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

(standard errors in parentheses)

f. Column (5) contains the random effects estimates. Which coefficients, apart from the intercepts, show the most difference from the fixed effects estimates? Use the Hausman test statistic (15.36) to test whether there are significant differences between the random effects estimates and the fixed effects estimates in column (3) (Why that one?). Based on the test results, is random effects estimation in this model appropriate?

$EXPER^2$ ($\frac{0.023}{0.012} = 1.92$倍) ★ Hausmen test $t_j = \frac{\hat{\beta}_{FE} - \hat{\beta}_{RE}}{\sqrt{Var(\hat{\beta}_{FE}) - Var(\hat{\beta}_{RE})}}$

$t_{EXPER} = \frac{0.0575 - 0.0986}{\sqrt{0.0333^2 - 0.0122^2}} \approx -1.67$ $t_{EXPER^2} = \frac{-0.0012 - (-0.0021)}{\sqrt{0.0011^2 - 0.0007^2}} \approx 1.29$

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

無顯著差異，random effects is appropriate

Q17.

(b)使用RE後的income之信賴區間如下圖

```
> # 建立 95% 信賴區間
> confint(re_model)
                  2.5 %     97.5 %
(Intercept) -0.05211904 1.99018381
income       0.01283111 0.04031983
```

(c)p-value<0.05,拒絕H0，不使用隨機效果。

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

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

(d)incomem的p-value大於0.05,income和個體隨機效果無相關性，RE模型可被使用。

```
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
```

Q20

(d)係數與(a)、(b)具一致性，LM test之p-value<0.05=>應使用隨機效果模型

```
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 ***
---

        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
```

(e)Hausmen Test的p-value<0.05，拒絕虛無假設=>隨機效果存在偏誤，且固定效果跟隨機效果針對boy變數具一致性=>使用固定效果即可。

```
        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
```

(f)其中只有boy_m的p-value<0.05,針對boy使用固定效果(FE),其餘變數則可採隨機效果(RE)

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

Call:
plm(formula = readscore ~ small + aide + tchexper + boy + white_asian +
    freelunch + small_m + aide_m + tchexper_m + boy_m + white_asian_m +
    freelunch_m, data = pdata_clean, model = "random")

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

Total Sum of Squares:    6007200
Residual Sum of Squares: 4281300
R-Squared:      0.28737
Adj. R-Squared: 0.28586
Chisq: 500.306 on 12 DF, p-value: < 2.22e-16
```