Applied (Financial) Econometrics

Panel data

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Data

- Some U.S. states have enacted 'shall-issue' laws which allow citizens to carry concealed weapons.
- We are going to investigate the effect of shall-issue laws on violent crime rates.
- In this exercise we use the data set *Guns.dta.*
- This is a balanced panel of data on 50 US states, plus the District of Columbia for the years 1977 – 1999.
- There are a total of 51 states × 23 years = 1173 observations.
- These data were provided by Professor John Donohue of Stanford University.
- Data were used in the: "Shooting Down the 'More Guns Less Crime' Hypothesis" Stanford Law Review (2003)

Data

Variable Definitions

Variable	Definition
vio	violent crime rate (incidents per 100,000 members of the population)
rob	robbery rate (incidents per 100,000)
mur	murder rate (incidents per 100,000)
shall	= 1 if the state has a shall-carry law in effect in that year = 0 otherwise
incarc_rate	incarceration rate in the state in the previous year (sentenced prisoners per 100,000 residents; value for the previous year)
density	population per square mile of land area, divided by 1000
avginc	real per capita personal income in the state, in thousands of dollars
pop	state population, in millions of people
pm1029	percent of state population that is male, ages 10 to 29
pw1064	percent of state population that is white, ages 10 to 64
pb1064	percent of state population that is black, ages 10 to 64
stateid	ID number of states (Alabama = 1, Alaska = 2, etc.)
year	Year (1977-1999)

Data

```
. sum vio mur rob shall incarc_rate pb1064 pw1064 pm1029 pop avginc density stateid year
```

Variable	Obs	Mean	Std. Dev.	Min	Max
vio	1173	503.0747	334.2772	47	2921.8
mur	1173	7.665132	7.52271	.2	80.6
rob	1173	161.8202	170.51	6.4	1635.1
shall	1173	.2429668	.4290581	0	1
incarc_rate	1173	226.5797	178.8881	19	1913
pb1064	1173	5.336217	4.885688	.2482066	26.97957
pw1064	1173	62.94543	9.761527	21.78043	76.52575
pm1029	1173	16.08113	1.732143	12.21368	22.35269
pop	1173	4.816341	5.252115	.402753	33.14512
avginc	1173	13.7248	2.554543	8.554884	23.64671
density	1173	.3520382	1.355472	.0007071	11.10212
stateid	1173	28.96078	15.68352	1	56
year	1173	88	6.636079	77	99

Part 2&3

```
1 . gen ln_vio=ln(vio)

2 . regress ln_vio shall, robust

Linear regression                               Number of obs =      1173
                                                F(  1,  1171) =     86.86
                                                Prob > F      =    0.0000
                                                R-squared     =    0.0866
                                                Root MSE      =    .61735

------------------------------------------------------------------------------
             |               Robust
      ln_vio |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       shall |  -.4429646   .0475283    -9.32   0.000    -.5362148   -.3497144
       _cons |   6.134919   .0193039   317.81   0.000     6.097045    6.172793
------------------------------------------------------------------------------
```

- The coefficient equals -0.44, which suggests that shall-issue laws reduce the violent crime rate by 44%.
- This is a large effect.
- Are there threats to the internal validity of the estimated regression model?

Part 4

```
. regress ln_vio shall incarc_rate density avginc pop pb1064 pw1064 pm1029, robust

Linear regression                               Number of obs =      1173
                                                F(  8,  1164) =     95.67
                                                Prob > F      =    0.0000
                                                R-squared     =    0.5643
                                                Root MSE      =    .42769
```

ln_vio	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
shall	-.3683869	.0347879	-10.59	0.000	-.436641	-.3001329
incarc_rate	.0016126	.0001807	8.92	0.000	.0012581	.0019672
density	.0266885	.0143494	1.86	0.063	-.0014651	.054842
avginc	.0012051	.0072778	0.17	0.869	-.013074	.0154842
pop	.0427098	.0031466	13.57	0.000	.0365361	.0488836
pb1064	.0808526	.0199924	4.04	0.000	.0416274	.1200778
pw1064	.0312005	.0097271	3.21	0.001	.012116	.0502851
pm1029	.0088709	.0120604	0.74	0.462	-.0147917	.0325334
_cons	2.981738	.6090198	4.90	0.000	1.786839	4.176638

- Are there still omitted variables that might cause omitted variable bias?

Part 4&5

(1) Regression without control variables:

ln_vio	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
shall	-.4429646	.0475283	-9.32	0.000	-.5362148	-.3497144
_cons	6.134919	.0193039	317.81	0.000	6.097045	6.172793

(2) Regression with control variables

ln_vio	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
shall	-.3683869	.0347879	-10.59	0.000	-.436641	-.3001329

- The coefficient in (1) is $\widehat{\beta}_{shall} = -0.443$; in (2) it is $\widehat{\beta}_{shall} = -0.369$. Both are highly statistically significant.
- Adding the control variables results in a small drop in the estimated coefficient.
- Possible omitted variables that vary between states but not over time: Attitudes towards guns and crime, quality of police and other crime-prevention programs.

Part 6

```
1 . regress ln_vio shall incarc_rate density avginc pop pb1064 pw1064 pm1029 Dstate*, robust
  note: Dstate9 omitted because of collinearity

  Linear regression                               Number of obs     =      1,173
                                                  F(58, 1114)       =     364.90
                                                  Prob > F          =     0.0000
                                                  R-squared         =     0.9411
                                                  Root MSE          =     .16072

------------------------------------------------------------------------------
             |               Robust
      ln_vio |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       shall |  -.0461415   .0199433    -2.31   0.021    -.0852721   -.0070109
 incarc_rate |   -.000071   .0000973    -0.73   0.466    -.0002619    .0001199
     density |    -.17229   .1048789    -1.64   0.101    -.3780724    .0334925
      avginc |  -.0092037   .0067335    -1.37   0.172    -.0224155     .004008
         pop |   .0115247   .0097044     1.19   0.235    -.0075162    .0305655
      pb1064 |   .1042804   .0165552     6.30   0.000     .0717976    .1367633
      pw1064 |   .0408611   .0053859     7.59   0.000     .0302935    .0514287
      pm1029 |  -.0502725   .0077908    -6.45   0.000    -.0655588   -.0349863
     Dstate1 |  -2.759404   1.004794    -2.75   0.006    -4.730905   -.7879023
     Dstate2 |  -2.703439   1.005641    -2.69   0.007    -4.676602   -.7302757
     Dstate3 |  -2.518992   .9965431    -2.53   0.012    -4.474305   -.5636793
     Dstate4 |   -2.88668    1.00048    -2.89   0.004    -4.849718   -.9236416
     Dstate5 |  -2.515163   1.063879    -2.36   0.018    -4.602595    -.427731
     Dstate6 |   -2.86449   1.008317    -2.84   0.005    -4.842904   -.8860768
     Dstate7 |  -2.854969   .9448351    -3.02   0.003    -4.708826   -1.001112
     Dstate8 |  -2.661806   .9674257    -2.75   0.006    -4.559988   -.7636241
     Dstate9 |          0  (omitted)
    Dstate10 |  -2.082257   1.005363    -2.07   0.039    -4.054877   -.1096381
```

⋮

Why is `Dstate9` omitted?

Part 6

```
1 . xi: regress ln_vio shall incarc_rate density avginc pop pb1064 pw1064 pm1029 i.state, robust
  i.stateid         _Istateid_1-56      (naturally coded; _Istateid_1 omitted)

  Linear regression                               Number of obs     =      1,173
                                                  F(58, 1114)       =     364.90
                                                  Prob > F          =     0.0000
                                                  R-squared         =     0.9411
                                                  Root MSE          =     .16072

------------------------------------------------------------------------------
             |               Robust
      ln_vio |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       shall |  -.0461415   .0199433    -2.31   0.021    -.0852721   -.0070109
 incarc_rate |   -.000071   .0000973    -0.73   0.466    -.0002619    .0001199
     density |    -.17229   .1048789    -1.64   0.101    -.3780724    .0334925
      avginc |  -.0092037   .0067335    -1.37   0.172    -.0224155     .004008
         pop |   .0115247   .0097044     1.19   0.235    -.0075162    .0305655
      pb1064 |   .1042804   .0165552     6.30   0.000     .0717976    .1367633
      pw1064 |   .0408611   .0053859     7.59   0.000     .0302935    .0514287
      pm1029 |  -.0502725   .0077908    -6.45   0.000    -.0655588   -.0349863
 _Istateid_2 |   .0559649   .0788371     0.71   0.478    -.0987211    .2106508
 _Istateid_4 |   .2404116   .0872338     2.76   0.006     .0692506    .4115726
 _Istateid_5 |  -.1272758   .0714501    -1.78   0.075    -.2674677    .0129161
 _Istateid_6 |   .2442407   .2377303     1.03   0.304    -.2222089    .7106903
 _Istateid_8 |  -.1050866   .1180061    -0.89   0.373    -.3366259    .1264526
 _Istateid_9 |  -.0955652   .1412479    -0.68   0.499    -.3727071    .1815767
_Istateid_10 |   .0975979   .0824469     1.18   0.237    -.0641709    .2593666
_Istateid_11 |   2.759404   1.004794     2.75   0.006     .7879023    4.730905
```

⋮

Part 7

```
1 . xtset state
        panel variable:    stateid (balanced)

2 . xtreg ln_vio shall incarc_rate density avginc pop pb1064 pw1064 pm1029, fe robust

  Fixed-effects (within) regression               Number of obs      =         1173
  Group variable:  stateid                        Number of groups   =           51

  R-sq:  within  =  0.2178                        Obs per group: min =           23
         between =  0.0033                                       avg =         23.0
         overall =  0.0001                                       max =           23

                                                  F(8,50)            =        34.10
  corr(u_i, Xb)  =  -0.3687                       Prob > F           =       0.0000

                                       (Std. Err. adjusted for     51 clusters in stateid)
```

ln_vio	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
shall	-.0461415	.0417616	-1.10	0.275	-.1300222	.0377392
incarc_rate	-.000071	.0002504	-0.28	0.778	-.0005739	.0004318
density	-.17229	.1376128	-1.25	0.216	-.4486935	.1041135
avginc	-.0092037	.0129649	-0.71	0.481	-.0352445	.016837
pop	.0115247	.014224	0.81	0.422	-.0170452	.0400945
pb1064	.1042804	.0326849	3.19	0.002	.0386308	.16993
pw1064	.0408611	.0134585	3.04	0.004	.0138289	.0678932
pm1029	-.0502725	.0206949	-2.43	0.019	-.0918394	-.0087057
_cons	3.866017	.7701057	5.02	0.000	2.319214	5.41282
sigma_u	.68024947					
sigma_e	.16072287					
rho	.94712778	(fraction of variance due to u_i)				

Part 7

- The results change when we add state fixed effects.
- The absolute value of the coefficient on shall falls to 0.046, a large reduction in the coefficient from 0.369 without fixed effects.
- Evidently there was important omitted variable bias in the specification without fixed effects.
- The estimate of the effect of shall issue laws on the violent crime rate is no longer statistically significantly different from zero
- The estimated coefficient on shall is identical in parts 6 and 7; within estimation and LSDV give identical estimates!

```
1 . xi: xtreg ln_vio shall i.year incarc_rate density avginc pop pb1064 pw1064 pm1029, fe robust
  i.year            _Iyear_77-99       (naturally coded; _Iyear_77 omitted)

Fixed-effects (within) regression               Number of obs      =         1173
Group variable:  stateid                        Number of groups   =           51

R-sq:  within  =  0.4180                        Obs per group: min =           23
       between =  0.0419                                       avg =         23.0
       overall =  0.0009                                       max =           23

                                                F(30,50)           =        56.86
corr(u_i, Xb)  =  -0.2929                       Prob > F           =       0.0000

                                    (Std. Err. adjusted for    51 clusters in stateid)
------------------------------------------------------------------------------
             |               Robust
      ln_vio |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       shall |  -.0279935   .0407168    -0.69   0.495    -.1097757    .0537886
   _Iyear_78 |   .0585261   .0161556     3.62   0.001     .0260767    .0909755
   _Iyear_79 |   .1639486   .0244579     6.70   0.000     .1148234    .2130738
   _Iyear_80 |   .2170759   .0334184     6.50   0.000     .1499531    .2841987
   _Iyear_81 |   .2172551   .0391956     5.54   0.000     .1385284    .2959819
   _Iyear_82 |   .1946328   .0465743     4.18   0.000     .1010856      .28818
   _Iyear_83 |    .158645   .0593845     2.67   0.010     .0393676    .2779223
   _Iyear_84 |   .1929883   .0770021     2.51   0.015     .0383251    .3476515
   _Iyear_85 |   .2444765   .0922217     2.65   0.011     .0592438    .4297091
   _Iyear_86 |   .3240904   .1089181     2.98   0.004     .1053219    .5428589
   _Iyear_87 |    .324365   .1249881     2.60   0.012     .0733189    .5754111
   _Iyear_88 |   .3867412   .1397074     2.77   0.008     .1061305    .6673518
   _Iyear_89 |   .4422142   .1535358     2.88   0.006     .1338286    .7505999
   _Iyear_90 |   .5430478   .1960859     2.77   0.008     .1491976     .936898
   _Iyear_91 |   .5959456   .2040685     2.92   0.005     .1860619    1.005829
   _Iyear_92 |   .6275171   .2170306     2.89   0.006     .1915982    1.063436
   _Iyear_93 |   .6497414   .2246177     2.89   0.006     .1985834    1.100899
   _Iyear_94 |   .6354187   .2332437     2.72   0.009     .1669349    1.103903
   _Iyear_95 |   .6276831   .2423607     2.59   0.013     .1408874    1.114479
   _Iyear_96 |   .5713423   .2534067     2.25   0.029       .06236    1.080325
   _Iyear_97 |   .5501153   .2613516     2.10   0.040     .0251751    1.075056
   _Iyear_98 |   .4932905   .2746546     1.80   0.079    -.0583696    1.044951
   _Iyear_99 |   .4328777   .2862198     1.51   0.137    -.1420116    1.007767
 incarc_rate |    .000076   .0002079     0.37   0.716    -.0003416    .0004935
     density |  -.0915549   .1238622    -0.74   0.463    -.3403395    .1572297
```

Part 8

- The absolute value of the coefficient on shall falls further to 0.028, the coefficient is not significantly different from zero.
- The time effects are jointly statistically significant, so this regression seems better specified than the regression in part 7.

```
. test _Iyear_78= _Iyear_79= _Iyear_80= _Iyear_81= _Iyear_82= _Iyea
> r_83= _Iyear_84= _Iyear_85= _Iyear_86= _Iyear_87= _Iyear_88= _Iye
> ar_89= _Iyear_90= _Iyear_91= _Iyear_92= _Iyear_93= _Iyear_94= _Iy
> ear_95= _Iyear_96= _Iyear_97= _Iyear_98= _Iyear_99=0

 ( 1)  _Iyear_78 - _Iyear_79 = 0
 ( 2)  _Iyear_78 - _Iyear_80 = 0
 ( 3)  _Iyear_78 - _Iyear_81 = 0
 ( 4)  _Iyear_78 - _Iyear_82 = 0
 ( 5)  _Iyear_78 - _Iyear_83 = 0
 ( 6)  _Iyear_78 - _Iyear_84 = 0
 ( 7)  _Iyear_78 - _Iyear_85 = 0
 ( 8)  _Iyear_78 - _Iyear_86 = 0
 ( 9)  _Iyear_78 - _Iyear_87 = 0
 (10)  _Iyear_78 - _Iyear_88 = 0
 (11)  _Iyear_78 - _Iyear_89 = 0
 (12)  _Iyear_78 - _Iyear_90 = 0
 (13)  _Iyear_78 - _Iyear_91 = 0
 (14)  _Iyear_78 - _Iyear_92 = 0
 (15)  _Iyear_78 - _Iyear_93 = 0
 (16)  _Iyear_78 - _Iyear_94 = 0
 (17)  _Iyear_78 - _Iyear_95 = 0
 (18)  _Iyear_78 - _Iyear_96 = 0
 (19)  _Iyear_78 - _Iyear_97 = 0
 (20)  _Iyear_78 - _Iyear_98 = 0
 (21)  _Iyear_78 - _Iyear_99 = 0
 (22)  _Iyear_78 = 0

       F( 22,    50) =    21.62
            Prob > F =     0.0000
```

Part 9

```
. **part 9
. esttab vio_eq*, b(3) se(3) compress title(Logarithm of violent crime rate)

Logarithm of violent crime rate
```

	(1) ln_vio	(2) ln_vio	(3) ln_vio	(4) ln_vio
shall	-0.443***	-0.368***	-0.046	-0.028
	(0.048)	(0.035)	(0.042)	(0.041)
incarc_r~e		0.002***	-0.000	0.000
		(0.000)	(0.000)	(0.000)
density		0.027	-0.172	-0.092
		(0.014)	(0.138)	(0.124)
avginc		0.001	-0.009	0.001
		(0.007)	(0.013)	(0.016)
pop		0.043***	0.012	-0.005
		(0.003)	(0.014)	(0.015)
pb1064		0.081***	0.104**	0.029
		(0.020)	(0.033)	(0.050)
pw1064		0.031**	0.041**	0.009
		(0.010)	(0.013)	(0.024)
pm1029		0.009	-0.050*	0.073
		(0.012)	(0.021)	(0.052)
_Iyear_78				0.059***
				(0.016)
_Iyear_79				0.164***
				(0.024)
_Iyear_80				0.217***
				(0.033)

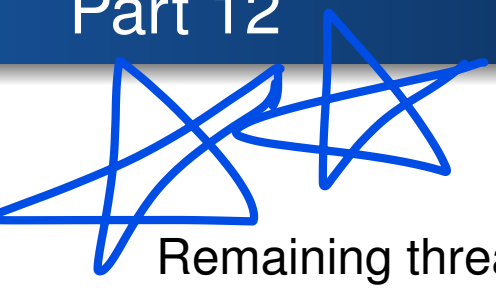
Part 10&11

Dependent variable is ln(rob)				
	(1)	(2)	(3)	(4)
shall	-0.773***	-0.529***	-0.008	0.027
	(0.069)	(0.051)	(0.055)	(0.052)
Control variables	-	yes	yes	yes
State fixed effects	-	-	yes	yes
Time fixed effects	-	-	-	yes
Dependent variable is ln(mur)				
	(1)	(2)	(3)	(4)
shall	-0.473***	-0.313***	-0.061	-0.015
	(0.049)	(0.036)	(0.037)	(0.038)
Control variables	-	yes	yes	yes
State fixed effects	-	-	yes	yes
Time fixed effects	-	-	-	yes

The results are similar to the results using violent crimes:

- There is a large estimated effect of concealed weapons laws in specifications (1) and (2).
- This effect is however due to omitted variable bias because the effect disappears when state and time effects are added.

Part 12



Remaining threats to internal validity:

Omitted variables: There might be important variables that vary between states and over time that are omitted from the regression model. For example other policy measures that are related to the implementation of shall issue laws and that affect crime rates.

Simultaneous causality: If there are many violent crimes this may induce policy makers to change concealed weapons laws.

Serial correlation: There might be variables in the error term that are correlated over time. Will this result in a bias in the estimated effect of the variable shall?

Conclusion

- The most credible results include both state fixed effects and time fixed effects.
- These results indicate that there is no significant effect of concealed weapon laws on the violent crime rate, the robbery rate nor on the murder rate.