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专业、班级：

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浙江财经大学 2022～2023 学年第二学期

《计量经济学(双语)》课程期末考试试卷上机部分参考答案

考核方式：　上机考试　　　　　　　考试日期：2023 年 6 月 14 日

适用专业、班级：20 应用统计

题　号	一	二	三	四	五	六	七	总分
得　分								
评卷人								

（共　六　大题）

1: [16 marks] Use the data in **SLEEP75.dta** for this exercise. The equation of interest is

$$sleep = \beta_0 + \beta_1 totwrk + \beta_2 educ + \beta_3 age + \beta_4 age^2 + \beta_5 ynkid + \mu$$

(i) Estimate this equation **separately for men and women** and report the results in the usual form. Are there **notable differences** in the two estimated equations ? **[4marks]**
(ii) Compute the **Chow test** for equality of the parameters in the sleep equation for men and women. Use the form of the test that adds ***male*** and the interaction terms ***maletotwrk*, …, *male yngkid*** and uses the full set of observations. What are the relevant ***df*** for the test? Should you reject the null at the 5% level? **[4marks]**
(iii) Now allow for a **different intercept** for males and females and determine **whether the interaction terms involving *male* are jointly significant. [4marks]**
(iv) Given the results from parts (ii) and (iii), what would be **your final model**? **[4marks]**

Solutions:
(i) The estimated equation for men is

$$\widehat{sleep} = 3{,}648.2 - .182\, totwrk - 13.05\, educ + 7.16\, age - .0448\, age^2 + 60.38\, yngkid$$
$$(310.0)\quad (.024)\quad (7.41)\quad (14.32)\quad (.1684)\quad (59.02)$$
$$n = 400,\quad R^2 = .156$$

and the estimated equation for women is

$$\widehat{sleep} = 4{,}238.7 - .140\, totwrk - 10.21\, educ - 30.36\, age + .368\, age^2 - 118.28\, yngkid$$
$$(384.9)\quad (.028)\quad (9.59)\quad (18.53)\quad (.223)\quad (93.19)$$

$n = 306, \quad R^2 = .098.$

There are certainly **notable differences** in the point estimates. **For example,** having a young child in the household leads to less sleep for women (about two hours a week) while men are estimated to sleep about an hour more. The quadratic in *age* is a **hump-shape** for men but a **U-shape** for women. The intercepts for men and women are also notably different.

(ii) The ***F*** **statistic (with 6 and 694 *df*) is about 2.12 with *p*-value** ≈ **.05**, and so we **reject the null** that the sleep equations are the same at the 5% level.

(iii) If we leave the coefficient on *male* unspecified under H_0, and test only the five interaction terms, $male \cdot totwrk$, $male \cdot educ$, $male \cdot age$, $male \cdot age^2$, and $male \cdot yngkid$, **the *F* statistic (with 5 and 694 *df*) is about 1.26 and *p*-value** ≈ **.28.**

(iv) The outcome of the test in part (iii) shows that, once an intercept difference is allowed, there is not strong evidence of slope differences between men and women. This is one of those cases where the practically important differences in estimates for women and men in part (i) do not translate into statistically significant differences. We need a larger sample size to confidently determine whether there are differences in slopes. For the purposes of studying the sleep-work tradeoff, the original model with *male* added as an explanatory variable seems sufficient.

Output:

```
reg  sleep totwrk  educ age agesq yngkid if  male==1

      Source |       SS       df       MS              Number of obs =     400
-------------+------------------------------           F(  5,   394) =   14.59
       Model |  11806161.6     5  2361232.32           Prob > F      =  0.0000
    Residual |    63763979   394   161837.51           R-squared     =  0.1562
-------------+------------------------------           Adj R-squared =  0.1455
       Total |  75570140.6   399  189398.849           Root MSE      =  402.29

------------------------------------------------------------------------------
       sleep |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      totwrk |  -.1821232   .0244855    -7.44   0.000    -.2302618   -.1339846
        educ |  -13.05238   7.414218    -1.76   0.079    -27.62876    1.523996
         age |   7.156591   14.32037     0.50   0.618    -20.99731    35.31049
       agesq |  -.0447674   .1684053    -0.27   0.791    -.3758528    .2863181
      yngkid |   60.38021   59.02278     1.02   0.307    -55.65877    176.4192
       _cons |   3648.208   310.0393    11.77   0.000      3038.67    4257.747
------------------------------------------------------------------------------

reg  sleep totwrk  educ age agesq yngkid if  male==0

      Source |       SS       df       MS              Number of obs =     306
-------------+------------------------------           F(  5,   300) =    6.50
```

```
       Model |  6201576.18     5  1240315.24           Prob > F      =  0.0000
    Residual |  57288575.9   300   190961.92           R-squared     =  0.0977
-------------+------------------------------           Adj R-squared =  0.0826
       Total |  63490152.1   305  208164.433           Root MSE      =  436.99

------------------------------------------------------------------------------
       sleep |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      totwrk |  -.1399495   .0276594    -5.06   0.000    -.1943806   -.0855184
        educ |  -10.20514   9.588848    -1.06   0.288    -29.07506    8.664787
         age |  -30.35657   18.53091    -1.64   0.102    -66.82361    6.110464
       agesq |   .3679406   .2233398     1.65   0.101    -.0715705    .8074516
      yngkid |  -118.2826   93.18757    -1.27   0.205    -301.6667    65.10154
       _cons |   4238.729   384.8923    11.01   0.000     3481.299     4996.16
------------------------------------------------------------------------------
```

```
reg  sleep totwrk  educ age agesq yngkid  male  mtotwrk meduc mage magesq myngkid
```

```
      Source |       SS       df       MS              Number of obs =     706
-------------+------------------------------           F( 11,   694) =    9.48
       Model |  18187280.8    11  1653389.17           Prob > F      =  0.0000
    Residual |   121052555   694  174427.313           R-squared     =  0.1306
-------------+------------------------------           Adj R-squared =  0.1168
       Total |   139239836   705  197503.313           Root MSE      =  417.64

------------------------------------------------------------------------------
       sleep |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      totwrk |  -.1399495   .0264349    -5.29   0.000    -.1918514   -.0880476
        educ |  -10.20514   9.164321    -1.11   0.266    -28.19826    7.787983
         age |  -30.35657   17.71049    -1.71   0.087    -65.12914    4.415998
       agesq |   .3679406   .2134519     1.72   0.085    -.0511483    .7870294
      yngkid |  -118.2826   89.06187    -1.33   0.185    -293.1456    56.58047
        male |  -590.5211   488.7916    -1.21   0.227    -1550.209    369.1665
     mtotwrk |  -.0421737    .036674    -1.15   0.251     -.114179    .0298317
       meduc |  -2.847243   11.96795    -0.24   0.812    -26.34497    20.65048
        mage |   37.51316   23.12332     1.62   0.105    -7.886888    82.91321
      magesq |  -.4127079   .2759136    -1.50   0.135    -.9544333    .1290175
     myngkid |   178.6628   108.1051     1.65   0.099     -33.5895     390.915
       _cons |   4238.729   367.8519    11.52   0.000     3516.493    4960.965
------------------------------------------------------------------------------
```

```
test male  mtotwrk meduc mage magesq myngkid
```

```
( 1)  male = 0
( 2)  mtotwrk = 0
( 3)  meduc = 0
( 4)  mage = 0
( 5)  magesq = 0
( 6)  myngkid = 0

      F(  6,    694) =    2.12
           Prob > F =    0.0495

test   mtotwrk meduc mage magesq myngkid
( 1)  mtotwrk = 0
( 2)  meduc = 0
( 3)  mage = 0
( 4)  magesq = 0
( 5)  myngkid = 0
      F(  5,    694) =    1.26
           Prob > F =    0.2814
```

2: [18 marks]Use the data in **JTRAIN98.dta** to answer this question. The variable **unem98** is a binary variable indicating whether a worker was unemployed in 1998. It can be used to measure the effectiveness of the job training program in reducing the probability of being unemployed.

(i) What percentage of workers was unemployed in 1998, after the job training program? How does this compare with the unemployment rate in 1996? **[3marks]**

(ii) Run the simple regression **unem98** on **train.** How do you interpret the coefficient on train? Is it statistically significant? **[3marks]**

(iii) Add to the regression in part (ii) the explanatory variables **earn96**, **educ**, **age**, and **married**. Now interpret the estimated training effect. Why does it differ so much from that in part (ii)? **[3marks]**

(iv) Now perform **full regression adjustment** by running a regression with a full set of interactions, where all variables (except the training indicator) are centered around their sample means:

$$unem98_i \text{ on } train_i,\ earn96_i,\ educ_i,\ age_i,\ married,\ train_i\cdot(earn96_i-\overline{earn96}),\\ train_i\cdot(educ_i-\overline{educ}),\ train_i\cdot(age_i-\overline{age}),\ train_i\cdot(married_i-\overline{married}).$$

This regression uses all of the data. What happens to the estimated **average treatment effect** of train compared with part (iii). **[3marks]**

(v) Are the **interaction terms** in part (iv) jointly significant? **[3marks]**

(vi) Verify that you obtain exactly the same average treatment effect if you run two separate regressions. That is, run two separate regressions for the control and treated groups, obtain the fitted values $unem98_i^0$ and $unem98_i^1$ for everyone in the sample, and then compute $\tau_{ura} = \sum_{n=1}^{\infty} \frac{1}{n} [unem98_i^1 - unem98_i^0]$. Check this with the coefficient on train in part (iv). Which approach is more convenient for obtaining a standard error? **[3marks]**

Solutions:

C7.17 jtrain98.dta

(i)

sum unem98

Variable	Obs	Mean	Std. dev.	Min	Max
unem98	1,130	.1716814	.3772703	0	1

sum unem96

Variable	Obs	Mean	Std. dev.	Min	Max
unem96	1,130	.3123894	.4636729	0	1

The average value for $unem98$ is **0.172**. The average value for $unem96$ is **0.312**. Thus, a much lower fraction of workers was unemployed in 1998 as compared to 1995 (the year in which $unem96$ measures). This may be due to job training, but there are many other possible explanations for this (e.g. an improved job market in 1998 compared to 1995).

(ii)

reg unem98 train

Source	SS	df	MS			
				Number of obs	=	1,130
				F(1, 1128)	=	1.16
Model	.165706941	1	.165706941	Prob > F	=	0.2808
Residual	160.528098	1,128	.142312144	R-squared	=	0.0010
				Adj R-squared	=	0.0001
Total	160.693805	1,129	.142332866	Root MSE	=	.37724

unem98	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
train	.0256998	.0238166	1.08	0.281	-.0210301	.0724297
_cons	.16313	.0137384	11.87	0.000	.1361743	.1900856

We estimate $\widehat{unem98} = \underset{(0.014)}{0.163} + \underset{(0.024)}{0.026}train$. This suggests that participation in the training program increases the likelihood of being unemployed in 1998. Of course, it is more likely that we have reverse causality and those who are unemployed are more likely to participate in job training. In any event, the estimate is not significantly different from 0.

(iii)

reg unem98 train educ earn96 married age

Source	SS	df	MS			
				Number of obs	=	1,130
				F(5, 1124)	=	67.99
Model	37.3151546	5	7.46303091	Prob > F	=	0.0000
Residual	123.378651	1,124	.109767483	R-squared	=	0.2322
				Adj R-squared	=	0.2288
Total	160.693805	1,129	.142332866	Root MSE	=	.33131

unem98	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
train	-.1207668	.0241306	-5.00	**0.000**	-.1681129	-.0734207
educ	-.0130486	.0035507	-3.67	0.000	-.0200154	-.0060818
earn96	-.0132699	.0010326	-12.85	0.000	-.015296	-.0112438
married	-.0482881	.0236316	-2.04	0.041	-.0946551	-.001921
age	.0081618	.0010464	7.80	0.000	.0061087	.010215
_cons	.2895805	.0634935	4.56	0.000	.1650013	.4141597

The estimated training effect is now **-0.121** and it is statistically **significant** at the 1% level (standard error = 0.024). This estimate suggests that participating in job training reduces the likelihood of being unemployed, as we would hope. The change in sign and significance is due to the inclusion of $earn96, educ, age$, and $married$. These variables can **help control for non-random differences** between those people who participate in job training and those who do not. **We hope that conditioning upon these variables gets us closer to random assignment for training, allowing for identification of the causal effect of job training on unemployment.**

(iv)

```
sum earn96 educ age married
egen mearn96=mean( earn96 )
egen meduc =mean( educ )
egen mage =mean( age )
egen mmarried =mean( married )
g tmearn96= train* ( earn96 - mearn96 )
g tmage = train* ( age - mage )
g tmeduc = train* ( educ -meduc)
g tmmarried = train*( married- mmarried)
```

reg unem98 train earn96 educ age married tmearn96 tmage tmeduc tmmarried

Source	SS	df	MS		
Model	37.5027695	9	4.16697438	Number of obs =	1,130
Residual	123.191036	1,120	.109991996	F(9, 1120) =	37.88
				Prob > F =	0.0000
				R-squared =	0.2334
				Adj R-squared =	0.2272
Total	160.693805	1,129	.142332866	Root MSE =	.33165

unem98	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
train	-.1225648	.0295758	-4.14	0.000	-.180595	-.0645347
earn96	-.0133338	.0011141	-11.97	0.000	-.0155197	-.0111478
educ	-.0106719	.0043317	-2.46	0.014	-.0191712	-.0021727
age	.0079725	.0012667	6.29	0.000	.0054872	.0104578
married	-.0366406	.030297	-1.21	0.227	-.0960859	.0228047
tmearn96	.000205	.0030099	0.07	0.946	-.0057007	.0061106
tmage	.0007743	.0022675	0.34	0.733	-.0036746	.0052233
tmeduc	-.0073046	.0075912	-0.96	0.336	-.0221991	.0075899
tmmarried	-.0314146	.0490643	-0.64	0.522	-.1276828	.0648536
_cons	.2614036	.0772305	3.38	0.001	.1098709	.4129363

The estimated average treatment effect increases in magnitude to -0.123. This is **a small change** from the estimate in part iii. The standard error estimate is 0.030, which is also **larger** than what was estimated in part iii, but does **not change** the results of any significance tests.

(v) test tmearn96 tmage tmeduc tmmarried

(1) tmearn96 = 0
(2) tmage = 0
(3) tmeduc = 0
(4) tmmarried = 0

F(4, 1120) = **0.43**
Prob > F = 0.7896

The interaction terms are not jointly significant, with $F_{4,1120} = 0.43$ when testing the null hypothesis that the coefficients on the interactions are all equal to 0. We **fail to reject the null**.

(vi)

reg unem98 earn96 educ age married if train==1

Source	SS	df	MS		
Model	8.68604493	4	2.17151123	Number of obs =	376
Residual	48.9070402	371	.131824906	F(4, 371) =	16.47
				Prob > F =	0.0000
				R-squared =	0.1508
				Adj R-squared =	0.1417

```
       Total |  57.5930851       375  .15358156   Root MSE        =    .36308

------------------------------------------------------------------------------
      unem98 | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      earn96 |  -.0131288   .0030611    -4.29   0.000     -.019148   -.0071096
        educ |  -.0179765   .0068247    -2.63   0.009    -.0313964   -.0045567
         age |   .0087469   .0020589     4.25   0.000     .0046984    .0127954
     married |  -.0680552   .0422496    -1.61   0.108    -.1511339    .0150235
       _cons |   .2134445   .1108041     1.93   0.055    -.0044383    .4313273
------------------------------------------------------------------------------
```

predict y1,xb

reg unem98 earn96 educ age married if train==0

```
      Source |       SS           df       MS      Number of obs   =       754
-------------+----------------------------------   F(4, 749)       =     72.22
       Model |  28.6510176         4  7.1627544   Prob > F        =    0.0000
    Residual |  74.2839957       749  .099177564   R-squared       =    0.2783
-------------+----------------------------------   Adj R-squared   =    0.2745
       Total |  102.935013       753  .136699885   Root MSE        =    .31492

------------------------------------------------------------------------------
      unem98 | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      earn96 |  -.0133338   .0010579   -12.60   0.000    -.0154106   -.0112569
        educ |  -.0106719   .0041133    -2.59   0.010    -.0187469    -.002597
         age |   .0079725   .0012028     6.63   0.000     .0056113    .0103338
     married |  -.0366406   .0287691    -1.27   0.203    -.0931183    .0198371
       _cons |   .2614036   .0733356     3.56   0.000     .1174358    .4053714
------------------------------------------------------------------------------
```

predict y0,xb

sum y1 y0

```
    Variable |        Obs        Mean    Std. dev.       Min        Max
-------------+---------------------------------------------------------
          y1 |      1,130    .0884216     .203681  -.3831182    .631846
          y0 |      1,130    .2109865    .1904102  -.2182577   .6599041
```

di .0884216 - .2109865

-.1225649

【or

teffects ra (unem98 earn96 educ age married)(train) ,aequations pomeans

```
Iteration 0:   EE criterion =  1.096e-30
Iteration 1:   EE criterion =  6.039e-34
```

```
Treatment-effects estimation                    Number of obs     =      1,130
Estimator      : regression adjustment
Outcome model  : linear
Treatment model: none
```

unem98	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
POmeans						
train						
0	.2109865	.0161511	13.06	0.000	.1793308	.2426421
1	.0884216	.0203987	4.33	0.000	.0484408	.1284024
OME0						
earn96	-.0133338	.0012265	-10.87	0.000	-.0157377	-.0109298
educ	-.0106719	.0049024	-2.18	0.029	-.0202804	-.0010634
age	.0079725	.0014068	5.67	0.000	.0052153	.0107298
married	-.0366406	.0291886	-1.26	0.209	-.0938493	.0205681
_cons	.2614036	.0898368	2.91	0.004	.0853267	.4374806
OME1						
earn96	-.0131288	.0027166	-4.83	0.000	-.0184532	-.0078043
educ	-.0179765	.0071683	-2.51	0.012	-.032026	-.003927
age	.0087469	.0024011	3.64	0.000	.0040409	.0134529
married	-.0680552	.0415202	-1.64	0.101	-.1494332	.0133228
_cons	.2134445	.1249429	1.71	0.088	-.031439	.4583281

]

Obtain $\widehat{unem98}_1$ by regressing $unem98$ on $earn96, educ, age, married$ for observations for which $train = 1$. Run the same regression for $train = 0$ to obtain $\widehat{unem98}_0$. Calculate $\hat{\tau}_{ura} = n^{-1}\sum(\widehat{unem98}_{1i} - \widehat{unem98}_{0i}) = -0.123$, which is precisely the ATE we estimated in part iv. The regression in part iv is much more convenient in obtaining a standard error.

3: [21 marks]Use the data in **LABSUP.dta** to answer the following questions. These are data on almost 32,000 black or Hispanic women. **Every woman in the sample is married**. It is a subset of the data used in Angrist and Evans (1998). Our interest here is in determining how weekly hours worked, ***hours***, changes with number of children (***kids***). **All women in the sample have at least two children**. The two potential **instrumental variables** for ***kids***, which is suspected as being endogenous, work to generate exogenous variation starting with two children.

(i) Estimate the equation

$$hours = \beta_0 + \beta_1 kids + \beta_2 nonmomi + \beta_3 educ + \beta_4 age + \beta_5 age^2 + \beta_6 black + \beta_7 hispan + u$$

by OLS and obtain the **heteroskedasticity-robust standard errors**. Interpret the coefficient on ***kids***. Discuss its statistical significance. **[3marks]**

(ii) A variable that Angrist and Evans propose as an instrument is ***samesex***, a binary variable equal to one if the first two children are the same biological sex. What do you think is the argument for why it is a relevant instrument for kids? **[3marks]**

(iii) Run the regression $kids_i$ on $samesex_i$, $nonmomi_i$, $educ_i$, age_i ， $age^2{}_i$, $black_i$ $hispan_i$ and see if the story from part (ii) holds up. In particular, interepret the coefficient on ***samesex***. How statistically significant is ***samesex*** ? **[3marks]**

(iv) Using ***samesex*** as an **IV** for ***kids***, obtain the IV estimates of the equation in part (i). How does the ***kids*** coefficient compare with the OLS estimate? Is the IV estimate precise? **[3marks]**

(v) Now add ***multi2nd*** as an instrument. Obtain the F statistic from the first stage regression and determining whether ***samesex*** and ***multi2nd*** are sufficiently strong. **[3marks]**

(vi) Using ***samesex*** and ***multi2nd*** both as instruments for ***kids***, What is the IV estimate coefficient on ***kids*** ? **[3marks]**

(vii) In part (vi), how many **overidentification restrictions** are there? Does the **overidentification test** pass? **[3marks]**

C15.13 (i)

reg hours kids nonmomi educ age agesq black hispan, robust

Linear regression

Number of obs	=	31,857
F(7, 31849)	=	377.87
Prob > F	=	0.0000
R-squared	=	0.0727
Root MSE	=	18.779

hours	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
kids	-2.325836	.1155164	-20.13	0.000	-2.552253	-2.099419
nonmomi	-.0578328	.0053515	-10.81	0.000	-.068322	-.0473436
educ	.5860083	.0374881	15.63	0.000	.5125302	.6594865
age	2.048793	.4483823	4.57	0.000	1.169946	2.927639
agesq	-.0277198	.0076957	-3.60	0.000	-.0428036	-.012636
black	1.058285	1.35088	0.78	0.433	-1.589492	3.706063
hispan	-5.114147	1.35152	-3.78	0.000	-7.763179	-2.465116
_cons	-10.44695	6.588891	-1.59	0.113	-23.36143	2.467528

Estimating this model via OLS yields a coefficient on *kids* of **-2.326** with a heteroskedasticity robust standard error of **0.116**. Thus, the OLS results suggest that each child is predicted to reduce mother's weekly hours worked by about 2.3 hours (**significant** at the 1% level).

(ii) We would expect a **positive correlation** between *kids* and *samesex*. If the first two children born are of the same gender, a mother may desire to have another child if she has a preference for the opposite gender child. For example, a mother may want to have a daughter and if her first two children are boys, she is more likely to have a third child than if one of her first two children was a girl.

(iii)

reg kids samesex nonmomi educ age agesq black hispan

Source	SS	df	MS
Model	3624.08348	7	517.726212
Residual	26795.3197	31,849	.841323736
Total	30419.4031	31,856	.954903414

Number of obs	=	31,857
F(7, 31849)	=	615.37
Prob > F	=	0.0000
R-squared	=	0.1191
Adj R-squared	=	0.1189
Root MSE	=	.91724

kids	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
samesex	.0703744	.0102787	6.85	0.000	.0502276	.0905211
nonmomi	-.0027871	.0002632	-10.59	0.000	-.0033029	-.0022713
educ	-.0853676	.0017244	-49.51	0.000	-.0887474	-.0819877
age	.0589312	.0218769	2.69	0.007	.0160516	.1018108
agesq	1.98e-06	.000376	0.01	0.996	-.0007349	.0007389
black	.0128681	.065929	0.20	0.845	-.1163553	.1420916
hispan	-.0424722	.0660326	-0.64	0.520	-.1718985	.0869542
_cons	2.010258	.3209963	6.26	0.000	1.381093	2.639423

The coefficient on $samesex$ is **0.07,** with a heteroskedasticity robust standard error of 0.01. This is **significantly positive**, supporting the theory in part ii. We predict that a group of 100 mothers with two same gendered first children will have on average 7 more children overall than a group of 100 mothers with different gendered first two children, all else equal.

(iv)

The IV estimate for $kids$ is **-4.879,** which is larger in magnitude than the OLS estimate. However, this estimate is very imprecisely estimated with a standard error of 3.009 and is not significant at even the 10% level.

(v)

reg kids multi2nd samesex nonmomi educ age agesq black hispan

test multi2nd samesex

(1) multi2nd = 0

(2) samesex = 0

F(2, 31848) = 118.82

Prob > F = 0.0000

[reg kids multi2nd samesex nonmomi educ age agesq black hispan,robust

test multi2nd samesex
(1) multi2nd = 0
(2) samesex = 0
F(2, 31848) = 117.38
Prob > F = 0.0000
]

We strongly reject the null hypothesis that both $samesex$ and $multi2nd$ are jointly insignificant ($F_{2,3188} = 117.38$, p-value=0). This suggests that these are **sufficienty strong instruments** for $kids$.

(vi)
ivreg hours (kids= samesex multi2nd) nonmomi educ age agesq black hispan

Instrumental variables 2SLS regression

Source	SS	df	MS			
				Number of obs	=	31,857
				F(7, 31849)	=	298.30
Model	868822.264	7	124117.466	Prob > F	=	0.0000
Residual	11243074.3	31,849	353.011848	R-squared	=	0.0717
				Adj R-squared	=	0.0715
Total	12111896.6	31,856	380.207703	Root MSE	=	18.789

hours	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
kids	-2.986165	1.332728	-2.24	0.025	-5.598363	-.3739662
nonmomi	-.0596653	.0065372	-9.13	0.000	-.0724785	-.0468521
educ	.5296332	.1191374	4.45	0.000	.2961194	.763147
age	2.08815	.4551064	4.59	0.000	1.196124	2.980176
agesq	-.0277261	.0077012	-3.60	0.000	-.0428207	-.0126316
black	1.067778	1.350614	0.79	0.429	-1.579477	3.715032
hispan	-5.140945	1.353675	-3.80	0.000	-7.7942	-2.487691
_cons	-9.103834	7.111779	-1.28	0.201	-23.04319	4.835527

Instrumented: kids
Instruments: nonmomi educ age agesq black hispan samesex multi2nd

Using this method, we estimate a coefficient on $kids$ of **-2.986** .

(vii)

ivreg hours (kids= samesex multi2nd) nonmomi educ age agesq black hispan
Instrumental variables 2SLS regression

Source	SS	df	MS			
				Number of obs	=	31,857
				F(7, 31849)	=	298.30
Model	868822.264	7	124117.466	Prob > F	=	0.0000
Residual	11243074.3	31,849	353.011848	R-squared	=	0.0717
				Adj R-squared	=	0.0715
Total	12111896.6	31,856	380.207703	Root MSE	=	18.789

hours	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
kids	-2.986165	1.332728	-2.24	0.025	-5.598363	-.3739662
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Instrumented: kids
Instruments: nonmomi educ age agesq black hispan samesex multi2nd

overid
Tests of overidentifying restrictions:
Sargan N*R-sq test 0.499 Chi-sq(1) P-value = 0.4798
Basmann test 0.499 Chi-sq(1) P-value = 0.4798

Since we have two instruments and one (potentially) endogenous variable, there is **one overidentification restriction**. To test this overidentification restriction, we take the residuals from the 2SLS regression and regress it on all exogenous variables (including our two instruments $samesex$ and $multi2nd$). Doing so yields an $R^2 = 0$, which suggests that we **fail to reject the null that all of the IV's are exogenous**. Thus, the overidentification test passes.

4: [18marks] Use the data **CPS91.dta** for this exercise. These data are for married women, where we also have information on each husband's income and demographics.

(i) What **fraction** of the women report being **in the labor force**? **[3marks]**
(ii) Using only the data for **working women**--you have no choice--estimate the wage equation

$$\log(wage) = \beta_0 + \beta_1 educ + \beta_2 exper + \beta_3 exper^2 + \beta_4 black + \beta_5 hispanic + u$$

by ordinary least squares（**OLS**）. Do there appear to be significant **wage differences** by **race and ethnicity**? **[3marks]**

(iii) Estimate a **probit model** for ***inlf*** that includes the explanatory variables in the wage equation from part (ii) as well as ***nwifeinc*** and ***kidlt6***. Do these last two variables have coefficients of the **expected sign**? **Are they statistically significant**? **[3marks]**

(iv) Test hypothesis $\beta_2 = \beta_3 = 0$. Report the value of **likelihood ratio (LR) statistic.**

[3marks]

(v) Compute the average partial effect (**APE**) for ***educ*** from t probit model in part (iii). **[3marks]**

(vi) Compute the **inverse Mills ratio** (for each observation) and add it as additional regressor to the wage equation from part (ii). What is its two-sided **p-value**?

[3marks]

Solutions:

C17.11 **(i)** tab inlf

=1 if wife in labor force	Freq.	Percent	Cum.
0	2,348	41.68	41.68
1	3,286	58.32	100.00
Total	5,634	100.00	

The fraction of women in the work force is 3,286/5,634 ≈ **.5832**

(ii) reg lwage educ exper expersq black hispanic

Source	SS	df	MS
Model	185.581829	5	37.1163657
Residual	720.007572	3,280	.219514504
Total	905.589401	3,285	.275674095

Number of obs	=	3,286
F(5, 3280)	=	169.08
Prob > F	=	0.0000
R-squared	=	0.2049
Adj R-squared	=	0.2037
Root MSE	=	.46852

lwage	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
educ	.0991502	.0035898	27.62	0.000	.0921118	.1061887
exper	.0198554	.0032856	6.04	0.000	.0134133	.0262974

expersq	-.0003489	.000077	-4.53	0.000	-.0004999	-.0001979
black	-.0295532	.0343431	-0.86	**0.390**	-.0968892	.0377828
hispanic	.0136158	.0363565	0.37	**0.708**	-.0576679	.0848996
_cons	.648842	.0599659	10.82	0.000	.5312675	.7664164

test black hispanic

(1) black = 0

(2) hispanic = 0

F(2, 3280) = 0.46

Prob > F = 0.6324

The OLS results using the selected sample are

$$\log(wage) = .649 + .099\ educ + .020\ exper - .00035\ exper^2$$
$$(.060)\quad (.004)\quad (.003)\quad (.00008)$$
$$- .030\ black + .014\ hispanic$$
$$(.034)\quad (.036)$$
$$n = 3{,}286,\quad R^2 = .205.$$

While the point estimates imply blacks earn, on average, about 3% less and Hispanics about 1.3% more than the base group (non-black, non-Hispanic), **neither coefficient is statistically significant** – or even very close to statistical significance at the usual levels. The joint *F* test gives a *p*-value of about **.6324.** So, there is **little evidence** for differences by race and ethnicity once education and experience have been controlled for.

(iii)probit **inlf** educ exper expersq black hispanic **nwifeinc kidlt6**,nolog

```
Probit regression                           Number of obs   =      5,634
                                            LR chi2(7)      =     578.98
                                            Prob > chi2     =     0.0000
Log likelihood = -3537.2544                 Pseudo R2       =     0.0756
```

inlf	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
educ	.0964837	.0077854	12.39	0.000	.0812246	.1117428
exper	.0077141	.0072385	1.07	0.287	-.0064732	.0219014
expersq	-.0006143	.0001577	-3.90	0.000	-.0009234	-.0003052
black	.0167548	.0755896	0.22	0.825	-.1313981	.1649077
hispanic	-.1219554	.0704695	-1.73	0.084	-.260073	.0161623
nwifeinc	-.0091239	.0006775	-13.47	0.000	-.0104518	-.007796
kidlt6	-.500167	.0452776	-11.05	0.000	-.5889096	-.4114245
_cons	-.4393231	.1338545	-3.28	0.001	-.7016732	-.176973

The coefficient on *nwifeinc* is –.0091, with $t = -13.47$, and the coefficient on *kidlt6* is –.500, with $t = -11.05$. We **expect** both coefficients to be **negative**. If a woman's spouse earns more, she is less likely to work. Having a young child in the family also reduces the probability that the woman works. Each variable is very statistically **significant**. (Not surprisingly, the joint test also yields a *p*-value of essentially zero.)

(iv) probit inlf educ exper expersq black hispanic nwifeinc kidlt6,nolog

probit inlf educ black hispanic nwifeinc kidlt6,nolog
di 2*(-3537.2544 -(-3589.9891))
105.4694

(v) margins,dydx(*)

```
Average marginal effects                        Number of obs     =      5,634
Model VCE    : OIM

Expression   : Pr(inlf), predict()
dy/dx w.r.t. : educ exper expersq black hispanic nwifeinc kidlt6

------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        educ |   .0346142    .002685    12.89   0.000     .0293518    .0398767
       exper |   .0027675   .0025962     1.07   0.286    -.0023209    .0078559
     expersq |  -.0002204   .0000564    -3.91   0.000    -.0003308   -.0001099
       black |   .0060109   .0271181     0.22   0.825    -.0471396    .0591614
    hispanic |  -.0437523   .0252626    -1.73   0.083     -.093266    .0057613
    nwifeinc |  -.0032733   .0002314   -14.14   0.000    -.0037268   -.0028197
      kidlt6 |  -.1794385   .0157159   -11.42   0.000    -.2102411   -.1486358
------------------------------------------------------------------------------
```

(vi) qui probit inlf educ exper expersq black hispanic nwifeinc kidlt6,nolog

predict xb,xb
gen lambda= normalden(xb)/normal(xb)
reg lwage educ exper expersq black hispanic lambda

```
      Source |       SS           df       MS      Number of obs   =     3,286
-------------+----------------------------------   F(6, 3279)      =    141.52
       Model |  186.268673         6  31.0447788   Prob > F        =    0.0000
    Residual |  719.320728     3,279  .219371982   R-squared       =    0.2057
-------------+----------------------------------   Adj R-squared   =    0.2042
       Total |  905.589401     3,285  .275674095   Root MSE        =    .46837
```

```
------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        educ |   .1032796   .0042807    24.13   0.000     .0948865    .1116726
       exper |   .0204788   .0033034     6.20   0.000     .0140019    .0269557
     expersq |  -.0003781   .0000787    -4.80   0.000    -.0005325   -.0002237
       black |  -.0251464   .0344221    -0.73   0.465    -.0926374    .0423447
    hispanic |   .0056534   .0366222     0.15   0.877    -.0661514    .0774581
      lambda |   .0918995   .0519368     1.77   0.077    -.0099322    .1937313
       _cons |    .538856   .0863552     6.24   0.000     .3695403    .7081716
------------------------------------------------------------------------------
```

The *t* statistic on the inverse Mills ratio is **1.77,** and the *p*-value against the two-sided alternative is **.077**. With 3,286 observations, this is not a very small *p*-value. The test on $\hat{\lambda}$ does not provide strong evidence against the null hypothesis of no selection bias.

5: [11 marks]Use the data in JTRAIN98 to answer the following questions. Here you will use a **Tobit model** because the outcome, ***earn98***, sometimes is zero.

(i) How many observations (men) in the sample have earn98 = 0? Is it a large percentage of the sample? **[3marks]**

(ii)Estimate a Tobit model for ***earn98***, using train, earn96, educ, and married as the explanatory variables. Report the β_{train} and its standard error. Is the sign what you expect? How statistically significant is it? **[4marks]**

(iii) In part (ii), obtain the average partial effect—which is the average treatment effect—of train, and obtain its standard error. **[4marks]**

C17.17 (i)

table earn98

di 194/1130

.17168142

194 out of 1,130 observations have $earn98 = 0$. This represents 17.2% of the sample, a non-trivial proportion.

(ii)

```
tobit earn98 train earn96 educ married,ll(0)
```

```
Refining starting values:
Grid node 0:    log likelihood = -3378.7988
Fitting full model:
Iteration 0:    log likelihood = -3378.7988
```

```
Iteration 1:   log likelihood = -3347.5418
Iteration 2:   log likelihood = -3346.5943
Iteration 3:   log likelihood = -3346.5939
Iteration 4:   log likelihood = -3346.5939

Tobit regression                                Number of obs     =  1,130
                                                   Uncensored =    936
Limits: Lower =      0                           Left-censored =    194
        Upper = +inf                            Right-censored =      0

                                                LR chi2(4)        = 505.23
                                                Prob > chi2       = 0.0000
Log likelihood = -3346.5939                     Pseudo R2         = 0.0702
------------------------------------------------------------------------------
      earn98 | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
       train |   3.754894   .5370196     6.99   0.000     2.701222    4.808565
      earn96 |   .4920415   .0226626    21.71   0.000     .4475759    .5365072
        educ |   .7004805   .0748021     9.36   0.000     .5537133    .8472476
     married |   1.017523   .4903724     2.08   0.038     .0553766    1.979669
       _cons |  -6.499808   1.021731    -6.36   0.000    -8.504519   -4.495098
-------------+----------------------------------------------------------------
 var(e.earn98)|  51.24396   2.449745                      46.65592    56.28318
------------------------------------------------------------------------------
```

Running a Tobit regression yields $\hat{\beta}_{train} = 3.75$ and $SE(\hat{\beta}_{train}) = 0.54$, statistically significant at the 1% level. This positive coefficient suggests that those in job training have higher earnings. This makes sense given that job training is intended to increase productivity and in turn earnings.

(iii)

margins,dydx(*)

```
Average marginal effects                              Number of obs = 1,130
Model VCE: OIM
Expression: Linear prediction, predict()
dy/dx wrt:  train earn96 educ married
------------------------------------------------------------------------------
             |            Delta-method
             |      dy/dx   std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
       train |   3.754894   .5370196     6.99   0.000     2.701222    4.808565
      earn96 |   .4920415   .0226626    21.71   0.000     .4475759    .5365072
        educ |   .7004805   .0748021     9.36   0.000     .5537133    .8472476
     married |   1.017523   .4903724     2.08   0.038     .0553766    1.979669
```

The estimated average marginal effect of train is **3.755** with a standard error of **0.537**.

6: [16 marks]Use the data in **wagepan.dta** for this exercise.

(i) Estimate the model

$$lwage_{it} = \beta_0 + \beta_1 \text{exper}_{it} + \beta_2 \text{expersq}_{it} + \beta_3 educ_{it} + \beta_4 black_{it} + \beta_5 hisp_{it} + v_{it}, v_{it} = a_i + u_{it}$$

by **pooled OLS**, and report the estimates and standard errors in the usual form. **[4marks]**

(ii) Estimate the **random effects model** (thinking that $v_{it} = a_i + u_{it}$), and then carry out the **Lagrange multiplier test** of the hypothesis that the classical model without the unobserved effect applies. **[4marks]**

(iii) Estimate the **fixed effects model** and then test the hypothesis that the constant term(a_i) is the same for all i. **[4marks]**

(iv) Carry out **Hausman's test** for the random versus the fixed effect model. **[4marks]**

Stata output and solutions：

(i) reg lwage exper expersq educ black hisp

```
      Source |       SS       df       MS              Number of obs =    4360
-------------+------------------------------           F(  5,  4354) =  160.42
       Model |  192.362033     5  38.4724067           Prob > F      =  0.0000
    Residual |  1044.16761  4354  .239818008           R-squared     =  0.1556
-------------+------------------------------           Adj R-squared =  0.1546
       Total |  1236.52964  4359  .283672779           Root MSE      =  .48971

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       exper |   .1068858   .0101379    10.54   0.000     .0870104    .1267613
     expersq |  -.0036707   .0007171    -5.12   0.000    -.0050765   -.0022648
        educ |    .102369    .004741    21.59   0.000     .0930742    .1116639
       black |   -.140472   .0235548    -5.96   0.000    -.1866513   -.0942927
        hisp |   .0251073   .0211718     1.19   0.236    -.0164002    .0666147
       _cons |   -.054339   .0653907    -0.83   0.406    -.1825381    .0738601
------------------------------------------------------------------------------
```

(ii)

```
. xtreg  lwage exper expersq educ black hisp,re theta
```

```
Random-effects GLS regression                   Number of obs      =      4360
Group variable: nr                              Number of groups   =       545

R-sq:  within  = 0.1727                         Obs per group: min =         8
       between = 0.1410                                        avg =       8.0
       overall = 0.1553                                        max =         8

                                                Wald chi2(5)       =    883.75
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
theta          = .65631589

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       exper |   .1201973   .0080601    14.91   0.000     .1043998    .1359948
     expersq |  -.0044098   .0005894    -7.48   0.000     -.005565   -.0032546
        educ |   .1029853   .0092493    11.13   0.000     .0848571    .1211135
       black |  -.1416532   .0492947    -2.87   0.004    -.2382691   -.0450372
        hisp |   .0256586   .0443106     0.58   0.563    -.0611885    .1125057
       _cons |  -.1109867   .1145815    -0.97   0.333    -.3355624    .1135889
-------------+----------------------------------------------------------------
     sigma_u |  .34034385
     sigma_e |  .35230378
         rho |  .48273817   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. xttest0

Breusch and Pagan Lagrangian multiplier test for random effects
        lwage[nr,t] = Xb + u[nr] + e[nr,t]
        Estimated results:
                         |       Var     sd = sqrt(Var)
                ---------+-----------------------------
                   lwage |   .2836728       .5326094
                       e |    .124118       .3523038
                       u |   .1158339       .3403438
        Test:   Var(u) = 0
                             chibar2(01) =  3534.68
                          Prob > chibar2 =   0.0000
```

(iii) xtreg lwage exper expersq educ black hisp,fe

```
note: educ omitted because of collinearity
note: black omitted because of collinearity
note: hisp omitted because of collinearity
```

```
Fixed-effects (within) regression               Number of obs      =      4360
Group variable: nr                              Number of groups   =       545
R-sq:  within  = 0.1727                         Obs per group: min =         8
       between = 0.0067                                        avg =       8.0
       overall = 0.0458                                        max =         8

                                                F(2,3813)          =    397.97
corr(u_i, Xb)  = -0.1483                        Prob > F           =    0.0000

------------------------------------------------------------------------------
       lwage |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       exper |    .122257   .0081889    14.93   0.000      .106202    .1383121
     expersq |  -.0045228   .0006025    -7.51   0.000    -.0057042   -.0033415
        educ |          0  (omitted)
       black |          0  (omitted)
        hisp |          0  (omitted)
       _cons |   1.080743   .0262616    41.15   0.000     1.029255    1.132231
-------------+----------------------------------------------------------------
     sigma_u |  .40747307
     sigma_e |  .35230378
         rho |  .57223164   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(544, 3813) =    10.98            Prob > F = 0.0000
```

(iv)

qui xtreg lwage exper expersq educ black hisp,fe
est store fe
qui xtreg lwage exper expersq educ black hisp,re
est store re
hausman fe re

```
                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
       exper |     .122257     .1201973        .0020598        .0014467
     expersq |   -.0045228    -.0044098        -.000113        .0001252
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg
    Test:  Ho:  difference in coefficients not systematic
                 chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
```

```
                   =        5.12
              Prob>chi2 =      0.0771

hausman fe re,sigmamore

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
       exper |     .122257     .1201973        .0020598        .0014623
     expersq |   -.0045228    -.0044098        -.000113        .0001262
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        4.95
                Prob>chi2 =      0.0842
```