Day 11 - TSCS

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TSCS and Panel Data Analyses

- There are no agreed upon defining characteristics between TSCS and panel data, but for our purposes we will refer to large N, mostly balanced data as panel
- It is very important to note which of the modeling strategies (most of them) assume balance; this is often overlooked
- We will first deal with last week's protest data

One- and Two-Way Fixed Effects Models

- A 'fixed effect' is colloquially simply an indicator, a dummy variable - but really they are all effects that are not assumed randomly distributed
- In panel data, we can include a 'wave' (temporal) effect and/or a unit effect
- Most common to use two-way (both temporal and unit) for panel data
- For TSCS, two-way is also common, but the interpretability and framework are hurt by multiple observations for a unit-time
- Fixed effects control for heterogeneity in the data
- The inclusion of unit and time fixed effects accounts for both unit-specific (but time-invariant) and time-specific (but unit-invariant) unobserved confounders in a flexible manner
- Additivity and separability of the two types of unobserved confounders
- However, their statistical power can be very low with small N, because of the loss in degrees of freedom
- Unlike random/mixed effects, they do not have distributional assumptions
- These two points mean that there is no information 'borrowed' from other unit-times, and the variation that would be explained by your independent variable is largely absorbed
- These have great asymptotic properties, but a lot of research on the actual practice show they perform rather poorly, even when assumptions are met
- Linearity (although one could nonparametrically adjust for unit-specific (time-specific) unobserved confounders by matching a treated observation with control observations of the same unit (time period), no other observation shares the same unit and time indices. Thus, the 2FE estimator critically relies upon the linearityassumption for its simultaneous adjustment for the two types of unobserved confounders)
- Separability (precisely when their respective convex hulls are disjoint (colloquially, do not overlap); means that the marginal rate of substitution between any pair of primary inputs is independent of the amount of intermediate inputs used)
- Additivity (means that the effect of one independent variable(s) on the dependent variable does NOT depend on the value of another independent variable(s))
- Functional form assumption (are we modeling the DGP?)
- Adjustment for the two types of unobserved confounders cannot be done nonparametrically under the 2FE framework
- Very simple to run; just a linear model with factors
- Let us explore the models from last week, but take into account that this is actually (highly unbalanced) TSCS data

```
simpleMod = lm(politychanget1 ~ nonviol, data = data)
summary(simpleMod)
```

```
## 
## Call:
## lm(formula = politychanget1 ~ nonviol, data = data)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max 
## -17.8295 -2.8295  0.0643  1.0643 12.1705 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) -0.06433    0.32629  -0.197    0.844    
## nonviol      3.89387    0.55977   6.956 2.89e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 4.267 on 257 degrees of freedom
##   (64 observations deleted due to missingness)
## Multiple R-squared:  0.1585, Adjusted R-squared:  0.1552 
## F-statistic: 48.39 on 1 and 257 DF,  p-value: 2.89e-11
```

```r
#lets add a temporal effect - the beginning year seems most appropriate
timeMod = lm(politychanget1 ~ nonviol + as.factor(byear), #notice the as.factor wrapper - always use th
             data = data)
summary(timeMod) #holds up
```

```
## 
## Call:
## lm(formula = politychanget1 ~ nonviol + as.factor(byear), data = data)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max 
## -12.600  -2.000   0.000   1.479  10.107 
## 
## Coefficients:
##                        Estimate Std. Error t value Pr(>|t|)    
## (Intercept)          -3.607e-13  4.482e+00   0.000   1.0000    
## nonviol               3.571e+00  8.318e-01   4.293 2.95e-05 ***
## as.factor(byear)1901  3.193e-13  6.339e+00   0.000   1.0000    
## as.factor(byear)1902  3.605e-13  6.339e+00   0.000   1.0000    
## as.factor(byear)1903  3.624e-13  6.339e+00   0.000   1.0000    
## as.factor(byear)1904  1.500e+00  5.490e+00   0.273   0.7850    
## as.factor(byear)1905  2.000e+00  6.339e+00   0.316   0.7528    
## as.factor(byear)1906  3.615e-13  6.339e+00   0.000   1.0000    
## as.factor(byear)1907  3.601e-13  5.490e+00   0.000   1.0000    
## as.factor(byear)1908  3.939e-13  6.339e+00   0.000   1.0000    
## as.factor(byear)1910  3.307e-13  6.339e+00   0.000   1.0000    
## as.factor(byear)1911 -4.000e+00  6.339e+00  -0.631   0.5289    
## as.factor(byear)1912 -4.000e+00  6.339e+00  -0.631   0.5289    
## as.factor(byear)1916  5.000e+00  6.339e+00   0.789   0.4313    
## as.factor(byear)1917  3.602e-13  5.490e+00   0.000   1.0000    
## as.factor(byear)1918  3.880e-13  5.490e+00   0.000   1.0000    
## as.factor(byear)1919  8.096e-01  5.183e+00   0.156   0.8761    
## as.factor(byear)1922 -3.000e+00  6.339e+00  -0.473   0.6366    
## as.factor(byear)1923 -1.857e+00  5.183e+00  -0.358   0.7206    
## as.factor(byear)1924  3.407e-13  5.490e+00   0.000   1.0000    
```
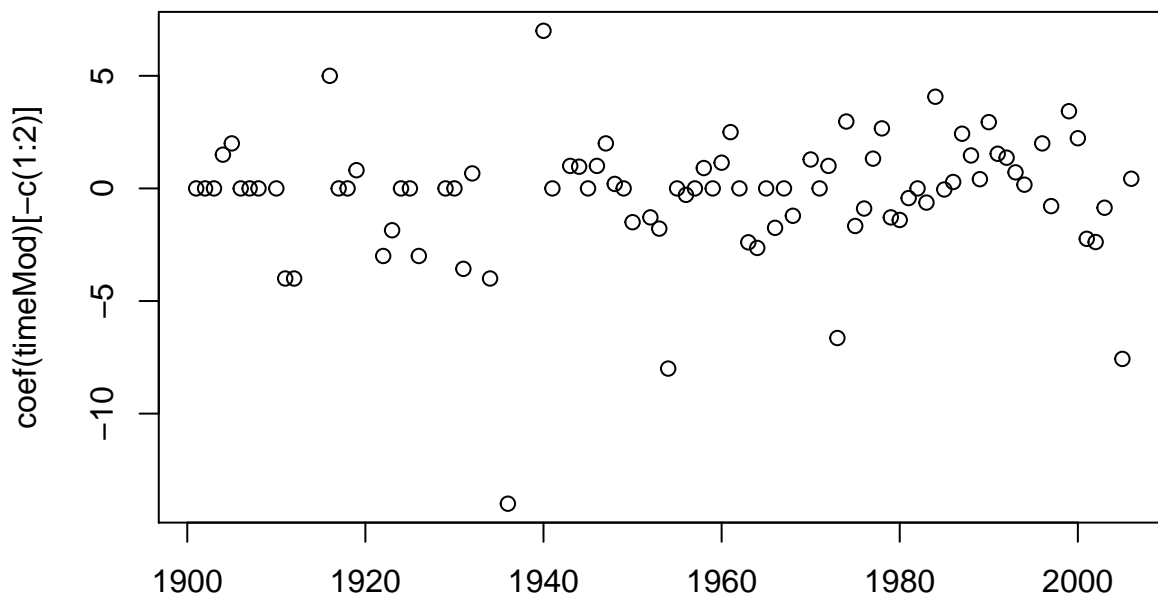
```
## as.factor(byear)1925  3.273e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1926 -3.000e+00  6.339e+00  -0.473   0.6366
## as.factor(byear)1929  3.452e-13  5.490e+00   0.000   1.0000
## as.factor(byear)1930  3.591e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1931 -3.571e+00  6.393e+00  -0.559   0.5772
## as.factor(byear)1932  6.667e-01  5.176e+00   0.129   0.8977
## as.factor(byear)1934 -4.000e+00  5.490e+00  -0.729   0.4672
## as.factor(byear)1936 -1.400e+01  6.339e+00  -2.209   0.0285 *
## as.factor(byear)1940  7.000e+00  6.339e+00   1.104   0.2710
## as.factor(byear)1941  3.577e-13  5.490e+00   0.000   1.0000
## as.factor(byear)1943  1.000e+00  5.490e+00   0.182   0.8557
## as.factor(byear)1944  9.645e-01  5.029e+00   0.192   0.8481
## as.factor(byear)1945  3.686e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1946  1.000e+00  5.490e+00   0.182   0.8557
## as.factor(byear)1947  2.000e+00  5.490e+00   0.364   0.7161
## as.factor(byear)1948  2.000e-01  4.910e+00   0.041   0.9676
## as.factor(byear)1949  3.244e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1950 -1.500e+00  5.490e+00  -0.273   0.7850
## as.factor(byear)1952 -1.286e+00  5.505e+00  -0.234   0.8156
## as.factor(byear)1953 -1.786e+00  5.505e+00  -0.324   0.7461
## as.factor(byear)1954 -8.000e+00  6.339e+00  -1.262   0.2087
## as.factor(byear)1955  3.655e-13  5.490e+00   0.000   1.0000
## as.factor(byear)1956 -2.855e-01  4.859e+00  -0.059   0.9532
## as.factor(byear)1957  3.764e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1958  9.048e-01  4.843e+00   0.187   0.8520
## as.factor(byear)1959  3.599e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1960  1.143e+00  5.183e+00   0.221   0.8257
## as.factor(byear)1961  2.500e+00  5.490e+00   0.455   0.6494
## as.factor(byear)1962  3.469e-13  5.176e+00   0.000   1.0000
## as.factor(byear)1963 -2.393e+00  5.016e+00  -0.477   0.6339
## as.factor(byear)1964 -2.643e+00  5.016e+00  -0.527   0.5989
## as.factor(byear)1965  3.273e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1966 -1.750e+00  5.011e+00  -0.349   0.7274
## as.factor(byear)1967  3.606e-13  5.176e+00   0.000   1.0000
## as.factor(byear)1968 -1.214e+00  4.873e+00  -0.249   0.8036
## as.factor(byear)1970  1.286e+00  4.913e+00   0.262   0.7939
## as.factor(byear)1971  3.804e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1972  1.000e+00  5.176e+00   0.193   0.8470
## as.factor(byear)1973 -6.643e+00  5.016e+00  -1.324   0.1871
## as.factor(byear)1974  2.972e+00  4.921e+00   0.604   0.5468
## as.factor(byear)1975 -1.667e+00  5.176e+00  -0.322   0.7478
## as.factor(byear)1976 -8.928e-01  5.016e+00  -0.178   0.8589
## as.factor(byear)1977  1.322e+00  5.050e+00   0.262   0.7939
## as.factor(byear)1978  2.667e+00  5.176e+00   0.515   0.6071
## as.factor(byear)1979 -1.286e+00  4.859e+00  -0.265   0.7917
## as.factor(byear)1980 -1.400e+00  4.910e+00  -0.285   0.7759
## as.factor(byear)1981 -4.283e-01  5.050e+00  -0.085   0.9325
## as.factor(byear)1982  3.631e-13  6.339e+00   0.000   1.0000
## as.factor(byear)1983 -6.284e-01  4.921e+00  -0.128   0.8985
## as.factor(byear)1984  4.072e+00  5.050e+00   0.806   0.4212
## as.factor(byear)1985 -4.738e-02  5.205e+00  -0.009   0.9927
## as.factor(byear)1986  2.860e-01  5.205e+00   0.055   0.9563
## as.factor(byear)1987  2.429e+00  4.980e+00   0.488   0.6264
## as.factor(byear)1988  1.464e+00  5.029e+00   0.291   0.7712
```

```
## as.factor(byear)1989    4.098e-01   4.677e+00    0.088    0.9303
## as.factor(byear)1990    2.943e+00   4.955e+00    0.594    0.5533
## as.factor(byear)1991    1.540e+00   4.728e+00    0.326    0.7451
## as.factor(byear)1992    1.365e+00   4.733e+00    0.288    0.7734
## as.factor(byear)1993    7.145e-01   5.505e+00    0.130    0.8969
## as.factor(byear)1994    1.667e-01   4.841e+00    0.034    0.9726
## as.factor(byear)1996    2.000e+00   4.841e+00    0.413    0.6800
## as.factor(byear)1997   -7.855e-01   5.505e+00   -0.143    0.8867
## as.factor(byear)1999    3.429e+00   6.393e+00    0.536    0.5924
## as.factor(byear)2000    2.229e+00   4.980e+00    0.448    0.6550
## as.factor(byear)2001   -2.238e+00   5.242e+00   -0.427    0.6700
## as.factor(byear)2002   -2.381e+00   5.205e+00   -0.457    0.6480
## as.factor(byear)2003   -8.570e-01   5.183e+00   -0.165    0.8689
## as.factor(byear)2005   -7.571e+00   5.552e+00   -1.364    0.1745
## as.factor(byear)2006    4.289e-01   5.242e+00    0.082    0.9349
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.482 on 170 degrees of freedom
##   (64 observations deleted due to missingness)
## Multiple R-squared:  0.3857, Adjusted R-squared:  0.0677
## F-statistic: 1.213 on 88 and 170 DF,  p-value: 0.143
```

```r
#we can make inferences about the fixed effects
plot(coef(timeMod)[-c(1:2)] ~ as.numeric(substr(names(coef(timeMod)[-c(1:2)]),
                                    start = 17, stop = 20)))
```



```r
#doesnt actually seem that there is much of a trend in the baseline aggregate outcome
#now, lets add a location fixed effect
twowayMod = lm(politychanget1 ~ nonviol + as.factor(byear) + as.factor(location), #notice the as.factor
        data = data)
summary(twowayMod) #still holds up, but keep in mind the very strong assumptions, especially when the f
```

```
##
## Call:
## lm(formula = politychanget1 ~ nonviol + as.factor(byear) + as.factor(location),
##     data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.8541 -0.6554  0.0000  0.5956  6.5973
##
## Coefficients: (4 not defined because of singularities)
##                            Estimate Std. Error t value
## (Intercept)               -5.329e+00  6.602e+00  -0.807
## nonviol                    4.824e+00  1.305e+00   3.697
## as.factor(byear)1901       8.874e+00  1.086e+01   0.817
## as.factor(byear)1902      -3.890e+00  8.721e+00  -0.446
## as.factor(byear)1903       5.329e+00  7.749e+00   0.688
## as.factor(byear)1904       4.362e+00  8.575e+00   0.509
## as.factor(byear)1905       8.774e+00  8.293e+00   1.058
## as.factor(byear)1906       5.329e+00  7.749e+00   0.688
## as.factor(byear)1907      -2.952e+00  8.334e+00  -0.354
## as.factor(byear)1908       5.927e+00  8.211e+00   0.722
## as.factor(byear)1910       5.100e+00  8.446e+00   0.604
## as.factor(byear)1911       2.113e+00  7.906e+00   0.267
## as.factor(byear)1912      -5.090e-01  8.678e+00  -0.059
## as.factor(byear)1916       1.177e+01  8.293e+00   1.420
## as.factor(byear)1917       6.443e+00  7.365e+00   0.875
## as.factor(byear)1918       8.661e+00  9.258e+00   0.935
## as.factor(byear)1919       3.752e+00  6.856e+00   0.547
## as.factor(byear)1922       3.113e+00  7.906e+00   0.394
## as.factor(byear)1923       3.907e+00  7.700e+00   0.507
## as.factor(byear)1924       5.236e+00  7.250e+00   0.722
## as.factor(byear)1925      -6.685e+00  8.479e+00  -0.788
## as.factor(byear)1926       2.100e+00  8.446e+00   0.249
## as.factor(byear)1929       5.100e+00  8.446e+00   0.604
## as.factor(byear)1930      -8.812e-01  9.124e+00  -0.097
## as.factor(byear)1931      -7.586e-02  8.284e+00  -0.009
## as.factor(byear)1932       5.230e+00  7.254e+00   0.721
## as.factor(byear)1934       2.087e+00  8.966e+00   0.233
## as.factor(byear)1936      -1.191e+01  8.966e+00  -1.329
## as.factor(byear)1940       1.796e+01  1.187e+01   1.514
## as.factor(byear)1941      -3.812e-01  7.916e+00  -0.048
## as.factor(byear)1943       5.118e+00  8.275e+00   0.618
## as.factor(byear)1944       3.301e+00  6.986e+00   0.473
## as.factor(byear)1945       2.674e+00  8.234e+00   0.325
## as.factor(byear)1946       6.188e-01  7.916e+00   0.078
## as.factor(byear)1947       6.113e+00  7.906e+00   0.773
## as.factor(byear)1948       3.714e+00  7.315e+00   0.508
## as.factor(byear)1949       2.416e+00  8.757e+00   0.276
## as.factor(byear)1950       1.583e+00  7.665e+00   0.206
## as.factor(byear)1952       3.794e-01  7.953e+00   0.048
## as.factor(byear)1953       2.571e+00  7.707e+00   0.334
## as.factor(byear)1954      -1.029e+01  8.258e+00  -1.247
## as.factor(byear)1955       3.209e+00  7.602e+00   0.422
## as.factor(byear)1956       2.363e+00  6.934e+00   0.341
```

```
## as.factor(byear)1957                      -2.952e+00  1.012e+01   -0.292
## as.factor(byear)1958                       1.096e+01  1.039e+01    1.055
## as.factor(byear)1959                       3.826e+00  8.005e+00    0.478
## as.factor(byear)1960                       6.050e+00  7.453e+00    0.812
## as.factor(byear)1961                       3.266e+00  7.372e+00    0.443
## as.factor(byear)1962                       1.514e+00  6.910e+00    0.219
## as.factor(byear)1963                      -1.735e-02  7.181e+00   -0.002
## as.factor(byear)1964                       1.118e+00  7.804e+00    0.143
## as.factor(byear)1965                       5.329e+00  7.749e+00    0.688
## as.factor(byear)1966                       7.264e-01  7.017e+00    0.104
## as.factor(byear)1967                       6.697e+00  7.041e+00    0.951
## as.factor(byear)1968                       2.087e+00  6.889e+00    0.303
## as.factor(byear)1970                       2.659e+00  6.814e+00    0.390
## as.factor(byear)1971                      -2.374e-01  9.485e+00   -0.025
## as.factor(byear)1972                       7.626e-01  7.552e+00    0.101
## as.factor(byear)1973                      -4.062e+00  6.824e+00   -0.595
## as.factor(byear)1974                       6.421e+00  7.071e+00    0.908
## as.factor(byear)1975                       5.962e+00  1.187e+01    0.502
## as.factor(byear)1976                       1.180e+00  6.970e+00    0.169
## as.factor(byear)1977                       3.017e+00  7.092e+00    0.425
## as.factor(byear)1978                       6.207e-01  7.258e+00    0.086
## as.factor(byear)1979                       2.776e+00  7.137e+00    0.389
## as.factor(byear)1980                       1.009e+00  7.008e+00    0.144
## as.factor(byear)1981                       5.166e+00  7.056e+00    0.732
## as.factor(byear)1982                       7.696e-14  5.738e+00    0.000
## as.factor(byear)1983                       4.734e+00  6.812e+00    0.695
## as.factor(byear)1984                       7.918e+00  7.231e+00    1.095
## as.factor(byear)1985                       3.836e+00  7.230e+00    0.531
## as.factor(byear)1986                       2.915e-03  7.432e+00    0.000
## as.factor(byear)1987                       5.752e-01  7.218e+00    0.080
## as.factor(byear)1988                       5.564e+00  7.205e+00    0.772
## as.factor(byear)1989                       6.970e-01  6.612e+00    0.105
## as.factor(byear)1990                       3.617e+00  7.094e+00    0.510
## as.factor(byear)1991                       4.050e+00  7.018e+00    0.577
## as.factor(byear)1992                       1.370e-13  5.738e+00    0.000
## as.factor(byear)1993                       7.649e+00  7.370e+00    1.038
## as.factor(byear)1994                       5.436e+00  7.045e+00    0.772
## as.factor(byear)1996                       4.151e+00  6.671e+00    0.622
## as.factor(byear)1997                      -1.499e-01  8.315e+00   -0.018
## as.factor(byear)1999                       7.505e+00  7.844e+00    0.957
## as.factor(byear)2000                       8.872e+00  7.263e+00    1.222
## as.factor(byear)2001                      -5.598e+00  7.603e+00   -0.736
## as.factor(byear)2002                       4.050e+00  9.065e+00    0.447
## as.factor(byear)2003                       7.761e-01  6.885e+00    0.113
## as.factor(byear)2005                      -2.274e+01  7.708e+00   -2.950
## as.factor(byear)2006                       1.170e+00  7.544e+00    0.155
## as.factor(location)Albania                -1.919e-01  5.520e+00   -0.035
## as.factor(location)Algeria                 4.572e+00  4.504e+00    1.015
## as.factor(location)Angola                 -6.329e-01  1.120e+01   -0.057
## as.factor(location)Argentina               2.794e+00  4.644e+00    0.602
## as.factor(location)Austria                -4.758e+00  8.211e+00   -0.579
## as.factor(location)Azerbaijan              1.279e+00  5.828e+00    0.219
## as.factor(location)Bangladesh              1.979e+00  4.682e+00    0.423
## as.factor(location)Belarus                -6.654e-01  6.572e+00   -0.101
```

```
## as.factor(location)Benin                      6.808e+00  5.520e+00   1.233
## as.factor(location)Bolivia                     9.219e+00  5.496e+00   1.677
## as.factor(location)Brazil                      8.432e-01  5.268e+00   0.160
## as.factor(location)Bulgaria                    6.150e-01  5.060e+00   0.122
## as.factor(location)Burma                      -2.827e-01  4.664e+00  -0.061
## as.factor(location)Burundi                     5.923e+00  5.074e+00   1.167
## as.factor(location)Cambodia                    2.189e+00  5.009e+00   0.437
## as.factor(location)CAR                        -1.069e-01  6.040e+00  -0.018
## as.factor(location)Chad                        2.248e+00  4.999e+00   0.450
## as.factor(location)Chile                       5.810e-01  4.916e+00   0.118
## as.factor(location)China                      -7.840e-01  3.828e+00  -0.205
## as.factor(location)Colombia                    2.914e+00  5.595e+00   0.521
## as.factor(location)Congo-Brazzaville (ROC)     5.479e+00  7.437e+00   0.737
## as.factor(location)Costa Rica                  1.615e+00  6.440e+00   0.251
## as.factor(location)Croatia                            NA         NA         NA
## as.factor(location)Cuba                        1.197e+01  5.818e+00   2.057
## as.factor(location)Czechoslovakia              3.113e+00  4.732e+00   0.658
## as.factor(location)Djibouti                    1.279e+00  5.828e+00   0.219
## as.factor(location)Dominican Republic                 NA         NA         NA
## as.factor(location)East Germany               -1.962e+00  5.426e+00  -0.362
## as.factor(location)East Timor                  2.425e+00  5.130e+00   0.473
## as.factor(location)Egypt                      -5.367e+00  6.343e+00  -0.846
## as.factor(location)El Salvador                 3.965e-01  4.673e+00   0.085
## as.factor(location)Ethiopia                    7.922e+00  4.576e+00   1.731
## as.factor(location)Finland                    -3.331e+00  8.535e+00  -0.390
## as.factor(location)France                     -5.633e+00  9.618e+00  -0.586
## as.factor(location)Georgia                     5.041e-01  4.820e+00   0.105
## as.factor(location)Germany                    -3.402e+00  6.990e+00  -0.487
## as.factor(location)Ghana                      -8.367e+00  6.343e+00  -1.319
## as.factor(location)Greece                      2.116e-01  4.717e+00   0.045
## as.factor(location)Guatemala                   7.623e+00  4.677e+00   1.630
## as.factor(location)Guyana                      9.888e+00  6.133e+00   1.612
## as.factor(location)Haiti                      -3.331e+00  6.319e+00  -0.527
## as.factor(location)Hungary                     6.693e+00  4.239e+00   1.579
## as.factor(location)India                       5.064e-01  4.328e+00   0.117
## as.factor(location)Indonesia                   2.655e+00  4.563e+00   0.582
## as.factor(location)Iran                       -5.981e-01  4.632e+00  -0.129
## as.factor(location)Iraq                        1.503e+00  4.195e+00   0.358
## as.factor(location)Israel                     -4.660e+00  6.153e+00  -0.757
## as.factor(location)Italy                       2.212e+00  7.428e+00   0.298
## as.factor(location)Ivory Coast                 1.279e+00  8.179e+00   0.156
## as.factor(location)Jordan                      2.670e+00  5.861e+00   0.456
## as.factor(location)Kenya                      -1.490e+00  5.079e+00  -0.293
## as.factor(location)Kyrgyzstan                  2.925e+01  7.132e+00   4.101
## as.factor(location)Laos                       -2.721e+00  6.522e+00  -0.417
## as.factor(location)Lebanon                    -5.633e+00  9.618e+00  -0.586
## as.factor(location)Liberia                     5.673e+00  3.779e+00   1.501
## as.factor(location)Madagascar                 -3.545e+00  6.053e+00  -0.586
## as.factor(location)Malawi                      1.451e+01  5.348e+00   2.712
## as.factor(location)Malaysia                    1.615e+00  6.440e+00   0.251
## as.factor(location)Mali                        5.720e+00  4.657e+00   1.228
## as.factor(location)Mexico                      2.288e-01  4.990e+00   0.046
## as.factor(location)Moldova                     5.329e+00  5.208e+00   1.023
## as.factor(location)Mongolia                    8.808e+00  5.520e+00   1.596
```

```
## as.factor(location)Morocco                      8.281e+00  7.479e+00    1.107
## as.factor(location)Mozambique                    2.554e+00  6.148e+00    0.415
## as.factor(location)Namibia/South West Africa     9.669e-01  7.766e+00    0.125
## as.factor(location)Natal                                NA         NA       NA
## as.factor(location)Nepal                         1.044e+01  4.429e+00    2.357
## as.factor(location)Nicaragua                     1.201e+01  5.090e+00    2.361
## as.factor(location)Niger                         3.455e+00  6.053e+00    0.571
## as.factor(location)Nigeria                      -3.826e+00  4.422e+00   -0.865
## as.factor(location)Northern Ireland              3.242e+00  5.873e+00    0.552
## as.factor(location)Oman                          4.212e+00  6.930e+00    0.608
## as.factor(location)Ottoman Empire                       NA         NA       NA
## as.factor(location)Pakistan                     -2.882e+00  4.274e+00   -0.674
## as.factor(location)Panama                        1.593e+01  6.170e+00    2.582
## as.factor(location)Papua New Guinea             -2.343e-01  6.262e+00   -0.037
## as.factor(location)Paraguay                      3.216e+00  6.898e+00    0.466
## as.factor(location)Peru                          1.058e+00  4.360e+00    0.243
## as.factor(location)Philippines                   5.210e+00  4.583e+00    1.137
## as.factor(location)Poland                        1.232e+00  4.329e+00    0.285
## as.factor(location)Portugal                      8.454e-02  6.218e+00    0.014
## as.factor(location)Romania                       8.281e+00  4.797e+00    1.726
## as.factor(location)Russia                       -1.444e+00  4.716e+00   -0.306
## as.factor(location)Rwanda                        2.651e+00  4.677e+00    0.567
## as.factor(location)Saudi Arabia                  2.288e-01  7.605e+00    0.030
## as.factor(location)Senegal                       6.334e-01  6.343e+00    0.100
## as.factor(location)Serbia                       -1.069e-01  6.040e+00   -0.018
## as.factor(location)Sierra Leone                  1.228e+01  5.828e+00    2.107
## as.factor(location)Somalia                       5.329e+00  5.208e+00    1.023
## as.factor(location)South Africa                 -3.144e+00  5.704e+00   -0.551
## as.factor(location)South Korea                   3.371e+00  4.844e+00    0.696
## as.factor(location)Spain                         3.242e+00  5.873e+00    0.552
## as.factor(location)Sri Lanka                     5.567e+00  6.586e+00    0.845
## as.factor(location)Sudan                         3.658e+00  4.225e+00    0.866
## as.factor(location)Syria                         4.320e+00  5.996e+00    0.720
## as.factor(location)Taiwan                       -2.270e+00  6.293e+00   -0.361
## as.factor(location)Tajikistan                    6.329e+00  5.208e+00    1.215
## as.factor(location)Tanzania                      5.505e+00  5.348e+00    1.029
## as.factor(location)Thailand                      9.247e+00  4.235e+00    2.183
## as.factor(location)Tibet                         1.838e+00  5.355e+00    0.343
## as.factor(location)Turkey                        1.861e-01  4.331e+00    0.043
## as.factor(location)Uganda                        1.034e+00  4.463e+00    0.232
## as.factor(location)Ukraine                       6.103e+00  6.697e+00    0.911
## as.factor(location)Uruguay                       3.967e+00  5.233e+00    0.758
## as.factor(location)USSR                          6.210e+00  6.121e+00    1.015
## as.factor(location)Venezuela                    -3.545e+00  8.341e+00   -0.425
## as.factor(location)Vietnam                      -5.633e+00  9.180e+00   -0.614
## as.factor(location)West Papua                   -6.124e-01  7.145e+00   -0.086
## as.factor(location)Western Sahara               -6.329e-01  1.120e+01   -0.057
## as.factor(location)Yemen                         3.733e+00  5.405e+00    0.691
## as.factor(location)Yemen Arab Republic           3.215e+00  5.183e+00    0.620
## as.factor(location)Yemen People's Republic       6.326e+00  6.545e+00    0.967
## as.factor(location)Yugoslavia                   -7.910e-01  4.181e+00   -0.189
## as.factor(location)Zaire/DRC                    -6.373e-01  4.427e+00   -0.144
## as.factor(location)Zambia                        1.100e+01  5.333e+00    2.062
## as.factor(location)Zimbabwe                     -3.748e+00  4.934e+00   -0.760
```

```
##                              Pr(>|t|)
## (Intercept)                  0.422852
## nonviol                      0.000486 ***
## as.factor(byear)1901         0.417301
## as.factor(byear)1902         0.657225
## as.factor(byear)1903         0.494378
## as.factor(byear)1904         0.612863
## as.factor(byear)1905         0.294442
## as.factor(byear)1906         0.494378
## as.factor(byear)1907         0.724476
## as.factor(byear)1908         0.473265
## as.factor(byear)1910         0.548286
## as.factor(byear)1911         0.790175
## as.factor(byear)1912         0.953426
## as.factor(byear)1916         0.161029
## as.factor(byear)1917         0.385262
## as.factor(byear)1918         0.353434
## as.factor(byear)1919         0.586347
## as.factor(byear)1922         0.695167
## as.factor(byear)1923         0.613755
## as.factor(byear)1924         0.473043
## as.factor(byear)1925         0.433647
## as.factor(byear)1926         0.804484
## as.factor(byear)1929         0.548286
## as.factor(byear)1930         0.923389
## as.factor(byear)1931         0.992725
## as.factor(byear)1932         0.473821
## as.factor(byear)1934         0.816752
## as.factor(byear)1936         0.189157
## as.factor(byear)1940         0.135540
## as.factor(byear)1941         0.961756
## as.factor(byear)1943         0.538680
## as.factor(byear)1944         0.638296
## as.factor(byear)1945         0.746514
## as.factor(byear)1946         0.937964
## as.factor(byear)1947         0.442494
## as.factor(byear)1948         0.613566
## as.factor(byear)1949         0.783627
## as.factor(byear)1950         0.837144
## as.factor(byear)1952         0.962112
## as.factor(byear)1953         0.739934
## as.factor(byear)1954         0.217581
## as.factor(byear)1955         0.674431
## as.factor(byear)1956         0.734464
## as.factor(byear)1957         0.771533
## as.factor(byear)1958         0.295633
## as.factor(byear)1959         0.634500
## as.factor(byear)1960         0.420268
## as.factor(byear)1961         0.659406
## as.factor(byear)1962         0.827334
## as.factor(byear)1963         0.998081
## as.factor(byear)1964         0.886628
## as.factor(byear)1965         0.494378
## as.factor(byear)1966         0.917904
```

```
## as.factor(byear)1967                0.345494
## as.factor(byear)1968                0.763013
## as.factor(byear)1970                0.697769
## as.factor(byear)1971                0.980114
## as.factor(byear)1972                0.919919
## as.factor(byear)1973                0.553998
## as.factor(byear)1974                0.367630
## as.factor(byear)1975                0.617265
## as.factor(byear)1976                0.866112
## as.factor(byear)1977                0.672153
## as.factor(byear)1978                0.932137
## as.factor(byear)1979                0.698772
## as.factor(byear)1980                0.885981
## as.factor(byear)1981                0.467038
## as.factor(byear)1982                1.000000
## as.factor(byear)1983                0.489861
## as.factor(byear)1984                0.278038
## as.factor(byear)1985                0.597702
## as.factor(byear)1986                0.999688
## as.factor(byear)1987                0.936755
## as.factor(byear)1988                0.443160
## as.factor(byear)1989                0.916409
## as.factor(byear)1990                0.612055
## as.factor(byear)1991                0.566079
## as.factor(byear)1992                1.000000
## as.factor(byear)1993                0.303650
## as.factor(byear)1994                0.443461
## as.factor(byear)1996                0.536248
## as.factor(byear)1997                0.985678
## as.factor(byear)1999                0.342637
## as.factor(byear)2000                0.226828
## as.factor(byear)2001                0.464542
## as.factor(byear)2002                0.656690
## as.factor(byear)2003                0.910637
## as.factor(byear)2005                0.004572 **
## as.factor(byear)2006                0.877236
## as.factor(location)Albania          0.972383
## as.factor(location)Algeria          0.314268
## as.factor(location)Angola           0.955126
## as.factor(location)Argentina        0.549753
## as.factor(location)Austria          0.564515
## as.factor(location)Azerbaijan       0.827044
## as.factor(location)Bangladesh       0.674150
## as.factor(location)Belarus          0.919708
## as.factor(location)Benin            0.222389
## as.factor(location)Bolivia          0.098868 .
## as.factor(location)Brazil           0.873389
## as.factor(location)Bulgaria         0.903687
## as.factor(location)Burma            0.951870
## as.factor(location)Burundi          0.247829
## as.factor(location)Cambodia         0.663666
## as.factor(location)CAR              0.985943
## as.factor(location)Chad             0.654579
## as.factor(location)Chile            0.906336
```

```
## as.factor(location)China                       0.838427
## as.factor(location)Colombia                     0.604504
## as.factor(location)Congo-Brazzaville (ROC)       0.464259
## as.factor(location)Costa Rica                    0.802837
## as.factor(location)Croatia                             NA
## as.factor(location)Cuba                          0.044224 *
## as.factor(location)Czechoslovakia                0.513185
## as.factor(location)Djibouti                      0.827044
## as.factor(location)Dominican Republic                  NA
## as.factor(location)East Germany                  0.718964
## as.factor(location)East Timor                    0.638149
## as.factor(location)Egypt                         0.400989
## as.factor(location)El Salvador                   0.932670
## as.factor(location)Ethiopia                      0.088700 .
## as.factor(location)Finland                       0.697745
## as.factor(location)France                        0.560354
## as.factor(location)Georgia                       0.917073
## as.factor(location)Germany                       0.628273
## as.factor(location)Ghana                         0.192341
## as.factor(location)Greece                        0.964369
## as.factor(location)Guatemala                     0.108536
## as.factor(location)Guyana                        0.112336
## as.factor(location)Haiti                         0.600052
## as.factor(location)Hungary                       0.119822
## as.factor(location)India                         0.907264
## as.factor(location)Indonesia                     0.562930
## as.factor(location)Iran                          0.897717
## as.factor(location)Iraq                          0.721338
## as.factor(location)Israel                        0.451844
## as.factor(location)Italy                         0.766970
## as.factor(location)Ivory Coast                   0.876261
## as.factor(location)Jordan                        0.650409
## as.factor(location)Kenya                         0.770267
## as.factor(location)Kyrgyzstan                    0.000130 ***
## as.factor(location)Laos                          0.678084
## as.factor(location)Lebanon                       0.560354
## as.factor(location)Liberia                       0.138710
## as.factor(location)Madagascar                    0.560372
## as.factor(location)Malawi                        0.008780 **
## as.factor(location)Malaysia                      0.802837
## as.factor(location)Mali                          0.224253
## as.factor(location)Mexico                        0.963586
## as.factor(location)Moldova                       0.310447
## as.factor(location)Mongolia                      0.115973
## as.factor(location)Morocco                       0.272759
## as.factor(location)Mozambique                    0.679383
## as.factor(location)Namibia/South West Africa 0.901348
## as.factor(location)Natal                               NA
## as.factor(location)Nepal                         0.021808 *
## as.factor(location)Nicaragua                     0.021633 *
## as.factor(location)Niger                         0.570341
## as.factor(location)Nigeria                       0.390521
## as.factor(location)Northern Ireland              0.583014
## as.factor(location)Oman                          0.545716
```

```
## as.factor(location)Ottoman Empire               NA
## as.factor(location)Pakistan                 0.502849
## as.factor(location)Panama                   0.012374 *
## as.factor(location)Papua New Guinea         0.970281
## as.factor(location)Paraguay                 0.642788
## as.factor(location)Peru                     0.809181
## as.factor(location)Philippines              0.260247
## as.factor(location)Poland                   0.777029
## as.factor(location)Portugal                 0.989199
## as.factor(location)Romania                  0.089602 .
## as.factor(location)Russia                   0.760470
## as.factor(location)Rwanda                   0.573083
## as.factor(location)Saudi Arabia             0.976099
## as.factor(location)Senegal                  0.920803
## as.factor(location)Serbia                   0.985943
## as.factor(location)Sierra Leone             0.039461 *
## as.factor(location)Somalia                  0.310447
## as.factor(location)South Africa             0.583689
## as.factor(location)South Korea              0.489192
## as.factor(location)Spain                    0.583014
## as.factor(location)Sri Lanka                0.401435
## as.factor(location)Sudan                    0.390191
## as.factor(location)Syria                    0.474146
## as.factor(location)Taiwan                   0.719575
## as.factor(location)Tajikistan               0.229200
## as.factor(location)Tanzania                 0.307575
## as.factor(location)Thailand                 0.033071 *
## as.factor(location)Tibet                    0.732615
## as.factor(location)Turkey                   0.965870
## as.factor(location)Uganda                   0.817641
## as.factor(location)Ukraine                  0.365925
## as.factor(location)Uruguay                  0.451505
## as.factor(location)USSR                     0.314502
## as.factor(location)Venezuela                0.672385
## as.factor(location)Vietnam                  0.541857
## as.factor(location)West Papua               0.931988
## as.factor(location)Western Sahara           0.955126
## as.factor(location)Yemen                    0.492509
## as.factor(location)Yemen Arab Republic      0.537483
## as.factor(location)Yemen People's Republic  0.337735
## as.factor(location)Yugoslavia               0.850589
## as.factor(location)Zaire/DRC                0.886022
## as.factor(location)Zambia                   0.043711 *
## as.factor(location)Zimbabwe                 0.450543
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.057 on 58 degrees of freedom
##   (64 observations deleted due to missingness)
## Multiple R-squared:  0.8283, Adjusted R-squared:  0.236
## F-statistic: 1.399 on 200 and 58 DF,  p-value: 0.06703
#now lets look at a balanced example, which makes more intuitive and mathematical sense
#Bosnian ethnic voting as a function of violence experienced during the war
```

```
data2 = read.csv('bosnia.csv')
Log_Casualty.Model <- lm(Ethnic_Vote_Share ~ Log_Casualty,
                         data = data2)
summary(Log_Casualty.Model) #notice the lack of reliable effects
```

```
##
## Call:
## lm(formula = Ethnic_Vote_Share ~ Log_Casualty, data = data2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -61.526 -10.098   3.915  12.273  18.561
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   81.2928     0.8418  96.570   <2e-16 ***
## Log_Casualty  -0.6111     0.8462  -0.722    0.471
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 15.18 on 426 degrees of freedom
## Multiple R-squared:  0.001223,   Adjusted R-squared:  -0.001122
## F-statistic: 0.5215 on 1 and 426 DF,  p-value: 0.4706
```

```
#lets add a province dummy
Log_Casualty.Model2 <- lm(Ethnic_Vote_Share ~ Log_Casualty + as.factor(Municipality),
                          data = data2)
summary(Log_Casualty.Model2) #still nothing, but notice the NAs - why?
```

```
##
## Call:
## lm(formula = Ethnic_Vote_Share ~ Log_Casualty + as.factor(Municipality),
##     data = data2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -45.067  -4.548   1.650   4.583  50.961
##
## Coefficients: (1 not defined because of singularities)
##                                                     Estimate
## (Intercept)                                         87.78648
## Log_Casualty                                         1.80880
## as.factor(Municipality)Banovici                    -18.38521
## as.factor(Municipality)Bihac                       -30.23323
## as.factor(Municipality)Bijeljina                     0.91318
## as.factor(Municipality)Bileca                        5.66981
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)  1.88312
## as.factor(Municipality)Bosanska Gradiska (Gradiska)   4.66507
## as.factor(Municipality)Bosanska Krupa              -12.19123
## as.factor(Municipality)Bosanski Brod                -5.79667
## as.factor(Municipality)Bosanski Novi (Novi Grad)     3.67511
## as.factor(Municipality)Bosanski Petrovac           -18.12054
## as.factor(Municipality)Bosansko Grahovo (Grahovo)  -17.67652
## as.factor(Municipality)Bratunac                      1.88079
```

```
## as.factor(Municipality)Brcko                      -14.54025
## as.factor(Municipality)Breza                      -22.35659
## as.factor(Municipality)Bugojno                    -19.56926
## as.factor(Municipality)Busovaca                     -8.33076
## as.factor(Municipality)Cajnice                       6.81146
## as.factor(Municipality)Capljina                      1.84665
## as.factor(Municipality)Cazin                       -13.63238
## as.factor(Municipality)Celinac                       4.70628
## as.factor(Municipality)Centar Sarajevo             -38.50807
## as.factor(Municipality)Citluk                       12.60337
## as.factor(Municipality)Derventa                     -0.02266
## as.factor(Municipality)Doboj                        -7.26418
## as.factor(Municipality)Donji Vakuf                 -18.36382
## as.factor(Municipality)Drvar                       -13.52460
## as.factor(Municipality)Foca (Srbinje)               0.84201
## as.factor(Municipality)Fojnica                     -11.62344
## as.factor(Municipality)Gacko                         3.99828
## as.factor(Municipality)Glamoc                       -7.31188
## as.factor(Municipality)Gorazde                     -18.93680
## as.factor(Municipality)Gornji Vakuf - Uskopolje     -4.21910
## as.factor(Municipality)Gradacac                    -20.43093
## as.factor(Municipality)Grude                         4.80119
## as.factor(Municipality)Hadzici                     -22.07409
## as.factor(Municipality)Han Pijesak                   5.67462
## as.factor(Municipality)Ilidza                      -16.94301
## as.factor(Municipality)Ilijas                      -20.76151
## as.factor(Municipality)Jablanica                   -24.69193
## as.factor(Municipality)Jajce                       -10.42958
## as.factor(Municipality)Kakanj                      -14.63352
## as.factor(Municipality)Kalesija                    -20.03774
## as.factor(Municipality)Kalinovik                     2.00610
## as.factor(Municipality)Kiseljak                     -4.05129
## as.factor(Municipality)Kladanj                     -22.65948
## as.factor(Municipality)Kljuc                       -11.49551
## as.factor(Municipality)Konjic                      -15.30172
## as.factor(Municipality)Kotor Varos                   5.10987
## as.factor(Municipality)Kresevo                      -7.43886
## as.factor(Municipality)Kupres (FBiH)                 3.01030
## as.factor(Municipality)Laktasi                       4.87878
## as.factor(Municipality)Livno                        -1.33171
## as.factor(Municipality)Ljubinje                      9.77993
## as.factor(Municipality)Ljubuski                      6.35017
## as.factor(Municipality)Lopare                       -5.93991
## as.factor(Municipality)Maglaj                      -19.15586
## as.factor(Municipality)Modrica                      -3.15609
## as.factor(Municipality)Mostar                      -12.55278
## as.factor(Municipality)Mrkonjic Grad                 3.34105
## as.factor(Municipality)Neum                          9.95773
## as.factor(Municipality)Nevesinje                     0.76051
## as.factor(Municipality)Novi Grad Sarajevo          -30.10479
## as.factor(Municipality)Novi Travnik                -12.84643
## as.factor(Municipality)Novo Sarajevo               -32.95022
## as.factor(Municipality)Odzak                        -8.64433
## as.factor(Municipality)Olovo                       -16.17042
```

```
## as.factor(Municipality)Orasje                             2.67803
## as.factor(Municipality)Pale (RS)                          4.26364
## as.factor(Municipality)Posusje                           10.93523
## as.factor(Municipality)Prijedor                          -3.50837
## as.factor(Municipality)Prnjavor                           2.11269
## as.factor(Municipality)Prozor (Prozor-Rama)               4.97342
## as.factor(Municipality)Rogatica                          -0.54407
## as.factor(Municipality)Rudo                               5.11882
## as.factor(Municipality)Samac (Bosanski Samac)             0.85634
## as.factor(Municipality)Sanski Most                      -14.02514
## as.factor(Municipality)Sekovici                          -0.64380
## as.factor(Municipality)Sipovo                             6.31584
## as.factor(Municipality)Siroki Brijeg                      3.11603
## as.factor(Municipality)Skender Vakuf (Knezevo)            5.02701
## as.factor(Municipality)Sokolac                            4.73670
## as.factor(Municipality)Srbac                              4.48245
## as.factor(Municipality)Srebrenica                         0.33361
## as.factor(Municipality)Srebrenik                        -32.35237
## as.factor(Municipality)Stari Grad Sarajevo              -26.76183
## as.factor(Municipality)Stolac                             3.36583
## as.factor(Municipality)Tesanj                           -18.85756
## as.factor(Municipality)Teslic                            -1.60026
## as.factor(Municipality)Tomislavgrad                       8.65787
## as.factor(Municipality)Travnik                          -10.76784
## as.factor(Municipality)Trebinje                           3.30728
## as.factor(Municipality)Trnovo (FBiH)                     -9.78708
## as.factor(Municipality)Tuzla                            -46.53079
## as.factor(Municipality)Ugljevik                           0.81542
## as.factor(Municipality)Vares                            -23.91164
## as.factor(Municipality)Velika Kladusa                   -47.48446
## as.factor(Municipality)Visegrad                           2.91782
## as.factor(Municipality)Visoko                           -15.45174
## as.factor(Municipality)Vitez                             -7.82968
## as.factor(Municipality)Vlasenica                          4.45992
## as.factor(Municipality)Vogosca                          -22.47008
## as.factor(Municipality)Zavidovici                       -17.43838
## as.factor(Municipality)Zenica                           -22.28474
## as.factor(Municipality)Zepce                             -2.32357
## as.factor(Municipality)Zivince                          -25.69799
## as.factor(Municipality)Zvornik                                 NA
##                                                         Std. Error
## (Intercept)                                                4.55938
## Log_Casualty                                               3.97367
## as.factor(Municipality)Banovici                            6.40974
## as.factor(Municipality)Bihac                               5.86519
## as.factor(Municipality)Bijeljina                           6.48500
## as.factor(Municipality)Bileca                              7.15734
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)   6.35099
## as.factor(Municipality)Bosanska Gradiska (Gradiska)        6.59876
## as.factor(Municipality)Bosanska Krupa                      5.86716
## as.factor(Municipality)Bosanski Brod                       5.90768
## as.factor(Municipality)Bosanski Novi (Novi Grad)           5.98737
## as.factor(Municipality)Bosanski Petrovac                   5.88055
## as.factor(Municipality)Bosansko Grahovo (Grahovo)          5.86451
```

```
## as.factor(Municipality)Bratunac                        8.55328
## as.factor(Municipality)Brcko                           5.88686
## as.factor(Municipality)Breza                           6.00423
## as.factor(Municipality)Bugojno                         5.94165
## as.factor(Municipality)Busovaca                        5.87802
## as.factor(Municipality)Cajnice                         6.04717
## as.factor(Municipality)Capljina                        6.96078
## as.factor(Municipality)Cazin                           6.06104
## as.factor(Municipality)Celinac                         6.22273
## as.factor(Municipality)Centar Sarajevo                 5.87365
## as.factor(Municipality)Citluk                         10.62360
## as.factor(Municipality)Derventa                        5.95853
## as.factor(Municipality)Doboj                           5.86691
## as.factor(Municipality)Donji Vakuf                     6.34860
## as.factor(Municipality)Drvar                           7.06526
## as.factor(Municipality)Foca (Srbinje)                  7.42823
## as.factor(Municipality)Fojnica                         5.89252
## as.factor(Municipality)Gacko                           6.12501
## as.factor(Municipality)Glamoc                          6.16697
## as.factor(Municipality)Gorazde                         6.46800
## as.factor(Municipality)Gornji Vakuf - Uskopolje        5.89522
## as.factor(Municipality)Gradacac                        5.98415
## as.factor(Municipality)Grude                          11.19567
## as.factor(Municipality)Hadzici                         6.17200
## as.factor(Municipality)Han Pijesak                     5.87904
## as.factor(Municipality)Ilidza                          5.88311
## as.factor(Municipality)Ilijas                          5.86516
## as.factor(Municipality)Jablanica                       5.86433
## as.factor(Municipality)Jajce                           5.99211
## as.factor(Municipality)Kakanj                          6.58425
## as.factor(Municipality)Kalesija                        5.98062
## as.factor(Municipality)Kalinovik                       7.10355
## as.factor(Municipality)Kiseljak                        5.91028
## as.factor(Municipality)Kladanj                         6.09570
## as.factor(Municipality)Kljuc                           6.12761
## as.factor(Municipality)Konjic                          5.86731
## as.factor(Municipality)Kotor Varos                     5.94498
## as.factor(Municipality)Kresevo                         5.95411
## as.factor(Municipality)Kupres (FBiH)                   6.00465
## as.factor(Municipality)Laktasi                         7.07124
## as.factor(Municipality)Livno                          10.63107
## as.factor(Municipality)Ljubinje                        7.47684
## as.factor(Municipality)Ljubuski                       11.54723
## as.factor(Municipality)Lopare                          5.95335
## as.factor(Municipality)Maglaj                          5.87284
## as.factor(Municipality)Modrica                         5.91771
## as.factor(Municipality)Mostar                          5.87214
## as.factor(Municipality)Mrkonjic Grad                   5.91646
## as.factor(Municipality)Neum                           12.37966
## as.factor(Municipality)Nevesinje                       6.54111
## as.factor(Municipality)Novi Grad Sarajevo              5.87378
## as.factor(Municipality)Novi Travnik                    6.00222
## as.factor(Municipality)Novo Sarajevo                   5.87290
## as.factor(Municipality)Odzak                           6.81897
```

```
## as.factor(Municipality)Olovo                                 5.95203
## as.factor(Municipality)Orasje                                 6.26199
## as.factor(Municipality)Pale (RS)                              5.98245
## as.factor(Municipality)Posusje                               12.98803
## as.factor(Municipality)Prijedor                               6.62554
## as.factor(Municipality)Prnjavor                               6.39809
## as.factor(Municipality)Prozor (Prozor-Rama)                   5.87357
## as.factor(Municipality)Rogatica                               8.25900
## as.factor(Municipality)Rudo                                   5.87525
## as.factor(Municipality)Samac (Bosanski Samac)                 5.88997
## as.factor(Municipality)Sanski Most                            5.86649
## as.factor(Municipality)Sekovici                               5.87758
## as.factor(Municipality)Sipovo                                 6.27157
## as.factor(Municipality)Siroki Brijeg                         11.61352
## as.factor(Municipality)Skender Vakuf (Knezevo)                6.96033
## as.factor(Municipality)Sokolac                                5.93671
## as.factor(Municipality)Srbac                                  7.78169
## as.factor(Municipality)Srebrenica                            10.75618
## as.factor(Municipality)Srebrenik                              6.94356
## as.factor(Municipality)Stari Grad Sarajevo                    5.87248
## as.factor(Municipality)Stolac                                 6.64992
## as.factor(Municipality)Tesanj                                 6.00866
## as.factor(Municipality)Teslic                                 6.34619
## as.factor(Municipality)Tomislavgrad                          10.04927
## as.factor(Municipality)Travnik                                5.89486
## as.factor(Municipality)Trebinje                               6.40765
## as.factor(Municipality)Trnovo (FBiH)                          6.76903
## as.factor(Municipality)Tuzla                                  6.56707
## as.factor(Municipality)Ugljevik                               5.86506
## as.factor(Municipality)Vares                                  5.97918
## as.factor(Municipality)Velika Kladusa                         5.86758
## as.factor(Municipality)Visegrad                               7.78931
## as.factor(Municipality)Visoko                                 6.08099
## as.factor(Municipality)Vitez                                  6.21051
## as.factor(Municipality)Vlasenica                              7.91786
## as.factor(Municipality)Vogosca                                5.97720
## as.factor(Municipality)Zavidovici                             6.00070
## as.factor(Municipality)Zenica                                 6.60188
## as.factor(Municipality)Zepce                                  6.05466
## as.factor(Municipality)Zivince                                7.07663
## as.factor(Municipality)Zvornik                                     NA
##                                                  t value Pr(>|t|)
## (Intercept)                                       19.254  < 2e-16
## Log_Casualty                                       0.455 0.649277
## as.factor(Municipality)Banovici                   -2.868 0.004400
## as.factor(Municipality)Bihac                      -5.155 4.45e-07
## as.factor(Municipality)Bijeljina                   0.141 0.888106
## as.factor(Municipality)Bileca                      0.792 0.428849
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)  0.297 0.767034
## as.factor(Municipality)Bosanska Gradiska (Gradiska)  0.707 0.480103
## as.factor(Municipality)Bosanska Krupa             -2.078 0.038515
## as.factor(Municipality)Bosanski Brod              -0.981 0.327228
## as.factor(Municipality)Bosanski Novi (Novi Grad)   0.614 0.539776
## as.factor(Municipality)Bosanski Petrovac          -3.081 0.002238
```

```
## as.factor(Municipality)Bosansko Grahovo (Grahovo)      -3.014 0.002782
## as.factor(Municipality)Bratunac                         0.220 0.826095
## as.factor(Municipality)Brcko                           -2.470 0.014033
## as.factor(Municipality)Breza                           -3.723 0.000232
## as.factor(Municipality)Bugojno                         -3.294 0.001100
## as.factor(Municipality)Busovaca                        -1.417 0.157373
## as.factor(Municipality)Cajnice                          1.126 0.260843
## as.factor(Municipality)Capljina                         0.265 0.790953
## as.factor(Municipality)Cazin                           -2.249 0.025179
## as.factor(Municipality)Celinac                          0.756 0.450021
## as.factor(Municipality)Centar Sarajevo                 -6.556 2.21e-10
## as.factor(Municipality)Citluk                           1.186 0.236359
## as.factor(Municipality)Derventa                        -0.004 0.996968
## as.factor(Municipality)Doboj                           -1.238 0.216562
## as.factor(Municipality)Donji Vakuf                     -2.893 0.004082
## as.factor(Municipality)Drvar                           -1.914 0.056479
## as.factor(Municipality)Foca (Srbinje)                   0.113 0.909822
## as.factor(Municipality)Fojnica                         -1.973 0.049402
## as.factor(Municipality)Gacko                            0.653 0.514366
## as.factor(Municipality)Glamoc                          -1.186 0.236636
## as.factor(Municipality)Gorazde                         -2.928 0.003658
## as.factor(Municipality)Gornji Vakuf - Uskopolje        -0.716 0.474709
## as.factor(Municipality)Gradacac                        -3.414 0.000722
## as.factor(Municipality)Grude                            0.429 0.668325
## as.factor(Municipality)Hadzici                         -3.576 0.000402
## as.factor(Municipality)Han Pijesak                      0.965 0.335157
## as.factor(Municipality)Ilidza                          -2.880 0.004245
## as.factor(Municipality)Ilijas                          -3.540 0.000460
## as.factor(Municipality)Jablanica                       -4.211 3.31e-05
## as.factor(Municipality)Jajce                           -1.741 0.082720
## as.factor(Municipality)Kakanj                          -2.223 0.026946
## as.factor(Municipality)Kalesija                        -3.350 0.000903
## as.factor(Municipality)Kalinovik                        0.282 0.777812
## as.factor(Municipality)Kiseljak                        -0.685 0.493545
## as.factor(Municipality)Kladanj                         -3.717 0.000238
## as.factor(Municipality)Kljuc                           -1.876 0.061560
## as.factor(Municipality)Konjic                          -2.608 0.009534
## as.factor(Municipality)Kotor Varos                      0.860 0.390691
## as.factor(Municipality)Kresevo                         -1.249 0.212442
## as.factor(Municipality)Kupres (FBiH)                    0.501 0.616483
## as.factor(Municipality)Laktasi                          0.690 0.490726
## as.factor(Municipality)Livno                           -0.125 0.900392
## as.factor(Municipality)Ljubinje                         1.308 0.191799
## as.factor(Municipality)Ljubuski                         0.550 0.582750
## as.factor(Municipality)Lopare                          -0.998 0.319156
## as.factor(Municipality)Maglaj                          -3.262 0.001226
## as.factor(Municipality)Modrica                         -0.533 0.594175
## as.factor(Municipality)Mostar                          -2.138 0.033297
## as.factor(Municipality)Mrkonjic Grad                    0.565 0.572669
## as.factor(Municipality)Neum                             0.804 0.421783
## as.factor(Municipality)Nevesinje                        0.116 0.907514
## as.factor(Municipality)Novi Grad Sarajevo              -5.125 5.14e-07
## as.factor(Municipality)Novi Travnik                    -2.140 0.033086
## as.factor(Municipality)Novo Sarajevo                   -5.611 4.36e-08
```

```
## as.factor(Municipality)Odzak                                 -1.268 0.205828
## as.factor(Municipality)Olovo                                  -2.717 0.006949
## as.factor(Municipality)Orasje                                  0.428 0.669182
## as.factor(Municipality)Pale (RS)                               0.713 0.476555
## as.factor(Municipality)Posusje                                 0.842 0.400445
## as.factor(Municipality)Prijedor                               -0.530 0.596809
## as.factor(Municipality)Prnjavor                                0.330 0.741460
## as.factor(Municipality)Prozor (Prozor-Rama)                    0.847 0.397768
## as.factor(Municipality)Rogatica                               -0.066 0.947518
## as.factor(Municipality)Rudo                                    0.871 0.384268
## as.factor(Municipality)Samac (Bosanski Samac)                  0.145 0.884495
## as.factor(Municipality)Sanski Most                            -2.391 0.017391
## as.factor(Municipality)Sekovici                               -0.110 0.912847
## as.factor(Municipality)Sipovo                                  1.007 0.314664
## as.factor(Municipality)Siroki Brijeg                           0.268 0.788633
## as.factor(Municipality)Skender Vakuf (Knezevo)                 0.722 0.470674
## as.factor(Municipality)Sokolac                                 0.798 0.425538
## as.factor(Municipality)Srbac                                   0.576 0.565001
## as.factor(Municipality)Srebrenica                              0.031 0.975277
## as.factor(Municipality)Srebrenik                              -4.659 4.65e-06
## as.factor(Municipality)Stari Grad Sarajevo                    -4.557 7.38e-06
## as.factor(Municipality)Stolac                                  0.506 0.613102
## as.factor(Municipality)Tesanj                                 -3.138 0.001856
## as.factor(Municipality)Teslic                                 -0.252 0.801078
## as.factor(Municipality)Tomislavgrad                            0.862 0.389583
## as.factor(Municipality)Travnik                                -1.827 0.068681
## as.factor(Municipality)Trebinje                                0.516 0.606108
## as.factor(Municipality)Trnovo (FBiH)                          -1.446 0.149192
## as.factor(Municipality)Tuzla                                  -7.085 8.83e-12
## as.factor(Municipality)Ugljevik                                0.139 0.889513
## as.factor(Municipality)Vares                                  -3.999 7.89e-05
## as.factor(Municipality)Velika Kladusa                         -8.093 1.22e-14
## as.factor(Municipality)Visegrad                                0.375 0.708211
## as.factor(Municipality)Visoko                                 -2.541 0.011524
## as.factor(Municipality)Vitez                                  -1.261 0.208327
## as.factor(Municipality)Vlasenica                               0.563 0.573642
## as.factor(Municipality)Vogosca                                -3.759 0.000202
## as.factor(Municipality)Zavidovici                             -2.906 0.003915
## as.factor(Municipality)Zenica                                 -3.376 0.000827
## as.factor(Municipality)Zepce                                  -0.384 0.701406
## as.factor(Municipality)Zivince                                -3.631 0.000328
## as.factor(Municipality)Zvornik                                   NA       NA
##
## (Intercept)                                    ***
## Log_Casualty
## as.factor(Municipality)Banovici                **
## as.factor(Municipality)Bihac                   ***
## as.factor(Municipality)Bijeljina
## as.factor(Municipality)Bileca
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)
## as.factor(Municipality)Bosanska Gradiska (Gradiska)
## as.factor(Municipality)Bosanska Krupa          *
## as.factor(Municipality)Bosanski Brod
## as.factor(Municipality)Bosanski Novi (Novi Grad)
```

```
## as.factor(Municipality)Bosanski Petrovac            **
## as.factor(Municipality)Bosansko Grahovo (Grahovo)    **
## as.factor(Municipality)Bratunac
## as.factor(Municipality)Brcko                         *
## as.factor(Municipality)Breza                         ***
## as.factor(Municipality)Bugojno                       **
## as.factor(Municipality)Busovaca
## as.factor(Municipality)Cajnice
## as.factor(Municipality)Capljina
## as.factor(Municipality)Cazin                         *
## as.factor(Municipality)Celinac
## as.factor(Municipality)Centar Sarajevo               ***
## as.factor(Municipality)Citluk
## as.factor(Municipality)Derventa
## as.factor(Municipality)Doboj
## as.factor(Municipality)Donji Vakuf                   **
## as.factor(Municipality)Drvar                         .
## as.factor(Municipality)Foca (Srbinje)
## as.factor(Municipality)Fojnica                       *
## as.factor(Municipality)Gacko
## as.factor(Municipality)Glamoc
## as.factor(Municipality)Gorazde                       **
## as.factor(Municipality)Gornji Vakuf - Uskopolje
## as.factor(Municipality)Gradacac                      ***
## as.factor(Municipality)Grude
## as.factor(Municipality)Hadzici                       ***
## as.factor(Municipality)Han Pijesak
## as.factor(Municipality)Ilidza                        **
## as.factor(Municipality)Ilijas                        ***
## as.factor(Municipality)Jablanica                     ***
## as.factor(Municipality)Jajce                         .
## as.factor(Municipality)Kakanj                        *
## as.factor(Municipality)Kalesija                      ***
## as.factor(Municipality)Kalinovik
## as.factor(Municipality)Kiseljak
## as.factor(Municipality)Kladanj                       ***
## as.factor(Municipality)Kljuc                         .
## as.factor(Municipality)Konjic                        **
## as.factor(Municipality)Kotor Varos
## as.factor(Municipality)Kresevo
## as.factor(Municipality)Kupres (FBiH)
## as.factor(Municipality)Laktasi
## as.factor(Municipality)Livno
## as.factor(Municipality)Ljubinje
## as.factor(Municipality)Ljubuski
## as.factor(Municipality)Lopare
## as.factor(Municipality)Maglaj                        **
## as.factor(Municipality)Modrica
## as.factor(Municipality)Mostar                        *
## as.factor(Municipality)Mrkonjic Grad
## as.factor(Municipality)Neum
## as.factor(Municipality)Nevesinje
## as.factor(Municipality)Novi Grad Sarajevo            ***
## as.factor(Municipality)Novi Travnik                  *
```

```
## as.factor(Municipality)Novo Sarajevo                    ***
## as.factor(Municipality)Odzak
## as.factor(Municipality)Olovo                            **
## as.factor(Municipality)Orasje
## as.factor(Municipality)Pale (RS)
## as.factor(Municipality)Posusje
## as.factor(Municipality)Prijedor
## as.factor(Municipality)Prnjavor
## as.factor(Municipality)Prozor (Prozor-Rama)
## as.factor(Municipality)Rogatica
## as.factor(Municipality)Rudo
## as.factor(Municipality)Samac (Bosanski Samac)
## as.factor(Municipality)Sanski Most                      *
## as.factor(Municipality)Sekovici
## as.factor(Municipality)Sipovo
## as.factor(Municipality)Siroki Brijeg
## as.factor(Municipality)Skender Vakuf (Knezevo)
## as.factor(Municipality)Sokolac
## as.factor(Municipality)Srbac
## as.factor(Municipality)Srebrenica
## as.factor(Municipality)Srebrenik                        ***
## as.factor(Municipality)Stari Grad Sarajevo              ***
## as.factor(Municipality)Stolac
## as.factor(Municipality)Tesanj                           **
## as.factor(Municipality)Teslic
## as.factor(Municipality)Tomislavgrad
## as.factor(Municipality)Travnik                          .
## as.factor(Municipality)Trebinje
## as.factor(Municipality)Trnovo (FBiH)
## as.factor(Municipality)Tuzla                            ***
## as.factor(Municipality)Ugljevik
## as.factor(Municipality)Vares                            ***
## as.factor(Municipality)Velika Kladusa                   ***
## as.factor(Municipality)Visegrad
## as.factor(Municipality)Visoko                           *
## as.factor(Municipality)Vitez
## as.factor(Municipality)Vlasenica
## as.factor(Municipality)Vogosca                          ***
## as.factor(Municipality)Zavidovici                       **
## as.factor(Municipality)Zenica                           ***
## as.factor(Municipality)Zepce
## as.factor(Municipality)Zivince                          ***
## as.factor(Municipality)Zvornik
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9.576 on 321 degrees of freedom
## Multiple R-squared:  0.7005, Adjusted R-squared:  0.6016
## F-statistic: 7.084 on 106 and 321 DF,  p-value: < 2.2e-16
```

```r
#add temporal effects
Log_Casualty.Model3 <- lm(Ethnic_Vote_Share ~ Log_Casualty + as.factor(Municipality) + as.factor(Year),
                          data = data2)
summary(Log_Casualty.Model3) #still nothing
```

```
##
## Call:
## lm(formula = Ethnic_Vote_Share ~ Log_Casualty + as.factor(Municipality) +
##     as.factor(Year), data = data2)
##
## Residuals:
##     Min      1Q   Median      3Q     Max
## -46.879  -4.009   0.625   4.205  52.609
##
## Coefficients: (1 not defined because of singularities)
##                                                      Estimate
## (Intercept)                                           86.13840
## Log_Casualty                                           1.80880
## as.factor(Municipality)Banovici                      -18.38521
## as.factor(Municipality)Bihac                         -30.23323
## as.factor(Municipality)Bijeljina                       0.91318
## as.factor(Municipality)Bileca                          5.66981
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)  1.88312
## as.factor(Municipality)Bosanska Gradiska (Gradiska)    4.66507
## as.factor(Municipality)Bosanska Krupa                -12.19123
## as.factor(Municipality)Bosanski Brod                  -5.79667
## as.factor(Municipality)Bosanski Novi (Novi Grad)       3.67511
## as.factor(Municipality)Bosanski Petrovac             -18.12054
## as.factor(Municipality)Bosansko Grahovo (Grahovo)    -17.67652
## as.factor(Municipality)Bratunac                        1.88079
## as.factor(Municipality)Brcko                         -14.54025
## as.factor(Municipality)Breza                         -22.35659
## as.factor(Municipality)Bugojno                       -19.56926
## as.factor(Municipality)Busovaca                       -8.33076
## as.factor(Municipality)Cajnice                         6.81146
## as.factor(Municipality)Capljina                        1.84665
## as.factor(Municipality)Cazin                         -13.63238
## as.factor(Municipality)Celinac                         4.70628
## as.factor(Municipality)Centar Sarajevo               -38.50807
## as.factor(Municipality)Citluk                         12.60337
## as.factor(Municipality)Derventa                       -0.02266
## as.factor(Municipality)Doboj                          -7.26418
## as.factor(Municipality)Donji Vakuf                   -18.36382
## as.factor(Municipality)Drvar                         -13.52460
## as.factor(Municipality)Foca (Srbinje)                  0.84201
## as.factor(Municipality)Fojnica                       -11.62344
## as.factor(Municipality)Gacko                           3.99828
## as.factor(Municipality)Glamoc                         -7.31188
## as.factor(Municipality)Gorazde                       -18.93680
## as.factor(Municipality)Gornji Vakuf - Uskopolje       -4.21910
## as.factor(Municipality)Gradacac                      -20.43093
## as.factor(Municipality)Grude                           4.80119
## as.factor(Municipality)Hadzici                       -22.07409
## as.factor(Municipality)Han Pijesak                     5.67462
## as.factor(Municipality)Ilidza                        -16.94301
## as.factor(Municipality)Ilijas                        -20.76151
## as.factor(Municipality)Jablanica                     -24.69193
## as.factor(Municipality)Jajce                         -10.42958
## as.factor(Municipality)Kakanj                        -14.63352
```

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## as.factor(Municipality)Kalesija                           -20.03774
## as.factor(Municipality)Kalinovik                            2.00610
## as.factor(Municipality)Kiseljak                            -4.05129
## as.factor(Municipality)Kladanj                             -22.65948
## as.factor(Municipality)Kljuc                               -11.49551
## as.factor(Municipality)Konjic                              -15.30172
## as.factor(Municipality)Kotor Varos                           5.10987
## as.factor(Municipality)Kresevo                              -7.43886
## as.factor(Municipality)Kupres (FBiH)                         3.01030
## as.factor(Municipality)Laktasi                               4.87878
## as.factor(Municipality)Livno                                -1.33171
## as.factor(Municipality)Ljubinje                              9.77993
## as.factor(Municipality)Ljubuski                              6.35017
## as.factor(Municipality)Lopare                               -5.93991
## as.factor(Municipality)Maglaj                              -19.15586
## as.factor(Municipality)Modrica                              -3.15609
## as.factor(Municipality)Mostar                              -12.55278
## as.factor(Municipality)Mrkonjic Grad                         3.34105
## as.factor(Municipality)Neum                                  9.95773
## as.factor(Municipality)Nevesinje                             0.76051
## as.factor(Municipality)Novi Grad Sarajevo                  -30.10479
## as.factor(Municipality)Novi Travnik                        -12.84643
## as.factor(Municipality)Novo Sarajevo                       -32.95022
## as.factor(Municipality)Odzak                                -8.64433
## as.factor(Municipality)Olovo                               -16.17042
## as.factor(Municipality)Orasje                                2.67803
## as.factor(Municipality)Pale (RS)                             4.26364
## as.factor(Municipality)Posusje                              10.93523
## as.factor(Municipality)Prijedor                             -3.50837
## as.factor(Municipality)Prnjavor                              2.11269
## as.factor(Municipality)Prozor (Prozor-Rama)                  4.97342
## as.factor(Municipality)Rogatica                             -0.54407
## as.factor(Municipality)Rudo                                  5.11882
## as.factor(Municipality)Samac (Bosanski Samac)                0.85634
## as.factor(Municipality)Sanski Most                         -14.02514
## as.factor(Municipality)Sekovici                             -0.64380
## as.factor(Municipality)Sipovo                                6.31584
## as.factor(Municipality)Siroki Brijeg                         3.11603
## as.factor(Municipality)Skender Vakuf (Knezevo)               5.02701
## as.factor(Municipality)Sokolac                               4.73670
## as.factor(Municipality)Srbac                                 4.48245
## as.factor(Municipality)Srebrenica                            0.33361
## as.factor(Municipality)Srebrenik                           -32.35237
## as.factor(Municipality)Stari Grad Sarajevo                 -26.76183
## as.factor(Municipality)Stolac                                3.36583
## as.factor(Municipality)Tesanj                              -18.85756
## as.factor(Municipality)Teslic                               -1.60026
## as.factor(Municipality)Tomislavgrad                          8.65787
## as.factor(Municipality)Travnik                             -10.76784
## as.factor(Municipality)Trebinje                              3.30728
## as.factor(Municipality)Trnovo (FBiH)                        -9.78708
## as.factor(Municipality)Tuzla                               -46.53079
## as.factor(Municipality)Ugljevik                              0.81542
## as.factor(Municipality)Vares                               -23.91164
```

```
## as.factor(Municipality)Velika Kladusa                        -47.48446
## as.factor(Municipality)Visegrad                               2.91782
## as.factor(Municipality)Visoko                                -15.45174
## as.factor(Municipality)Vitez                                  -7.82968
## as.factor(Municipality)Vlasenica                               4.45992
## as.factor(Municipality)Vogosca                               -22.47008
## as.factor(Municipality)Zavidovici                            -17.43838
## as.factor(Municipality)Zenica                                -22.28474
## as.factor(Municipality)Zepce                                   -2.32357
## as.factor(Municipality)Zivince                               -25.69799
## as.factor(Municipality)Zvornik                                      NA
## as.factor(Year)2006                                            3.46014
## as.factor(Year)2010                                           -0.51993
## as.factor(Year)2014                                            3.65210
##                                                              Std. Error
## (Intercept)                                                    4.52502
## Log_Casualty                                                   3.88413
## as.factor(Municipality)Banovici                                6.26530
## as.factor(Municipality)Bihac                                   5.73302
## as.factor(Municipality)Bijeljina                               6.33887
## as.factor(Municipality)Bileca                                  6.99606
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)       6.20787
## as.factor(Municipality)Bosanska Gradiska (Gradiska)            6.45006
## as.factor(Municipality)Bosanska Krupa                          5.73495
## as.factor(Municipality)Bosanski Brod                           5.77456
## as.factor(Municipality)Bosanski Novi (Novi Grad)              5.85245
## as.factor(Municipality)Bosanski Petrovac                       5.74803
## as.factor(Municipality)Bosansko Grahovo (Grahovo)              5.73236
## as.factor(Municipality)Bratunac                                8.36054
## as.factor(Municipality)Brcko                                   5.75420
## as.factor(Municipality)Breza                                   5.86893
## as.factor(Municipality)Bugojno                                 5.80776
## as.factor(Municipality)Busovaca                                5.74557
## as.factor(Municipality)Cajnice                                 5.91091
## as.factor(Municipality)Capljina                                6.80392
## as.factor(Municipality)Cazin                                   5.92446
## as.factor(Municipality)Celinac                                 6.08250
## as.factor(Municipality)Centar Sarajevo                         5.74129
## as.factor(Municipality)Citluk                                 10.38421
## as.factor(Municipality)Derventa                                5.82426
## as.factor(Municipality)Doboj                                   5.73471
## as.factor(Municipality)Donji Vakuf                             6.20554
## as.factor(Municipality)Drvar                                   6.90605
## as.factor(Municipality)Foca (Srbinje)                          7.26084
## as.factor(Municipality)Fojnica                                 5.75973
## as.factor(Municipality)Gacko                                   5.98699
## as.factor(Municipality)Glamoc                                  6.02800
## as.factor(Municipality)Gorazde                                 6.32225
## as.factor(Municipality)Gornji Vakuf - Uskopolje                5.76238
## as.factor(Municipality)Gradacac                                5.84931
## as.factor(Municipality)Grude                                  10.94339
## as.factor(Municipality)Hadzici                                 6.03292
## as.factor(Municipality)Han Pijesak                             5.74656
## as.factor(Municipality)Ilidza                                  5.75054
```

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## as.factor(Municipality)Ilijas                          5.73300
## as.factor(Municipality)Jablanica                       5.73219
## as.factor(Municipality)Jajce                           5.85708
## as.factor(Municipality)Kakanj                          6.43588
## as.factor(Municipality)Kalesija                        5.84585
## as.factor(Municipality)Kalinovik                       6.94348
## as.factor(Municipality)Kiseljak                        5.77710
## as.factor(Municipality)Kladanj                         5.95834
## as.factor(Municipality)Kljuc                           5.98953
## as.factor(Municipality)Konjic                          5.73509
## as.factor(Municipality)Kotor Varos                     5.81102
## as.factor(Municipality)Kresevo                         5.81994
## as.factor(Municipality)Kupres (FBiH)                   5.86934
## as.factor(Municipality)Laktasi                         6.91190
## as.factor(Municipality)Livno                          10.39151
## as.factor(Municipality)Ljubinje                        7.30836
## as.factor(Municipality)Ljubuski                       11.28703
## as.factor(Municipality)Lopare                          5.81920
## as.factor(Municipality)Maglaj                          5.74050
## as.factor(Municipality)Modrica                         5.78436
## as.factor(Municipality)Mostar                          5.73982
## as.factor(Municipality)Mrkonjic Grad                   5.78313
## as.factor(Municipality)Neum                           12.10070
## as.factor(Municipality)Nevesinje                       6.39371
## as.factor(Municipality)Novi Grad Sarajevo              5.74142
## as.factor(Municipality)Novi Travnik                    5.86697
## as.factor(Municipality)Novo Sarajevo                   5.74056
## as.factor(Municipality)Odzak                           6.66531
## as.factor(Municipality)Olovo                           5.81791
## as.factor(Municipality)Orasje                          6.12088
## as.factor(Municipality)Pale (RS)                       5.84765
## as.factor(Municipality)Posusje                        12.69536
## as.factor(Municipality)Prijedor                        6.47624
## as.factor(Municipality)Prnjavor                        6.25391
## as.factor(Municipality)Prozor (Prozor-Rama)            5.74122
## as.factor(Municipality)Rogatica                        8.07289
## as.factor(Municipality)Rudo                            5.74285
## as.factor(Municipality)Samac (Bosanski Samac)          5.75725
## as.factor(Municipality)Sanski Most                     5.73429
## as.factor(Municipality)Sekovici                        5.74514
## as.factor(Municipality)Sipovo                          6.13024
## as.factor(Municipality)Siroki Brijeg                  11.35182
## as.factor(Municipality)Skender Vakuf (Knezevo)         6.80348
## as.factor(Municipality)Sokolac                         5.80293
## as.factor(Municipality)Srbac                           7.60633
## as.factor(Municipality)Srebrenica                     10.51380
## as.factor(Municipality)Srebrenik                       6.78709
## as.factor(Municipality)Stari Grad Sarajevo             5.74015
## as.factor(Municipality)Stolac                          6.50007
## as.factor(Municipality)Tesanj                          5.87326
## as.factor(Municipality)Teslic                          6.20319
## as.factor(Municipality)Tomislavgrad                    9.82282
## as.factor(Municipality)Travnik                         5.76202
## as.factor(Municipality)Trebinje                        6.26326
```

```
## as.factor(Municipality)Trnovo (FBiH)                    6.61650
## as.factor(Municipality)Tuzla                             6.41909
## as.factor(Municipality)Ugljevik                          5.73289
## as.factor(Municipality)Vares                             5.84444
## as.factor(Municipality)Velika Kladusa                    5.73536
## as.factor(Municipality)Visegrad                          7.61379
## as.factor(Municipality)Visoko                            5.94396
## as.factor(Municipality)Vitez                             6.07057
## as.factor(Municipality)Vlasenica                         7.73944
## as.factor(Municipality)Vogosca                           5.84251
## as.factor(Municipality)Zavidovici                        5.86548
## as.factor(Municipality)Zenica                            6.45311
## as.factor(Municipality)Zepce                             5.91822
## as.factor(Municipality)Zivince                           6.91717
## as.factor(Municipality)Zvornik                                NA
## as.factor(Year)2006                                      1.27975
## as.factor(Year)2010                                      1.27975
## as.factor(Year)2014                                      1.27975
##                                                  t value Pr(>|t|)
## (Intercept)                                       19.036  < 2e-16
## Log_Casualty                                       0.466 0.641757
## as.factor(Municipality)Banovici                   -2.934 0.003585
## as.factor(Municipality)Bihac                      -5.274 2.48e-07
## as.factor(Municipality)Bijeljina                   0.144 0.885544
## as.factor(Municipality)Bileca                      0.810 0.418300
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)   0.303 0.761826
## as.factor(Municipality)Bosanska Gradiska (Gradiska)   0.723 0.470052
## as.factor(Municipality)Bosanska Krupa             -2.126 0.034292
## as.factor(Municipality)Bosanski Brod              -1.004 0.316224
## as.factor(Municipality)Bosanski Novi (Novi Grad)   0.628 0.530481
## as.factor(Municipality)Bosanski Petrovac          -3.152 0.001773
## as.factor(Municipality)Bosansko Grahovo (Grahovo) -3.084 0.002224
## as.factor(Municipality)Bratunac                    0.225 0.822154
## as.factor(Municipality)Brcko                      -2.527 0.011992
## as.factor(Municipality)Breza                      -3.809 0.000167
## as.factor(Municipality)Bugojno                    -3.370 0.000846
## as.factor(Municipality)Busovaca                   -1.450 0.148059
## as.factor(Municipality)Cajnice                     1.152 0.250041
## as.factor(Municipality)Capljina                    0.271 0.786252
## as.factor(Municipality)Cazin                      -2.301 0.022036
## as.factor(Municipality)Celinac                     0.774 0.439659
## as.factor(Municipality)Centar Sarajevo            -6.707 9.08e-11
## as.factor(Municipality)Citluk                      1.214 0.225761
## as.factor(Municipality)Derventa                   -0.004 0.996898
## as.factor(Municipality)Doboj                      -1.267 0.206188
## as.factor(Municipality)Donji Vakuf                -2.959 0.003315
## as.factor(Municipality)Drvar                      -1.958 0.051061
## as.factor(Municipality)Foca (Srbinje)             0.116 0.907753
## as.factor(Municipality)Fojnica                    -2.018 0.044425
## as.factor(Municipality)Gacko                       0.668 0.504728
## as.factor(Municipality)Glamoc                     -1.213 0.226035
## as.factor(Municipality)Gorazde                    -2.995 0.002957
## as.factor(Municipality)Gornji Vakuf - Uskopolje   -0.732 0.464598
## as.factor(Municipality)Gradacac                   -3.493 0.000546
```

```
## as.factor(Municipality)Grude                        0.439 0.661155
## as.factor(Municipality)Hadzici                      -3.659 0.000296
## as.factor(Municipality)Han Pijesak                   0.987 0.324158
## as.factor(Municipality)Ilidza                       -2.946 0.003453
## as.factor(Municipality)Ilijas                       -3.621 0.000341
## as.factor(Municipality)Jablanica                    -4.308 2.20e-05
## as.factor(Municipality)Jajce                        -1.781 0.075920
## as.factor(Municipality)Kakanj                       -2.274 0.023648
## as.factor(Municipality)Kalesija                     -3.428 0.000689
## as.factor(Municipality)Kalinovik                     0.289 0.772832
## as.factor(Municipality)Kiseljak                     -0.701 0.483649
## as.factor(Municipality)Kladanj                      -3.803 0.000171
## as.factor(Municipality)Kljuc                        -1.919 0.055845
## as.factor(Municipality)Konjic                       -2.668 0.008019
## as.factor(Municipality)Kotor Varos                   0.879 0.379880
## as.factor(Municipality)Kresevo                      -1.278 0.202123
## as.factor(Municipality)Kupres (FBiH)                 0.513 0.608387
## as.factor(Municipality)Laktasi                       0.706 0.480797
## as.factor(Municipality)Livno                        -0.128 0.898109
## as.factor(Municipality)Ljubinje                      1.338 0.181792
## as.factor(Municipality)Ljubuski                      0.563 0.574099
## as.factor(Municipality)Lopare                       -1.021 0.308152
## as.factor(Municipality)Maglaj                       -3.337 0.000947
## as.factor(Municipality)Modrica                      -0.546 0.585707
## as.factor(Municipality)Mostar                       -2.187 0.029473
## as.factor(Municipality)Mrkonjic Grad                 0.578 0.563860
## as.factor(Municipality)Neum                          0.823 0.411178
## as.factor(Municipality)Nevesinje                     0.119 0.905393
## as.factor(Municipality)Novi Grad Sarajevo           -5.243 2.88e-07
## as.factor(Municipality)Novi Travnik                 -2.190 0.029278
## as.factor(Municipality)Novo Sarajevo                -5.740 2.21e-08
## as.factor(Municipality)Odzak                        -1.297 0.195601
## as.factor(Municipality)Olovo                        -2.779 0.005770
## as.factor(Municipality)Orasje                        0.438 0.662028
## as.factor(Municipality)Pale (RS)                     0.729 0.466464
## as.factor(Municipality)Posusje                       0.861 0.389691
## as.factor(Municipality)Prijedor                     -0.542 0.588384
## as.factor(Municipality)Prnjavor                      0.338 0.735723
## as.factor(Municipality)Prozor (Prozor-Rama)          0.866 0.386997
## as.factor(Municipality)Rogatica                     -0.067 0.946310
## as.factor(Municipality)Rudo                          0.891 0.373422
## as.factor(Municipality)Samac (Bosanski Samac)        0.149 0.881852
## as.factor(Municipality)Sanski Most                  -2.446 0.014993
## as.factor(Municipality)Sekovici                     -0.112 0.910847
## as.factor(Municipality)Sipovo                        1.030 0.303663
## as.factor(Municipality)Siroki Brijeg                 0.274 0.783882
## as.factor(Municipality)Skender Vakuf (Knezevo)       0.739 0.460520
## as.factor(Municipality)Sokolac                       0.816 0.414962
## as.factor(Municipality)Srbac                         0.589 0.556075
## as.factor(Municipality)Srebrenica                    0.032 0.974707
## as.factor(Municipality)Srebrenik                    -4.767 2.85e-06
## as.factor(Municipality)Stari Grad Sarajevo          -4.662 4.61e-06
## as.factor(Municipality)Stolac                        0.518 0.604948
## as.factor(Municipality)Tesanj                       -3.211 0.001459
```

```
## as.factor(Municipality)Teslic                              -0.258 0.796594
## as.factor(Municipality)Tomislavgrad                         0.881 0.378765
## as.factor(Municipality)Travnik                             -1.869 0.062575
## as.factor(Municipality)Trebinje                             0.528 0.597837
## as.factor(Municipality)Trnovo (FBiH)                       -1.479 0.140078
## as.factor(Municipality)Tuzla                               -7.249 3.21e-12
## as.factor(Municipality)Ugljevik                             0.142 0.886984
## as.factor(Municipality)Vares                               -4.091 5.44e-05
## as.factor(Municipality)Velika Kladusa                      -8.279 3.47e-15
## as.factor(Municipality)Visegrad                             0.383 0.701806
## as.factor(Municipality)Visoko                              -2.600 0.009769
## as.factor(Municipality)Vitez                               -1.290 0.198065
## as.factor(Municipality)Vlasenica                            0.576 0.564848
## as.factor(Municipality)Vogosca                             -3.846 0.000145
## as.factor(Municipality)Zavidovici                          -2.973 0.003174
## as.factor(Municipality)Zenica                              -3.453 0.000629
## as.factor(Municipality)Zepce                               -0.393 0.694868
## as.factor(Municipality)Zivince                             -3.715 0.000240
## as.factor(Municipality)Zvornik                                 NA       NA
## as.factor(Year)2006                                         2.704 0.007225
## as.factor(Year)2010                                        -0.406 0.684814
## as.factor(Year)2014                                         2.854 0.004604
##
## (Intercept)                                                ***
## Log_Casualty
## as.factor(Municipality)Banovici                             **
## as.factor(Municipality)Bihac                                ***
## as.factor(Municipality)Bijeljina
## as.factor(Municipality)Bileca
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)
## as.factor(Municipality)Bosanska Gradiska (Gradiska)
## as.factor(Municipality)Bosanska Krupa                       *
## as.factor(Municipality)Bosanski Brod
## as.factor(Municipality)Bosanski Novi (Novi Grad)
## as.factor(Municipality)Bosanski Petrovac                    **
## as.factor(Municipality)Bosansko Grahovo (Grahovo)           **
## as.factor(Municipality)Bratunac
## as.factor(Municipality)Brcko                                *
## as.factor(Municipality)Breza                                ***
## as.factor(Municipality)Bugojno                              ***
## as.factor(Municipality)Busovaca
## as.factor(Municipality)Cajnice
## as.factor(Municipality)Capljina
## as.factor(Municipality)Cazin                                *
## as.factor(Municipality)Celinac
## as.factor(Municipality)Centar Sarajevo                      ***
## as.factor(Municipality)Citluk
## as.factor(Municipality)Derventa
## as.factor(Municipality)Doboj
## as.factor(Municipality)Donji Vakuf                          **
## as.factor(Municipality)Drvar                                .
## as.factor(Municipality)Foca (Srbinje)
## as.factor(Municipality)Fojnica                              *
## as.factor(Municipality)Gacko
```

```
## as.factor(Municipality)Glamoc
## as.factor(Municipality)Gorazde                        **
## as.factor(Municipality)Gornji Vakuf - Uskopolje
## as.factor(Municipality)Gradacac                       ***
## as.factor(Municipality)Grude
## as.factor(Municipality)Hadzici                         ***
## as.factor(Municipality)Han Pijesak
## as.factor(Municipality)Ilidza                          **
## as.factor(Municipality)Ilijas                          ***
## as.factor(Municipality)Jablanica                       ***
## as.factor(Municipality)Jajce                           .
## as.factor(Municipality)Kakanj                          *
## as.factor(Municipality)Kalesija                        ***
## as.factor(Municipality)Kalinovik
## as.factor(Municipality)Kiseljak
## as.factor(Municipality)Kladanj                         ***
## as.factor(Municipality)Kljuc                           .
## as.factor(Municipality)Konjic                          **
## as.factor(Municipality)Kotor Varos
## as.factor(Municipality)Kresevo
## as.factor(Municipality)Kupres (FBiH)
## as.factor(Municipality)Laktasi
## as.factor(Municipality)Livno
## as.factor(Municipality)Ljubinje
## as.factor(Municipality)Ljubuski
## as.factor(Municipality)Lopare
## as.factor(Municipality)Maglaj                          ***
## as.factor(Municipality)Modrica
## as.factor(Municipality)Mostar                          *
## as.factor(Municipality)Mrkonjic Grad
## as.factor(Municipality)Neum
## as.factor(Municipality)Nevesinje
## as.factor(Municipality)Novi Grad Sarajevo              ***
## as.factor(Municipality)Novi Travnik                    *
## as.factor(Municipality)Novo Sarajevo                   ***
## as.factor(Municipality)Odzak
## as.factor(Municipality)Olovo                           **
## as.factor(Municipality)Orasje
## as.factor(Municipality)Pale (RS)
## as.factor(Municipality)Posusje
## as.factor(Municipality)Prijedor
## as.factor(Municipality)Prnjavor
## as.factor(Municipality)Prozor (Prozor-Rama)
## as.factor(Municipality)Rogatica
## as.factor(Municipality)Rudo
## as.factor(Municipality)Samac (Bosanski Samac)
## as.factor(Municipality)Sanski Most                     *
## as.factor(Municipality)Sekovici
## as.factor(Municipality)Sipovo
## as.factor(Municipality)Siroki Brijeg
## as.factor(Municipality)Skender Vakuf (Knezevo)
## as.factor(Municipality)Sokolac
## as.factor(Municipality)Srbac
## as.factor(Municipality)Srebrenica
```

```
## as.factor(Municipality)Srebrenik                          ***
## as.factor(Municipality)Stari Grad Sarajevo                ***
## as.factor(Municipality)Stolac
## as.factor(Municipality)Tesanj                             **
## as.factor(Municipality)Teslic
## as.factor(Municipality)Tomislavgrad
## as.factor(Municipality)Travnik                            .
## as.factor(Municipality)Trebinje
## as.factor(Municipality)Trnovo (FBiH)
## as.factor(Municipality)Tuzla                              ***
## as.factor(Municipality)Ugljevik
## as.factor(Municipality)Vares                              ***
## as.factor(Municipality)Velika Kladusa                     ***
## as.factor(Municipality)Visegrad
## as.factor(Municipality)Visoko                             **
## as.factor(Municipality)Vitez
## as.factor(Municipality)Vlasenica
## as.factor(Municipality)Vogosca                            ***
## as.factor(Municipality)Zavidovici                         **
## as.factor(Municipality)Zenica                             ***
## as.factor(Municipality)Zepce
## as.factor(Municipality)Zivince                            ***
## as.factor(Municipality)Zvornik
## as.factor(Year)2006                                       **
## as.factor(Year)2010
## as.factor(Year)2014                                       **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9.361 on 318 degrees of freedom
## Multiple R-squared:  0.7166, Adjusted R-squared:  0.6194
## F-statistic: 7.375 on 109 and 318 DF,  p-value: < 2.2e-16
```

```r
cbind(coef(Log_Casualty.Model)[2],
      coef(Log_Casualty.Model2)[2],
      coef(Log_Casualty.Model3)[2])
```

```
##                    [,1]     [,2]     [,3]
## Log_Casualty -0.611099 1.808797 1.808797
```

```r
#the coefficient gets larger, even though there are very few degrees of freedom - why?
#we are no longer strictly controlling for heterogeneity, but exploring/exploiting province-year-level
```

Difference-in-Difference Estimator

- DiD estimators have traditionally been used to analyze the effect of a treatment at different times
- There is absolutely no reason not to use them for continuous treatments though
- Basically, we interact temporal fixed effects (but not the first, or baseline year) with the variable of interest (and include the constituent terms of time), and include unit fixed effects
- This is an ideal model for the above Bosnian data
- However, we need to assume parallel trends, i.e. the units (municipalities) have parallel trends in the outcome if it were not for treatment

```r
dummy.matrix <- as.matrix(cbind(as.numeric(data2$Year == 2006), as.numeric(data2$Year==2010), as.numeric
Log_Casualty.Model.did <- lm(Ethnic_Vote_Share ~ Log_Casualty:dummy.matrix+dummy.matrix+
```

```
                  Municipality-1, data2) #why is there a minus 1?
summary(Log_Casualty.Model.did) #we see an effect, but decreasing in magnitude and reliability (keep th
```

```
##
## Call:
## lm(formula = Ethnic_Vote_Share ~ Log_Casualty:dummy.matrix +
##     dummy.matrix + Municipality - 1, data = data2)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -46.380 -4.067  0.755  4.056 52.935
##
## Coefficients:
##                                                Estimate Std. Error t value
## dummy.matrix1                                    1.9319     1.4614   1.322
## dummy.matrix2                                   -1.5266     1.4614  -1.045
## dummy.matrix3                                    3.4499     1.4614   2.361
## MunicipalityBanja Luka                          86.7888     4.7517  18.265
## MunicipalityBanovici                            68.4850     4.7356  14.462
## MunicipalityBihac                               56.9111     4.7319  12.027
## MunicipalityBijeljina                           87.7649     4.7386  18.521
## MunicipalityBileca                              92.3855     4.7720  19.360
## MunicipalityBosanska Dubica (Kozarska Dubica)   88.7685     4.7333  18.754
## MunicipalityBosanska Gradiska (Gradiska)        91.4906     4.7436  19.287
## MunicipalityBosanska Krupa                      74.9614     4.7330  15.838
## MunicipalityBosanski Brod                       81.2644     4.7247  17.200
## MunicipalityBosanski Novi (Novi Grad)           90.6859     4.7239  19.197
## MunicipalityBosanski Petrovac                   69.0579     4.7369  14.579
## MunicipalityBosansko Grahovo (Grahovo)          69.4523     4.7300  14.683
## MunicipalityBratunac                            89.6493     5.0078  17.902
## MunicipalityBrcko                               72.5412     4.7258  15.350
## MunicipalityBreza                               64.6460     4.7240  13.685
## MunicipalityBugojno                             67.4672     4.7240  14.282
## MunicipalityBusovaca                            78.7622     4.7266  16.664
## MunicipalityCajnice                             94.0958     4.7602  19.767
## MunicipalityCapljina                            88.5984     4.7613  18.608
## MunicipalityCazin                               73.3454     4.7248  15.524
## MunicipalityCelinac                             91.6281     4.7289  19.376
## MunicipalityCentar Sarajevo                     48.5921     4.7272  10.279
## MunicipalityCitluk                              98.8344     5.0385  19.616
## MunicipalityDerventa                            87.0037     4.7239  18.418
## MunicipalityDoboj                               79.8876     4.7329  16.879
## MunicipalityDonji Vakuf                         68.5222     4.7332  14.477
## MunicipalityDrvar                               73.2077     4.7669  15.358
## MunicipalityFoca (Srbinje)                      88.4406     4.8955  18.066
## MunicipalityFojnica                             75.4518     4.7254  15.967
## MunicipalityGacko                               91.3124     4.7688  19.148
## MunicipalityGlamoc                              79.6275     4.7272  16.844
## MunicipalityGorazde                             68.4752     4.8034  14.256
## MunicipalityGornji Vakuf - Uskopolje            82.9763     4.7398  17.506
## MunicipalityGradacac                            66.5815     4.7239  14.095
## MunicipalityGrude                               90.9631     5.0940  17.857
## MunicipalityHadzici                             65.2560     4.7737  13.670
## MunicipalityHan Pijesak                         92.8509     4.7366  19.603
```

```
## MunicipalityIlidza                              70.2388    4.7375  14.826
## MunicipalityIlijas                              66.3826    4.7319  14.029
## MunicipalityJablanica                           62.4439    4.7308  13.199
## MunicipalityJajce                               76.5789    4.7239  16.211
## MunicipalityKakanj                              72.1953    4.7429  15.222
## MunicipalityKalesija                            66.9765    4.7238  14.178
## MunicipalityKalinovik                           89.5486    4.8643  18.410
## MunicipalityKiseljak                            83.0076    4.7246  17.569
## MunicipalityKladanj                             64.3049    4.7255  13.608
## MunicipalityKljuc                               75.8195    4.7690  15.898
## MunicipalityKonjic                              71.8513    4.7331  15.181
## MunicipalityKotor Varos                         92.3433    4.7475  19.451
## MunicipalityKresevo                             79.5900    4.7239  16.848
## MunicipalityKupres (FBiH)                       90.2758    4.7552  18.985
## MunicipalityLaktasi                             91.6100    4.7672  19.217
## MunicipalityLivno                               84.8984    5.0392  16.848
## MunicipalityLjubinje                            96.4411    4.7906  20.131
## MunicipalityLjubuski                            92.4702    5.1294  18.027
## MunicipalityLopare                              81.0894    4.7239  17.166
## MunicipalityMaglaj                              67.9458    4.7273  14.373
## MunicipalityModrica                             83.8970    4.7244  17.758
## MunicipalityMostar                              74.5502    4.7274  15.770
## MunicipalityMrkonjic Grad                       90.3951    4.7244  19.134
## MunicipalityNeum                                95.9805    5.2175  18.396
## MunicipalityNevesinje                           88.1897    4.8105  18.333
## MunicipalityNovi Grad Sarajevo                  57.0631    4.7352  12.051
## MunicipalityNovi Travnik                        74.1571    4.7240  15.698
## MunicipalityNovo Sarajevo                       54.1513    4.7273  11.455
## MunicipalityOdzak                               78.1349    4.7540  16.436
## MunicipalityOlovo                               70.8597    4.7239  15.000
## MunicipalityOrasje                              89.5881    4.7301  18.940
## MunicipalityPale (RS)                           91.5181    4.7524  19.257
## MunicipalityPosusje                             96.8880    5.2854  18.331
## MunicipalityPrijedor                            83.9398    4.8186  17.420
## MunicipalityPrnjavor                            88.9858    4.7351  18.793
## MunicipalityProzor (Prozor-Rama)                92.1410    4.7352  19.459
## MunicipalityRogatica                            87.1826    4.9777  17.515
## MunicipalityRudo                                92.2162    4.7269  19.509
## MunicipalitySamac (Bosanski Samac)              87.9343    4.7256  18.608
## MunicipalitySanski Most                         73.1251    4.7327  15.451
## MunicipalitySekovici                            86.4499    4.7267  18.290
## MunicipalitySipovo                              93.2232    4.7305  19.707
## MunicipalitySiroki Brijeg                       89.2283    5.1363  17.372
## MunicipalitySkender Vakuf (Knezevo)             91.7788    4.7613  19.276
## MunicipalitySokolac                             91.9648    4.7464  19.376
## MunicipalitySrbac                               91.0950    4.8098  18.940
## MunicipalitySrebrenica                          88.3865    5.2514  16.831
## MunicipalitySrebrenik                           54.4026    4.7604  11.428
## MunicipalityStari Grad Sarajevo                 60.4037    4.7349  12.757
## MunicipalityStolac                              90.1802    4.7459  19.002
## MunicipalityTesanj                              68.1429    4.7240  14.425
## MunicipalityTeslic                              85.2864    4.7331  18.019
## MunicipalityTomislavgrad                        94.9600    4.9857  19.046
## MunicipalityTravnik                             76.3050    4.7253  16.148
```

```
## MunicipalityTrebinje                                    90.1780    4.7355   19.043
## MunicipalityTrnovo (FBiH)                               77.6914    4.8323   16.077
## MunicipalityTuzla                                       40.3019    4.7421    8.499
## MunicipalityUgljevik                                    87.9589    4.7318   18.589
## MunicipalityVares                                       63.1034    4.7238   13.358
## MunicipalityVelika Kladusa                              39.6295    4.7284    8.381
## MunicipalityVisegrad                                    90.5742    4.9308   18.369
## MunicipalityVisoko                                      71.5182    4.7251   15.136
## MunicipalityVitez                                       79.5126    4.7777   16.642
## MunicipalityVlasenica                                   92.1360    4.9435   18.638
## MunicipalityVogosca                                     64.7817    4.7518   13.633
## MunicipalityZavidovici                                  69.5659    4.7240   14.726
## MunicipalityZenica                                      64.5401    4.7437   13.605
## MunicipalityZepce                                       84.6568    4.7247   17.918
## MunicipalityZivince                                     61.0322    4.7675   12.802
## MunicipalityZvornik                                     87.4790    4.8326   18.102
## Log_Casualty:dummy.matrix1                               3.1353    1.4690    2.134
## Log_Casualty:dummy.matrix2                               2.0652    1.4690    1.406
## Log_Casualty:dummy.matrix3                               0.4148    1.4690    0.282
##                                                        Pr(>|t|)
## dummy.matrix1                                            0.1871
## dummy.matrix2                                            0.2970
## dummy.matrix3                                            0.0188 *
## MunicipalityBanja Luka                                 < 2e-16 ***
## MunicipalityBanovici                                   < 2e-16 ***
## MunicipalityBihac                                      < 2e-16 ***
## MunicipalityBijeljina                                  < 2e-16 ***
## MunicipalityBileca                                     < 2e-16 ***
## MunicipalityBosanska Dubica (Kozarska Dubica)          < 2e-16 ***
## MunicipalityBosanska Gradiska (Gradiska)               < 2e-16 ***
## MunicipalityBosanska Krupa                             < 2e-16 ***
## MunicipalityBosanski Brod                              < 2e-16 ***
## MunicipalityBosanski Novi (Novi Grad)                  < 2e-16 ***
## MunicipalityBosanski Petrovac                          < 2e-16 ***
## MunicipalityBosansko Grahovo (Grahovo)                 < 2e-16 ***
## MunicipalityBratunac                                   < 2e-16 ***
## MunicipalityBrcko                                      < 2e-16 ***
## MunicipalityBreza                                      < 2e-16 ***
## MunicipalityBugojno                                    < 2e-16 ***
## MunicipalityBusovaca                                   < 2e-16 ***
## MunicipalityCajnice                                    < 2e-16 ***
## MunicipalityCapljina                                   < 2e-16 ***
## MunicipalityCazin                                      < 2e-16 ***
## MunicipalityCelinac                                    < 2e-16 ***
## MunicipalityCentar Sarajevo                            < 2e-16 ***
## MunicipalityCitluk                                     < 2e-16 ***
## MunicipalityDerventa                                   < 2e-16 ***
## MunicipalityDoboj                                      < 2e-16 ***
## MunicipalityDonji Vakuf                                < 2e-16 ***
## MunicipalityDrvar                                      < 2e-16 ***
## MunicipalityFoca (Srbinje)                             < 2e-16 ***
## MunicipalityFojnica                                    < 2e-16 ***
## MunicipalityGacko                                      < 2e-16 ***
## MunicipalityGlamoc                                     < 2e-16 ***
```

```
## MunicipalityGorazde                        < 2e-16 ***
## MunicipalityGornji Vakuf - Uskopolje        < 2e-16 ***
## MunicipalityGradacac                        < 2e-16 ***
## MunicipalityGrude                           < 2e-16 ***
## MunicipalityHadzici                         < 2e-16 ***
## MunicipalityHan Pijesak                     < 2e-16 ***
## MunicipalityIlidza                          < 2e-16 ***
## MunicipalityIlijas                          < 2e-16 ***
## MunicipalityJablanica                       < 2e-16 ***
## MunicipalityJajce                           < 2e-16 ***
## MunicipalityKakanj                          < 2e-16 ***
## MunicipalityKalesija                        < 2e-16 ***
## MunicipalityKalinovik                       < 2e-16 ***
## MunicipalityKiseljak                        < 2e-16 ***
## MunicipalityKladanj                         < 2e-16 ***
## MunicipalityKljuc                           < 2e-16 ***
## MunicipalityKonjic                          < 2e-16 ***
## MunicipalityKotor Varos                     < 2e-16 ***
## MunicipalityKresevo                         < 2e-16 ***
## MunicipalityKupres (FBiH)                   < 2e-16 ***
## MunicipalityLaktasi                         < 2e-16 ***
## MunicipalityLivno                           < 2e-16 ***
## MunicipalityLjubinje                        < 2e-16 ***
## MunicipalityLjubuski                        < 2e-16 ***
## MunicipalityLopare                          < 2e-16 ***
## MunicipalityMaglaj                          < 2e-16 ***
## MunicipalityModrica                         < 2e-16 ***
## MunicipalityMostar                          < 2e-16 ***
## MunicipalityMrkonjic Grad                   < 2e-16 ***
## MunicipalityNeum                            < 2e-16 ***
## MunicipalityNevesinje                       < 2e-16 ***
## MunicipalityNovi Grad Sarajevo              < 2e-16 ***
## MunicipalityNovi Travnik                    < 2e-16 ***
## MunicipalityNovo Sarajevo                   < 2e-16 ***
## MunicipalityOdzak                           < 2e-16 ***
## MunicipalityOlovo                           < 2e-16 ***
## MunicipalityOrasje                          < 2e-16 ***
## MunicipalityPale (RS)                       < 2e-16 ***
## MunicipalityPosusje                         < 2e-16 ***
## MunicipalityPrijedor                        < 2e-16 ***
## MunicipalityPrnjavor                        < 2e-16 ***
## MunicipalityProzor (Prozor-Rama)            < 2e-16 ***
## MunicipalityRogatica                        < 2e-16 ***
## MunicipalityRudo                            < 2e-16 ***
## MunicipalitySamac (Bosanski Samac)          < 2e-16 ***
## MunicipalitySanski Most                     < 2e-16 ***
## MunicipalitySekovici                        < 2e-16 ***
## MunicipalitySipovo                          < 2e-16 ***
## MunicipalitySiroki Brijeg                   < 2e-16 ***
## MunicipalitySkender Vakuf (Knezevo)         < 2e-16 ***
## MunicipalitySokolac                         < 2e-16 ***
## MunicipalitySrbac                           < 2e-16 ***
## MunicipalitySrebrenica                      < 2e-16 ***
## MunicipalitySrebrenik                       < 2e-16 ***
```

```
## MunicipalityStari Grad Sarajevo                      < 2e-16 ***
## MunicipalityStolac                                   < 2e-16 ***
## MunicipalityTesanj                                   < 2e-16 ***
## MunicipalityTeslic                                   < 2e-16 ***
## MunicipalityTomislavgrad                             < 2e-16 ***
## MunicipalityTravnik                                  < 2e-16 ***
## MunicipalityTrebinje                                 < 2e-16 ***
## MunicipalityTrnovo (FBiH)                            < 2e-16 ***
## MunicipalityTuzla                                   7.77e-16 ***
## MunicipalityUgljevik                                 < 2e-16 ***
## MunicipalityVares                                    < 2e-16 ***
## MunicipalityVelika Kladusa                          1.77e-15 ***
## MunicipalityVisegrad                                 < 2e-16 ***
## MunicipalityVisoko                                   < 2e-16 ***
## MunicipalityVitez                                    < 2e-16 ***
## MunicipalityVlasenica                                < 2e-16 ***
## MunicipalityVogosca                                  < 2e-16 ***
## MunicipalityZavidovici                               < 2e-16 ***
## MunicipalityZenica                                   < 2e-16 ***
## MunicipalityZepce                                    < 2e-16 ***
## MunicipalityZivince                                  < 2e-16 ***
## MunicipalityZvornik                                  < 2e-16 ***
## Log_Casualty:dummy.matrix1                            0.0336 *
## Log_Casualty:dummy.matrix2                            0.1608
## Log_Casualty:dummy.matrix3                            0.7779
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 9.318 on 315 degrees of freedom
## Multiple R-squared:  0.9906, Adjusted R-squared:  0.9872
## F-statistic: 293.4 on 113 and 315 DF,  p-value: < 2.2e-16
```

```r
summary(Log_Casualty.Model.did)$r.squared # R-squared: 0.9905888
```

```
## [1] 0.9905888
```

```r
#what's wrong with this R-squared?
```

Correcting Standard Errors

- There are two main adjustments; robust clustered standard errors (RCSE) and panel corrected standard errors (PCSE)
- The latter takes time into effect as a measure of distance, the former is agnostic about the effects but still corrects for each 'cluster'
- RCSE are extremely popular, and you will be asked for revisions that include them
- Generally speaking, though, they suffer the same problems as robust standard errors
- Furthermore, it is WIDELY assumed that they will increase SEs, but this is very often not true in practice
- Let's look at the previous DiD model for RCSE, and the earlier model for PCSE (does not assume balance, but properties in unbalanced settings are questionable)

```r
library(sandwich)
library(multiwayvcov)
library(lmtest)
```

```
## Loading required package: zoo

##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##      as.Date, as.Date.numeric
```
```r
vcovCL1 <- cluster.vcov(Log_Casualty.Model.did, ~as.factor(data2$Municipality) + as.factor(data2$Year))
coeftest(Log_Casualty.Model.did, vcovCL1) #notice the standard errors actually decreased
```
```
##
## t test of coefficients:
##
##                                                 Estimate Std. Error t value
## dummy.matrix1                                    1.93186    1.41332  1.3669
## dummy.matrix2                                   -1.52659    1.35127 -1.1297
## dummy.matrix3                                    3.44992    1.04712  3.2947
## MunicipalityBanja Luka                          86.78883    4.93940 17.5707
## MunicipalityBanovici                            68.48499    3.96755 17.2613
## MunicipalityBihac                               56.91108    5.03957 11.2929
## MunicipalityBijeljina                           87.76491    3.32888 26.3647
## MunicipalityBileca                              92.38550    2.72309 33.9267
## MunicipalityBosanska Dubica (Kozarska Dubica)   88.76852    3.49133 25.4254
## MunicipalityBosanska Gradiska (Gradiska)        91.49062    1.94866 46.9504
## MunicipalityBosanska Krupa                      74.96136    4.05713 18.4764
## MunicipalityBosanski Brod                       81.26440    4.41998 18.3857
## MunicipalityBosanski Novi (Novi Grad)           90.68592    1.68411 53.8479
## MunicipalityBosanski Petrovac                   69.05789    6.20115 11.1363
## MunicipalityBosansko Grahovo (Grahovo)          69.45233   12.39451  5.6035
## MunicipalityBratunac                            89.64930    1.69955 52.7488
## MunicipalityBrcko                               72.54118    2.17763 33.3120
## MunicipalityBreza                               64.64597    1.98467 32.5727
## MunicipalityBugojno                             67.46725    4.53366 14.8814
## MunicipalityBusovaca                            78.76224    1.37960 57.0908
## MunicipalityCajnice                             94.09579    1.57632 59.6933
## MunicipalityCapljina                            88.59836    1.43960 61.5437
## MunicipalityCazin                               73.34541    5.53988 13.2395
## MunicipalityCelinac                             91.62805    2.14258 42.7653
## MunicipalityCentar Sarajevo                     48.59208    2.07983 23.3635
## MunicipalityCitluk                              98.83444    2.01386 49.0770
## MunicipalityDerventa                            87.00367    4.05818 21.4391
## MunicipalityDoboj                               79.88757    2.61926 30.5000
## MunicipalityDonji Vakuf                         68.52222    4.13249 16.5814
## MunicipalityDrvar                               73.20769   12.28161  5.9608
## MunicipalityFoca (Srbinje)                      88.44062    1.85853 47.5862
## MunicipalityFojnica                             75.45176    3.26960 23.0767
## MunicipalityGacko                               91.31237    1.47697 61.8242
## MunicipalityGlamoc                              79.62754    5.31667 14.9770
## MunicipalityGorazde                             68.47520    4.50827 15.1888
## MunicipalityGornji Vakuf - Uskopolje            82.97627    3.09864 26.7783
## MunicipalityGradacac                            66.58152    3.09173 21.5353
## MunicipalityGrude                               90.96309    2.46862 36.8477
## MunicipalityHadzici                             65.25595    2.93086 22.2651
## MunicipalityHan Pijesak                         92.85093    2.30068 40.3580
```

```
## MunicipalityIlidza                          70.23880    2.56002 27.4369
## MunicipalityIlijas                          66.38264    2.68898 24.6869
## MunicipalityJablanica                       62.44393    1.21812 51.2624
## MunicipalityJajce                           76.57887    1.74651 43.8467
## MunicipalityKakanj                          72.19527    1.53014 47.1821
## MunicipalityKalesija                        66.97654    5.28747 12.6670
## MunicipalityKalinovik                       89.54859    2.45627 36.4572
## MunicipalityKiseljak                        83.00762    2.25691 36.7794
## MunicipalityKladanj                         64.30487    3.90524 16.4663
## MunicipalityKljuc                           75.81950    3.24105 23.3935
## MunicipalityKonjic                          71.85133    3.55819 20.1932
## MunicipalityKotor Varos                     92.34326    1.88512 48.9854
## MunicipalityKresevo                         79.59005    2.45819 32.3775
## MunicipalityKupres (FBiH)                   90.27575    2.38722 37.8163
## MunicipalityLaktasi                         91.60998    3.27798 27.9471
## MunicipalityLivno                           84.89844    2.20113 38.5704
## MunicipalityLjubinje                        96.44111    1.90200 50.7051
## MunicipalityLjubuski                        92.47025    2.75926 33.5127
## MunicipalityLopare                          81.08944    1.99290 40.6892
## MunicipalityMaglaj                          67.94578    3.66480 18.5401
## MunicipalityModrica                         83.89697    4.48543 18.7043
## MunicipalityMostar                          74.55021    2.75664 27.0439
## MunicipalityMrkonjic Grad                   90.39507    1.02509 88.1822
## MunicipalityNeum                            95.98045    1.84201 52.1065
## MunicipalityNevesinje                       88.18974    1.53776 57.3496
## MunicipalityNovi Grad Sarajevo              57.06311    2.60226 21.9283
## MunicipalityNovi Travnik                    74.15709    2.46519 30.0817
## MunicipalityNovo Sarajevo                   54.15131    1.81948 29.7620
## MunicipalityOdzak                           78.13492    1.28140 60.9761
## MunicipalityOlovo                           70.85972    2.25953 31.3603
## MunicipalityOrasje                          89.58812    1.50182 59.6529
## MunicipalityPale (RS)                       91.51813    2.47658 36.9534
## MunicipalityPosusje                         96.88801    2.72504 35.5547
## MunicipalityPrijedor                        83.93980    3.82551 21.9421
## MunicipalityPrnjavor                        88.98584    4.55394 19.5404
## MunicipalityProzor (Prozor-Rama)            92.14095    0.96909 95.0802
## MunicipalityRogatica                        87.18256    2.77778 31.3857
## MunicipalityRudo                            92.21619    2.14201 43.0512
## MunicipalitySamac (Bosanski Samac)          87.93426    2.63060 33.4274
## MunicipalitySanski Most                     73.12510    1.96819 37.1535
## MunicipalitySekovici                        86.44986    5.39970 16.0101
## MunicipalitySipovo                          93.22317    2.81133 33.1598
## MunicipalitySiroki Brijeg                   89.22828    3.14343 28.3856
## MunicipalitySkender Vakuf (Knezevo)         91.77880    2.49188 36.8311
## MunicipalitySokolac                         91.96482    2.49133 36.9140
## MunicipalitySrbac                           91.09502    4.29096 21.2295
## MunicipalitySrebrenica                      88.38652    2.24707 39.3342
## MunicipalitySrebrenik                       54.40261    1.96315 27.7119
## MunicipalityStari Grad Sarajevo             60.40365    3.27551 18.4410
## MunicipalityStolac                          90.18016    1.76810 51.0040
## MunicipalityTesanj                          68.14292    2.53975 26.8306
## MunicipalityTeslic                          85.28642    3.29099 25.9151
## MunicipalityTomislavgrad                    94.96004    1.89123 50.2108
## MunicipalityTravnik                         76.30498    1.49541 51.0261
```

```
## MunicipalityTrebinje                                   90.17801    2.91126 30.9756
## MunicipalityTrnovo (FBiH)                               77.69139    5.93635 13.0874
## MunicipalityTuzla                                       40.30187    2.68076 15.0338
## MunicipalityUgljevik                                    87.95893    1.33703 65.7870
## MunicipalityVares                                       63.10339    3.62345 17.4153
## MunicipalityVelika Kladusa                              39.62946   13.58911  2.9163
## MunicipalityVisegrad                                    90.57424    2.18270 41.4964
## MunicipalityVisoko                                      71.51820    3.54301 20.1857
## MunicipalityVitez                                       79.51261    1.84673 43.0558
## MunicipalityVlasenica                                   92.13604    1.72439 53.4310
## MunicipalityVogosca                                     64.78167    2.69794 24.0116
## MunicipalityZavidovici                                  69.56587    5.33960 13.0283
## MunicipalityZenica                                      64.54012    2.33455 27.6456
## MunicipalityZepce                                       84.65681    1.94164 43.6007
## MunicipalityZivince                                     61.03222    4.05836 15.0386
## MunicipalityZvornik                                     87.47898    1.57449 55.5604
## Log_Casualty:dummy.matrix1                               3.13527    0.89983  3.4843
## Log_Casualty:dummy.matrix2                               2.06516    0.91761  2.2506
## Log_Casualty:dummy.matrix3                               0.41477    0.82743  0.5013
##                                                         Pr(>|t|)
## dummy.matrix1                                           0.1726343
## dummy.matrix2                                           0.2594451
## dummy.matrix3                                           0.0010976 **
## MunicipalityBanja Luka                                  < 2.2e-16 ***
## MunicipalityBanovici                                    < 2.2e-16 ***
## MunicipalityBihac                                       < 2.2e-16 ***
## MunicipalityBijeljina                                   < 2.2e-16 ***
## MunicipalityBileca                                      < 2.2e-16 ***
## MunicipalityBosanska Dubica (Kozarska Dubica)           < 2.2e-16 ***
## MunicipalityBosanska Gradiska (Gradiska)                < 2.2e-16 ***
## MunicipalityBosanska Krupa                              < 2.2e-16 ***
## MunicipalityBosanski Brod                               < 2.2e-16 ***
## MunicipalityBosanski Novi (Novi Grad)                   < 2.2e-16 ***
## MunicipalityBosanski Petrovac                           < 2.2e-16 ***
## MunicipalityBosansko Grahovo (Grahovo)                  4.587e-08 ***
## MunicipalityBratunac                                    < 2.2e-16 ***
## MunicipalityBrcko                                       < 2.2e-16 ***
## MunicipalityBreza                                       < 2.2e-16 ***
## MunicipalityBugojno                                     < 2.2e-16 ***
## MunicipalityBusovaca                                    < 2.2e-16 ***
## MunicipalityCajnice                                     < 2.2e-16 ***
## MunicipalityCapljina                                    < 2.2e-16 ***
## MunicipalityCazin                                       < 2.2e-16 ***
## MunicipalityCelinac                                     < 2.2e-16 ***
## MunicipalityCentar Sarajevo                             < 2.2e-16 ***
## MunicipalityCitluk                                      < 2.2e-16 ***
## MunicipalityDerventa                                    < 2.2e-16 ***
## MunicipalityDoboj                                       < 2.2e-16 ***
## MunicipalityDonji Vakuf                                 < 2.2e-16 ***
## MunicipalityDrvar                                       6.725e-09 ***
## MunicipalityFoca (Srbinje)                              < 2.2e-16 ***
## MunicipalityFojnica                                     < 2.2e-16 ***
## MunicipalityGacko                                       < 2.2e-16 ***
## MunicipalityGlamoc                                      < 2.2e-16 ***
```

```
## MunicipalityGorazde                         < 2.2e-16 ***
## MunicipalityGornji Vakuf - Uskopolje        < 2.2e-16 ***
## MunicipalityGradacac                        < 2.2e-16 ***
## MunicipalityGrude                           < 2.2e-16 ***
## MunicipalityHadzici                         < 2.2e-16 ***
## MunicipalityHan Pijesak                     < 2.2e-16 ***
## MunicipalityIlidza                          < 2.2e-16 ***
## MunicipalityIlijas                          < 2.2e-16 ***
## MunicipalityJablanica                       < 2.2e-16 ***
## MunicipalityJajce                           < 2.2e-16 ***
## MunicipalityKakanj                          < 2.2e-16 ***
## MunicipalityKalesija                        < 2.2e-16 ***
## MunicipalityKalinovik                       < 2.2e-16 ***
## MunicipalityKiseljak                        < 2.2e-16 ***
## MunicipalityKladanj                         < 2.2e-16 ***
## MunicipalityKljuc                           < 2.2e-16 ***
## MunicipalityKonjic                          < 2.2e-16 ***
## MunicipalityKotor Varos                     < 2.2e-16 ***
## MunicipalityKresevo                         < 2.2e-16 ***
## MunicipalityKupres (FBiH)                   < 2.2e-16 ***
## MunicipalityLaktasi                         < 2.2e-16 ***
## MunicipalityLivno                           < 2.2e-16 ***
## MunicipalityLjubinje                        < 2.2e-16 ***
## MunicipalityLjubuski                        < 2.2e-16 ***
## MunicipalityLopare                          < 2.2e-16 ***
## MunicipalityMaglaj                          < 2.2e-16 ***
## MunicipalityModrica                         < 2.2e-16 ***
## MunicipalityMostar                          < 2.2e-16 ***
## MunicipalityMrkonjic Grad                   < 2.2e-16 ***
## MunicipalityNeum                            < 2.2e-16 ***
## MunicipalityNevesinje                       < 2.2e-16 ***
## MunicipalityNovi Grad Sarajevo              < 2.2e-16 ***
## MunicipalityNovi Travnik                    < 2.2e-16 ***
## MunicipalityNovo Sarajevo                   < 2.2e-16 ***
## MunicipalityOdzak                           < 2.2e-16 ***
## MunicipalityOlovo                           < 2.2e-16 ***
## MunicipalityOrasje                          < 2.2e-16 ***
## MunicipalityPale (RS)                       < 2.2e-16 ***
## MunicipalityPosusje                         < 2.2e-16 ***
## MunicipalityPrijedor                        < 2.2e-16 ***
## MunicipalityPrnjavor                        < 2.2e-16 ***
## MunicipalityProzor (Prozor-Rama)            < 2.2e-16 ***
## MunicipalityRogatica                        < 2.2e-16 ***
## MunicipalityRudo                            < 2.2e-16 ***
## MunicipalitySamac (Bosanski Samac)          < 2.2e-16 ***
## MunicipalitySanski Most                     < 2.2e-16 ***
## MunicipalitySekovici                        < 2.2e-16 ***
## MunicipalitySipovo                          < 2.2e-16 ***
## MunicipalitySiroki Brijeg                   < 2.2e-16 ***
## MunicipalitySkender Vakuf (Knezevo)         < 2.2e-16 ***
## MunicipalitySokolac                         < 2.2e-16 ***
## MunicipalitySrbac                           < 2.2e-16 ***
## MunicipalitySrebrenica                      < 2.2e-16 ***
## MunicipalitySrebrenik                       < 2.2e-16 ***
```

```
## MunicipalityStari Grad Sarajevo                        < 2.2e-16 ***
## MunicipalityStolac                                     < 2.2e-16 ***
## MunicipalityTesanj                                     < 2.2e-16 ***
## MunicipalityTeslic                                     < 2.2e-16 ***
## MunicipalityTomislavgrad                               < 2.2e-16 ***
## MunicipalityTravnik                                    < 2.2e-16 ***
## MunicipalityTrebinje                                   < 2.2e-16 ***
## MunicipalityTrnovo (FBiH)                              < 2.2e-16 ***
## MunicipalityTuzla                                      < 2.2e-16 ***
## MunicipalityUgljevik                                   < 2.2e-16 ***
## MunicipalityVares                                      < 2.2e-16 ***
## MunicipalityVelika Kladusa                             0.0037968 **
## MunicipalityVisegrad                                   < 2.2e-16 ***
## MunicipalityVisoko                                     < 2.2e-16 ***
## MunicipalityVitez                                      < 2.2e-16 ***
## MunicipalityVlasenica                                  < 2.2e-16 ***
## MunicipalityVogosca                                    < 2.2e-16 ***
## MunicipalityZavidovici                                 < 2.2e-16 ***
## MunicipalityZenica                                     < 2.2e-16 ***
## MunicipalityZepce                                      < 2.2e-16 ***
## MunicipalityZivince                                    < 2.2e-16 ***
## MunicipalityZvornik                                    < 2.2e-16 ***
## Log_Casualty:dummy.matrix1                             0.0005634 ***
## Log_Casualty:dummy.matrix2                             0.0251005 *
## Log_Casualty:dummy.matrix3                             0.6165272
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#?cluster.vcov
#now lets try pcse for the first set of models
library(pcse)
```

```
##
## Attaching package: 'pcse'

## The following object is masked from 'package:sandwich':
##
##     vcovPC
```

```r
data.1 = na.omit(data[, c('politychanget1',
                          'nonviol',
                          'byear',
                          'location')])
twowayMod = lm(politychanget1 ~ nonviol + as.factor(byear) + as.factor(location),
            data = data.1)
# vcovPC1 = pcse(twowayMod,
#      groupN = data.1$location,
#      groupT = data.1$byear,
#      pairwise = T) #takes some time
# coeftest(twowayMod, vcovPC1) #does not work - any idea why? think about how the data is assumed relat
```

Mixed (Random and Fixed) Effects

- We can use these in much the same way (and a lot more) as FEs
- Random effects have a distributional assumption

- This distribution buys us a lot of things
- We can borrow information from other units to find a generalized pattern across units
- The statistical power is much higher
- The power means we can get false positives, but generally only under mis-specification
- We can directly estimate the variation of the underlying distribution, meaning we can inspect which levels need variation accounted for
- We no longer make the assumption of separability, and estimate the covariation of the parameters
- The distribution, in general, assumes that the population under study is representative of the group-of-interest, in that the effects are random realizations of the randomly distributed population (and temporal) heterogeneity (prevalancy kind of)
- We will generally want to go Bayesian, for a number of reasons we will cover later, but basically it allows for much more control over the model and a much more flexible DGP
- Random effects do not require balance
- You can model units that only have one observation
- You can model a small number of units
- You can model a small number of observations
- You can add predictors to the random effects for more precision (contextual effects)
- You can also model any slope coefficient randomly, allowing it to vary at any desired level
- Assumes that errors are uncorrelated with regressors
- For now, let's look at the first models in an RE specification

```r
library(lme4)
```

```
## Loading required package: Matrix
```

```r
REMod = lmer(politychanget1 ~ nonviol + (1|location),
             data = data.1)
summary(REMod) #if you look at the variation of random effects, location is not warranted
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: politychanget1 ~ nonviol + (1 | location)
##    Data: data.1
##
## REML criterion at convergence: 1483.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.2593 -0.5136  0.0068  0.2342  2.7996
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  location (Intercept)  1.06     1.030
##  Residual             17.16     4.142
## Number of obs: 259, groups:  location, 117
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept) -0.02993    0.33985  -0.088
## nonviol      3.95755    0.56247   7.036
##
## Correlation of Fixed Effects:
##         (Intr)
## nonviol -0.564
```

```r
#now let's check location
REMod2 = lmer(politychanget1 ~ nonviol + (1|byear),
```

```
            data = data.1)
```

boundary (singular) fit: see ?isSingular

```
summary(REMod2) #no variation – no need for any heterogeneous exploration (though you might need to for
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: politychanget1 ~ nonviol + (1 | byear)
##    Data: data.1
##
## REML criterion at convergence: 1484.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.1787 -0.6632  0.0151  0.2494  2.8524
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  byear    (Intercept)  0.00     0.000
##  Residual             18.21     4.267
## Number of obs: 259, groups:  byear, 88
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept) -0.06433    0.32629  -0.197
## nonviol      3.89387    0.55977   6.956
##
## Correlation of Fixed Effects:
##         (Intr)
## nonviol -0.583
## convergence code: 0
## boundary (singular) fit: see ?isSingular
```

Hausman Test

- The null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects
- Tests whether the unique errors are correlated with the regressors, the null hypothesis is they are not

```
#only works for uncoupled data, e.g.:
library(plm)
```

Loading required package: Formula

```
# phtest(politychanget1 ~ nonviol,
#            data = data.1,
#        model = c("within", "random"),
#        index = c('byear', 'location'))
REmod = plm(Ethnic_Vote_Share ~ Log_Casualty,
                      data = data2,
            index = 'Year',
    model='random')
FEmod = plm(Ethnic_Vote_Share ~ Log_Casualty  + 1 | Year,
                      data = data2,
    index='Year',
```

```
    model='within')
phtest(FEmod, REmod)
```

```
## 
##  Hausman Test
## 
## data:  Ethnic_Vote_Share ~ Log_Casualty + 1 | Year
## chisq = 7.5108e-31, df = 1, p-value = 1
## alternative hypothesis: one model is inconsistent
```

```
#compare the models; why would we get this p-value?
```