Economics

Lecture #10

Panel Data II

Outline

1. Time effects: two ways in STATA
2. Equivalence of FE+TE effects and "changes + intercept" regressions when $T = 2$
3. Fixed effects regression with multiple regressors
4. Fixed effects regression assumptions
5. Standard errors for panel data regression
6. Application: Drunk driving laws & traffic deaths

Regression with entity and time fixed effects:
entity de-meaning and time dummy variables

```
. gen y83=(year==1983)
. gen y84=(year==1984)
. gen y85=(year==1985)
. gen y86=(year==1986)
. gen y87=(year==1987)
. gen y88=(year==1988)
. global yeardum "y83 y84 y85 y86 y87 y88"
```

```
. xtreg vfrall beertax $yeardum, fe vce(cluster state)

Fixed-effects (within) regression               Number of obs      =       336
Group variable: state                           Number of groups   =        48

R-sq:  within  = 0.0803                         Obs per group: min =         7
       between = 0.1101                                        avg =       7.0
       overall = 0.0876                                        max =         7

                                                F(7,47)            =      4.36
corr(u_i, Xb)  = -0.6781                        Prob > F           =    0.0009

                                    (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
      vfrall |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |   -.6399799   .3570783    -1.79   0.080    -1.358329    .0783691
         y83 |   -.0799029   .0350861    -2.28   0.027    -.1504869   -.0093188
         y84 |   -.0724206   .0438809    -1.65   0.106    -.1606975    .0158564
         y85 |   -.1239763   .0460559    -2.69   0.010    -.2166288   -.0313238
         y86 |   -.0378645   .0570604    -0.66   0.510    -.1526552    .0769262
         y87 |   -.0509021   .0636084    -0.80   0.428    -.1788656    .0770615
         y88 |   -.0518038   .0644023    -0.80   0.425    -.1813645    .0777568
       _cons |     2.42847   .2016885    12.04   0.000     2.022725    2.834215
-------------+----------------------------------------------------------------
     sigma_u |  .70945965
     sigma_e |  .18788295
         rho |  .93446372   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
.  test $yeardum

 ( 1)  y83 = 0
 ( 2)  y84 = 0
 ( 3)  y85 = 0
 ( 4)  y86 = 0
 ( 5)  y87 = 0
 ( 6)  y88 = 0

       F(  6,    47) =    4.22
            Prob > F =    0.0018
```

Alternatives Fixed+Time Effect commands in STATA

```
. xtreg vfrall beertax i.year, fe vce(cluster state)

Fixed-effects (within) regression               Number of obs      =       336
Group variable: state                           Number of groups   =        48

R-sq:  within  = 0.0803                         Obs per group: min =         7
       between = 0.1101                                        avg =       7.0
       overall = 0.0876                                        max =         7

                                                F(7,47)            =      4.36
corr(u_i, Xb)  = -0.6781                        Prob > F           =    0.0009

                                        (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
      vfrall |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |   -.6399799   .3570783    -1.79   0.080    -1.358329    .0783691
             |
        year |
        1983 |  -.0799029   .0350861    -2.28   0.027    -.1504869   -.0093188
        1984 |  -.0724206   .0438809    -1.65   0.106    -.1606975    .0158564
        1985 |  -.1239763   .0460559    -2.69   0.010    -.2166288   -.0313238
        1986 |  -.0378645   .0570604    -0.66   0.510    -.1526552    .0769262
        1987 |  -.0509021   .0636084    -0.80   0.428    -.1788656    .0770615
        1988 |  -.0518038   .0644023    -0.80   0.425    -.1813645    .0777568
             |
```

```
       _cons |    2.42847   .2016885    12.04   0.000     2.022725    2.834215
-------------+----------------------------------------------------------------
     sigma_u |  .70945965
     sigma_e |  .18788295
         rho |  .93446372   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. reg vfrall beertax i.state i.year, vce(cluster state)

Linear regression                               Number of obs =     336
                                                F(  6,    47) =       .
                                                Prob > F      =       .
                                                R-squared     =  0.9089
                                                Root MSE      =  .18788

                                   (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
      vfrall |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |   -.6399799   .3857867    -1.66   0.104    -1.416083    .1361229
             |
       state |
          AZ |   -.5468622   .5064424    -1.08   0.286    -1.565693    .4719685
          AR |   -.6385298   .3986016    -1.60   0.116    -1.440413    .1633531
          CA |   -1.485192   .5892726    -2.52   0.015    -2.670655   -.2997283
          CO |   -1.461534   .5521075    -2.65   0.011    -2.572231   -.3508375
          CT |   -1.840129   .5371107    -3.43   0.001    -2.920656   -.7596018
          DE |   -1.284261   .5665606    -2.27   0.028    -2.424033   -.1444878
          FL |   -.2600533   .1960489    -1.33   0.191    -.6544529    .1343463
          GA |    .5116222   .3150776     1.62   0.111    -.1222321    1.145477
          ID |    -.648956   .4870686    -1.33   0.189    -1.628812    .3308996
          IL |   -1.938502   .5611923    -3.45   0.001    -3.067476    -.809529
          IN |   -1.440141   .5194629    -2.77   0.008    -2.485165   -.3951159
          IA |   -1.524283   .4769438    -3.20   0.002     -2.48377   -.5647957
          KS |   -1.204308    .458947    -2.62   0.012     -2.12759   -.2810258
          KY |   -1.194788   .5516945    -2.17   0.035    -2.304654   -.0849217
```

LA	-.8336592	.3266394	-2.55	0.014	-1.490773	-.1765455
ME	-1.094245	.3325993	-3.29	0.002	-1.763348	-.4251412
MD	-1.684068	.5430227	-3.10	0.003	-2.776489	-.5916472
MA	-2.088021	.5273308	-3.96	0.000	-3.148874	-1.027168
MI	-1.466498	.4376151	-3.35	0.002	-2.346866	-.5861298
MN	-1.876493	.5029294	-3.73	0.001	-2.888257	-.8647297
MS	-.0199125	.2225161	-0.09	0.929	-.4675571	.4277322
MO	-1.275395	.5064931	-2.52	0.015	-2.294328	-.2564622
MT	-.3397744	.5004346	-0.68	0.500	-1.346519	.6669701
NE	-1.502913	.4675998	-3.21	0.002	-2.443603	-.5622241
NV	-.5781556	.549033	-1.05	0.298	-1.682668	.5263564
NH	-1.238929	.376833	-3.29	0.002	-1.99702	-.4808393
NJ	-2.081217	.5954667	-3.50	0.001	-3.279142	-.8832926
NM	.4461054	.4789118	0.93	0.356	-.5173408	1.409552
NY	-2.162882	.5773941	-3.75	0.000	-3.324449	-1.001315
NC	-.285072	.1309033	-2.18	0.034	-.5484155	-.0217286
ND	-1.603756	.4777773	-3.36	0.002	-2.56492	-.6425916
OH	-1.654736	.4777773	-3.46	0.001	-2.6159	-.6935716
OK	-.5336141	.2778457	-1.92	0.061	-1.092568	.0253393
OR	-1.145402	.5485107	-2.09	0.042	-2.248863	-.0419408
PA	-1.745741	.5273308	-3.31	0.002	-2.806594	-.6848883
RI	-2.24173	.5661476	-3.96	0.000	-3.380672	-1.102788
SC	.553584	.0871318	6.35	0.000	.3782974	.7288706
SD	-.9882024	.3766754	-2.62	0.012	-1.745976	-.2304292
TN	-.8546704	.5094407	-1.68	0.100	-1.879533	.1701921
TX	-.8985543	.4592195	-1.96	0.056	-1.822385	.0252761
UT	-1.149722	.3453685	-3.33	0.002	-1.844514	-.4549299
VT	-.9503795	.380219	-2.50	0.016	-1.715281	-.1854775
VA	-1.275195	.3638045	-3.51	0.001	-2.007075	-.5433149
WA	-1.63713	.5435629	-3.01	0.004	-2.730637	-.5436223

```
          WV  |  -.8777371   .4615928    -1.90   0.063    -1.806342    .0508678
          WI  |  -1.735925   .5665606    -3.06   0.004    -2.875698    -.596152
          WY  |  -.2034611   .6078551    -0.33   0.739    -1.426308    1.019386
              |
        year  |
        1983  |  -.0799029   .0379069    -2.11   0.040    -.1561617    -.003644
        1984  |  -.0724206   .0474088    -1.53   0.133    -.1677948    .0229537
        1985  |  -.1239763   .0497587    -2.49   0.016    -.2240779   -.0238747
        1986  |  -.0378645   .0616479    -0.61   0.542    -.1618841    .0861552
        1987  |  -.0509021   .0687224    -0.74   0.463    -.1891536    .0873495
        1988  |  -.0518038   .0695801    -0.74   0.460    -.1917809    .0881732
              |
        _cons |   3.511375   .6437471     5.45   0.000     2.216322    4.806427
------------------------------------------------------------------------------
```

Equivalence of first differences+intercept and fixed effects regressions with time effects, $T = 2$

```
. reg dvfrall dbtax if (year==1988), r

Linear regression                               Number of obs =      48
                                                F(  1,    46) =    8.60
                                                Prob > F      =  0.0052
                                                R-squared     =  0.1192
                                                Root MSE      =  .39402

------------------------------------------------------------------------------
             |               Robust
     dvfrall |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       dbtax |  -1.040973   .3550062    -2.93   0.005    -1.755563   -.3263822
       _cons |  -.0720371   .0653552    -1.10   0.276    -.2035903    .0595161
------------------------------------------------------------------------------
```

```
. xtreg vfrall beertax y88 if (year==1982) | (year==1988), fe vce(cluster state)

Fixed-effects (within) regression               Number of obs      =        96
Group variable: state                           Number of groups   =        48

R-sq:  within  = 0.1212                         Obs per group: min =         2
       between = 0.0622                                        avg =       2.0
       overall = 0.0458                                        max =         2

                                                F(2,47)            =      4.57
corr(u_i, Xb)  = -0.7506                        Prob > F           =    0.0154

                                  (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
      vfrall |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |  -1.040973   .3549656    -2.93   0.005    -1.755071    -.326874
         y88 |  -.0720371   .0653477    -1.10   0.276    -.2034998    .0594256
       _cons |   2.641106   .1999991    13.21   0.000      2.23876    3.043452
-------------+----------------------------------------------------------------
     sigma_u |  .83504808
     sigma_e |  .27861757
         rho |  .89982651   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
. reg vfrall beertax i.state y88 if (year==1982)|(year==1988), r

Linear regression                               Number of obs =      96
                                                F( 49,    46) =  752.93
                                                Prob > F      =  0.0000
                                                R-squared     =  0.8941
                                                Root MSE      =  .27862

------------------------------------------------------------------------------
             |               Robust
      vfrall |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |   -1.040973   .3550062    -2.93   0.005    -1.755563   -.3263822
             |
       state |
          AZ |    -.999306   .5292627    -1.89   0.065    -2.064657    .0660446
          AR |    -.816812   .3922522    -2.08   0.043    -1.606375   -.0272492
          CA |   -1.910062   .5467185    -3.49   0.001    -3.010549   -.8095746
          CO |   -1.851832   .6082379    -3.04   0.004    -3.076151   -.6275125
          CT |    -2.09201   .5060714    -4.13   0.000    -3.110679   -1.073341
          DE |   -1.502359   .5689203    -2.64   0.011    -2.647536   -.3571818
          FL |   -.2801667   .2616107    -1.07   0.290    -.8067617    .2464284
          GA |    1.055078   .3905723     2.70   0.010     .2688964    1.841259
          ID |   -.9251982   .4593718    -2.01   0.050    -1.849866   -.0005309
          IL |   -2.206502   .5284646    -4.18   0.000    -3.270246   -1.142758
          IN |   -1.736005   .5003627    -3.47   0.001    -2.743183   -.7288273
          IA |   -1.637491   .5061966    -3.23   0.002    -2.656412   -.6185699
          KS |   -1.436746   .4423875    -3.25   0.002    -2.327226   -.5462667
          KY |   -1.453905    .513232    -2.83   0.007    -2.486987   -.4208226
          LA |   -.7854201   .4164084    -1.89   0.066    -1.623607    .0527666
```

ME	-1.291373	.479413	-2.69	0.010	-2.256381	-.3263649
MD	-2.072342	.5172675	-4.01	0.000	-3.113547	-1.031136
MA	-2.435649	.4944883	-4.93	0.000	-3.431002	-1.440295
MI	-1.695283	.4413468	-3.84	0.000	-2.583668	-.8068983
MN	-2.145405	.4698722	-4.57	0.000	-3.091208	-1.199601
MS	-.0165727	.2948142	-0.06	0.955	-.610003	.5768576
MO	-1.594734	.5063903	-3.15	0.003	-2.614044	-.5754229
MT	-.7379951	.5728126	-1.29	0.204	-1.891007	.4150168
NE	-1.803592	.445413	-4.05	0.000	-2.700162	-.9070226
NV	-.7572803	.5512327	-1.37	0.176	-1.866854	.3522935
NH	-1.626733	.3958194	-4.11	0.000	-2.423477	-.8299902
NJ	-2.415083	.5500579	-4.39	0.000	-3.522292	-1.307873
NM	.1595316	.6123082	0.26	0.796	-1.072981	1.392044
NY	-2.525504	.5398838	-4.68	0.000	-3.612233	-1.438774
NC	-.2523812	.2197526	-1.15	0.257	-.6947202	.1899577
ND	-1.609102	.5619322	-2.86	0.006	-2.740213	-.4779913
OH	-1.932057	.4545165	-4.25	0.000	-2.846951	-1.017163
OK	-.3794428	.6982273	-0.54	0.589	-1.784901	1.026016
OR	-1.488354	.5778696	-2.58	0.013	-2.651545	-.3251627
PA	-2.054399	.4941528	-4.16	0.000	-3.049077	-1.059721
RI	-2.550302	.5342498	-4.77	0.000	-3.625691	-1.474913
SC	.6664137	.3042036	2.19	0.034	.0540836	1.278744
SD	-1.113963	.3740036	-2.98	0.005	-1.866793	-.3611329
TN	-1.152023	.5055583	-2.28	0.027	-2.169659	-.1343868
TX	-1.072632	.555576	-1.93	0.060	-2.190948	.0456846
UT	-1.482735	.4377228	-3.39	0.001	-2.363825	-.6016447
VT	-1.037982	.3841369	-2.70	0.010	-1.811209	-.2647542
VA	-1.487425	.3626671	-4.10	0.000	-2.217436	-.757414
WA	-1.960903	.5071512	-3.87	0.000	-2.981746	-.9400609
WV	-1.072535	.4424411	-2.42	0.019	-1.963123	-.1819476

```
          WI  |  -2.088834   .5266935    -3.97   0.000    -3.149013   -1.028655
          WY  |  -.2548043   .6500726    -0.39   0.697    -1.563333    1.053724
              |
          y88 |  -.0720371   .0653552    -1.10   0.276    -.2035903    .0595161
        _cons |    3.92986   .5951485     6.60   0.000     2.731888    5.127832
------------------------------------------------------------------------------
```

Fixed Effects Regression with multiple regressors

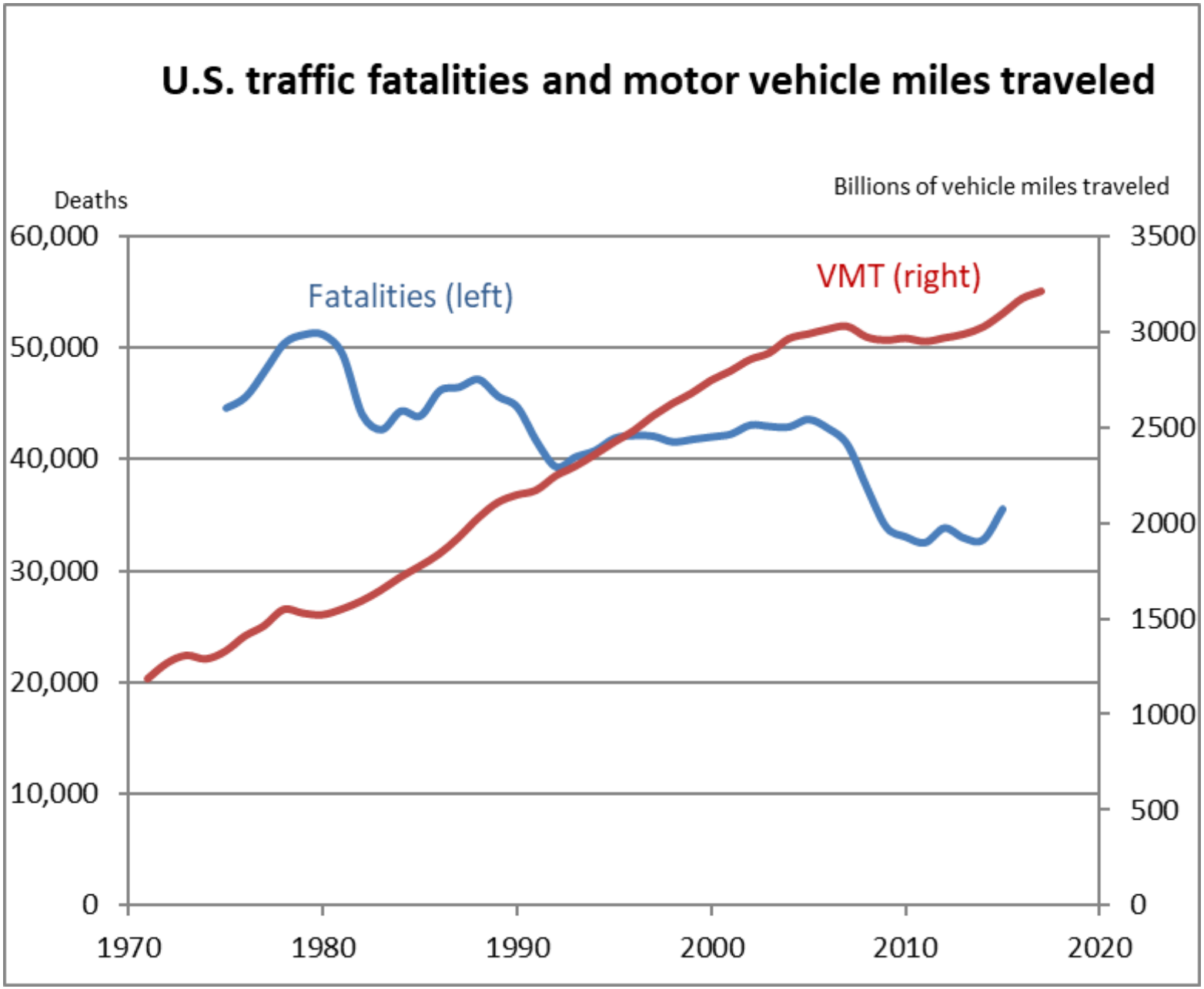
```
. xtreg vfrall beertax vmilespd unrate lincperc $yeardum, ///
>    fe vce(cluster state)

Fixed-effects (within) regression               Number of obs      =       336
Group variable: state                           Number of groups   =        48

R-sq:  within  = 0.3852                         Obs per group: min =         7
       between = 0.3296                                        avg =       7.0
       overall = 0.2343                                        max =         7

                                                F(10,47)           =     10.51
corr(u_i, Xb)  = -0.8434                        Prob > F           =    0.0000

                                 (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
      vfrall |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |  -.4448395   .3111611    -1.43   0.159    -1.070815     .181136
    vmilespd |   .0091341   .0071205     1.28   0.206    -.0051906    .0234587
      unrate |  -.0625262   .0130959    -4.77   0.000    -.0888718   -.0361806
    lincperc |   1.801303   .6407993     2.81   0.007     .5121812    3.090425
         y83 |  -.0955224   .0321761    -2.97   0.005    -.1602523   -.0307924
         y84 |  -.2832174   .0461776    -6.13   0.000    -.3761147   -.1903201
         y85 |  -.3734599   .0502845    -7.43   0.000    -.4746193   -.2723004
         y86 |  -.3394211   .0638323    -5.32   0.000    -.4678352    -.211007
         y87 |  -.4392719   .0769563    -5.71   0.000    -.5940879   -.2844558
```

```
         y88 |  -.5282471   .0885801    -5.96   0.000    -.7064474   -.3500469
       _cons |  -1.765275   1.751664    -1.01   0.319    -5.289168    1.758619
-------------+----------------------------------------------------------------
     sigma_u |  .89903666
     sigma_e |  .15443207
         rho |  .97133902   (fraction of variance due to u_i)
------------------------------------------------------------------------------

.  dis "Adjusted Rsquared = " e(r2_a)
Adjusted Rsquared = .36632108

.  test $yeardum

 ( 1)  y83 = 0
 ( 2)  y84 = 0
 ( 3)  y85 = 0
 ( 4)  y86 = 0
 ( 5)  y87 = 0
 ( 6)  y88 = 0

       F(  6,    47) =   10.81
            Prob > F =    0.0000

.  test unrate lincperc

 ( 1)  unrate = 0
 ( 2)  lincperc = 0

       F(  2,    47) =   30.95
            Prob > F =    0.0000
```

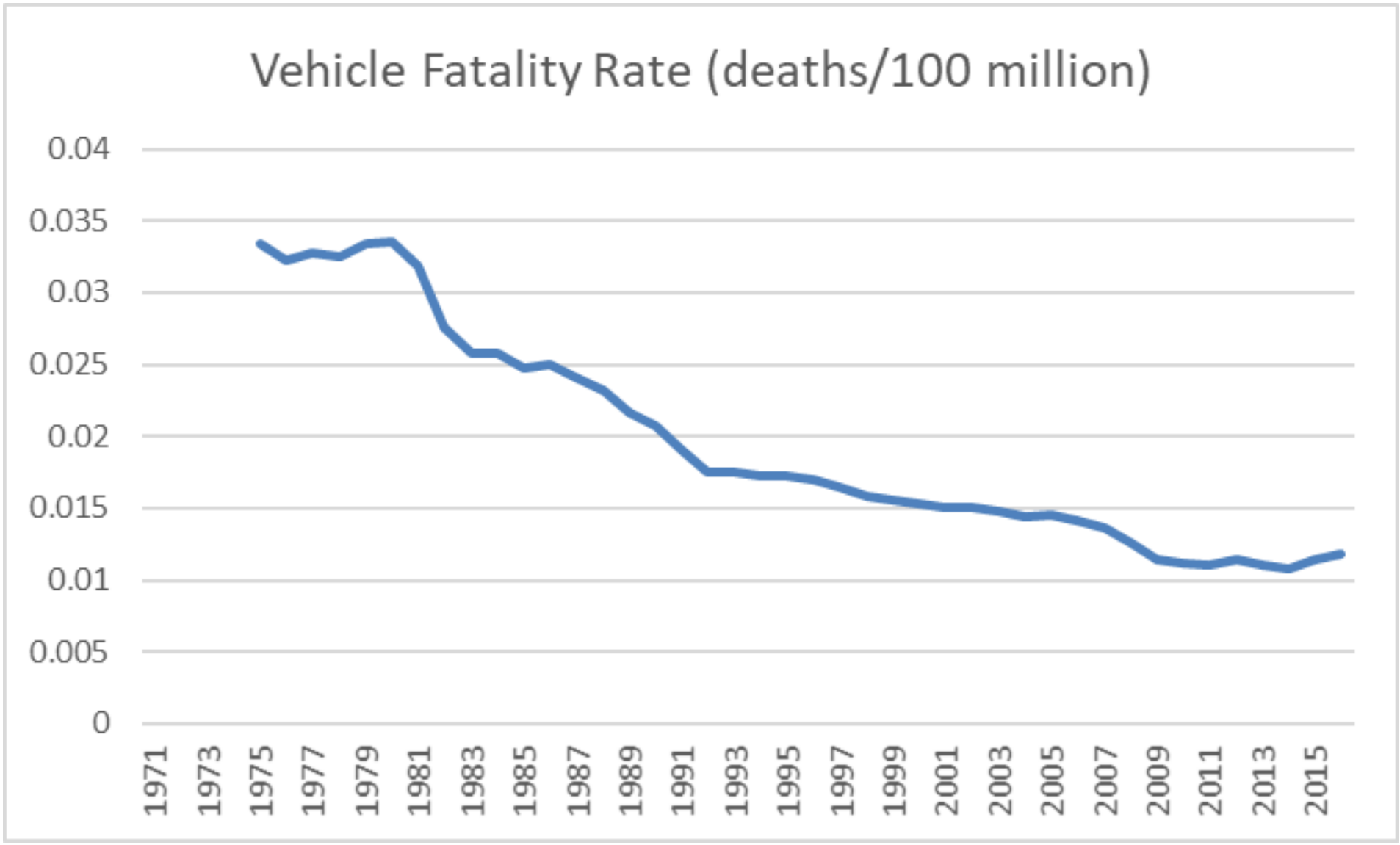
Standard Errors for Entity Fixed Effects Regression

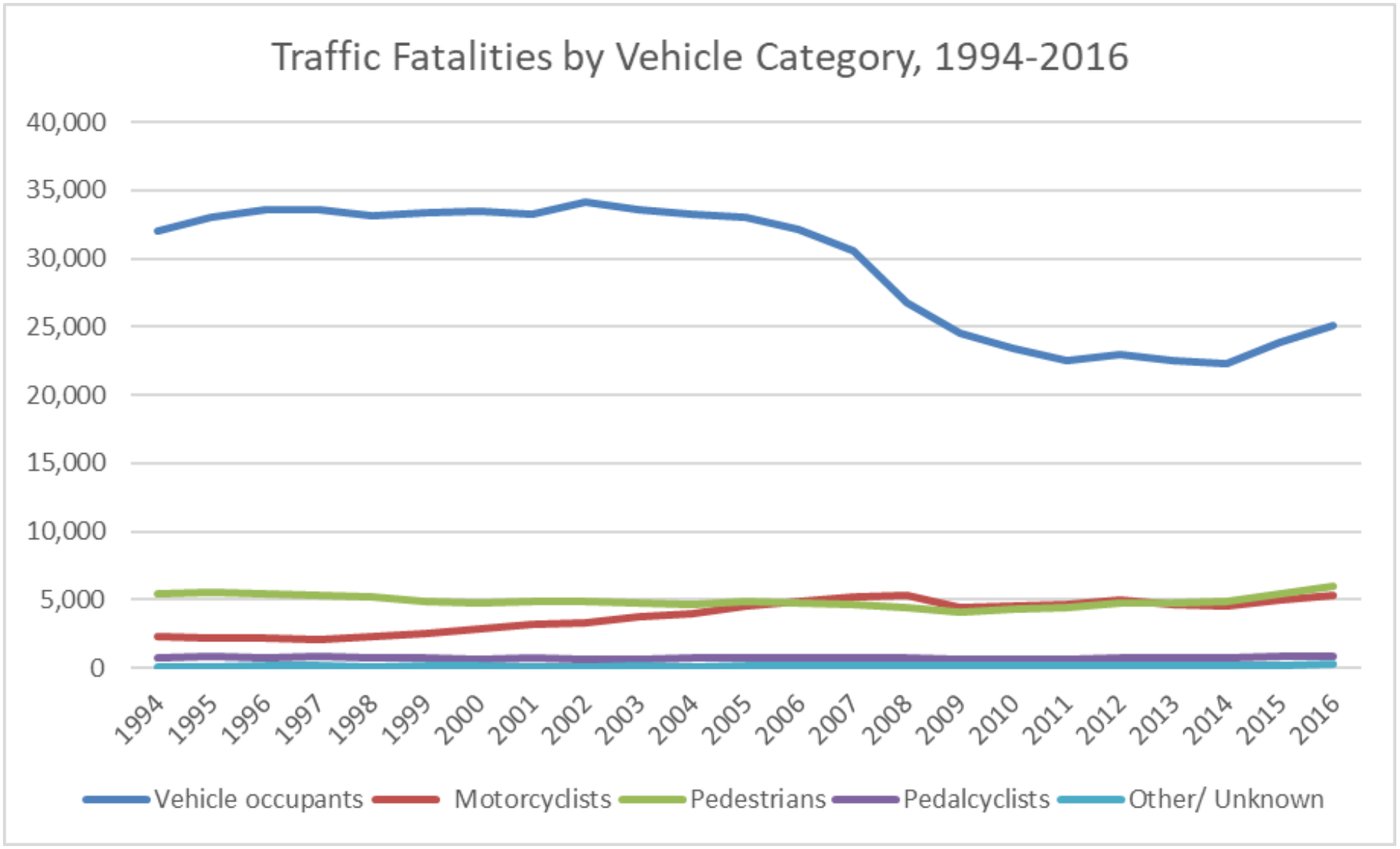
```
. xtreg vfrall beertax $yeardum, fe vce(cluster state);

Fixed-effects (within) regression               Number of obs      =       336
Group variable: state                           Number of groups   =        48
R-sq:  within  = 0.0803                         Obs per group: min =         7
       between = 0.1101                                        avg =       7.0
       overall = 0.0876                                        max =         7
                                                F(7,47)            =      4.36
corr(u_i, Xb)  = -0.6781                        Prob > F           =    0.0009

                                    (Std. Err. adjusted for 48 clusters in state)
------------------------------------------------------------------------------
             |               Robust
      vfrall |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     beertax |  -.6399799   .3570783    -1.79   0.080    -1.358329    .0783691
         y83 |  -.0799029   .0350861    -2.28   0.027    -.1504869   -.0093188
         y84 |  -.0724206   .0438809    -1.65   0.106    -.1606975    .0158564
         y85 |  -.1239763   .0460559    -2.69   0.010    -.2166288   -.0313238
         y86 |  -.0378645   .0570604    -0.66   0.510    -.1526552    .0769262
         y87 |  -.0509021   .0636084    -0.80   0.428    -.1788656    .0770615
         y88 |  -.0518038   .0644023    -0.80   0.425    -.1813645    .0777568
       _cons |    2.42847   .2016885    12.04   0.000     2.022725    2.834215
-------------+----------------------------------------------------------------
     sigma_u |  .70945965
     sigma_e |  .18788295
         rho |  .93446372   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Application: Drunk Driving Laws and Traffic Deaths



Source: U.S. Department of Transporation

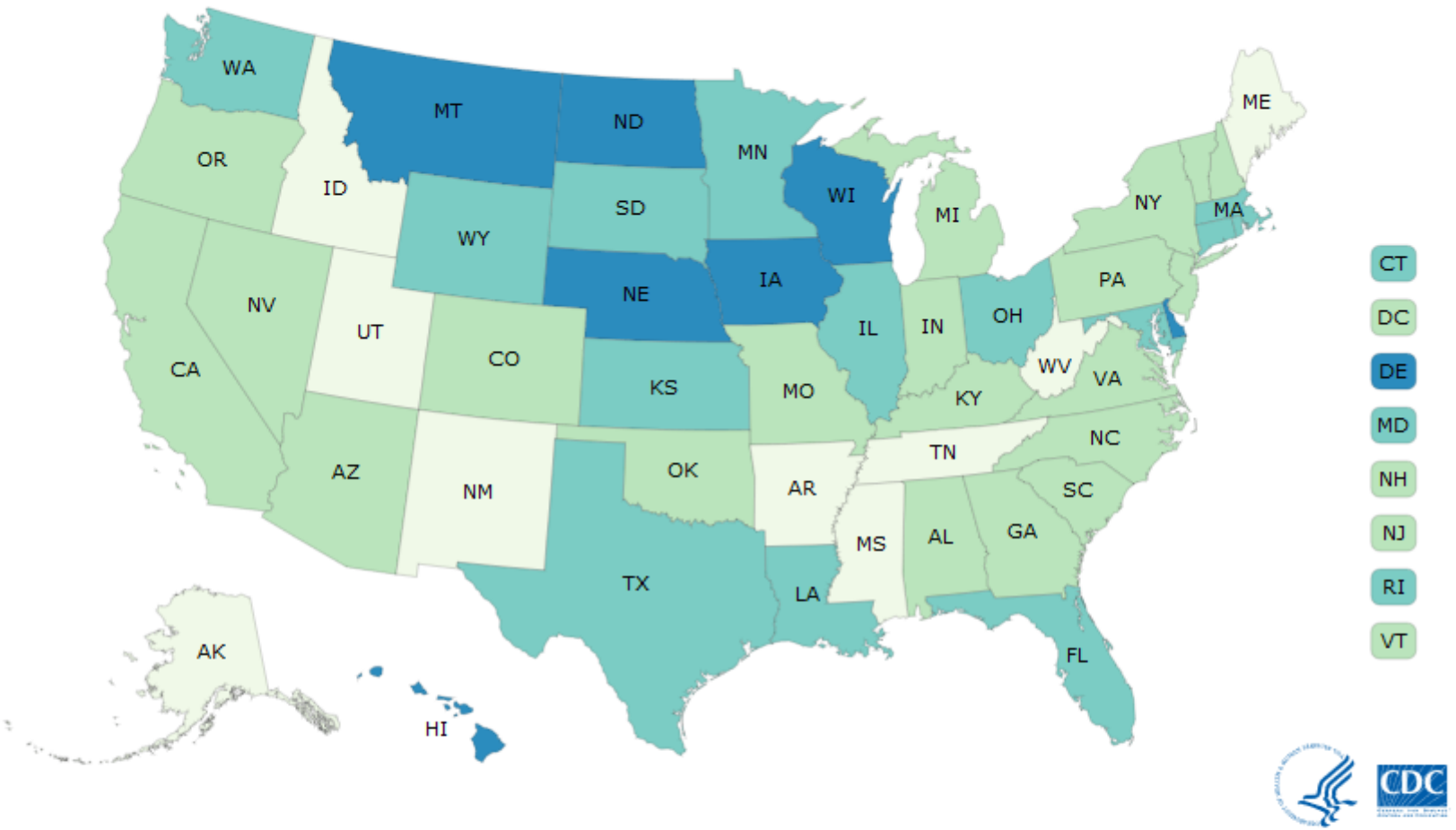

Vehicle Fatality Rate (deaths/100 million)
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015


Traffic Fatalities by Vehicle Category, 1994-2016
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Vehicle occupants
Motorcyclists
Pedestrians
Pedalcyclists
Other/ Unknown

Traffic fatalities: some facts

- Approx. 37,000 traffic fatalities annually in the U.S.
- In 2016, 28% of traffic fatalities involve a drinking driver (CDC)
- 25% of drivers on the road between 1am and 3am have been drinking (estimate)
- A drunk driver is 13 times as likely to cause a fatal crash as a non-drinking driver (estimate)

Percentage of Adults Who Report Driving After Drinking Too Much (in the past 30 days), 2012



About This Map

Percentage of Adults Who Report Driving After Drinking Too Much (in the past 30 days)

Source: Behavioral Risk Factor Surveillance System (BRFSS), 2012.

- 0.7% - <1.4%
- 1.4% - <2%
- 2% - <2.7%
- 2.7% - 3.4%

Policy remedies

- mandatory punishment
- National Drinking Age Act of 1984 (effective national age-21 limit – states made changes 1980-1987)
- economic interventions (alcohol taxes)

Traffic deaths and alcohol taxes data set

Observational unit: a year in a U.S. state

- 48 U.S. states, so n = of entities = 48
- 7 years (1982,…, 1988), so T = # of time periods = 7
- Balanced panel, so total # observations = $7 \times 48 = 336$

Variables:

- Traffic fatality rate (# traffic deaths in that state in that year, per 10,000 state residents)
- Tax on a case of beer
- Other (legal driving age, drunk driving laws, etc.)

TABLE 10.1 Regression Analysis of the Effect of Drunk Driving Laws on Traffic Deaths

Dependent variable: traffic fatality rate (deaths per 10,000).

Regressor	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Beer tax	0.36**	−0.66*	−0.64+	−0.45	−0.69*	−0.46	−0.93**
	(0.05)	(0.29)	(0.36)	(0.30)	(0.35)	(0.31)	(0.34)
Drinking age 18				0.028	−0.010		0.037
				(0.070)	(0.083)		(0.102)
Drinking age 19				−0.018	−0.076		−0.065
				(0.050)	(0.068)		(0.099)
Drinking age 20				0.032	−0.100+		−0.113
				(0.051)	(0.056)		(0.125)
Drinking age						−0.002	
						(0.021)	
Mandatory jail or community service?				0.038	0.085	0.039	0.089
				(0.103)	(0.112)	(0.103)	(0.164)
Average vehicle miles per driver				0.008	0.017	0.009	0.124
				(0.007)	(0.011)	(0.007)	(0.049)
Unemployment rate				−0.063**		−0.063**	−0.091**
				(0.013)		(0.013)	(0.021)
Real income per capita (logarithm)				1.82**		1.79**	1.00
				(0.64)		(0.64)	(0.68)
Years	1982–88	1982–88	1982–88	1982–88	1982–88	1982–88	1982 & 1988 only
State effects?	no	yes	yes	yes	yes	yes	yes
Time effects?	no	no	yes	yes	yes	yes	yes
Clustered standard errors?	no	yes	yes	yes	yes	yes	yes

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Drinking age 18				0.028	−0.010		0.037
...							
Years	1982–88	1982–88	1982–88	1982–88	1982–88	1982–88	1982 & 1988 only
State effects?	no	yes	yes	yes	yes	yes	yes
Time effects?	no	no	yes	yes	yes	yes	yes
Clustered standard errors?	no	yes	yes	yes	yes	yes	yes
***F*-Statistics and *p*-Values Testing Exclusion of Groups of Variables:**							
Time effects = 0			4.22 (0.002)	10.12 (< 0.001)	3.48 (0.006)	10.28 (< 0.001)	37.49 (< 0.001)
Drinking age coefficients = 0				0.35 (0.786)	1.41 (0.253)		0.42 (0.738)
Unemployment rate, income per capita = 0				29.62 (< 0.001)		31.96 (< 0.001)	25.20 (< 0.001)
$\overline{R}^2$	0.091	0.889	0.891	0.926	0.893	0.926	0.899

These regressions were estimated using panel data for 48 U.S. states. Regressions (1) through (6) use data for all years 1982 to 1988, and regression (7) uses data from 1982 and 1988 only. The data set is described in Appendix 10.1. Standard errors are given in parentheses under the coefficients, and *p*-values are given in parentheses under the *F*-statistics. The individual coefficient is statistically significant at the +10%, *5%, or **1% significance level.

STATA .do file for drunk driving example, lectures 10 & 11

```
clear
set scheme s1color
cap log close
log using drunk_ec1123_example.log,replace
set more 1
*************************************************************
* drunk_lecture10_11.do              JS
*   STATA command file for DRUNK.DTA data set analysis for Ec1123
*************************************************************
use data\drunk.dta
drop in 337/337
xtset state year
desc
*************************************************************
* summary statistics
summarize year
summarize state
*************************************************************
* Data transformations, create dummy variables, etc.
* year dummies
gen y82=(year==1982)
gen y83=(year==1983)
gen y84=(year==1984)
gen y85=(year==1985)
gen y86=(year==1986)
gen y87=(year==1987)
gen y88=(year==1988)
*fatality rate per 10,000 in the population
```

```
gen vfrall=10000*mrall
*night fatality rate per 10,000 in the population
gen vfralln=10000*mralln
gen vfr1520 = 10000*(a1517+a1820)/(pop1517+pop1820)
gen vfr1520n = 10000*(a1517n+a1820n)/(pop1517+pop1820)
gen vfr1820 = 10000*a1820/pop1820
gen vfr1820n = 10000*a1820n/pop1820
gen incperc=perinc/1000
gen lincperc = ln(incperc)
gen vmilespd = vmiles/1000
gen frmall = mrall/(vmiles/100000)
gen ltax=log(beertax)
gen dramlaw = ((dramcase+dramstat)>=1)
gen jailcom = ((jaild+comserd)>0)
gen mjailcom = (jaild==.)*(comserd==.)
mvdecode mjailcom,mv(1)
replace jailcom = jailcom + mjailcom
gen da18=(mlda<19)
gen da19=(mlda>=19)*(mlda<20)
gen da20=(mlda>=20)*(mlda<21)
gen da21=(mlda>=21)
summarize vfrall
summarize beertax
summarize mlda
summarize jaild
summarize comserd
summarize incperc
global yeardum "y83 y84 y85 y86 y87 y88"
global statevar "dry vmilespd yngdrv"
global dadum "da18 da19 da20"
```

```
* ------------------------------------------------------------
* data printout
* ------------------------------------------------------------
list state year vfrall vmilespd beertax
* ------------------------------------------------------------
* Plots
* ------------------------------------------------------------
reg vfrall beertax if (year==1982), r
 dis "Adjusted Rsquared = " _result(8)
 predict t1
*   Fig. 10.1a: 1982
twoway scatter vfrall t1 beertax if (year==1982), ms(O i) c(. l) ///
 title("Fatality Rate and Beer Tax, 1982") ///
 ytitle("Fatality Rate") xtitle("Beer Tax")
 graph export drunk_f15a.emf, replace
*   Fig. 10.1b: 1988
reg vfrall beertax if (year==1988), r
 dis "Adjusted Rsquared = " _result(8)
 predict t2
twoway scatter vfrall t2 beertax if (year==1988), ms(O i) c(. l) ///
 title("Fatality Rate and Beer Tax, 1988") ///
 ytitle("Fatality Rate") xtitle("Beer Tax")
 graph export drunk_f15b.emf, replace
*
*  Figure 10.2   1982 - 1988 differences
gen d6vfrall = vfrall-vfrall[_n-6]
gen d6beertax = beertax-beertax[_n-6]
reg d6vfrall d6beertax if year==1988, r
 predict t3
twoway scatter d6vfrall t3 d6beertax if year==1988, s(O i) c(. l) ///
```

```
 title("Changes in Fatality Rate and Beer Tax, 1982 - 1988") ///
 ytitle("Change in Fatality Rate") xtitle("Change in Beer Tax")
 graph export drunk_f15c.emf, replace
* ------------------------------------------------------------
* FE regression
* ------------------------------------------------------------
xtreg vfrall beertax, fe vce(cluster state)
reg vfrall beertax i.state, vce(cluster state)
* ------------------------------------------------------------
* FE + TE regression
* ------------------------------------------------------------
xtreg vfrall beertax $yeardum, fe vce(cluster state)
 test $yeardum
xtreg vfrall beertax i.year, fe vce(cluster state)
reg vfrall beertax i.state i.year, vce(cluster state)
* ------------------------------------------------------------
* equivalence of first differences, dummy vble, FE regression
* ------------------------------------------------------------
* Two periods
* (a) first differences
reg d6vfrall d6beertax if year==1988, noconstant r
* (b) dummy variable
reg vfrall beertax i.state if (year==1982)|(year==1988), r
* (c) fixed effects regression
xtreg vfrall beertax if (year==1982)|(year==1988), fe vce(cluster state)
*
* Multiple periods
* (a) first differences
gen dvfrall = vfrall-vfrall[_n-1]
gen dbeertax = beertax-beertax[_n-1]
```

```
reg dvfrall dbeertax if year>=1983, noconstant r
* (b) dummy variable
reg vfrall beertax i.state, r
* (c) fixed effects regression
xtreg vfrall beertax, fe vce(cluster state)
* ------------------------------------------------------------
* equivalence of first differences, dummy vble, FE regression with time
effects
* ------------------------------------------------------------
* Two periods
* (a) first differences
reg d6vfrall d6beertax if year==1988, constant r
* (b) dummy variable
reg vfrall beertax i.state y88 if (year==1982)|(year==1988), r
* (c) fixed effects regression
xtreg vfrall beertax y88 if (year==1982)|(year==1988), fe vce(cluster
state)
*
* Multiple periods
* (a) first differences
reg dvfrall dbeertax if year>=1983, r
* (b) dummy variable
reg vfrall beertax i.state y83 y84 y85 y86 y87 y88, r
* (c) fixed effects regression
xtreg vfrall beertax y83 y84 y85 y86 y87 y88, fe vce(cluster state)
*
* ------------------------------------------------------------
* FE + TE + additional controls
* ------------------------------------------------------------
* (4) beer tax, FE, year effects, base controls, da, economic vbles
```

```
xtreg vfrall beertax vmilespd unrate lincperc $yeardum, ///
   fe vce(cluster state)
 dis "Adjusted Rsquared = " e(r2_a)
 test $yeardum
 test unrate lincperc
**********************************
clear
log close
```