(NR2, df = 1, low
> cat("NR² 檢定統計量 =", NR2, "\n")
NR² 檢定統計量 = 7.438552
> cat("p-value =", p_value, "\n")
p-value = 0.006384122
```

(c)與原本的SE相比，Robust SE皆變大，符合異質變異的預測。95%信心區間如下圖

```
t test of coefficients:

              Estimate  Std. Error t value Pr(>|t|)
(Intercept)  0.04810030  0.42979772  0.1119 0.910945
exper        0.04417039  0.01554638  2.8412 0.004711 **
I(exper^2)  -0.00089897  0.00043008 -2.0902 0.037193 *
educ         0.06139663  0.03333859  1.8416 0.066231 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> cat("EDUC 的 95% 信賴區間為： [", lower, ",", upper, "]\n")
EDUC 的 95% 信賴區間為： [ -0.003947005 , 0.1267403 ]
```

(d) 跟baseline比boot_SE全都上升，與Robust SE比，截距與educ標準差增加，其餘降低。

```
> print(boot_se)
[1] 0.4379214892 0.0157743662 0.0004307738 0.0323454715
> cat("  95% CI for EDUC (bootstrap) = [",
+     round(ci_boot[1],4), ", ", round(ci_boot[2],4), "]\n")
  95% CI for EDUC (bootstrap) = [ 0.0305 ,  0.0923 ]
```