

# HW6

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```
here::i_am("HW6/HW6.Rmd")

## here() starts at /Users/erikandersen/Documents/Classes/ECON 587

# Load packages
pacman::p_load(tidyverse, magrittr, estimatr, broom, ri2)

# Load data
vote_df = haven::read_dta(here::here("HW6", "data", "GriffithNoonen2022_Econ587.dta"))

# Clean names
vote_df = janitor::clean_names(vote_df)

# Add variables of interest for Did.
# Post = after 2017 which is the year of interest
# Seattle = in seattle
# Treat = interaction of post and seattle
# city_cycle = interaction of city and cycle
vote_df = vote_df |>
  mutate(post = if_else(election_year >= 2017, 1, 0),
         seattle = if_else(city == 'Seattle', 1, 0),
         treatment = post * seattle,
         city = as.factor(city),
         cycle = as.factor(cycle),
         city_cycle = city:cycle) |>
  select(post, seattle, treatment, everything())
```

## Question 1

```
# did with regular SE's
did_reg_classical = lm_robust(candidates_ballot ~ post + seattle + treatment + at_large * special,
                             vote_df,
                             se_type = 'classical')
# Extract standard error of coefficient of interest
tidy(did_reg_classical) |> select(term, std.error, p.value) |> filter(term == 'treatment') # 0.958
```

a)

```
##           term std.error  p.value
## 1 treatment    0.9546 0.002916
```

```
# Rerun with HC robust SEs
did_reg_hc = lm_robust(candidates_ballot ~ post + seattle + treatment + at_large * special,
                      vote_df,
```

```

                                se_type = 'stata')
# Extract standard error again
tidy(did_reg_hc) |> select(term, std.error, p.value) |> filter(term == 'treatment') # 0.987

##           term std.error  p.value
## 1 treatment      0.985 0.003913

rm(did_reg_hc)

```

```

# Construct residuals for both regressions. The lm_robust function doesn't calculate these automatically
vote_df = vote_df |> mutate(resids = candidates_ballot - did_reg_classical$fitted.values)

# Naive test for heteroskedasticity
# resids^2 ~ treatment
reg_hetero = lm_robust(I(resids^2) ~ treatment,
                      vote_df,
                      se_type = 'classical')

tidy(reg_hetero)

```

b)

```

##           term estimate std.error statistic  p.value conf.low conf.high df
## 1 (Intercept)   5.991    0.8667    6.9117 1.096e-11    4.289    7.692 686
## 2 treatment     1.627    7.5780    0.2147 8.300e-01   -13.252   16.506 686
##           outcome
## 1 I(resids^2)
## 2 I(resids^2)

rm(reg_hetero)
rm(did_reg_classical)

```

```

# Cluster by city_cycle
reg_city_cycle = lm_robust(candidates_ballot ~ post + seattle + treatment + at_large * special,
                          vote_df,
                          clusters = city_cycle,
                          se_type = 'CR2') # CR2 is stata standard errors

tidy(reg_city_cycle)

```

c)

```

##           term estimate std.error statistic  p.value conf.low conf.high
## 1 (Intercept)   3.4816    0.1671    20.839 5.447e-37    3.14991    3.8134
## 2 post          0.4161    0.2447     1.701 9.717e-02   -0.07919    0.9113
## 3 seattle       1.3031    0.3317     3.928 3.706e-03    0.54871    2.0576
## 4 treatment     2.8517    0.5370     5.311 4.185e-02    0.28117    5.4222
## 5 at_large      -1.2364    0.1856    -6.663 1.354e-07   -1.61390   -0.8590
## 6 special        2.3456    0.6512     3.602 1.024e-03    1.02072    3.6704
## 7 at_large:special -2.4827    0.8282    -2.998 1.198e-02   -4.30288   -0.6624
##           df           outcome
## 1 93.911 candidates_ballot
## 2 38.066 candidates_ballot

```

```
## 3 8.698 candidates_ballot
## 4 1.803 candidates_ballot
## 5 33.173 candidates_ballot
## 6 33.041 candidates_ballot
## 7 11.135 candidates_ballot
```

```
rm(reg_city_cycle)
```

```
# Cluster by only city
reg_city = lm_robust(candidates_ballot ~ post + seattle + treatment + at_large * special,
                    vote_df,
                    clusters = city,
                    se_type = 'CR2') # CR2 is stata standard errors
tidy(reg_city)
```

d)

	term	estimate	std.error	statistic	p.value	conf.low	conf.high
## 1	(Intercept)	3.4816	0.3273	10.636	4.705e-07	2.7595	4.2038
## 2	post	0.4161	0.2914	1.428	1.787e-01	-0.2185	1.0507
## 3	seattle	1.3031	0.1786	7.296	1.341e-02	0.6065	1.9998
## 4	treatment	2.8517	0.2368	12.043	3.353e-07	2.3228	3.3806
## 5	at_large	-1.2364	0.3183	-3.885	3.551e-02	-2.3060	-0.1669
## 6	special	2.3456	1.0675	2.197	7.167e-02	-0.2850	4.9761
## 7	at_large:special	-2.4827	1.1434	-2.171	1.504e-01	-6.9967	2.0314

  

	df	outcome
## 1	10.790	candidates_ballot
## 2	12.046	candidates_ballot
## 3	2.233	candidates_ballot
## 4	9.820	candidates_ballot
## 5	2.740	candidates_ballot
## 6	5.830	candidates_ballot
## 7	2.201	candidates_ballot

```
rm(reg_city)
```

```
# Cluster by only cycle
reg_cycle = lm_robust(candidates_ballot ~ post + seattle + treatment + at_large * special,
                    vote_df,
                    clusters = cycle,
                    se_type = 'CR2') # CR2 is stata standard errors
tidy(reg_cycle)
```

	term	estimate	std.error	statistic	p.value	conf.low	conf.high
## 1	(Intercept)	3.4816	0.09349	37.240	9.346e-10	3.2633	3.6999
## 2	post	0.4161	0.09950	4.182	8.091e-02	-0.1607	0.9929
## 3	seattle	1.3031	0.28976	4.497	4.121e-03	0.5940	2.0123
## 4	treatment	2.8517	0.42981	6.635	3.931e-02	0.4170	5.2864
## 5	at_large	-1.2364	0.09288	-13.313	7.435e-07	-1.4496	-1.0233
## 6	special	2.3456	0.91581	2.561	3.435e-02	0.2233	4.4678
## 7	at_large:special	-2.4827	1.24859	-1.988	9.765e-02	-5.5965	0.6312

  

	df	outcome
## 1	7.469	candidates_ballot
## 2	1.541	candidates_ballot
## 3	5.997	candidates_ballot

```
## 4 1.568 candidates_ballot
## 5 8.231 candidates_ballot
## 6 7.780 candidates_ballot
## 7 5.566 candidates_ballot
```

```
rm(reg_cycle)
```

```
# Redo the earlier parts with the following new specifcation
# candidates_ballot = cycle_fixed_effct + city_fixed_effect + treatment

# First redo part a
# Classical errors
reg_two_way_classic = lm_robust(candidates_ballot ~ cycle + city + treatment + at_large * special,
                                vote_df,
                                se_type = "classical")
tidy(reg_two_way_classic)
```

e)

##		term	estimate	std.error	statistic	p.value	conf.low	conf.high
## 1	(Intercept)	2.99313	0.7685	3.89496	1.082e-04	1.48420	4.5021	
## 2	cycle2003	-0.10968	0.4056	-0.27042	7.869e-01	-0.90613	0.6868	
## 3	cycle2005	-0.38077	0.4036	-0.94347	3.458e-01	-1.17322	0.4117	
## 4	cycle2007	-0.55282	0.4088	-1.35222	1.768e-01	-1.35557	0.2499	
## 5	cycle2009	0.09001	0.4125	0.21823	8.273e-01	-0.71990	0.8999	
## 6	cycle2011	-0.30115	0.4073	-0.73934	4.600e-01	-1.10097	0.4987	
## 7	cycle2013	-0.26897	0.4105	-0.65516	5.126e-01	-1.07510	0.5372	
## 8	cycle2015	-0.30810	0.3993	-0.77164	4.406e-01	-1.09211	0.4759	
## 9	cycle2017	0.28212	0.4202	0.67142	5.022e-01	-0.54295	1.1072	
## 10	cycle2019	0.09605	0.4092	0.23474	8.145e-01	-0.70742	0.8995	
## 11	cityEverett	-0.01794	0.5452	-0.03290	9.738e-01	-1.08842	1.0525	
## 12	cityFresno	0.15972	0.8165	0.19562	8.450e-01	-1.44344	1.7629	
## 13	cityKent	-0.55572	0.8187	-0.67883	4.975e-01	-2.16320	1.0518	
## 14	cityLong Beach	0.55547	0.8027	0.69200	4.892e-01	-1.02069	2.1316	
## 15	cityLos Angeles	0.90663	0.7645	1.18596	2.361e-01	-0.59445	2.4077	
## 16	cityOakland	0.84596	0.7548	1.12083	2.628e-01	-0.63606	2.3280	
## 17	citySacramento	-0.19787	0.8034	-0.24631	8.055e-01	-1.77532	1.3796	
## 18	citySan Diego	1.61675	0.7952	2.03318	4.243e-02	0.05536	3.1781	
## 19	citySan Francisco	2.51049	0.7802	3.21763	1.356e-03	0.97846	4.0425	
## 20	citySan Jose	0.77741	0.7849	0.99050	3.223e-01	-0.76372	2.3185	
## 21	citySeattle	1.56212	0.5507	2.83658	4.700e-03	0.48077	2.6435	
## 22	citySpokane	0.94533	0.7616	1.24127	2.149e-01	-0.55009	2.4408	
## 23	cityTacoma	0.02720	0.8097	0.03359	9.732e-01	-1.56277	1.6172	
## 24	cityVancouver	-0.15675	0.8290	-0.18909	8.501e-01	-1.78451	1.4710	
## 25	treatment	3.23227	0.9819	3.29190	1.048e-03	1.30427	5.1603	
## 26	at_large	-0.66214	0.6007	-1.10221	2.708e-01	-1.84172	0.5174	
## 27	special	2.09710	0.3986	5.26179	1.931e-07	1.31451	2.8797	
## 28	at_large:special	-2.13876	0.9733	-2.19747	2.833e-02	-4.04987	-0.2277	
##	df	outcome						
## 1	660	candidates_ballot						
## 2	660	candidates_ballot						
## 3	660	candidates_ballot						
## 4	660	candidates_ballot						
## 5	660	candidates_ballot						

```
## 6 660 candidates_ballot
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## 23 660 candidates_ballot
## 24 660 candidates_ballot
## 25 660 candidates_ballot
## 26 660 candidates_ballot
## 27 660 candidates_ballot
## 28 660 candidates_ballot
```

```
rm(reg_two_way_classic)
# Het robust errors
reg_two_way_hc = lm_robust(candidates_ballot ~ cycle + city + treatment + at_large * special,
                           vote_df,
                           se_type = "stata")
tidy(reg_two_way_hc)
```

##		term	estimate	std.error	statistic	p.value	conf.low	conf.high
## 1	(Intercept)		2.99313	0.5418	5.52402	4.770e-08	1.92919	4.0571
## 2		cycle2003	-0.10968	0.4249	-0.25812	7.964e-01	-0.94408	0.7247
## 3		cycle2005	-0.38077	0.3953	-0.96332	3.357e-01	-1.15689	0.3954
## 4		cycle2007	-0.55282	0.3551	-1.55666	1.200e-01	-1.25014	0.1445
## 5		cycle2009	0.09001	0.4518	0.19924	8.421e-01	-0.79708	0.9771
## 6		cycle2011	-0.30115	0.3656	-0.82362	4.105e-01	-1.01912	0.4168
## 7		cycle2013	-0.26897	0.3794	-0.70897	4.786e-01	-1.01391	0.4760
## 8		cycle2015	-0.30810	0.3820	-0.80657	4.202e-01	-1.05816	0.4420
## 9		cycle2017	0.28212	0.4427	0.63722	5.242e-01	-0.58723	1.1515
## 10		cycle2019	0.09605	0.3746	0.25639	7.977e-01	-0.63957	0.8317
## 11		cityEverett	-0.01794	0.1949	-0.09200	9.267e-01	-0.40073	0.3649
## 12		cityFresno	0.15972	0.5906	0.27045	7.869e-01	-0.99989	1.3193
## 13		cityKent	-0.55572	0.5071	-1.09586	2.735e-01	-1.55148	0.4400
## 14		cityLong Beach	0.55547	0.5529	1.00473	3.154e-01	-0.53009	1.6410
## 15		cityLos Angeles	0.90663	0.6072	1.49312	1.359e-01	-0.28566	2.0989
## 16		cityOakland	0.84596	0.5111	1.65524	9.835e-02	-0.15758	1.8495
## 17		citySacramento	-0.19787	0.5360	-0.36919	7.121e-01	-1.25027	0.8545
## 18		citySan Diego	1.61675	0.5977	2.70508	7.005e-03	0.44318	2.7903
## 19		citySan Francisco	2.51049	0.7289	3.44426	6.089e-04	1.07927	3.9417
## 20		citySan Jose	0.77741	0.5758	1.35007	1.775e-01	-0.35327	1.9081
## 21		citySeattle	1.56212	0.2923	5.34403	1.253e-07	0.98815	2.1361
## 22		citySpokane	0.94533	0.4581	2.06370	3.944e-02	0.04587	1.8448
## 23		cityTacoma	0.02720	0.5252	0.05179	9.587e-01	-1.00398	1.0584

```
## 24      cityVancouver -0.15675    0.5296 -0.29600 7.673e-01 -1.19661    0.8831
## 25      treatment    3.23227    0.9800  3.29835 1.025e-03  1.30804    5.1565
## 26      at_large    -0.66214    0.4567 -1.44979 1.476e-01 -1.55892    0.2346
## 27      special     2.09710    0.6198  3.38358 7.578e-04  0.88011    3.3141
## 28  at_large:special -2.13876    0.8023 -2.66572 7.870e-03 -3.71417   -0.5634
##      df      outcome
## 1  660 candidates_ballot
## 2  660 candidates_ballot
## 3  660 candidates_ballot
## 4  660 candidates_ballot
## 5  660 candidates_ballot
## 6  660 candidates_ballot
## 7  660 candidates_ballot
## 8  660 candidates_ballot
## 9  660 candidates_ballot
## 10 660 candidates_ballot
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## 23 660 candidates_ballot
## 24 660 candidates_ballot
## 25 660 candidates_ballot
## 26 660 candidates_ballot
## 27 660 candidates_ballot
## 28 660 candidates_ballot
```

```
rm(reg_two_way_hc)
```

```
# Redo part c
```

```
# Clustered errors at city and cycle level
```

```
reg_two_way_city_cycle = lm_robust(candidates_ballot ~ cycle + city + treatment + at_large * special,
                                vote_df,
                                clusters = city_cycle,
                                se_type = 'CR2') # CR2 is stata standard errors
```

```
tidy(reg_two_way_city_cycle)
```

```
##      term estimate std.error statistic  p.value conf.low conf.high
## 1  (Intercept)  2.99313    0.6747  4.43651 0.0003004    1.5784    4.4078
## 2    cycle2003 -0.10968    0.5780 -0.18977 0.8510046   -1.2993    1.0800
## 3    cycle2005 -0.38077    0.4228 -0.90048 0.3769442   -1.2542    0.4926
## 4    cycle2007 -0.55282    0.4279 -1.29192 0.2083597   -1.4347    0.3291
## 5    cycle2009  0.09001    0.5767  0.15609 0.8772564   -1.0996    1.2796
## 6    cycle2011 -0.30115    0.4249 -0.70870 0.4851368   -1.1768    0.5745
## 7    cycle2013 -0.26897    0.4652 -0.57820 0.5685008   -1.2289    0.6910
## 8    cycle2015 -0.30810    0.4356 -0.70725 0.4858319   -1.2044    0.5882
```

```
## 9      cycle2017  0.28212    0.4389    0.64281 0.5263061 -0.6226    1.1869
## 10     cycle2019  0.09605    0.4469    0.21492 0.8315953 -0.8250    1.0171
## 11    cityEverett -0.01794    0.2653   -0.06761 0.9468600 -0.5761    0.5403
## 12    cityFresno  0.15972    0.6828    0.23392 0.8173684 -1.2624    1.5819
## 13    cityKent   -0.55572    0.6408   -0.86726 0.3959808 -1.8915    0.7800
## 14   cityLong Beach 0.55547    0.7010    0.79236 0.4374621 -0.9070    2.0179
## 15   cityLos Angeles 0.90663    0.7201    1.25896 0.2245400 -0.6092    2.4224
## 16    cityOakland 0.84596    0.6162    1.37295 0.1878130 -0.4552    2.1471
## 17   citySacramento -0.19787    0.6729   -0.29407 0.7717735 -1.6026    1.2068
## 18    citySan Diego 1.61675    0.7166    2.25609 0.0357711  0.1191    3.1144
## 19 citySan Francisco 2.51049    0.9169    2.73804 0.0133611  0.5866    4.4343
## 20    citySan Jose  0.77741    0.7045    1.10343 0.2838168 -0.6987    2.2535
## 21    citySeattle  1.56212    0.4066    3.84224 0.0013598  0.7026    2.4216
## 22    citySpokane  0.94533    0.5773    1.63744 0.1196765 -0.2715    2.1622
## 23    cityTacoma   0.02720    0.6524    0.04169 0.9671543 -1.3329    1.3873
## 24   cityVancouver -0.15675    0.6241   -0.25116 0.8041179 -1.4542    1.1407
## 25      treatment  3.23227    0.7230    4.47036 0.0419910  0.2772    6.1873
## 26      at_large  -0.66214    0.5701   -1.16154 0.2790835 -1.9779    0.6537
## 27      special   2.09710    0.6401    3.27644 0.0024636  0.7953    3.3989
## 28 at_large:special -2.13876    0.8301   -2.57654 0.0253148 -3.9604   -0.3171
##      df      outcome
## 1  18.493 candidates_ballot
## 2  25.307 candidates_ballot
## 3  23.653 candidates_ballot
## 4  24.665 candidates_ballot
## 5  24.231 candidates_ballot
## 6  24.735 candidates_ballot
## 7  24.079 candidates_ballot
## 8  25.483 candidates_ballot
## 9  24.537 candidates_ballot
## 10 24.662 candidates_ballot
## 11 17.619 candidates_ballot
## 12 20.473 candidates_ballot
## 13 20.207 candidates_ballot
## 14 19.969 candidates_ballot
## 15 17.542 candidates_ballot
## 16 16.804 candidates_ballot
## 17 19.757 candidates_ballot
## 18 19.423 candidates_ballot
## 19 18.328 candidates_ballot
## 20 18.729 candidates_ballot
## 21 16.570 candidates_ballot
## 22 17.225 candidates_ballot
## 23 20.186 candidates_ballot
## 24 21.139 candidates_ballot
## 25  2.114 candidates_ballot
## 26  7.956 candidates_ballot
## 27 33.247 candidates_ballot
## 28 11.270 candidates_ballot
```

```
# Redo part d
```

```
# Cluster by city only
```

```
reg_two_way_city = lm_robust(candidates_ballot ~ cycle + city + treatment + at_large * special,
                             vote_df,
```

```

clusters = city,
se_type = 'CR2') # CR2 is stata standard errors
tidy(reg_two_way_city)

```

	term	estimate	std.error	statistic	p.value	conf.low	conf.high
##							
## 1	(Intercept)	2.99313	0.8477	3.53099	0.041997	0.2103	5.7759
## 2	cycle2003	-0.10968	0.5104	-0.21490	0.833232	-1.2142	0.9948
## 3	cycle2005	-0.38077	0.4622	-0.82379	0.426155	-1.3880	0.6265
## 4	cycle2007	-0.55282	0.5030	-1.09905	0.292491	-1.6441	0.5384
## 5	cycle2009	0.09001	0.6183	0.14558	0.886622	-1.2542	1.4343
## 6	cycle2011	-0.30115	0.4421	-0.68120	0.508200	-1.2604	0.6581
## 7	cycle2013	-0.26897	0.4439	-0.60591	0.555699	-1.2346	0.6966
## 8	cycle2015	-0.30810	0.4445	-0.69308	0.500591	-1.2696	0.6534
## 9	cycle2017	0.28212	0.3161	0.89246	0.389235	-0.4046	0.9689
## 10	cycle2019	0.09605	0.4129	0.23264	0.819809	-0.7997	0.9918
## 11	cityEverett	-0.01794	0.0304	-0.58993	0.625797	-0.1793	0.1434
## 12	cityFresno	0.15972	0.7601	0.21013	0.852774	-3.0643	3.3837
## 13	cityKent	-0.55572	0.7668	-0.72471	0.543381	-3.8280	2.7166
## 14	cityLong Beach	0.55547	0.7743	0.71736	0.544940	-2.6481	3.7590
## 15	cityLos Angeles	0.90663	0.7600	1.19299	0.351544	-2.2557	4.0690
## 16	cityOakland	0.84596	0.6748	1.25366	0.334843	-2.0114	3.7033
## 17	citySacramento	-0.19787	0.7620	-0.25969	0.819079	-3.4313	3.0355
## 18	citySan Diego	1.61675	0.7660	2.11068	0.165373	-1.5853	4.8188
## 19	citySan Francisco	2.51049	0.7669	3.27346	0.079399	-0.7150	5.7360
## 20	citySan Jose	0.77741	0.7613	1.02122	0.412731	-2.4361	3.9910
## 21	citySeattle	1.56212	0.1568	9.96305	0.001897	1.0712	2.0530
## 22	citySpokane	0.94533	0.6577	1.43744	0.285098	-1.8371	3.7277
## 23	cityTacoma	0.02720	0.7623	0.03568	0.974731	-3.2003	3.2547
## 24	cityVancouver	-0.15675	0.7618	-0.20576	0.855584	-3.3542	3.0407
## 25	treatment	3.23227	0.5093	6.34631	0.003085	1.8220	4.6425
## 26	at_large	-0.66214	0.7584	-0.87309	0.474055	-3.9008	2.5765
## 27	special	2.09710	1.1008	1.90512	0.108263	-0.6351	4.8293
## 28	at_large:special	-2.13876	1.1735	-1.82262	0.198568	-6.7809	2.5034
##	df	outcome					
## 1	2.845	candidates_ballot					
## 2	12.790	candidates_ballot					
## 3	11.979	candidates_ballot					
## 4	12.485	candidates_ballot					
## 5	12.239	candidates_ballot					
## 6	12.471	candidates_ballot					
## 7	12.181	candidates_ballot					
## 8	12.854	candidates_ballot					
## 9	12.327	candidates_ballot					
## 10	12.486	candidates_ballot					
## 11	1.650	candidates_ballot					
## 12	2.030	candidates_ballot					
## 13	2.017	candidates_ballot					
## 14	2.086	candidates_ballot					
## 15	2.073	candidates_ballot					
## 16	2.034	candidates_ballot					
## 17	2.029	candidates_ballot					
## 18	2.062	candidates_ballot					
## 19	2.049	candidates_ballot					
## 20	2.041	candidates_ballot					



```
## 21 3.090 candidates_ballot
## 22 2.036 candidates_ballot
## 23 2.034 candidates_ballot
## 24 2.054 candidates_ballot
## 25 4.028 candidates_ballot
## 26 2.016 candidates_ballot
## 27 5.668 candidates_ballot
## 28 2.195 candidates_ballot
```

```
# Cluster by only cycle
```

```
reg_two_way_cycle = lm_robust(candidates_ballot ~ cycle + city + treatment + at_large * special,
                             vote_df,
                             clusters = cycle,
                             se_type = 'CR2') # CR2 is stata standard errors
tidy(reg_two_way_cycle)
```

	term	estimate	std.error	statistic	p.value	conf.low	conf.high
## 1	(Intercept)	2.99313	0.53039	5.64331	2.153e-03	1.64434	4.34192
## 2	cycle2003	-0.10968	0.05259	-2.08556	6.846e-02	-0.22973	0.01036
## 3	cycle2005	-0.38077	0.01618	-23.53738	1.657e-06	-0.42181	-0.33972
## 4	cycle2007	-0.55282	0.06098	-9.06617	1.148e-05	-0.69191	-0.41373
## 5	cycle2009	0.09001	0.04652	1.93489	8.967e-02	-0.01759	0.19761
## 6	cycle2011	-0.30115	0.06156	-4.89196	1.020e-03	-0.44173	-0.16057
## 7	cycle2013	-0.26897	0.03646	-7.37807	1.330e-04	-0.35470	-0.18324
## 8	cycle2015	-0.30810	0.05532	-5.56939	4.524e-03	-0.45936	-0.15684
## 9	cycle2017	0.28212	0.06891	4.09404	5.748e-03	0.11550	0.44875
## 10	cycle2019	0.09605	0.03834	2.50530	1.837e-01	-0.16741	0.35952
## 11	cityEverett	-0.01794	0.33557	-0.05345	9.586e-01	-0.77872	0.74285
## 12	cityFresno	0.15972	0.71201	0.22432	8.297e-01	-1.56733	1.88676
## 13	cityKent	-0.55572	0.65160	-0.85286	4.266e-01	-2.15175	1.04030
## 14	cityLong Beach	0.55547	0.47865	1.16048	2.884e-01	-0.60515	1.71608
## 15	cityLos Angeles	0.90663	0.61352	1.47775	1.923e-01	-0.61282	2.42607
## 16	cityOakland	0.84596	0.63331	1.33577	2.320e-01	-0.71970	2.41162
## 17	citySacramento	-0.19787	0.64983	-0.30450	7.710e-01	-1.78508	1.38934
## 18	citySan Diego	1.61675	0.62646	2.58076	4.189e-02	0.08228	3.15121
## 19	citySan Francisco	2.51049	1.00187	2.50582	4.791e-02	0.03233	4.98866
## 20	citySan Jose	0.77741	0.41295	1.88260	1.099e-01	-0.23891	1.79374
## 21	citySeattle	1.56212	0.37210	4.19807	2.716e-03	0.71062	2.41361
## 22	citySpokane	0.94533	0.56199	1.68213	1.443e-01	-0.43506	2.32573
## 23	cityTacoma	0.02720	0.63632	0.04275	9.673e-01	-1.52183	1.57623
## 24	cityVancouver	-0.15675	0.53817	-0.29127	7.801e-01	-1.45687	1.14337
## 25	treatment	3.23227	0.65067	4.96764	5.136e-02	-0.05319	6.51773
## 26	at_large	-0.66214	0.46316	-1.42962	2.330e-01	-2.00164	0.67737
## 27	special	2.09710	0.91738	2.28596	5.246e-02	-0.02855	4.22275
## 28	at_large:special	-2.13876	1.23447	-1.73254	1.378e-01	-5.21770	0.94018
##	df		outcome				
## 1	5.186		candidates_ballot				
## 2	8.502		candidates_ballot				
## 3	5.228		candidates_ballot				
## 4	8.536		candidates_ballot				
## 5	7.865		candidates_ballot				
## 6	8.476		candidates_ballot				
## 7	7.194		candidates_ballot				
## 8	4.162		candidates_ballot				
## 9	6.311		candidates_ballot				

```
## 10 1.372 candidates_ballot
## 11 8.871 candidates_ballot
## 12 6.226 candidates_ballot
## 13 5.975 candidates_ballot
## 14 6.235 candidates_ballot
## 15 5.717 candidates_ballot
## 16 5.757 candidates_ballot
## 17 6.045 candidates_ballot
## 18 5.975 candidates_ballot
## 19 5.744 candidates_ballot
## 20 5.860 candidates_ballot
## 21 8.371 candidates_ballot
## 22 5.907 candidates_ballot
## 23 6.130 candidates_ballot
## 24 6.336 candidates_ballot
## 25 1.720 candidates_ballot
## 26 3.629 candidates_ballot
## 27 7.786 candidates_ballot
## 28 5.564 candidates_ballot
```

```
# Cameron Miller two way clustering decomposition
# Variance for clustering only by city
var_city = reg_two_way_city$std.error["treatment"]^2

# Variance for clustering only by cycle
var_cycle = reg_two_way_cycle$std.error["treatment"]^2

# Variance for clustering at the intersection of city and cycle
var_intersection = reg_two_way_city_cycle$std.error["treatment"]^2

# Calculate two way clustering variance
se_two_way = sqrt(var_city + var_cycle - var_intersection)

rm(reg_two_way_city, reg_two_way_cycle, reg_two_way_city_cycle,
    var_city, var_cycle, var_intersection, se_two_way)
```

f)

## Question 2

```
# Define randomization procedure
# This is all we need to do since we're doing a naive estimate
randomization_naive = declare_ra(N = nrow(vote_df))

# Do randomization inference
conduct_ri(candidates_ballot ~ cycle + city + treatment + at_large * special,
    declaration = randomization_naive,
    assignment = "treatment",
    data = vote_df,
    sharp_hypothesis = 0,
    progress_bar = TRUE)
```

a)

```
##          term estimate two_tailed_p_value
## 1 treatment    3.232                0
```

```
# Now define randomization procedure based on clustering structure
randomization_intersection = declare_ra(N = nrow(vote_df),
                                       clusters = vote_df$city_cycle)

# Inference
conduct_ri(candidates_ballot ~ cycle + city + treatment + at_large * special,
           declaration = randomization_naive,
           assignment = "treatment",
           data = vote_df,
           sharp_hypothesis = 0,
           progress_bar = TRUE)
```

b)

```
##          term estimate two_tailed_p_value
## 1 treatment    3.232                0
```