Q6

TABLE 15.10 Estimation Results for Exercise 15.6

	(1) OLS 1987	(2) OLS 1988	(3) FE	(4) FE Robust	(5) RE
C	0.9348	0.8993	1.5468	1.5468	1.1497
	(0.2010)	(0.2407)	(0.2522)	(0.2688)	(0.1597)
EXPER	0.1270	0.1265	0.0575	0.0575	0.0986
	(0.0295)	(0.0323)	(0.0330)	(0.0328)	(0.0220)
EXPER^2	−0.0033	−0.0031	−0.0012	−0.0012	−0.0023
	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0007)
SOUTH	−0.2128	−0.2384	−0.3261	−0.3261	−0.2326
	(0.0338)	(0.0344)	(0.1258)	(0.2495)	(0.0317)
UNION	0.1445	0.1102	0.0822	0.0822	0.1027
	(0.0382)	(0.0387)	(0.0312)	(0.0367)	(0.0245)
N	716	716	1432	1432	1432

f. The most of difference ⇒ South

$EXPER^2 \quad \frac{0.023}{0.012} \doteqdot 1.92$. Hausman test: $t = \frac{\hat{\beta}_{FE} - \hat{\beta}_{RE}}{\sqrt{Var(\hat{\beta}_{FE}) \cdot Var(\hat{\beta}_{RE})}}$

$t_{EXPER} = \frac{0.0575 - 0.0986}{\sqrt{0.033^2 - 0.022^2}} \doteqdot -1.67$, $t_{EXPER^2} = \frac{-0.0012 - (-0.0021)}{\sqrt{0.0011^2 - 0.0007^2}} \doteqdot 1.29$

$t_{SOUTH} = \frac{-0.3261 - (-0.2326)}{\sqrt{0.1258^2 - 0.0317^2}} \doteqdot -0.77$ $\quad t_{UNION} = \frac{0.0822 - 0.1027}{\sqrt{0.0312^2 - 0.0245^2}} \doteqdot -1.06$

Random effect is appropriate ※

Q17

15.17 The data file *liquor* contains observations on annual expenditure on liquor (*LIQUOR*) and annual income (*INCOME*) (both in thousands of dollars) for 40 randomly selected households for three consecutive years.

b. Estimate the model $LIQUOR_{it} = \beta_1 + \beta_2 INCOME_{it} + u_i + e_{it}$ using random effects. Construct a 95% interval estimate of the coefficient on *INCOME*. How does it compare to the interval in part (a)?

```
2.5 %.income 97.5 %.income
  0.01283111    0.04031983
```

與(a)相比，不包含 0，表示 beta_2 顯著不為 0，支持收入變化會影響酒類支出

c. Test for the presence of random effects using the LM statistic in equation (15.35). Use the 5% level of significance.

```
        Lagrange Multiplier Test - (Breusch-Pagan)

data:  liquor ~ income
chisq = 20.68, df = 1, p-value = 5.429e-06
alternative hypothesis: significant effects

> qchisq(p=0.95,df=1)
[1] 3.841459
```

Reject H0 (H0: No random effect)

d. For each individual, compute the time averages for the variable *INCOME*. Call this variable *INCOMEM*. Estimate the model $LIQUOR_{it} = \beta_1 + \beta_2 INCOME_{it} + \gamma INCOMEM_i + c_i + e_{it}$ using the random effects estimator. Test the significance of the coefficient γ at the 5% level. Based on this test, what can we conclude about the correlation between the random effect u_i and *INCOME*? Is it OK to use the random effects estimator for the model in (b)?

```
Call:
plm(formula = liquor ~ income + INCOMEM, data = pdat2, model = "random")

Balanced Panel: n = 40, T = 3, N = 120

Effects:
                 var std.dev share
idiosyncratic 0.9640  0.9819 0.571
individual    0.7251  0.8515 0.429
theta: 0.4459

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-2.300955 -0.703840  0.054992  0.560255  2.257325

Coefficients:
             Estimate Std. Error z-value Pr(>|z|)
(Intercept) 0.9163337  0.5524439  1.6587  0.09718 .
income      0.0207421  0.0209083  0.9921  0.32117
INCOMEM     0.0065792  0.0222048  0.2963  0.76700
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    126.61
Residual Sum of Squares: 112.79
R-Squared:      0.10917
Adj. R-Squared: 0.093945
Chisq: 14.3386 on 2 DF, p-value: 0.00076987
```

H0: r = 0, H1: r != 1

p-value = 0.767 > 0.05

無法拒絕 H0

INCOMEM 和個體隨機效果 ui 沒有相關性，所以可以使用 random effect model

Q20

15.20 This exercise uses data from the STAR experiment introduced to illustrate fixed and random effects for grouped data. In the STAR experiment, children were randomly assigned within schools into three types of classes: small classes with 13–17 students, regular-sized classes with 22–25 students, and regular-sized classes with a full-time teacher aide to assist the teacher. Student scores on achievement tests were recorded as well as some information about the students, teachers, and schools. Data for the kindergarten classes are contained in the data file *star*.

d. Reestimate the model in part (a) with school random effects. Compare the results with those from parts (a) and (b). Are there any variables in the equation that might be correlated with the school effects? Use the LM test for the presence of random effects.

```
Oneway (individual) effect Random Effect Model
   (Swamy-Arora's transformation)

Call:
plm(formula = readscore ~ small + aide + tchexper + boy + white_asian
    freelunch, data = pdata, model = "random")

Unbalanced Panel: n = 79, T = 34-137, N = 5766

Effects:
                 var std.dev share
idiosyncratic 751.43   27.41 0.829
individual    155.31   12.46 0.171
theta:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.6470  0.7225  0.7523  0.7541  0.7831  0.8153

Residuals:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-97.483 -17.236  -3.282   0.037  12.803 192.346

Coefficients:
              Estimate Std. Error  z-value  Pr(>|z|)
(Intercept) 436.126774   2.064782 211.2217 < 2.2e-16 ***
small         6.458722   0.912548   7.0777 1.466e-12 ***
aide          0.992146   0.881159   1.1260    0.2602
tchexper      0.302679   0.070292   4.3060 1.662e-05 ***
boy          -5.512081   0.727639  -7.5753 3.583e-14 ***
white_asian   7.350477   1.431376   5.1353 2.818e-07 ***
freelunch   -14.584332   0.874676 -16.6740 < 2.2e-16 ***
```

估計相近

```
        Lagrange Multiplier Test - (Breusch-Pagan)

data:  readscore ~ small + aide + tchexper + boy + white_asian + freelunch
chisq = 6677.4, df = 1, p-value < 2.2e-16
alternative hypothesis: significant effects
```

p-value < 0.05，reject H0，存在 RE，school level unobserved heterogeneity

e. Using the *t*-test statistic in equation (15.36) and a 5% significance level, test whether there are any significant differences between the fixed effects and random effects estimates of the coefficients on *SMALL*, *AIDE*, *TCHEXPER*, *WHITE_ASIAN*, and *FREELUNCH*. What are the implications of the test outcomes? What happens if we apply the test to the fixed and random effects estimates of the coefficient on *BOY*?

```
        Hausman Test

data:  readscore ~ small + aide + tchexper + boy + white_asian + freelunch
chisq = 13.809, df = 6, p-value = 0.03184
alternative hypothesis: one model is inconsistent
```

H0: beta_FE = beta_RE, H1: beta_FE != beta_RE

```
small       :  t =  1.15,  p = 0.252
aide        :  t =  0.13,  p = 0.898
tchexper    :  t = -1.94,  p = 0.053
white_asian :  t =  1.22,  p = 0.223
freelunch   :  t = -0.10,  p = 0.924
```

f. Create school-averages of the variables and carry out the Mundlak test for correlation between them and the unobserved heterogeneity.

```
Unbalanced Panel: n = 78, T = 34-136, N = 5681

Effects:
                  var std.dev share
idiosyncratic 756.11   27.50 0.817
individual    169.40   13.02 0.183
theta:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.6593  0.7327  0.7615  0.7630  0.7892  0.8217

Residuals:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-98.886 -17.051  -3.166   0.039  12.846 193.321

Coefficients:
                Estimate Std. Error  z-value  Pr(>|z|)
(Intercept)   459.462989  20.529888  22.3802 < 2.2e-16 ***
small           6.637460   0.922068   7.1985 6.090e-13 ***
aide            1.157620   0.889542   1.3014    0.1931
tchexper        0.289286   0.071754   4.0316 5.539e-05 ***
boy            -5.386109   0.735063  -7.3274 2.346e-13 ***
white_asian     8.081423   1.550155   5.2133 1.855e-07 ***
freelunch     -14.699025   0.892109 -16.4767 < 2.2e-16 ***
small_m       -18.410060  22.273923  -0.8265    0.4085
aide_m         16.811358  20.793685   0.8085    0.4188
tchexper_m      1.006007   0.625690   1.6078    0.1079
boy_m         -53.353521  25.221654  -2.1154    0.0344 *
white_asian_m  -6.648191   6.320012  -1.0519    0.2928
freelunch_m    -3.318853   8.779553  -0.3780    0.7054
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Boy_m ‘s p-value < 0.05，應採用 FE

其他使用 RE