JTRAIN

54 firms → 87, 88, 89

$$\log(scrap_{it}) = \alpha_0 + \alpha_1 d88_t + \alpha_2 d89_t + \beta_1 grant_{it} + \beta_2 grant_{-1,it} + a_i + u_{it}$$

($grant_{-1,it}$: lagged grant)

scrap : scrap rate (items discarded per 100)

low ⇒ high productivity

scrap rate

$d88_t$ & $d89_t$: year dummies

grant : binary (=1 if grant received)

No grants before 88; 157 firms; 3 yrs.

```
. count if grant==1 & year==1988
  36

. count if grant==1 & year==1989
  30
```

$grant_{-1}$: lagged grant (0 in 1987)

```
. reg lscrap d88 d89 grant grant_1
```

Source	SS	df	MS	Number of obs	=	162
				F(4, 157)	=	0.69
Model	6.15830732	4	1.53957683	Prob > F	=	0.5989
Residual	349.586781	157	2.2266674	R-squared	=	0.0173
				Adj R-squared	=	-0.0077
Total	355.745089	161	2.20959682	Root MSE	=	1.4922

lscrap	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
d88	-.2393704	.3108639	-0.77	0.442	-.8533854	.3746446
d89	-.4965236	.3379281	-1.47	0.144	-1.163996	.1709483
grant	.2000197	.3382846	0.59	0.555	-.4681564	.8681958
grant_1	.0489357	.4360663	0.11	0.911	-.8123778	.9102492
_cons	.5974341	.203063	2.94	0.004	.1963462	.9985219

```
. reg D.(lscrap d88 d89 grant grant_1)
note: D.d89 omitted because of collinearity.
```

Source	SS	df	MS	Number of obs	=	108
				F(3, 104)	=	1.31
Model	1.31104125	3	.43701375	Prob > F	=	0.2739
Residual	34.5904876	104	.332600842	R-squared	=	0.0365
				Adj R-squared	=	0.0087
Total	35.9015288	107	.335528307	Root MSE	=	.57672

D.lscrap	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
d88						
D1.	.0481041	.0627235	0.77	0.445	-.0762789	.172487
d89						
D1.	0	(omitted)				
grant						
D1.	-.222781	.1307423	-1.70	0.091	-.482048	.0364859
grant_1						
D1.	-.3512459	.2350848	-1.49	0.138	-.817428	.1149362
_cons	-.1387113	.075184	-1.84	0.068	-.2878039	.0103814

```
. xtreg lscrap d88 d89 grant grant_1, fe

Fixed-effects (within) regression               Number of obs      =       162
Group variable: fcode                           Number of groups   =        54

R-squared:                                      Obs per group:
     Within  = 0.2010                                         min =         3
     Between = 0.0079                                         avg =       3.0
     Overall = 0.0068                                         max =         3

                                                F(4, 104)          =      6.54
corr(u_i, Xb) = -0.0714                         Prob > F           =    0.0001
```

lscrap	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
d88	-.0802157	.1094751	-0.73	0.465	-.297309	.1368776
d89	-.2472028	.1332183	-1.86	0.066	-.5113797	.0169741
grant	-.2523149	.150629	-1.68	0.097	-.5510178	.0463881
grant_1	-.4215895	.2102	-2.01	0.047	-.8384239	-.0047551
_cons	.5974341	.0677344	8.82	0.000	.4631142	.7317539
sigma_u	1.438982					
sigma_e	.49774421					
rho	.89313867	(fraction of variance due to u_i)				

```
. reg lscrap d88 d89 grant grant_1 i.fcode
```

Source	SS	df	MS	Number of obs	=	162
				F(57, 104)	=	23.37
Model	329.979162	57	5.7891081	Prob > F	=	0.0000
Residual	25.7659272	104	.2477493	R-squared	=	0.9276
				Adj R-squared	=	0.8879
Total	355.745089	161	2.20959682	Root MSE	=	.49774

lscrap	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
d88	-.0802157	.1094751	-0.73	0.465	-.297309	.1368776
d89	-.2472028	.1332183	-1.86	0.066	-.5113797	.0169741
grant	-.2523149	.150629	-1.68	0.097	-.5510178	.0463881
grant_1	-.4215895	.2102	-2.01	0.047	-.8384239	-.0047551
fcode						
410538	3.905259	.4064064	9.61	0.000	3.09934	4.711178
410563	4.717328	.4064064	11.61	0.000	3.911408	5.523247
410565	4.443668	.4064064	10.93	0.000	3.637748	5.249587
410566	4.621434	.4064064	11.37	0.000	3.815514	5.427353
410567	2.279588	.4064064	5.61	0.000	1.473668	3.085507
410577	3.423147	.4064064	8.42	0.000	2.617228	4.229066
410592	6.12662	.4064064	15.08	0.000	5.3207	6.932539
410593	2.934958	.4064064	7.22	0.000	2.129039	3.740878
410596	4.761838	.4064064	11.72	0.000	3.955919	5.567757

```
. xtreg lscrap d88 d89 grant grant_1, re

Random-effects GLS regression                   Number of obs     =       162
Group variable: fcode                           Number of groups  =        54

R-squared:                                      Obs per group:
     Within  = 0.2005                                         min =         3
     Between = 0.0078                                         avg =       3.0
     Overall = 0.0079                                         max =         3

                                                Wald chi2(4)      =     25.32
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =    0.0000
```

lscrap	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
d88	-.0935437	.108975	-0.86	0.391	-.3071308	.1200434
d89	-.2713576	.1314505	-2.06	0.039	-.5289959	-.0137194
grant	-.2144353	.1475938	-1.45	0.146	-.5037139	.0748433
grant_1	-.3728755	.2050742	-1.82	0.069	-.7748136	.0290626
_cons	.5974341	.2032854	2.94	0.003	.199002	.9958661
sigma_u	1.4082313					
sigma_e	.49774421					
rho	.88894472	(fraction of variance due to u_i)				

Ch: 15 Instrumental Variables

$$y = \beta_0 + \beta_1 x + u$$

$x \not\perp u$: correlated

↳ endog. $\Rightarrow$ OLS is biased

Suppose there is a variable z corr. w/ x
uncorr. w/ u

& only affects y via x

then we may still be able to estimate β_1

wage / grade = educ / charter

$$\text{grade} = \beta_0 + \beta_1 \text{attendance} + u$$

e.g. z = distance from school
charter lottery
compulsory schooling laws