

Day 10 - 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 protest data, and the relationship between violent protest and polity change

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 linearity assumption 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
```

#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)    -2.561e-14  4.482e+00  0.000   1.0000
## nonviol         3.571e+00  8.318e-01  4.293 2.95e-05 ***
## as.factor(byear)1901  2.366e-14  6.339e+00  0.000   1.0000
## as.factor(byear)1902  2.735e-14  6.339e+00  0.000   1.0000
## as.factor(byear)1903  2.671e-14  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  2.724e-14  6.339e+00  0.000   1.0000
## as.factor(byear)1907  2.738e-14  5.490e+00  0.000   1.0000
## as.factor(byear)1908  3.097e-14  6.339e+00  0.000   1.0000
## as.factor(byear)1910  2.359e-14  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
```

```

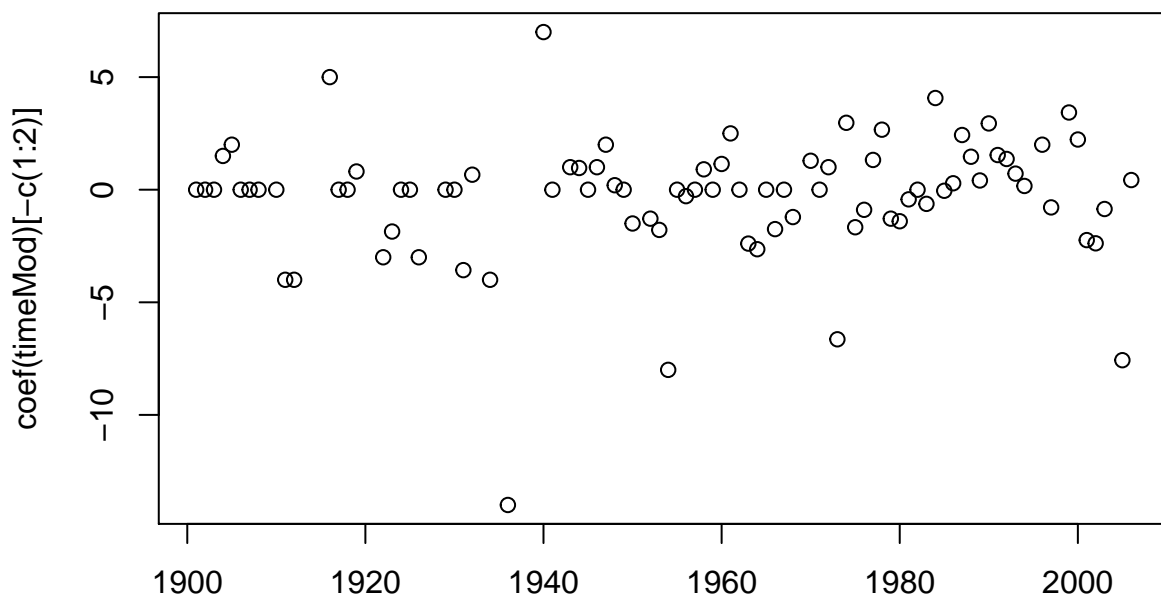
## as.factor(byear)1917 2.757e-14 5.490e+00 0.000 1.0000
## as.factor(byear)1918 2.882e-14 5.490e+00 0.000 1.0000
## as.factor(byear)1919 8.096e-01 5.183e+00 0.156 0.8761
## as.factor(byear)1922 -3.000e+00 6.339e+00 -0.473 0.6366
## as.factor(byear)1923 -1.857e+00 5.183e+00 -0.358 0.7206
## as.factor(byear)1924 2.589e-14 5.490e+00 0.000 1.0000
## as.factor(byear)1925 2.034e-14 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 2.797e-14 5.490e+00 0.000 1.0000
## as.factor(byear)1930 2.769e-14 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 2.764e-14 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 2.755e-14 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 2.267e-14 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 2.890e-14 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 2.943e-14 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 2.809e-14 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 2.664e-14 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 2.938e-14 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 2.862e-14 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 3.061e-14 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 2.805e-14 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
```

#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)))
```



```
as.numeric(substr(names(coef(timeMod)[-c(1:2)]), start = 17, stop = 20))
```

```

#doesn't 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	-1.283e-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	-2.525e-14	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 Std. Error
## (Intercept)   87.78648    4.55938
## Log_Casualty    1.80880    3.97367
## as.factor(Municipality)Banovici  -18.38521    6.40974
## as.factor(Municipality)Bihac    -30.23323    5.86519
## as.factor(Municipality)Bijeljina   0.91318    6.48500
## as.factor(Municipality)BILECA      5.66981    7.15734
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)  1.88312    6.35099
## as.factor(Municipality)Bosanska Gradiska (Gradiska)     4.66507    6.59876
## as.factor(Municipality)Bosanska Krupa    -12.19123    5.86716
## as.factor(Municipality)Bosanski Brod     -5.79667    5.90768
```

## as.factor(Municipality)Bosanski Novi (Novi Grad)	3.67511	5.98737
## as.factor(Municipality)Bosanski Petrovac	-18.12054	5.88055
## as.factor(Municipality)Bosansko Grahovo (Grahovo)	-17.67652	5.86451
## as.factor(Municipality)Bratunac	1.88079	8.55328
## as.factor(Municipality)Brcko	-14.54025	5.88686
## as.factor(Municipality)Breza	-22.35659	6.00423
## as.factor(Municipality>Bugojno	-19.56926	5.94165
## as.factor(Municipality)Busovaca	-8.33076	5.87802
## as.factor(Municipality)Cajnice	6.81146	6.04717
## as.factor(Municipality)Capljina	1.84665	6.96078
## as.factor(Municipality>Cazin	-13.63238	6.06104
## as.factor(Municipality>Celinac	4.70628	6.22273
## as.factor(Municipality>Centar Sarajevo	-38.50807	5.87365
## as.factor(Municipality>Citluk	12.60337	10.62360
## as.factor(Municipality>Derвента	-0.02266	5.95853
## as.factor(Municipality>Doboj	-7.26418	5.86691
## as.factor(Municipality>Donji Vakuf	-18.36382	6.34860
## as.factor(Municipality>Drvar	-13.52460	7.06526
## as.factor(Municipality>Foca (Srbinje)	0.84201	7.42823
## as.factor(Municipality>Fojnica	-11.62344	5.89252
## as.factor(Municipality>Gacko	3.99828	6.12501
## as.factor(Municipality>Glamoc	-7.31188	6.16697
## as.factor(Municipality>Gorazde	-18.93680	6.46800
## as.factor(Municipality>Gornji Vakuf - Uskopolje	-4.21910	5.89522
## as.factor(Municipality>Gradacac	-20.43093	5.98415
## as.factor(Municipality>Grude	4.80119	11.19567
## as.factor(Municipality>Hadzici	-22.07409	6.17200
## as.factor(Municipality>Han Pijesak	5.67462	5.87904
## as.factor(Municipality>Ilidza	-16.94301	5.88311
## as.factor(Municipality>Ilijas	-20.76151	5.86516
## as.factor(Municipality>Jablanica	-24.69193	5.86433
## as.factor(Municipality>Jajce	-10.42958	5.99211
## as.factor(Municipality>Kakanj	-14.63352	6.58425
## as.factor(Municipality>Kalesija	-20.03774	5.98062
## as.factor(Municipality>Kalinovik	2.00610	7.10355
## as.factor(Municipality>Kiseljak	-4.05129	5.91028
## as.factor(Municipality>Kladanj	-22.65948	6.09570
## as.factor(Municipality>Kljuc	-11.49551	6.12761
## as.factor(Municipality>Konjic	-15.30172	5.86731
## as.factor(Municipality>Kotor Varos	5.10987	5.94498
## as.factor(Municipality>Kresevo	-7.43886	5.95411
## as.factor(Municipality>Kupres (FBiH)	3.01030	6.00465
## as.factor(Municipality>Laktasi	4.87878	7.07124
## as.factor(Municipality>Livno	-1.33171	10.63107
## as.factor(Municipality>Ljubinje	9.77993	7.47684
## as.factor(Municipality>Ljubuski	6.35017	11.54723
## as.factor(Municipality>Lopare	-5.93991	5.95335
## as.factor(Municipality>Maglaj	-19.15586	5.87284
## as.factor(Municipality>Modrica	-3.15609	5.91771
## as.factor(Municipality>Mostar	-12.55278	5.87214
## as.factor(Municipality>Mrkonjic Grad	3.34105	5.91646
## as.factor(Municipality>Neum	9.95773	12.37966
## as.factor(Municipality>Nevesinje	0.76051	6.54111
## as.factor(Municipality>Novi Grad Sarajevo	-30.10479	5.87378

## as.factor(Municipality)Novi Travnik	-12.84643	6.00222
## as.factor(Municipality)Novo Sarajevo	-32.95022	5.87290
## as.factor(Municipality)Odzak	-8.64433	6.81897
## as.factor(Municipality)Olovo	-16.17042	5.95203
## as.factor(Municipality)Orasje	2.67803	6.26199
## as.factor(Municipality)Pale (RS)	4.26364	5.98245
## as.factor(Municipality)Posusje	10.93523	12.98803
## as.factor(Municipality>Prijedor	-3.50837	6.62554
## as.factor(Municipality>Prnjavor	2.11269	6.39809
## as.factor(Municipality>Prozor (Prozor-Rama)	4.97342	5.87357
## as.factor(Municipality>Rogatica	-0.54407	8.25900
## as.factor(Municipality>Rudo	5.11882	5.87525
## as.factor(Municipality>Samac (Bosanski Samac)	0.85634	5.88997
## as.factor(Municipality>Sanski Most	-14.02514	5.86649
## as.factor(Municipality>Sekovici	-0.64380	5.87758
## as.factor(Municipality>Sipovo	6.31584	6.27157
## as.factor(Municipality>Siroki Brijeg	3.11603	11.61352
## as.factor(Municipality>Skender Vakuf (Knezevo)	5.02701	6.96033
## as.factor(Municipality>Sokolac	4.73670	5.93671
## as.factor(Municipality>Srbac	4.48245	7.78169
## as.factor(Municipality>Srebrenica	0.33361	10.75618
## as.factor(Municipality>Srebrenik	-32.35237	6.94356
## as.factor(Municipality>Stari Grad Sarajevo	-26.76183	5.87248
## as.factor(Municipality>Stolac	3.36583	6.64992
## as.factor(Municipality>Tesanj	-18.85756	6.00866
## as.factor(Municipality>Teslic	-1.60026	6.34619
## as.factor(Municipality>Tomislavgrad	8.65787	10.04927
## as.factor(Municipality>Travnik	-10.76784	5.89486
## as.factor(Municipality>Trebinje	3.30728	6.40765
## as.factor(Municipality>Trnovo (FBiH)	-9.78708	6.76903
## as.factor(Municipality>Tuzla	-46.53079	6.56707
## as.factor(Municipality>Ugljevik	0.81542	5.86506
## as.factor(Municipality>Vares	-23.91164	5.97918
## as.factor(Municipality>Velika Kladusa	-47.48446	5.86758
## as.factor(Municipality>Visegrad	2.91782	7.78931
## as.factor(Municipality>Visoko	-15.45174	6.08099
## as.factor(Municipality>Vitez	-7.82968	6.21051
## as.factor(Municipality>Vlasenica	4.45992	7.91786
## as.factor(Municipality>Vogosca	-22.47008	5.97720
## as.factor(Municipality>Zavidovici	-17.43838	6.00070
## as.factor(Municipality>Zenica	-22.28474	6.60188
## as.factor(Municipality>Zepce	-2.32357	6.05466
## as.factor(Municipality>Zivince	-25.69799	7.07663
## as.factor(Municipality>Zvornik	NA	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)Derвента	-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)Prijeedor              -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
## ---
```

```
## 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
```

```
#add temporal effects
```

```
Log_Casualty.Model3 <- lm(Ethnic_Vote_Share ~ Log_Casualty + as.factor(Municipality) + as.factor(Year),
```

```

data = data2)
summary(Log_Casualty.Model13) #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 Std. Error
## (Intercept)                       86.13840    4.52502
## Log_Casualty                       1.80880    3.88413
## as.factor(Municipality)Banovici     -18.38521    6.26530
## as.factor(Municipality)Bihac       -30.23323    5.73302
## as.factor(Municipality)Bijeljina     0.91318    6.33887
## as.factor(Municipality)Bileca        5.66981    6.99606
## as.factor(Municipality)Bosanska Dubica (Kozarska Dubica)  1.88312    6.20787
## as.factor(Municipality)Bosanska Gradiska (Gradiska)      4.66507    6.45006
## as.factor(Municipality)Bosanska Krupa    -12.19123    5.73495
## as.factor(Municipality)Bosanski Brod     -5.79667    5.77456
## as.factor(Municipality)Bosanski Novi (Novi Grad)      3.67511    5.85245
## as.factor(Municipality)Bosanski Petrovac  -18.12054    5.74803
## as.factor(Municipality)Bosansko Grahovo (Grahovo)  -17.67652    5.73236
## as.factor(Municipality)Bratunac         1.88079    8.36054
## as.factor(Municipality)Brcko           -14.54025    5.75420
## as.factor(Municipality)Breza           -22.35659    5.86893
## as.factor(Municipality)Bugojno         -19.56926    5.80776
## as.factor(Municipality)Busovaca        -8.33076    5.74557
## as.factor(Municipality)Cajnice          6.81146    5.91091
## as.factor(Municipality)Capljina         1.84665    6.80392
## as.factor(Municipality)Cazin          -13.63238    5.92446
## as.factor(Municipality)Celinac          4.70628    6.08250
## as.factor(Municipality)Centar Sarajevo  -38.50807    5.74129
## as.factor(Municipality)Citluk           12.60337   10.38421
## as.factor(Municipality)Derвента        -0.02266    5.82426
## as.factor(Municipality)Doboj           -7.26418    5.73471
## as.factor(Municipality)Donji Vakuf     -18.36382    6.20554
## as.factor(Municipality)Drvar           -13.52460    6.90605
## as.factor(Municipality)Foca (Srbinje)    0.84201    7.26084
## as.factor(Municipality)Fojnica        -11.62344    5.75973
## as.factor(Municipality)Gacko            3.99828    5.98699
## as.factor(Municipality)Glamoc          -7.31188    6.02800
## as.factor(Municipality)Gorazde        -18.93680    6.32225
## as.factor(Municipality)Gornji Vakuf - Uskopolje    -4.21910    5.76238
## as.factor(Municipality)Gradacac       -20.43093    5.84931
## as.factor(Municipality)Grude            4.80119   10.94339
## as.factor(Municipality)Hadzici        -22.07409    6.03292
## as.factor(Municipality)Han Pijesak      5.67462    5.74656
## as.factor(Municipality)Ilidza         -16.94301    5.75054
## as.factor(Municipality)Ilijas        -20.76151    5.73300

```

## as.factor(Municipality)Jablanica	-24.69193	5.73219
## as.factor(Municipality)Jajce	-10.42958	5.85708
## as.factor(Municipality)Kakanj	-14.63352	6.43588
## as.factor(Municipality)Kalesija	-20.03774	5.84585
## as.factor(Municipality)Kalinovik	2.00610	6.94348
## as.factor(Municipality)Kiseljak	-4.05129	5.77710
## as.factor(Municipality)Kladanj	-22.65948	5.95834
## as.factor(Municipality)Kljuc	-11.49551	5.98953
## as.factor(Municipality)Konjic	-15.30172	5.73509
## as.factor(Municipality)Kotor Varos	5.10987	5.81102
## as.factor(Municipality)Kresevo	-7.43886	5.81994
## as.factor(Municipality)Kupres (FBiH)	3.01030	5.86934
## as.factor(Municipality)Laktasi	4.87878	6.91190
## as.factor(Municipality)Livno	-1.33171	10.39151
## as.factor(Municipality)Ljubinje	9.77993	7.30836
## as.factor(Municipality)Ljubuski	6.35017	11.28703
## as.factor(Municipality)Lopare	-5.93991	5.81920
## as.factor(Municipality)Maglaj	-19.15586	5.74050
## as.factor(Municipality)Modrica	-3.15609	5.78436
## as.factor(Municipality)Mostar	-12.55278	5.73982
## as.factor(Municipality)Mrkonjic Grad	3.34105	5.78313
## as.factor(Municipality)Neum	9.95773	12.10070
## as.factor(Municipality)Nevesinje	0.76051	6.39371
## as.factor(Municipality)Novi Grad Sarajevo	-30.10479	5.74142
## as.factor(Municipality)Novi Travnik	-12.84643	5.86697
## as.factor(Municipality)Novo Sarajevo	-32.95022	5.74056
## as.factor(Municipality)Odzak	-8.64433	6.66531
## as.factor(Municipality)Olovo	-16.17042	5.81791
## as.factor(Municipality)Orasje	2.67803	6.12088
## as.factor(Municipality)Pale (RS)	4.26364	5.84765
## as.factor(Municipality)Posusje	10.93523	12.69536
## as.factor(Municipality)Prijedor	-3.50837	6.47624
## as.factor(Municipality)Prnjavor	2.11269	6.25391
## as.factor(Municipality)Prozor (Prozor-Rama)	4.97342	5.74122
## as.factor(Municipality)Rogatica	-0.54407	8.07289
## as.factor(Municipality)Rudo	5.11882	5.74285
## as.factor(Municipality)Samac (Bosanski Samac)	0.85634	5.75725
## as.factor(Municipality)Sanski Most	-14.02514	5.73429
## as.factor(Municipality)Sekovici	-0.64380	5.74514
## as.factor(Municipality)Sipovo	6.31584	6.13024
## as.factor(Municipality)Siroki Brijeg	3.11603	11.35182
## as.factor(Municipality)Skender Vakuf (Knezevo)	5.02701	6.80348
## as.factor(Municipality)Sokolac	4.73670	5.80293
## as.factor(Municipality)Srbac	4.48245	7.60633
## as.factor(Municipality)Srebrenica	0.33361	10.51380
## as.factor(Municipality)Srebrenik	-32.35237	6.78709
## as.factor(Municipality)Stari Grad Sarajevo	-26.76183	5.74015
## as.factor(Municipality)Stolac	3.36583	6.50007
## as.factor(Municipality)Tesanj	-18.85756	5.87326
## as.factor(Municipality)Teslic	-1.60026	6.20319
## as.factor(Municipality)Tomislavgrad	8.65787	9.82282
## as.factor(Municipality)Travnik	-10.76784	5.76202
## as.factor(Municipality)Trebinje	3.30728	6.26326
## as.factor(Municipality)Trnovo (FBiH)	-9.78708	6.61650

## as.factor(Municipality)Tuzla	-46.53079	6.41909
## as.factor(Municipality)Ugljevik	0.81542	5.73289
## as.factor(Municipality)Vares	-23.91164	5.84444
## as.factor(Municipality)Velika Kladusa	-47.48446	5.73536
## as.factor(Municipality)Visegrad	2.91782	7.61379
## as.factor(Municipality)Visoko	-15.45174	5.94396
## as.factor(Municipality)Vitez	-7.82968	6.07057
## as.factor(Municipality)Vlasenica	4.45992	7.73944
## as.factor(Municipality)Vogosca	-22.47008	5.84251
## as.factor(Municipality)Zavidovici	-17.43838	5.86548
## as.factor(Municipality)Zenica	-22.28474	6.45311
## as.factor(Municipality)Zepce	-2.32357	5.91822
## as.factor(Municipality)Zivinice	-25.69799	6.91717
## as.factor(Municipality)Zvornik	NA	NA
## as.factor(Year)2006	3.46014	1.27975
## as.factor(Year)2010	-0.51993	1.27975
## as.factor(Year)2014	3.65210	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)Derвента	-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)Foynica	-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)Prijeedor	-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 **
## ---
## 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
```

```
cbind(coef(Log_Casualty.Model1)[2],
      coef(Log_Casualty.Model2)[2],
      coef(Log_Casualty.Model3)[2])
```

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

#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

```
dummy.matrix <- as.matrix(cbind(as.numeric(data2$Year == 2006), as.numeric(data2$Year==2010), as.numeric(data2$Year==2014)))
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 the
```

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

## [1] 0.9905888
#what's wrong with this R-squared?
```

Lagged Dependent Variable (LDV) Models

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)

```
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

vcovCL1 <- cluster.vcov(Log_Casualty.Model.did, ~as.factor(data2$Municipality) + as.factor(data2$Year))
coefest(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
## MunicipalityDerвента      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	***	
## MunicipalityFoynica	< 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
```

```
##?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
```

```
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

```
library(lme4)

## Loading required package: Matrix
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

#now let's check time
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
## optimizer (nloptwrap) convergence code: 0 (OK)
## 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)
# 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,
            data = data2,
            index='Year',
            model='within')
ptest(FEmod, REmod)
```

```
##
## Hausman Test
##
```

```
## data: Ethnic_Vote_Share ~ Log_Casualty
## chisq = 2.2204e-16, df = 1, p-value = 1
## alternative hypothesis: one model is inconsistent
#compare the models; why would we get this p-value?
```