10.24

Consider the data file $mroz$ on working wives. Use the 428 observations on married women who participate in the labor force. In this exercise, we examine the effectiveness of alternative standard errors for the IV estimator. Estimate the model in Example 10.5 using IV/2SLS using both $MOTHEREDUC$ and $FATHEREDUC$ as IV. These will serve as our baseline results.

a. Calculate the IV/2SLS residuals, $\hat{e_{IV}}$. Plot them versus $EXPER$. Do the residuals exhibit a pattern consistent with homoskedasticity?

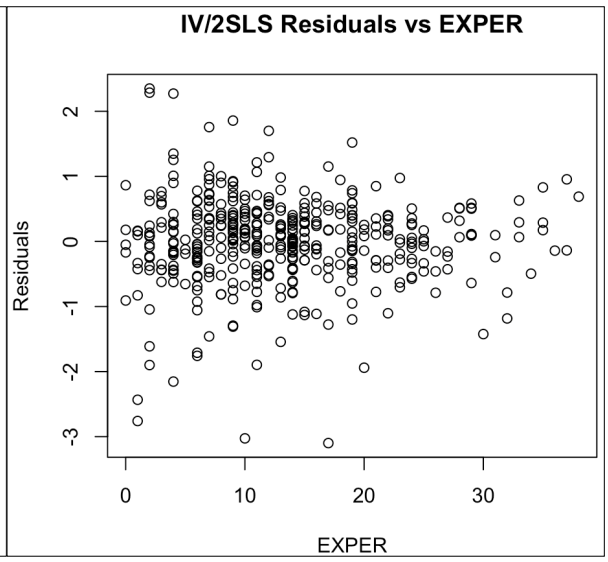
Ans. 殘差呈現漏斗形，表示可能存在異方差性

```
Call:
ivreg(formula = lwage ~ exper + exper2 + educ | exper + exper2 +
    mothereduc + fathereduc, data = mroz_sub)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0986 -0.3196  0.0551  0.3689  2.3493

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.0481003  0.4003281   0.120  0.90442
exper        0.0441704  0.0134325   3.288  0.00109 **
exper2      -0.0008990  0.0004017  -2.238  0.02574 *
educ         0.0613966  0.0314367   1.953  0.05147 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6747 on 424 degrees of freedom
Multiple R-Squared: 0.1357,     Adjusted R-squared: 0.1296
Wald test: 8.141 on 3 and 424 DF,  p-value: 2.787e-05
```



b. Regress $\hat{e_{IV}}^2$ against a constant and $EXPER$. Apply the NR^2 test from Chapter 8 to test for the presence of heteroskedasticity.

Ans.

H_0 : homoskedasticity　　H_1 : hetroskedasticity

$\alpha = 0.05$　臨界值：$\chi^2_{0.95,\,1} = 3.841459$

$NR^2 = 7.438552$　　$\geq \chi^2_{0.95,\,1} = 3.841459$

NR^2 檢定的 p 值 = 0.006 < 0.05，拒絕虛無假設

表示 $EXPER$ 與殘差平方之間存在顯著關係，證明存在異方差性。

```
> qchisq(1-0.05, df = 1)
[1] 3.841459
> nR2
[1] 7.438552
> p_value
[1] 0.006384122
```

```
Call:
lm(formula = iv_resid2 ~ exper, data = mroz_sub)

Residuals:
    Min      1Q  Median      3Q     Max
-0.6740 -0.4341 -0.2685 -0.0168  9.2188

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.676563   0.096573   7.006 9.65e-12 ***
exper       -0.017303   0.006303  -2.745  0.00631 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.049 on 426 degrees of freedom
Multiple R-squared:  0.01738,    Adjusted R-squared:  0.01507
F-statistic: 7.535 on 1 and 426 DF,  p-value: 0.006308
```

c. **Obtain the IV/2SLS estimates with the software option for Heteroskedasticity Robust Standard Errors. Are the robust standard errors larger or smaller than those for the baseline model? Compute the 95% interval estimate for the coefficient of $EDUC$ using the robust standard error.**

Ans.

The robust standard errors are larger than the usual IV standard errors.

Using robust standard errors the interval estimate for the coefficient of EDUC is [−0.0041329, 0.1269261].

The usual IV estimated standard errors give an interval of [−0.0003945, 0.1231878]

	Estimate	Baseline_SE	Robust_SE	SE_Change
(Intercept)	0.04810	0.40033	0.42980	Increase
exper	0.04417	0.01343	0.01555	Increase
exper2	-0.00090	0.00040	0.00043	Increase
educ	0.06140	0.03144	0.03334	Increase

```
> robust_ci
              2.5 %    97.5 %
educ -0.004132858 0.1269261
> baseline_ci
               2.5 %    97.5 %
educ -0.0003945456 0.1231878
```

d. **Obtain the IV/2SLS estimates with the software option for Bootstrap standard errors, using B = 200 bootstrap replications. Are the bootstrap standard errors larger or smaller than those for the baseline model? How do they compare to the heteroskedasticity robust standard errors in (c)? Compute the 95% interval estimate for the coefficient of $EDUC$ using the bootstrap standard error.**

Ans.

The bootstrap standard errors are ever so slightly smaller than the robust standard errors, but still a bit larger than the usual IV standard errors. The interval estimate is [−0.002, 0.1248].

	Coefficient	Baseline_SE	Robust_SE	Bootstrap_SE	Bootstrap_vs_Baseline	Bootstrap_vs_Robust
(Intercept)	0.04810	0.40033	0.42980	0.43792	Increase	Increase
exper	0.04417	0.01343	0.01555	0.01577	Increase	Increase
exper2	-0.00090	0.00040	0.00043	0.00043	Increase	Increase
educ	0.06140	0.03144	0.03334	0.03235	Increase	Decrease

```
> ci_boot
[1] -0.001999331  0.124792587
```