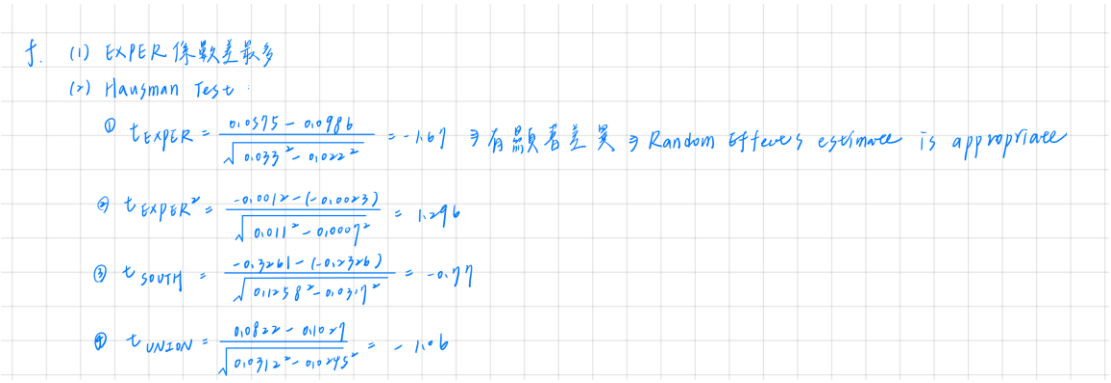
HW0519 王彩寧 313707006

15.06

(f)



15.17

(b)

The result of part (a):

```
Call:
lm(formula = liquord ~ incomed + 0, data = df)

Residuals:
    Min      1Q  Median      3Q     Max
-3.6852 -0.9196 -0.0323  0.9027  3.3620

Coefficients:
        Estimate Std. Error t value Pr(>|t|)
incomed  0.02975    0.02922   1.018    0.312

Residual standard error: 1.417 on 79 degrees of freedom
Multiple R-squared:  0.01295,   Adjusted R-squared:  0.0004544
F-statistic: 1.036 on 1 and 79 DF,  p-value: 0.3118

> confint(model)
              2.5 %     97.5 %
incomed -0.02841457 0.08790818
```

The result of part (b):

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

Call:
plm(formula = liquor ~ income, data = pdata, 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.
-2.263634 -0.697383  0.078697  0.552680  2.225798

Coefficients:
             Estimate Std. Error z-value  Pr(>|z|)
(Intercept) 0.9690324  0.5210052  1.8599 0.0628957 .
income      0.0265755  0.0070126  3.7897 0.0001508 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    126.61
Residual Sum of Squares: 112.88
R-Squared:      0.1085
Adj. R-Squared: 0.10095
Chisq: 14.3618 on 1 DF, p-value: 0.00015083
>
> # 計算 95% 信賴區間
> confint(re_model)
                   2.5 %     97.5 %
(Intercept) -0.05211904 1.99018381
income       0.01283111 0.04031983
```

The random effects estimator for income (0.0266) is slightly smaller than the first-difference estimate (0.0298). However, the standard error in the random effects model (0.0070) is only about 24% of the first-difference model's standard error (0.0292), making the estimate highly statistically significant. The 95% confidence interval in the random effects model is narrow and entirely positive, while the first-difference interval contains zero, indicating insignificance.

(c)

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

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

Based on the BP test, the p-value is smaller than 0.05. We reject the null hypothesis. There is statistically significant unobserved heterogeneity.

(d)

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

Call:
plm(formula = liquor ~ income + incomem, data = pdata2, 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
```

The coefficient on INCOMEM is statistically insignificant (p = 0.767), indicating no significant correlation between the time-invariant individual effect and income. Therefore, the assumption underlying the random effects model holds, and it is appropriate to use the random effects estimator for the model in (b).

15.20(d)

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

Call:
plm(formula = readscore ~ small + aide + tchexper + boy + white_asian +
    freelunch, data = pdata, effect = "individual", 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 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    6158000
Residual Sum of Squares: 4332100
R-Squared:      0.29655
Adj. R-Squared: 0.29582
Chisq: 493.205 on 6 DF, p-value: < 2.22e-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
```

Most coefficients from the random-effects model align closely with those from OLS and fixed-effects models, suggesting minimal correlation with unobserved school-level heterogeneity. However, the highly significant Breusch–Pagan LM test confirms the presence of school-level heterogeneity, justifying the use of a random-effects specification over pooled OLS.

(e)

```
        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
```

There are significant differences between the fixed effects and random effects estimates. The random effects model is inconsistent, likely due to correlation between the individual effects and the regressors. Therefore, the fixed effects model should be preferred for estimating the impact of the variables on reading scores.

(f)

```
Linear hypothesis test:
small_avg = 0
aide_avg = 0
tchexper_avg = 0
boy_avg = 0
white_asian_avg = 0
freelunch_avg = 0

Model 1: restricted model
Model 2: readscore ~ small + aide + tchexper + boy + white_asian + freelunch +
    small_avg + aide_avg + tchexper_avg + boy_avg + white_asian_avg +
    freelunch_avg

Note: Coefficient covariance matrix supplied.

  Res.Df Df      F  Pr(>F)
1   5695
2   5689  6 2.2541 0.03557 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

The test yields an F statistic of 2.2541 with a p-value of 0.03557, less than the 5% significance level. Therefore, we reject the null hypothesis and conclude that the school-level average characteristics jointly have a statistically significant effect on reading scores.