DISCRETIZ: Command to Convert a Continuous Instrument into a Dummy Variable for Instrumental Variable Estimation

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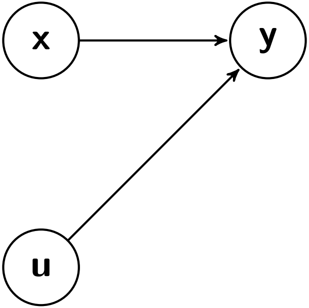
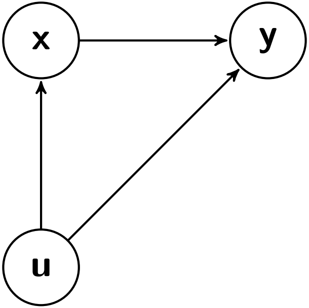
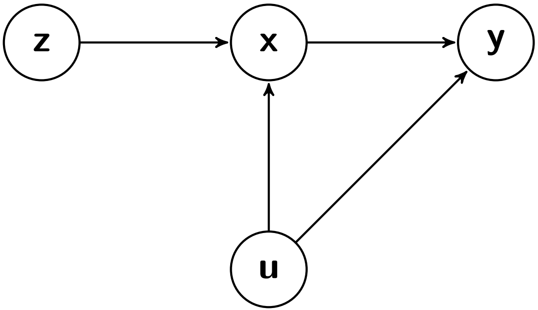
Simple regression model assumes X is uncorrelated with the errors U



If there is an association between X and U: **endogeneity bias**
$\rightarrow$ omitted variable, measurement error or simultaneity



Instrumental Variable (IV): instrument Z excluded from outcome equation (second stage), but determinant of endogenous X (first stage)



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Unfortunately, construction of binary instrument **often appears to be arbitrary**, which may raise concerns about the robustness of the second stage results

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discretiz command

The `discretiz` command offers a **data-driven procedure** to build discrete instruments → boundaries chosen to maximize F-statistic in first stage

Main advantages:

1. Minimizes weak instrument problem that can arise in case of incorrect functional specification in the first stage
2. Transparent procedure that does not depend on arbitrary decisions made by the researcher

First stage estimation

```
discretiz contvarname, endogenous(varname)
    range(min/max) interval(min(step)max)
```

contvarname = continuous instrument to be discretized (integer because loops do not handle well decimals)

`endogenous(`*varname*`)` = endogenous variable

`range(`*min/max*`)` = minimum/maximum values of range

`interval(`*min(step)max*`)` = minimum/maximum width of interval

Second stage estimation

```
discretiz contvarname, endogenous(varname)
     range(min/max) interval(min(step)max)
     second depvar(varname)
```

One needs to specify also `second` and the name of the dependent variable with `depvar(`*varname*`)`

Estimation performed using the command `ivregress` with the two-stage least squares (2sls) estimator

Available options

`exogenous(`*varlist*`)`	exogenous variable(s) used in first and second stage
`interact(`*varname*`)`	interaction with discretized instrument
`xt(`*estimator*`)`	panel-data estimators available with the commands `xtreg` and `xtivreg`
`vce(`*vcetype*`)`	for robust or cluster standard errors
`print`	displays values contained in matrix 'results'
`save`	saves file with variables stored in matrix 'results' + 95% CI
`graph(`*string*`)`	graph coefficient estimates (coef) or F-statistics (ftstat)

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- Understand if violent crime in city centers affects the spread of cities in the US (movement of people from city centers to suburbs)
- Idea for instrument:
  - Lead heavy metal that in case of poisoning generates violent behavior
  - People are exposed to lead through car emissions
  - Most common method of contact: lead mixed with soil dust
  - Lead is less dangerous when mixed with neutral pH soil
- Time variation: After the end of WW2 lead poisoning increase dramatically. Decreased after 1972 because of lead use regulation
- Cross-sectional variation: pH of the soil of different cities

Chemical theory predicts that during the high lead use years cities with neutral soil (around the 6.5-7.5 pH) should have less of an increase in violent crime.

After first stage estimation, the matrix 'results' stores: Instruments' boundaries, F-statistic, parameter estimate of discrete instrument and standard error

```
. discretiz ph10, range(65/80) interval(5(1)10) endogenous(totnpcc_cc_offenses_vc)
>  exogenous(i.year) interact(tetra_corr) xt(fe) graph(fstat) print

results[51,5]
             lb          ub       fstat        beta          se
 r1          68          77   262.16462  -.00527984   .00032609
 r2          68          76   234.77293  -.00515082   .00033617
 r3          69          77   227.45227  -.00527996   .00035009
 r4          68          78   223.39974  -.00461751   .00030893
 r5          68          75   222.05374  -.00523717   .00035145
 r6          67          77   207.42131  -.00451308   .00031336
 r7          69          76   201.19534   -.0051533   .00036331
 r8          70          77   199.14216  -.00526872   .00037336
 r9          71          77   199.14216  -.00526872   .00037336
r10          65          75   191.22497  -.00381797    .0002761
r11          69          75   189.88088  -.00529106   .00038397
r12          69          78   188.03554  -.00449492   .00032779
r13          67          76   182.06497  -.00434235   .00032182
r14          66          76   176.64343  -.00396422   .00029827
r15          72          77   175.57532  -.00550638   .00041556
r16          71          76   173.76344  -.00514243   .00039011
r17          70          76   173.76344  -.00514243   .00039011
r18          68          74   173.53996  -.00487553    .0003701
r19          67          75   168.13245  -.00433725   .00033449
r20          70          75    163.5051  -.00533389   .00041714
```

We can use the new discrete instrument with boundaries 6.8 and 7.7 that has been found to maximize the F-stat in the first stage

```
. gen good_soil = (ph1_plc_wtm_wtm_0_r>=6.8 & ph1_plc_wtm_wtm_0_r<=7.7)
. xtivreg perc_cc i.year (standardized_vc = c.good_soil#c.tetra_corr), fe
Fixed-effects (within) IV regression            Number of obs      =      9,481
Group variable: fipsplace_00                    Number of groups   =        305
R-sq:                                           Obs per group:
     within  =      .                                        min =          8
     between = 0.0855                                        avg =       31.1
     overall = 0.0795                                        max =         32
                                                Wald chi2(32)      =  633103.54
corr(u_i, Xb)  = 0.0259                         Prob > chi2        =     0.0000
------------------------------------------------------------------------------
        perc_cc |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
----------------+-------------------------------------------------------------
standardized_vc |  -.0717297     .00594   -12.08   0.000    -.0833718   -.0600876
                |
           year |
           1961 |   .0017654   .0040017     0.44   0.659    -.0060779    .0096087
           ...
           1991 |   .0768294   .0113749     6.75   0.000     .0545349    .0991238
                |
          _cons |   .4348947   .0031643   137.44   0.000     .4286929    .4410965
----------------+-------------------------------------------------------------
        sigma_u |  .18215015
        sigma_e |  .04846004
            rho |  .93389896   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(304,9144) =   435.91          Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   standardized_vc
```

After second stage estimation, the matrix ‘results’ stores: Instruments’ boundaries, parameter estimate of endogenous variable and standard error

```
. discretiz ph10, range(65/80) interval(5(1)10) endogenous(standardized_vc) second
> depvar(perc_cc) exogenous(i.year) interact(tetra_corr) xt(fe) graph(coef) print

results[51,4]
             lb          ub        beta          se
 r1          70          77  -.04097976   .00580547
 r2          71          77  -.04097976   .00580547
 r3          69          77  -.05647729   .00583521
 r4          68          77  -.07172966   .00593996
 r5          68          78  -.05994759   .00599139
 r6          69          78    -.042527   .00599988
 r7          72          77  -.03381604   .00603609
 r8          71          78  -.02463927   .00619798
 r9          70          78  -.02463927   .00619798
r10          71          76  -.04882763   .00641164
r11          70          76  -.04882763   .00641164
r12          70          75  -.04405828   .00647297
r13          69          76  -.06484251   .00648862
r14          69          75  -.06214748   .00657464
r15          68          76  -.08023395   .00660769
r16          68          75  -.07907977   .00674165
r17          72          78  -.01415127   .00674563
r18          65          75  -.07021066   .00684718
r19          71          80  -.01309482   .00686332
r20          70          80  -.01309482   .00686332
```

Graphics allow users to check the sensitivity of the results to the choice of instruments