15.6

(a) 若有相同迴歸係數，且參數不變。在 1987, 1988 年的 estimation of OLS 結果非常接近 ⇒ No heterogeneity

(b) OLS 忽略 v_{it}（不隨時間改變），加了 time, individual ⇒ 假設個體有隨時間變動的殘差 e_{it}

(c) SOUTH, UNION 無大變動 ⇒ 變數沒大變異

EXPER 被高估（0.0375 < 0.127）

EXPER^2 變化明顯

(d) ① $H_0: \mu_i = 0$

$H_A: \mu_i \neq 0$

② df = 745, 711

③ $F = 1.12 < 11.68$ ⇒ reject H_0. 個體無差異，用固定效果

(e) 標準差 within transformation：$\ddot{e}_{it} = e_{it} - \bar{e}_{it}$ ⇒ column 4 的標準差較大

15.17

(a)

```
Call:
lm(formula = d_liquor ~ d_income + 0, data = liquor_diff)

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

Coefficients:
         Estimate Std. Error t value Pr(>|t|)
d_income  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(reg_result, "d_income", level = 0.95)
                2.5 %     97.5 %
d_income -0.02841457 0.08790818
```

15.20

(a)

```
Call:
lm(formula = readscore ~ small + aide + tchexper + boy + white_asian +
    freelunch, data = star)

Residuals:
     Min       1Q   Median       3Q      Max
-107.220  -20.214   -3.935   14.339  185.956

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 437.76425    1.34622 325.180  < 2e-16 ***
small         5.82282    0.98933   5.886 4.19e-09 ***
aide          0.81784    0.95299   0.858    0.391
tchexper      0.49247    0.06956   7.080 1.61e-12 ***
boy          -6.15642    0.79613  -7.733 1.23e-14 ***
white_asian   3.90581    0.95361   4.096 4.26e-05 ***
freelunch   -14.77134    0.89025 -16.592  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 30.19 on 5759 degrees of freedom
  (因為不存在，20 個觀察量被刪除了)
Multiple R-squared:  0.09685,   Adjusted R-squared:  0.09591
F-statistic: 102.9 on 6 and 5759 DF,  p-value: < 2.2e-16
```

Small is significant : positive impact

Aide isn't significant : no significant evidence that Aide improve scores

TCHEXPER is significant = teachers with experience are associated with better scores.

Boy is significant = Girls outperform boys

White_asian is significant = Both got higher scores.

FREELUNCH is significant = is strongly associated with lower scores.

(b)

```
Call:
lm(formula = readscore ~ small + aide + tchexper + boy + white_asian +
    freelunch, data = star)

Residuals:
     Min       1Q   Median       3Q      Max
-107.220  -20.214   -3.935   14.339  185.956

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 437.76425    1.34622 325.180  < 2e-16 ***
small         5.82282    0.98933   5.886 4.19e-09 ***
aide          0.81784    0.95299   0.858    0.391
tchexper      0.49247    0.06956   7.080 1.61e-12 ***
boy          -6.15642    0.79613  -7.733 1.23e-14 ***
white_asian   3.90581    0.95361   4.096 4.26e-05 ***
freelunch   -14.77134    0.89025 -16.592  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 30.19 on 5759 degrees of freedom
  (因為不存在，20 個觀察量被刪除了)
Multiple R-squared:  0.09685,   Adjusted R-squared:  0.09591
F-statistic: 102.9 on 6 and 5759 DF,  p-value: < 2.2e-16
```

no change

(c)

```
Analysis of Variance Table

Model 1: readscore ~ small + aide + tchexper + boy + white_asian + freelunch
Model 2: readscore ~ small + aide + tchexper + boy + white_asian + freelunch +
    factor(schid)
  Res.Df     RSS Df Sum of Sq      F    Pr(>F)
1   5759 5247584
2   5681 4268894 78    978690 16.698 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Reject H_0 ⇒ school fixed effects are significant.