The effect of shall laws on crime rate.

Agenda

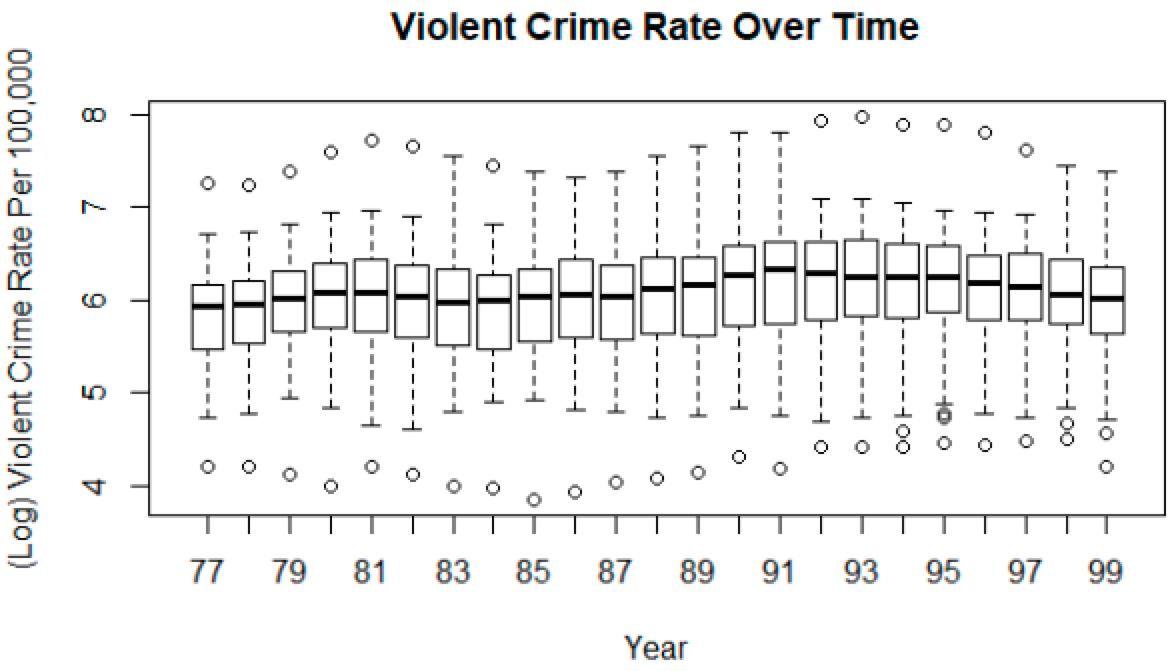
Introduction

Data Exploration

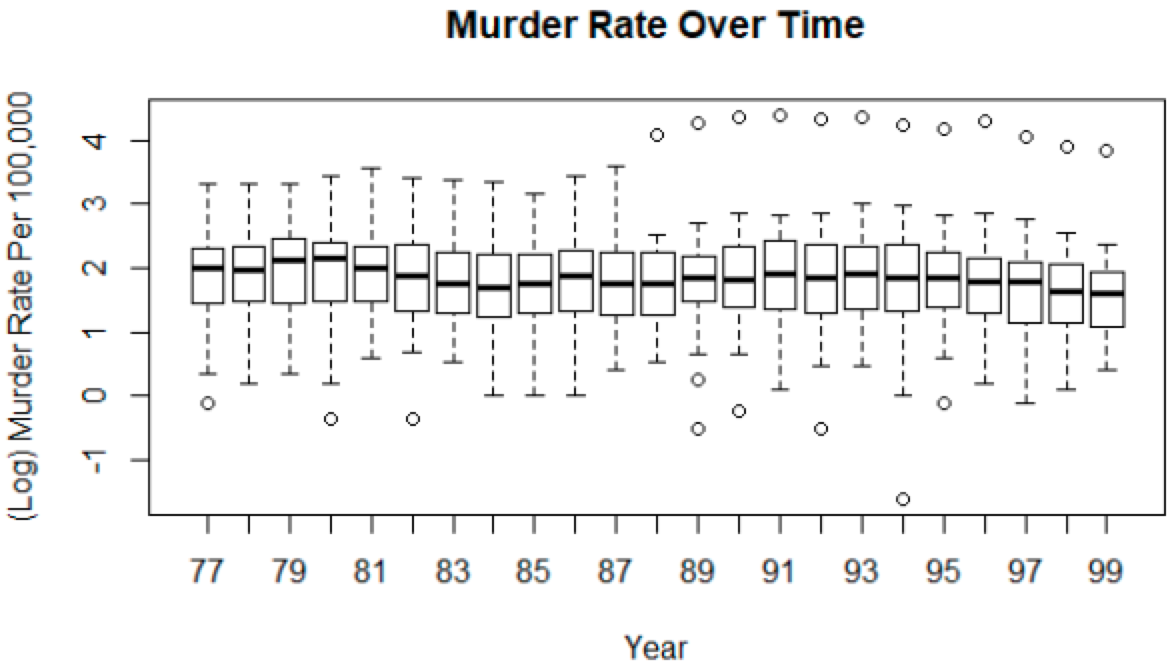
Data Modeling

Summary

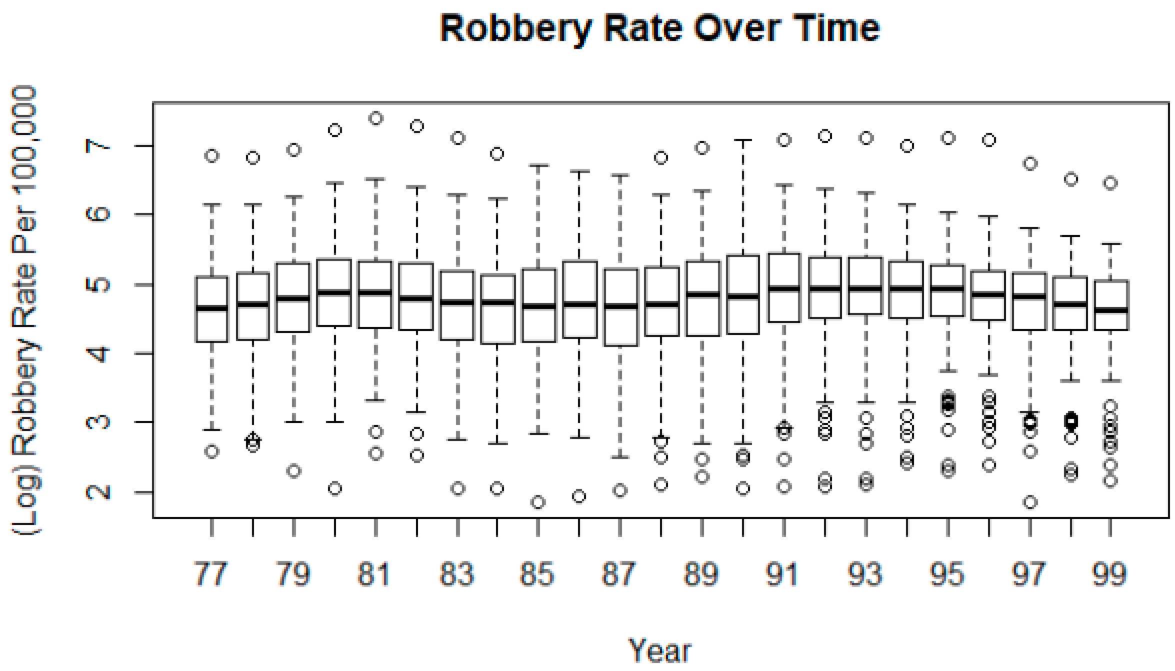
Trends Over Time



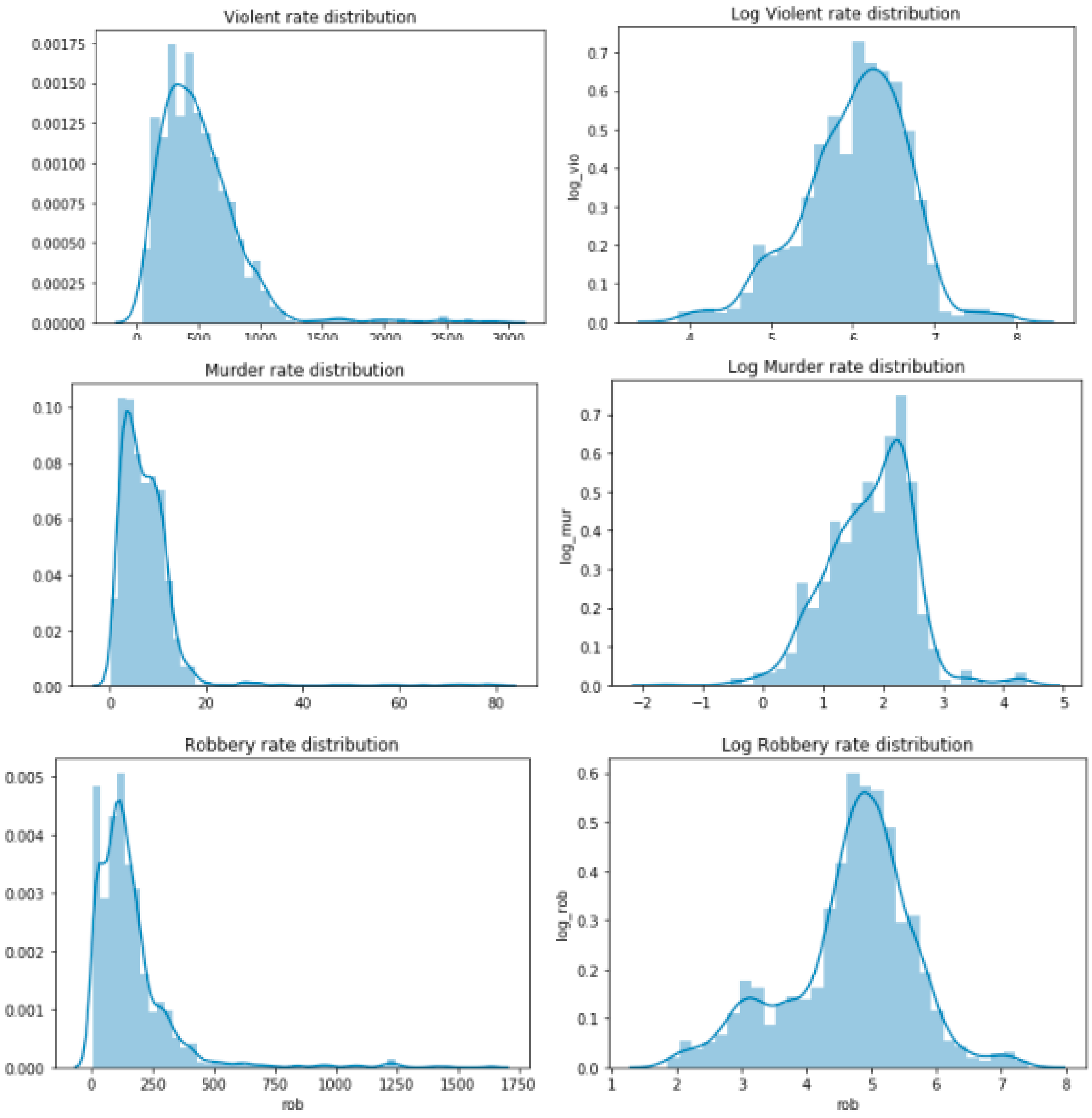
Trends Over Time



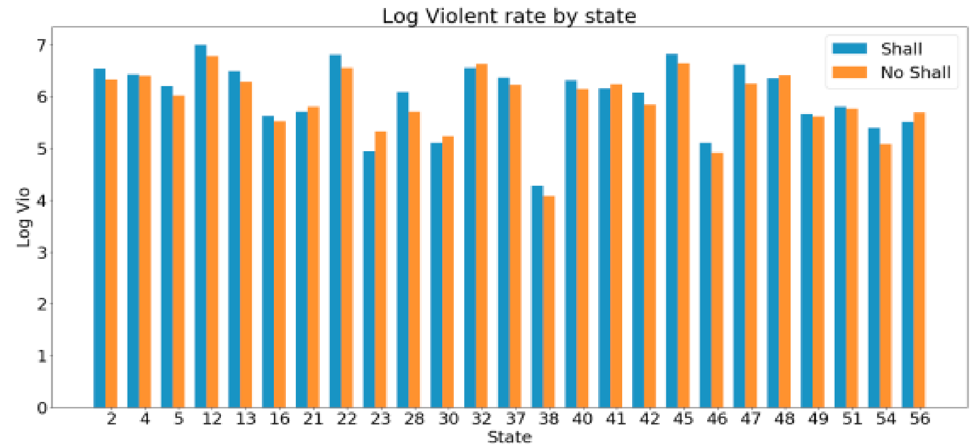
Trends Over Time

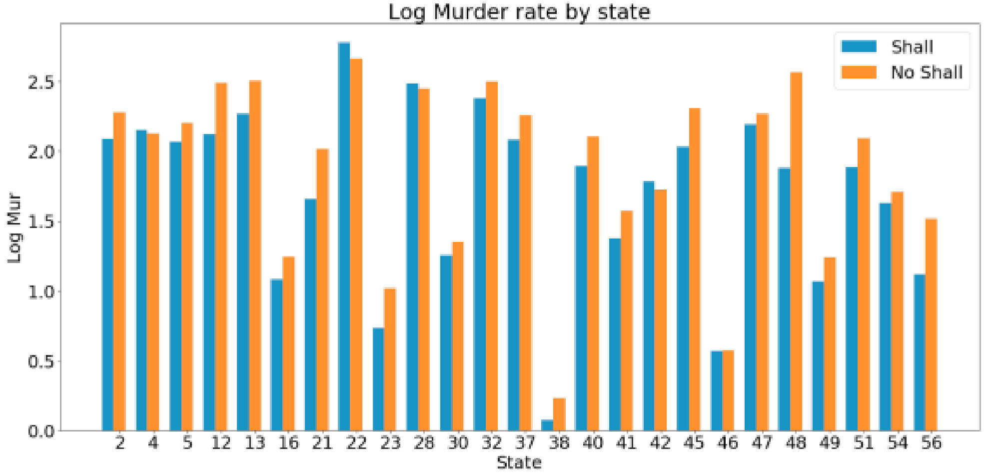


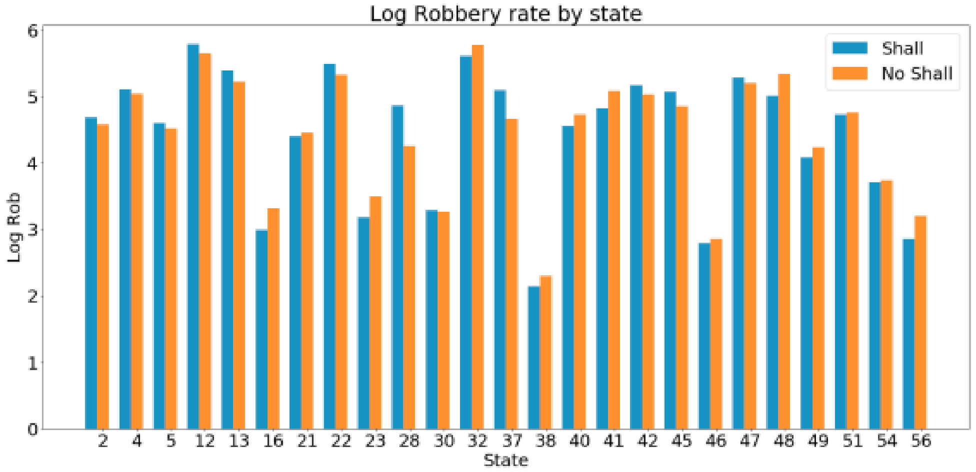
Distribution of violent, murder, and robbery rate



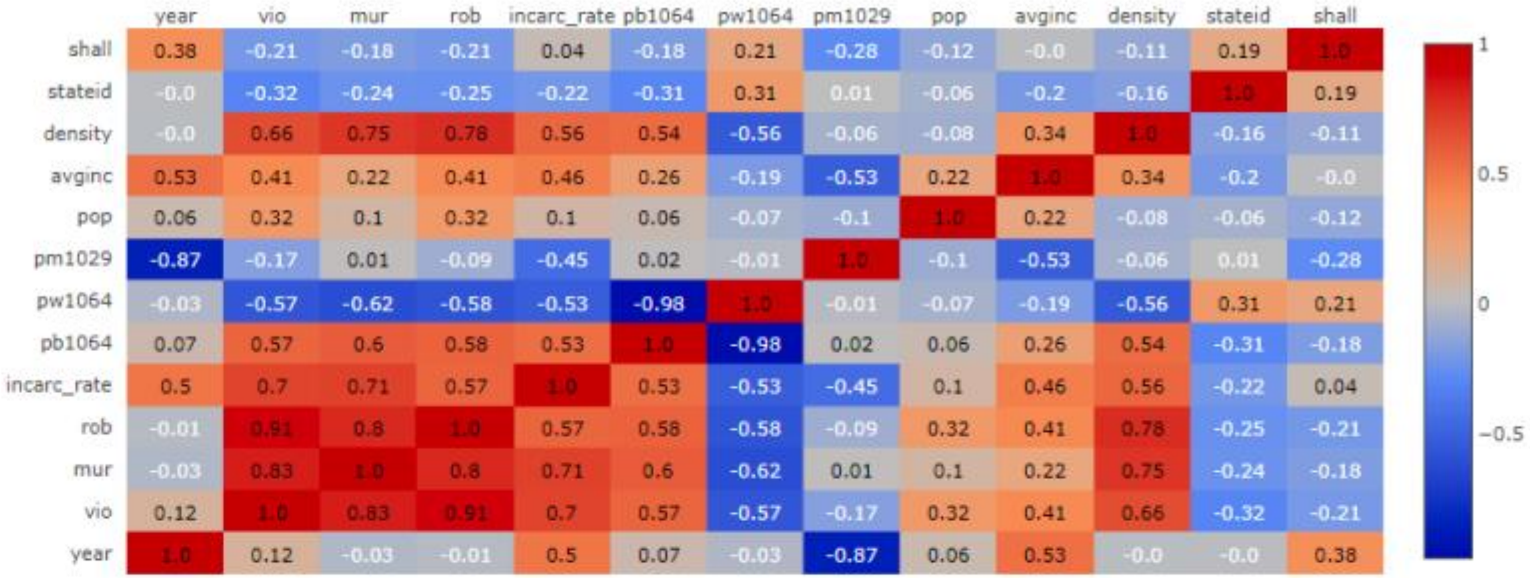
Distribution of Violent, Murder, Robbery Rate by State







Correlation matrix



Top Absolute Correlations		
pb1064	pw1064	0.981978
vio	rob	0.907077
year	pm1029	0.865828
vio	mur	0.826509
mur	rob	0.797606
rob	density	0.781834
mur	density	0.748592
mur	incarc_rate	0.709608
vio	incarc_rate	0.70266
vio	density	0.664726
mur	pw1064	0.615368
mur	pb1064	0.601833
rob	pw1064	0.584192
vio	pw1064	0.573018
vio	pb1064	0.569788
rob	incarc_rate	0.56685
incarc_rate	density	0.559313
pw1064	density	0.555113
pb1064	density	0.543244

Walds Test

The Wald test is frequently used to compare the differences between nested models.

One model is considered nested in another if the first model can be generated by imposing restrictions on the parameters of the second. Most often, the restriction is that the parameter is equal to zero. In a regression model restricting a parameters to zero is accomplished by removing the predictor variables from the model

The Walds test ask the same basic question, which is, does constraining these parameters to zero (i.e., leaving out these predictor variables) significantly reduce the fit of the model?

Walds Test

The Wald test works by testing that the parameters of interest are simultaneously equal to zero. If they are, this strongly suggests that removing them from the model will not substantially reduce the fit of that model, since a predictor whose coefficient is very small relative to its standard error is generally not doing much to help predict the dependent variable.

Walds Test

The code we used -

quietly: reg vio mur rob incarc_rate pb1064 pw1064 pm1029 pop avginc density stateid shall

test mur rob

OUTPUT

```
. quietly:  reg vio mur rob incarc_rate pb1064 pw1064 pm1029 pop avginc density
> stateid shall

.

.

.

. test mur rob

 ( 1)  mur = 0
 ( 2)  rob = 0

       F(  2,  1161) = 1071.25
            Prob > F =    0.0000
```

Walds Test

Explanation -

The first line of syntax below does this (but uses the quietly prefix so that the output from the regression is not shown). The second line of syntax below instructs Stata to run a Wald test in order to test whether the coefficients for the variables **mur** and **rob** are simultane ously equal to zero. The output first gives the null hypothesis.

Below that we see the F-test value generated by the Wald test, as well as the p-value associated with a F-test of 1071.25 with two degrees of freedom. Based on the p-value, we can reject the null hypothesis, again indicating that the coefficients for **mur** and **rob** are not simultaneously equal to zero, meaning that including these variables create a statistically significant improvement in the fit of the model.

Walds Test

The code we used -

quietly: reg vio mur rob incarc_rate pb1064 pw1064 pm1029 pop avginc density stateid shall

test pb1064 pm1029

OUTPUT

```
quietly: reg vio year mur rob incarc_rate pb1064 pw1064 pm1029 pop avginc density stateid shall


test pb1064 pm1029

( 1)  pb1064 = 0
( 2)  pm1029 = 0

      F(  2,  1160) =    2.28
           Prob > F =    0.1029
```

Walds Test

Explanation -

The first line of syntax below does this (but uses the quietly prefix so that the output from the regression is not shown). The second line of syntax below instructs Stata to run a Wald test in order to test whether the coefficients for the variables **pb1064** and **pm1029** are simultaneously equal to zero. The output first gives the null hypothesis.

Below that we see the F-test value generated by the Wald test, as well as the p-value associated with a F-test of 2.28 with two degrees of freedom. Based on the p-value, we cannot reject the null hypothesis. So, we need to remove either of variable in model.

Summary

Fixed Effects Model

The fixed effects regression model is used to estimate the effect of variables that vary over time in a panel data set.

The objective of including a fixed effects model is to understand if time-invariant characteristics of individual state affect the regression.

Fixed Effects test

The code we used -

xtset state

We saved our dataset as state, and converted it into a balanced panel dataset

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

OUTPUT

```
Panel variable: stateid (balanced)

.
end of do-file

. do "C:\Users\SXR210~1\AppData\Local\Temp\14\STD3f50_000000.tmp"

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

Fixed-effects (within) regression               Number of obs     =      1,173
Group variable: stateid                         Number of groups  =         51

R-squared:                                      Obs per group:
     Within  = 0.2178                                         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	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
shall	-.0461415	.0417616	-1.10	0.275	-.1300223	.0377392
incarc_rate	-.000071	.0002504	-0.28	0.778	-.0005739	.0004318
density	-.1722901	.1376129	-1.25	0.216	-.4486936	.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	.1699301
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	5.412819
sigma_u	.68024951					
sigma_e	.16072287					
rho	.94712779	(fraction of variance due to u_i)				

Fixed Effects Interpretation

- The results of the fixed effects of the model change when we add fixed effects of states.
- The absolute value of the coefficient on shall reduce to 0.046, compared to 0.369 without fixed effects.
- We also understand that the effect of shall laws on the violent crime rate is no longer statistically significant.

Fixed Effects Summary

- There was an important omitted variable bias in the equation without fixed effects.
- We also understand that the regression model with fixed effects is better because it controls for unobservable characteristics which may depend on individual state characteristics but are constant over time.

Random Effects Model for violent variable

The code we used

```
/* Random effects model */
xtreg lvio shall incarc_rate density avginc pop pm1029 pw1064, re
```

Although we believe a random effects model will not be appropriate in this case (because the
data set is not from a random sampling process), we still run a random effects model and
perform a Hausman test to further support our argument.

OUTPUT

```
. xtreg lvio shall incarc_rate density avginc pop pm1029 pw1064, re

Random-effects GLS regression                   Number of obs      =     1,173
Group variable: stateid                         Number of groups   =        51

R-sq:                                           Obs per group:
     within  = 0.1748                                         min =        23
     between = 0.2468                                         avg =      23.0
     overall = 0.2408                                         max =        23

                                                Wald chi2(7)       =    259.25
corr(u_i, X)    = 0 (assumed)                   Prob > chi2        =    0.0000

------------------------------------------------------------------------------
        lvio |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       shall |  -.0264826     .01883    -1.41   0.160    -.0633887    .0104236
 incarc_rate |   .0002083   .0000704     2.96   0.003     .0000703    .0003464
     density |    .181367    .034834     5.21   0.000     .1130936    .2496404
      avginc |  -.0005904   .0059071    -0.10   0.920    -.0121681    .0109873
         pop |   .0257448   .0064512     3.99   0.000     .0131007    .0383889
      pm1029 |  -.0366962   .0062142    -5.91   0.000    -.0488758   -.0245165
      pw1064 |   .0110645   .0037326     2.96   0.003     .0037487    .0183803
       _cons |   5.700438   .2855744    19.96   0.000     5.140723    6.260154
-------------+----------------------------------------------------------------
     sigma_u |  .33409053
     sigma_e |  .16311876
         rho |  .80750312   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Hausman test for violent variable

The code we used

```
/* Hausman test */
xtreg lvio shall incarc_rate density avginc pop pm1029 pw1064, fe
estimates store vio_fixed
xtreg lvio shall incarc_rate density avginc pop pm1029 pw1064, re
estimates store vio_random
hausman vio_fixed vio_random
```

OUTPUT

```
. hausman vio_fixed vio_random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |   vio_fixed    vio_random     Difference          S.E.
-------------+----------------------------------------------------------------
       shall |   -.0243845    -.0264826       .0020981               .
 incarc_rate |    .0000167     .0002083      -.0001917         .0000619
     density |    .0847004      .181367      -.0966666         .0652883
      avginc |    -.000474    -.0005904       .0001165               .
         pop |    .0171825     .0257448      -.0085623         .0059848
      pm1029 |   -.0526988    -.0366962      -.0160026         .0018567
      pw1064 |    .0264819     .0110645       .0154173         .0025331
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       73.57
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

According to the Hausman test, the null hypothesis will be that there is no correlation between the explanatory variables and the error terms. With the p-value = 0.0000, we will reject the null hypothesis and conclude that there is a correlation between the explanatory variables and the error terms. Therefore, the estimates derived from the random-effects model will be biased and inconsistent, and thus, fixed effects model will be the better model in this case. This is on the same line with our argument in the previous part.

Random Effects Model for robbery variable

The code we used

/* Random effects model */
xtreg lrob shall incarc_rate density avginc pop pm1029 pw1064, re

OUTPUT

```
. xtreg lrob shall incarc_rate density avginc pop pm1029 pw1064, re

Random-effects GLS regression                   Number of obs     =      1,173
Group variable: stateid                         Number of groups  =         51

R-sq:                                           Obs per group:
     within  = 0.0091                                         min =         23
     between = 0.4264                                         avg =       23.0
     overall = 0.4034                                         max =         23

                                                Wald chi2(7)      =      65.15
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
        lrob |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       shall |   .0004736   .0249693     0.02   0.985    -.0484654    .0494126
 incarc_rate |    .000193   .0000943     2.05   0.041     8.26e-06    .0003778
     density |   .2242059   .0485076     4.62   0.000     .1291326    .3192791
      avginc |  -.0052941   .0078335    -0.68   0.499    -.0206474    .0100592
         pop |   .0443882   .0088126     5.04   0.000     .0271158    .0616606
      pm1029 |    .025615   .0082529     3.10   0.002     .0094395    .0417904
      pw1064 |   .0004343   .0050627     0.09   0.932    -.0094884     .010357
       _cons |   3.982001   .3855551    10.33   0.000     3.226326    4.737675
-------------+----------------------------------------------------------------
     sigma_u |  .47914767
     sigma_e |  .21716752
         rho |  .82958368   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Hausman test for robbery variable

The code we used

```
/* Hausman test */
xtreg lrob shall incarc_rate density avginc pop pm1029 pw1064, fe
estimates store rob_fixed
xtreg lrob shall incarc_rate density avginc pop pm1029 pw1064, re
estimates store rob_random
hausman rob_fixed rob_random
```

OUTPUT

```
. hausman rob_fixed rob_random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |   rob_fixed    rob_random     Difference          S.E.
-------------+----------------------------------------------------------------
       shall |    .0154532     .0004736        .0149796        .0011633
 incarc_rate |    .0000174      .000193       -.0001756        .0000819
     density |    .0887945     .2242059       -.1354113        .0857501
      avginc |   -.0081818    -.0052941       -.0028877               .
         pop |    .0223849     .0443882       -.0220033        .0077196
      pm1029 |    .0085865      .025615       -.0170285         .002539
      pw1064 |    .0118002     .0004343        .0113659        .0032307
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       47.69
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Random Effects Model for murder variable

The code we used

/* Random effects model */
xtreg lmur shall incarc_rate density avginc pop pm1029 pw1064, re

OUTPUT

```
. xtreg lmur shall incarc_rate density avginc pop pm1029 pw1064, re

Random-effects GLS regression                   Number of obs     =      1,173
Group variable: stateid                         Number of groups  =         51

R-sq:                                           Obs per group:
     within  = 0.0835                                         min =         23
     between = 0.4737                                         avg =       23.0
     overall = 0.4136                                         max =         23

                                                Wald chi2(7)      =     155.03
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
        lmur |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       shall |  -.0898712   .0256421    -3.50   0.000    -.1401288   -.0396136
 incarc_rate |   .0004356   .0000929     4.69   0.000     .0002535    .0006176
     density |   .0478661   .0376065     1.27   0.203    -.0258414    .1215735
      avginc |   .0152264   .0080026     1.90   0.057    -.0004585    .0309112
         pop |   .0014712   .0074722     0.20   0.844    -.0131741    .0161165
      pm1029 |   .0746036   .0084021     8.88   0.000     .0581358    .0910714
      pw1064 |   -.009669   .0044636    -2.17   0.030    -.0184176   -.0009205
       _cons |   .8816771   .3542234     2.49   0.013     .1874121    1.575942
-------------+----------------------------------------------------------------
     sigma_u |  .32150357
     sigma_e |  .21948634
         rho |  .68209954   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Hausman test for murder variable

OUTPUT

The code we used

```
/* Hausman test */
xtreg lmur shall incarc_rate density avginc pop pm1029 pw1064, fe
estimates store mur_fixed
xtreg lmur shall incarc_rate density avginc pop pm1029 pw1064, re
estimates store mur_random
hausman mur_fixed mur_random
```

```
. hausman mur_fixed mur_random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |   mur_fixed    mur_random     Difference          S.E.
-------------+----------------------------------------------------------------
       shall |   -.0544046    -.0898712        .0354666               .
 incarc_rate |   -.0003342     .0004356       -.0007698        .0000854
     density |   -.5950535     .0478661       -.6429195        .0921965
      avginc |    .0268815     .0152264        .0116551               .
         pop |   -.0240397     .0014712       -.0255109        .0091851
      pm1029 |    .0385241     .0746036       -.0360795        .0023585
      pw1064 |    .0060979     -.009669         .015767        .0041132
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      126.73
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

Thank you