15-6

(f) SOUTH is the most different coefficient of variable.

$t_{south} = \frac{-0.326 + 0.2326}{\sqrt{0.1258^2 - 0.0317^2}} = -0.768 \Rightarrow$ prefer random effect estimation

15-17

(b)

```
> cat("95% Confidence Interval:", round(confInt, 4), "\n")
95% Confidence Interval: 0.0122 0.0409
```

(c)

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

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

$< 0.05 \Rightarrow$ reject H_0. There is no individual random effects.

(d)

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

Call:
plm(formula = liquor ~ income + incomeMean, 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.
-2.300955 -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
incomeMean  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
```

$\widehat{LIQUOR}_{it} = 0.9163337 + 0.0207421\,INCOME + 0.0065792\,INCOMEMEAN_{it}$

It not significant difference (0.3) $\Rightarrow$ There is no evidence to indicate that individual random effect is correlated with INCOME.

15-20

(d)

```
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
```

RE estimator is similar in OLS and fixed effects. In LM test, reject H_0 of no endogeneity, the model should be used. So suggest the RE exist.

```
             Estimate Std. Error    z-value     Pr(>|z|)
(Intercept) 436.1267737 2.06478223 211.221681 0.000000e+00
small         6.4587216 0.91254764   7.077682 1.465861e-12
aide          0.9921460 0.88115884   1.125956 2.601842e-01
tchexper      0.3026787 0.07029195   4.306023 1.662160e-05
boy          -5.5120812 0.72763883  -7.575298 3.583032e-14
white_asian   7.3504772 1.43137578   5.135253 2.817642e-07
freelunch   -14.5843317 0.87467623 -16.673977 2.026499e-62
>
> pool_model <- plm(readscore ~ small + aide + tchexper + boy + white_asian +
h,
+                 data = panel_data, model = "pooling")
> plmtest(pool_model, effect = "individual")

        Lagrange Multiplier Test - (Honda)

data:  readscore ~ small + aide + tchexper + boy + white_asian + freelunch
normal = 81.715, p-value < 2.2e-16
alternative hypothesis: significant effects
```

(e)

```
b2 t-stat: 1.146
b3 t-stat: 0.128
b4 t-stat: -1.938
b5 → invalid sqrt: diff = -1e-04
b6 t-stat: 1.218
b7 t-stat: -0.096
Critical value (df=6): ± 2.447
```

RE estimation is appropriate. No significant difference between RE estimates and fixed effects estimates.

(f)

```
   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_mean       -18.410060  22.273923  -0.8265    0.4085
aide_mean         16.811358  20.793685   0.8085    0.4188
tchexper_mean      1.006007   0.625690   1.6078    0.1079
boy_mean         -53.353521  25.221654  -2.1154    0.0344 *
white_asian_mean  -6.648191   6.320012  -1.0519    0.2928
freelunch_mean    -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
```

The boy's coefficient is statistically significant ⇒ endogeneity exists.