d.

d. Obtain the 2SLS estimates of the investment equation using all eight exogenous and predetermined variables as IVs and software designed for 2SLS. Compare the estimates to the OLS estimates in part (a). Do you find any important differences?

e. Estimate the second-stage model $I_t = \beta_1 + \beta_2 \hat{P}_t + \beta_3 P_{t-1} + \beta_4 K_{t-1} + e_{2t}$ by OLS. Compare the estimates and standard errors from this estimation to those in part (d). What differences are there?

```
> summary(iv_inv)

Call:
ivreg(formula = i ~ p + plag + klag | g + w2 + tx + time + plag +
    klag + elag, data = df)

Residuals:
    Min      1Q  Median      3Q     Max
-3.2909 -0.8069  0.1423  0.8601  1.7956

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 20.27821    8.38325   2.419  0.02707 *
p            0.15022    0.19253   0.780  0.44598
plag         0.61594    0.18093   3.404  0.00338 **
klag        -0.15779    0.04015  -3.930  0.00108 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.307 on 17 degrees of freedom
Multiple R-Squared: 0.8849,     Adjusted R-squared: 0.8646
Wald test:  41.2 on 3 and 17 DF,  p-value: 5.148e-08
```

```
> print(compare_slopes, n = Inf)
# A tibble: 8 x 6
  model term        estimate std.error statistic  p.value
  <chr> <chr>          <dbl>     <dbl>     <dbl>    <dbl>
1 OLS   (Intercept)   10.1       5.47       1.85  0.0814
2 OLS   p              0.480     0.0971     4.94  0.000125
3 OLS   plag           0.333     0.101      3.30  0.00421
4 OLS   klag          -0.112     0.0267    -4.18  0.000624
5 2SLS  (Intercept)   20.3       8.38       2.42  0.0271
6 2SLS  p              0.150     0.193      0.780 0.446
7 2SLS  plag           0.616     0.181      3.40  0.00338
8 2SLS  klag          -0.158     0.0402    -3.93  0.00108
```

OLS的估計結果會有simultaneity bias

例如，當投資多的年份，同時利潤

也高時，OLS會高估兩者關係

而2SLS可解決內生性問題，

但可能會犧牲部份精確度

c.

```
> summary(stage2)

Call:
lm(formula = i ~ phat + plag + klag, data = df)

Residuals:
    Min      1Q  Median      3Q     Max
-3.8778 -1.0029  0.3058  0.7275  2.1831

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 20.27821    9.97663   2.033  0.05802 .
phat         0.15022    0.22913   0.656  0.52084
plag         0.61594    0.21531   2.861  0.01083 *
klag        -0.15779    0.04778  -3.302  0.00421 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.556 on 17 degrees of freedom
Multiple R-squared:  0.837,     Adjusted R-squared:  0.8082
F-statistic: 29.09 on 3 and 17 DF,  p-value: 6.393e-07
```

所有slope的正負值皆沒變.
和standard error有改變。