Applied Econometrics
Prof. Leo Feler
Quiz 6: Instrumental Variables in Practice

4 points Name: Key

For this quiz, you'll be analyzing the attached Stata output. You have 30 minutes.

Research question: how do changes in local lending lead to changes in local employment?

Experiment: State-owned banks are privatized (by the state government) in Brazil. Cities with state bank branches see their branches converted to private ownership and possibly lose lending.

1. The Stata output shows the OLS estimates of the effects of changes in lending on changes in employment of low and high-skilled workers. What are the OLS estimates? How might these estimates be biased compared to the "true" effect that changes in lending have on employment? Specifically, under what conditions are the OLS estimates overstating or understating the "true" effect of lending on employment?

a) 10% ↑ lending → .79% ↑ low skilled employment

b) 10% ↑ lending → .76% ↑ high skilled employment

Estimates are biased if we have an omitted variable

true model: $Y_i = \alpha + \gamma S_i + \theta A_i + \varepsilon_i$ $\quad E(\varepsilon_i | S_i, A_i) = 0$ unbiased

estimated: $Y_i = \tilde{\alpha} + \tilde{\gamma} S_i + \tilde{\varepsilon}_i$ $\quad E(\tilde{\varepsilon}_i | S_i) \neq 0$ biased

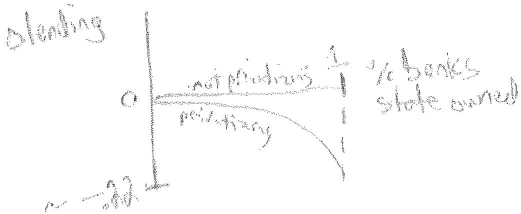
$\rightarrow E(\hat{\tilde{\gamma}}) \neq \gamma$

Direction of bias depends on relationship between A & Y and between S & A:

$$E(\hat{\tilde{\gamma}}) = \gamma + \theta \cdot \frac{Cov(S, A)}{Var(S)}$$

2. As an instrument for changes in lending, we use whether a city is "privatizing", i.e., whether it is in a state that privatizes, and its initial share (prior to privatization) of state-owned bank branches relative to all bank branches. For example, if a city has one state bank branch and one private bank branch, its initial share of state-owned bank branches is 0.50. If it only has one bank branch and this branch is state-owned, its initial share of state-owned bank branches is 1. We also use the PrivatizingX(InitialShareofStateBanks)^2. What is the relationship between these instruments and lending? What is this estimation called? What is the relationship between these instruments and employment? What is this estimation called? At this point, can you calculate by hand what is the causal effect of changes in lending on changes in employment for a city that has 100% of its bank branches initially state-owned?

The relationship between the instruments and lending is that, for cities that are privatizing, there is a more rapid decline in lending the greater the initial share of banks that are state-owned. This is the first stage regression.



The relationship between the instruments and employment is similarly shaped. This is the reduced form.
When 100% of banks are initially state-owned, we can add the coefficients on the instruments and divide the reduced form over the first stage estimate to estimate the causal effect of changes in lending on changes in employment.

low skill:

$$\begin{array}{r} -.18 \\ + \; -.04 \\ \hline -.22 \end{array} \qquad \begin{array}{r} -.15 \\ + \; -.07 \\ \hline -.22 \end{array}$$

$$\frac{-.22}{-.22} = +1.00$$

↑1% lending → ↑1% low skilled employment

high skill:

$$\begin{array}{r} -.15 \\ + \; -.07 \\ \hline -.22 \end{array}$$

$$\begin{array}{r} -.034 \\ + \; -.066 \\ \hline -.10 \end{array}$$

$$\frac{-.10}{-.22} = +.45$$

↑10% lending → ↑4.5% high skilled employment

3. What conditions must instruments satisfy? Do our instruments satisfy these conditions? How do you know if our instruments satisfy these conditions (if/when applicable, what are the null hypotheses that we're testing—do we reject them)?

(don't not satisfy)

Instruments must be strong and valid. Our instruments satisfy both conditions.

significant relationship between instrument and instrumented variable

only affects variable of interest through the instrumented variable

$E[z_i \varepsilon_i] = 0$

Check by looking at F-stat in 1st stage regression for joint significance of IVs

We want $F \geq 10$

$F_{low} = 39.84$ ✓

$F_{high} = 38.75$

Check with Hansen-Sargan test (if more instruments than endogenous variables)

H_0: Instruments not invalid

H_a: Instruments are invalid

$p\text{value}_{low} = .8155$

$p\text{value}_{high} = .7175$

4. Look at the difference between the 2SLS and LIML estimates. What can we conclude? Were we ever concerned that our 2SLS estimates would have been biased toward the OLS estimates? Why or why not?

	2SLS	LIML
high	.422	.423
low	1.00	1.00

A comparison between the 2SLS and LIML estimates confirms our belief in the unbiasedness of the estimators.

We had little reason to be concerned about the 2SLS estimates being biased towards the OLS estimates since the instruments satisfied ~~both conditions in question~~ the strength condition (Fstat > 10)

LIML estimates are less likely to be biased but have higher standard errors.

5. What is Heckman selection? When is a correction for Heckman selection used? Suppose you are estimating the following equation: $\ln w_i = \alpha + \beta s_i + \varepsilon_i$, where w_i, the wage, is only observed for people for whom L=1, i.e., for people in the labor force. We want a measure of the return to schooling, s, for the total population, regardless of whether they are in the labor force. For all individuals, you can observe their characteristics (x's) and whether or not they participate in the labor force, but you only observe wages for those who actually work. Using the Heckman selection correction, how do you estimate β, and how do you test for whether selection into employment exists?

Heckman selection allows us to make results obtained from a non-representative sample more generalizable to the population, i.e., it allows us to correct for selection into the sample.

Heckman selection is used when a sample is not representative of the overall population to which we would like to extend inference. To make results obtained from the selected sample generalizable, we need to correct for selection into the sample.

Based on the example, estimate

① $P(L=1|X) = \Phi(x\delta)$ using, all N observations, via probit

$$L = \delta_1 x_1 + \delta_2 x_2 + \dots + \delta_k x_k$$

obtain predicted values, $\hat{\delta}_1, \dots, \hat{\delta}_k$.

② Calculate inverse Mills Ratio, $\lambda(x\hat{\delta})$, for N_1 which is a subsample (i.e., the selected sample) of N. The Inverse Mills Ratio is $\lambda(x\hat{\delta}) = \frac{\phi(x\hat{\delta})}{\Phi(x\hat{\delta})}$ is the probability density function over the cumulative distribution function.

[END OF QUIZ].

③ With $\hat{\lambda}_i$ for each individual (observation), calculated from ②, estimate $\ln w_i = \alpha + \beta s_i + \gamma \hat{\lambda}_i + \varepsilon_i$.

β is now unbiased since we have controlled for what was previously an omitted variable (sample selection). [Note, however, that β might still be biased b/c of other omitted variables (like unobserved ability) but we are assuming the only reason for bias in this case was non-random sampling].

A simple t-test of $H_0: \gamma = 0$ versus $H_a: \gamma \neq 0$ will let us know whether there's selection into employment and whether this selection also affects wages.

```
--------------------------------------------------------------------------------------
----------------------------------------------------------------
      name:  <unnamed>
       log:  C:\Users\lfeler1\Documents\Banking\Data\Quiz6.log
  log type:  text
 opened on:  20 Apr 2011, 14:35:46

.
. reg dlnlowskill dlnmeandefvalue1600 lnlowskill0, robust

Linear regression                                      Number of obs =    2664
                                                       F(  2,  2661) =  236.46
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.3101
                                                       Root MSE      =  .43117

------------------------------------------------------------------------------
             |               Robust
 dlnlowskill |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
dlnmean~1600 |   .0791818   .0177977     4.45   0.000      .044283    .1140806
 lnlowskill0 |  -.1765377   .0083785   -21.07   0.000    -.1929667   -.1601087
       _cons |    1.55004   .0590426    26.25   0.000     1.434266    1.665815
------------------------------------------------------------------------------

.
. reg dlnhighskill dlnmeandefvalue1600 lnhighskill0, robust

Linear regression                                      Number of obs =    2664
                                                       F(  2,  2661) =  178.79
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.2078
                                                       Root MSE      =  .44065

------------------------------------------------------------------------------
             |               Robust
dlnhighskill |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
dlnmean~1600 |   .0762369   .0173699     4.39   0.000     .0421772    .1102967
lnhighskill0 |  -.1415063    .007543   -18.76   0.000     -.156297   -.1267156
       _cons |   1.758588   .0455028    38.65   0.000     1.669364    1.847813
------------------------------------------------------------------------------

.
.
. reg dlnmeandefvalue1600 lnlowskill0 privXinitshareSB privXinitshareSB2, robust

Linear regression                                      Number of obs =    2664
                                                       F(  3,  2660) =   95.87
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.0869
                                                       Root MSE      =  .50161

------------------------------------------------------------------------------
             |               Robust
dlnmean~1600 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 lnlowskill0 |   .0728979   .0070515    10.34   0.000      .059071    .0867248
privXinits~B |  -.1852632   .1005906    -1.84   0.066    -.3825069    .0119805
privXinits~2 |  -.0409581   .1035499    -0.40   0.692    -.2440045    .1620884
       _cons |  -.1276807   .0460681    -2.77   0.006    -.2180136   -.0373477
------------------------------------------------------------------------------

.
. reg dlnmeandefvalue1600 lnhighskill0 privXinitshareSB privXinitshareSB2, robust
```

```
Linear regression                                      Number of obs =    2664
                                                       F(  3,  2660) =   83.92
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.0780
                                                       Root MSE      =  .50406

------------------------------------------------------------------------------
             |               Robust
dlnmean~1600 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lnhighskill0 |   .0676812   .0076967     8.79   0.000      .052589    .0827733
privXinits~B |  -.1549929   .1013876    -1.53   0.126    -.3537995    .0438136
privXinits~2 |   -.076597   .1051499    -0.73   0.466    -.2827808    .1295869
       _cons |  -.0181677    .042047    -0.43   0.666    -.1006158    .0642804
------------------------------------------------------------------------------

.
.
. reg dlnlowskill lnlowskill0 privXinitshareSB privXinitshareSB2, robust

Linear regression                                      Number of obs =    2664
                                                       F(  3,  2660) =  161.73
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.3215
                                                       Root MSE      =  .42766

------------------------------------------------------------------------------
             |               Robust
 dlnlowskill |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 lnlowskill0 |  -.1801152   .0084626   -21.28   0.000    -.1967091   -.1635213
privXinits~B |  -.1576193   .0781498    -2.02   0.044    -.3108598   -.0043788
privXinits~2 |  -.0718823   .0855897    -0.84   0.401    -.2397113    .0959468
       _cons |   1.647099   .0640072    25.73   0.000      1.52159    1.772608
------------------------------------------------------------------------------

.
. reg dlnhighskill lnhighskill0 privXinitshareSB privXinitshareSB2, robust

Linear regression                                      Number of obs =    2664
                                                       F(  3,  2660) =  121.19
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.2051
                                                       Root MSE      =  .44147

------------------------------------------------------------------------------
             |               Robust
dlnhighskill |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lnhighskill0 |  -.1408115   .0077016   -18.28   0.000    -.1559133   -.1257096
privXinits~B |  -.0341719   .0806024    -0.42   0.672    -.1922217    .1238778
privXinits~2 |  -.0664065   .0877393    -0.76   0.449    -.2384506    .1056377
       _cons |   1.796883   .0505231    35.57   0.000     1.697815    1.895952
------------------------------------------------------------------------------

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.
. ivreg2 dlnlowskill lnlowskill0 (dlnmeandefvalue1600=privXinitshareSB
privXinitshareSB2), ffirst robust

Summary results for first-stage regressions
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```
                                     (Underid)            (Weak id)
Variable     | F(  2,   2660)  P-val | AP Chi-sq(  2) P-val | AP F(  2,   2660)
dlnmeandefva |       39.84    0.0000 |       79.80   0.0000 |       39.84

NB: first-stage test statistics heteroskedasticity-robust

Stock-Yogo weak ID test critical values for single endogenous regressor:
                                   10% maximal IV size             19.93
                                   15% maximal IV size             11.59
                                   20% maximal IV size              8.75
                                   25% maximal IV size              7.25
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Underidentification test
Ho: matrix of reduced form coefficients has rank=K1-1 (underidentified)
Ha: matrix has rank=K1 (identified)
Kleibergen-Paap rk LM statistic          Chi-sq(2)=73.80    P-val=0.0000

Weak identification test
Ho: equation is weakly identified
Cragg-Donald Wald F statistic                                      24.68
Kleibergen-Paap Wald rk F statistic                                39.84

Stock-Yogo weak ID test critical values for K1=1 and L1=2:
                                   10% maximal IV size             19.93
                                   15% maximal IV size             11.59
                                   20% maximal IV size              8.75
                                   25% maximal IV size              7.25
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Weak-instrument-robust inference
Tests of joint significance of endogenous regressors B1 in main equation
Ho: B1=0 and orthogonality conditions are valid
Anderson-Rubin Wald test           F(2,2660)=      25.08     P-val=0.0000
Anderson-Rubin Wald test           Chi-sq(2)=      50.24     P-val=0.0000
Stock-Wright LM S statistic        Chi-sq(2)=      46.05     P-val=0.0000

NB: Underidentification, weak identification and weak-identification-robust
    test statistics heteroskedasticity-robust

Number of observations               N  =        2664
Number of regressors                 K  =           3
Number of endogenous regressors      K1 =           1
Number of instruments                L  =           4
Number of excluded instruments       L1 =           2

IV (2SLS) estimation
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Estimates efficient for homoskedasticity only
Statistics robust to heteroskedasticity

                                                   Number of obs =      2664
                                                   F(  2,   2661) =   143.44
                                                   Prob > F      =    0.0000
Total (centered) SS     =  717.0313335             Centered R2   =   -0.4990
Total (uncentered) SS   =  1110.381167             Uncentered R2 =    0.0320
Residual SS             =  1074.821984             Root MSE      =     .6352

------------------------------------------------------------------------------
             |               Robust
 dlnlowskill |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

```
dlnmean~1600 |   1.001681   .1749025     5.73   0.000     .6588782    1.344483
 lnlowskill0 |  -.2526149   .0191228   -13.21   0.000    -.2900948   -.215135
       _cons |   1.773286   .0891614    19.89   0.000     1.598533    1.948039
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):             73.805
                                                   Chi-sq(2) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):               24.676
                         (Kleibergen-Paap rk Wald F statistic):         39.840
Stock-Yogo weak ID test critical values: 10% maximal IV size             19.93
                                         15% maximal IV size             11.59
                                         20% maximal IV size              8.75
                                         25% maximal IV size              7.25
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):         0.054
                                                   Chi-sq(1) P-val =    0.8155
------------------------------------------------------------------------------
Instrumented:         dlnmeandefvalue1600
Included instruments: lnlowskill0
Excluded instruments: privXinitshareSB privXinitshareSB2
------------------------------------------------------------------------------

.
. ivreg2 dlnhighskill lnhighskill0 (dlnmeandefvalue1600=privXinitshareSB
privXinitshareSB2), ffirst robust


Summary results for first-stage regressions
-------------------------------------------

                                           (Underid)            (Weak id)
Variable     | F(  2,  2660)  P-val | AP Chi-sq(  2) P-val | AP F(  2,  2660)
dlnmeandefva |      38.75    0.0000 |       77.61   0.0000 |       38.75

NB: first-stage test statistics heteroskedasticity-robust

Stock-Yogo weak ID test critical values for single endogenous regressor:
                                    10% maximal IV size             19.93
                                    15% maximal IV size             11.59
                                    20% maximal IV size              8.75
                                    25% maximal IV size              7.25
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Underidentification test
Ho: matrix of reduced form coefficients has rank=K1-1 (underidentified)
Ha: matrix has rank=K1 (identified)
Kleibergen-Paap rk LM statistic          Chi-sq(2)=71.42    P-val=0.0000

Weak identification test
Ho: equation is weakly identified
Cragg-Donald Wald F statistic                                       24.71
Kleibergen-Paap Wald rk F statistic                                 38.75

Stock-Yogo weak ID test critical values for K1=1 and L1=2:
                                    10% maximal IV size             19.93
                                    15% maximal IV size             11.59
                                    20% maximal IV size              8.75
                                    25% maximal IV size              7.25
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Weak-instrument-robust inference
```

```
Tests of joint significance of endogenous regressors B1 in main equation
Ho: B1=0 and orthogonality conditions are valid
Anderson-Rubin Wald test           F(2,2660)=       4.29     P-val=0.0138
Anderson-Rubin Wald test           Chi-sq(2)=       8.59     P-val=0.0136
Stock-Wright LM S statistic        Chi-sq(2)=       8.32     P-val=0.0156

NB: Underidentification, weak identification and weak-identification-robust
    test statistics heteroskedasticity-robust

Number of observations               N  =       2664
Number of regressors                 K  =          3
Number of endogenous regressors      K1 =          1
Number of instruments                L  =          4
Number of excluded instruments       L1 =          2

IV (2SLS) estimation
--------------------

Estimates efficient for homoskedasticity only
Statistics robust to heteroskedasticity

                                                      Number of obs =     2664
                                                      F(  2,  2661) =   149.37
                                                      Prob > F      =   0.0000
Total (centered) SS     =  652.1992465                Centered R2   =   0.0815
Total (uncentered) SS   =  3246.973899                Uncentered R2 =   0.8155
Residual SS             =  599.0156561                Root MSE      =    .4742

------------------------------------------------------------------------------
             |               Robust
dlnhighskill |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
dlnmean~1600 |   .4220745   .1469603     2.87   0.004     .1340376    .7101115
lnhighskill0 |  -.1687982   .0150686   -11.20   0.000    -.1983322   -.1392643
       _cons |   1.803372   .0545017    33.09   0.000     1.696551    1.910194
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):             71.420
                                                   Chi-sq(2) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):               24.713
                         (Kleibergen-Paap rk Wald F statistic):         38.749
Stock-Yogo weak ID test critical values: 10% maximal IV size             19.93
                                         15% maximal IV size             11.59
                                         20% maximal IV size              8.75
                                         25% maximal IV size              7.25
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):        0.131
                                                   Chi-sq(1) P-val =    0.7175
------------------------------------------------------------------------------
Instrumented:         dlnmeandefvalue1600
Included instruments: lnhighskill0
Excluded instruments: privXinitshareSB privXinitshareSB2
------------------------------------------------------------------------------

.
.
. ivreg2 dlnlowskill lnlowskill0 (dlnmeandefvalue1600=privXinitshareSB
privXinitshareSB2), ffirst robust liml


Summary results for first-stage regressions
-------------------------------------------
```

```
                                              (Underid)              (Weak id)
Variable        | F(  2,  2660)  P-val | AP Chi-sq(  2) P-val | AP F(  2,  2660)
dlnmeandefva |        39.84    0.0000 |        79.80   0.0000 |        39.84

NB: first-stage test statistics heteroskedasticity-robust

Stock-Yogo weak ID test critical values for single endogenous regressor:
                                   10% maximal LIML size             8.68
                                   15% maximal LIML size             5.33
                                   20% maximal LIML size             4.42
                                   25% maximal LIML size             3.92
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Underidentification test
Ho: matrix of reduced form coefficients has rank=K1-1 (underidentified)
Ha: matrix has rank=K1 (identified)
Kleibergen-Paap rk LM statistic          Chi-sq(2)=73.80    P-val=0.0000

Weak identification test
Ho: equation is weakly identified
Cragg-Donald Wald F statistic                                       24.68
Kleibergen-Paap Wald rk F statistic                                 39.84

Stock-Yogo weak ID test critical values for K1=1 and L1=2:
                                   10% maximal LIML size             8.68
                                   15% maximal LIML size             5.33
                                   20% maximal LIML size             4.42
                                   25% maximal LIML size             3.92
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Weak-instrument-robust inference
Tests of joint significance of endogenous regressors B1 in main equation
Ho: B1=0 and orthogonality conditions are valid
Anderson-Rubin Wald test           F(2,2660)=      25.08       P-val=0.0000
Anderson-Rubin Wald test           Chi-sq(2)=      50.24       P-val=0.0000
Stock-Wright LM S statistic        Chi-sq(2)=      46.05       P-val=0.0000

NB: Underidentification, weak identification and weak-identification-robust
    test statistics heteroskedasticity-robust

Number of observations               N  =        2664
Number of regressors                 K  =           3
Number of endogenous regressors      K1 =           1
Number of instruments                L  =           4
Number of excluded instruments       L1 =           2

LIML estimation
---------------
k               =1.00002
lambda          =1.00002

Estimates efficient for homoskedasticity only
Statistics robust to heteroskedasticity

                                                      Number of obs =     2664
                                                      F(  2,  2661) =   143.34
                                                      Prob > F      =   0.0000
Total (centered) SS     =  717.0313335                Centered R2   =  -0.5006
Total (uncentered) SS   =  1110.381167                Uncentered R2 =   0.0310
Residual SS             =   1075.96272                Root MSE      =    .6355

------------------------------------------------------------------------------
             |               Robust
```

```
 dlnlowskill |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
dlnmean~1600 |   1.002587   .1751292     5.72   0.000     .6593403    1.345834
 lnlowskill0 |  -.2526897   .0191404   -13.20   0.000    -.2902042   -.2151751
       _cons |   1.773506   .0892126    19.88   0.000     1.598652    1.948359
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):             73.805
                                                   Chi-sq(2) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):               24.676
                         (Kleibergen-Paap rk Wald F statistic):         39.840
Stock-Yogo weak ID test critical values: 10% maximal LIML size            8.68
                                         15% maximal LIML size            5.33
                                         20% maximal LIML size            4.42
                                         25% maximal LIML size            3.92
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):         0.054
                                                   Chi-sq(1) P-val =    0.8156
------------------------------------------------------------------------------
Instrumented:         dlnmeandefvalue1600
Included instruments: lnlowskill0
Excluded instruments: privXinitshareSB privXinitshareSB2
------------------------------------------------------------------------------


.
. ivreg2 dlnhighskill lnhighskill0 (dlnmeandefvalue1600=privXinitshareSB
privXinitshareSB2), ffirst robust liml


Summary results for first-stage regressions
-------------------------------------------

                                          (Underid)            (Weak id)
Variable     | F(  2,  2660)  P-val | AP Chi-sq(  2) P-val | AP F(  2,  2660)
dlnmeandefva |      38.75    0.0000 |       77.61   0.0000 |       38.75

NB: first-stage test statistics heteroskedasticity-robust

Stock-Yogo weak ID test critical values for single endogenous regressor:
                                   10% maximal LIML size             8.68
                                   15% maximal LIML size             5.33
                                   20% maximal LIML size             4.42
                                   25% maximal LIML size             3.92
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.

Underidentification test
Ho: matrix of reduced form coefficients has rank=K1-1 (underidentified)
Ha: matrix has rank=K1 (identified)
Kleibergen-Paap rk LM statistic          Chi-sq(2)=71.42    P-val=0.0000

Weak identification test
Ho: equation is weakly identified
Cragg-Donald Wald F statistic                                      24.71
Kleibergen-Paap Wald rk F statistic                                38.75

Stock-Yogo weak ID test critical values for K1=1 and L1=2:
                                   10% maximal LIML size             8.68
                                   15% maximal LIML size             5.33
                                   20% maximal LIML size             4.42
                                   25% maximal LIML size             3.92
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.
```

```
Weak-instrument-robust inference
Tests of joint significance of endogenous regressors B1 in main equation
Ho: B1=0 and orthogonality conditions are valid
Anderson-Rubin Wald test           F(2,2660)=       4.29      P-val=0.0138
Anderson-Rubin Wald test           Chi-sq(2)=       8.59      P-val=0.0136
Stock-Wright LM S statistic        Chi-sq(2)=       8.32      P-val=0.0156

NB: Underidentification, weak identification and weak-identification-robust
    test statistics heteroskedasticity-robust

Number of observations               N  =       2664
Number of regressors                 K  =          3
Number of endogenous regressors      K1 =          1
Number of instruments                L  =          4
Number of excluded instruments       L1 =          2

LIML estimation
---------------
k               =1.00004
lambda          =1.00004

Estimates efficient for homoskedasticity only
Statistics robust to heteroskedasticity

                                                      Number of obs =     2664
                                                      F(  2,  2661) =   149.29
                                                      Prob > F      =   0.0000
Total (centered) SS     =  652.1992465                Centered R2   =   0.0810
Total (uncentered) SS   =  3246.973899                Uncentered R2 =   0.8154
Residual SS             =  599.3715161                Root MSE      =    .4743

------------------------------------------------------------------------------
             |               Robust
dlnhighskill |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
dlnmean~1600 |   .4228211    .147288     2.87   0.004     .1341419    .7115003
lnhighskill0 |  -.1688572   .0150919   -11.19   0.000    -.1984367   -.1392776
       _cons |   1.803469   .0545314    33.07   0.000     1.696589    1.910348
------------------------------------------------------------------------------
Underidentification test (Kleibergen-Paap rk LM statistic):             71.420
                                                   Chi-sq(2) P-val =    0.0000
------------------------------------------------------------------------------
Weak identification test (Cragg-Donald Wald F statistic):               24.713
                         (Kleibergen-Paap rk Wald F statistic):         38.749
Stock-Yogo weak ID test critical values: 10% maximal LIML size            8.68
                                         15% maximal LIML size            5.33
                                         20% maximal LIML size            4.42
                                         25% maximal LIML size            3.92
Source: Stock-Yogo (2005).  Reproduced by permission.
NB: Critical values are for Cragg-Donald F statistic and i.i.d. errors.
------------------------------------------------------------------------------
Hansen J statistic (overidentification test of all instruments):         0.131
                                                   Chi-sq(1) P-val =    0.7176
------------------------------------------------------------------------------
Instrumented:         dlnmeandefvalue1600
Included instruments: lnhighskill0
Excluded instruments: privXinitshareSB privXinitshareSB2
------------------------------------------------------------------------------

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. log close
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  log type:  text
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closed on: 20 Apr 2011, 14:35:47

