A3_Xinwei

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4/25/2021

Exercise 1

```
population <- read.csv("population.csv")
crime_long <- read.csv("crime_long.csv")
officers <- read.csv("officers.csv")
```

Exercise 2

Exercise 2-1

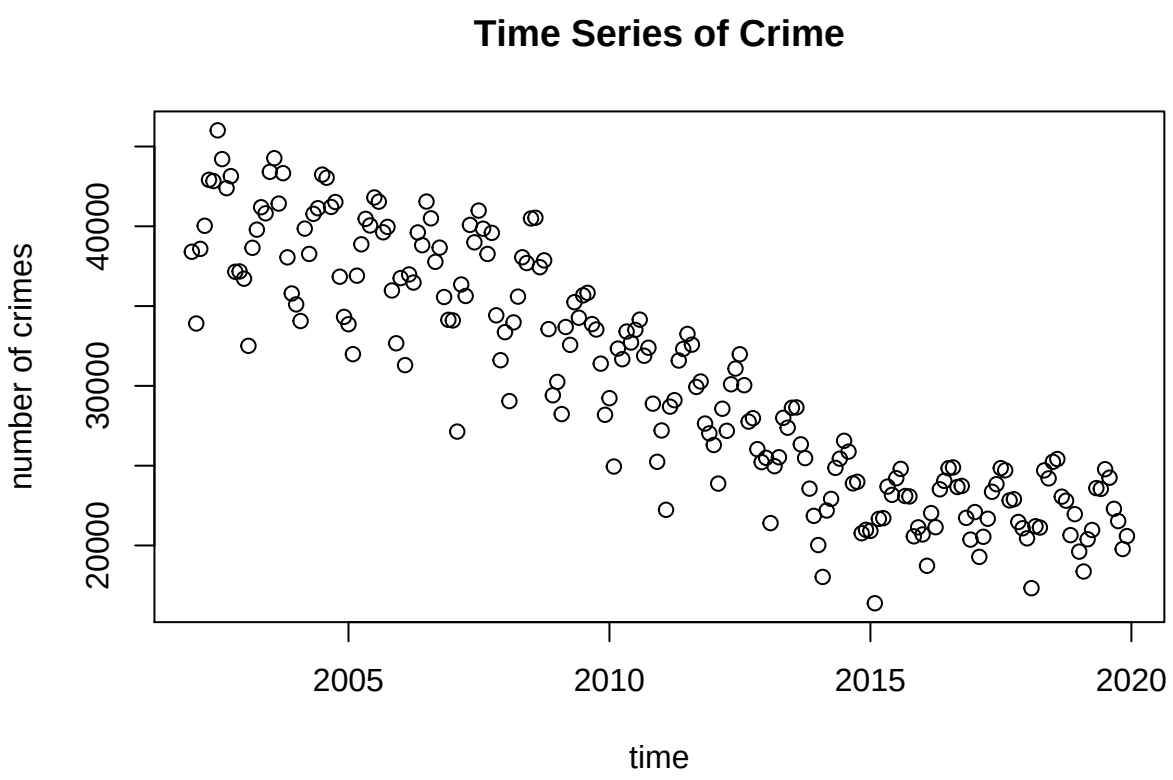
```
# Calculate total crime per month and plot the time series of crime

crime_group <-group_by(crime_long, crime_month)
crime_groupbymonth <- summarise(crime_group, crimes = sum(crimes))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
mean(crime_groupbymonth$crimes)
```

```
## [1] 30379.96
```

```
plot(x = as.Date(crime_groupbymonth$crime_month),
     y = crime_groupbymonth$crimes,
     main = "Time Series of Crime",
     xlab = "time",
     ylab = "number of crimes")
```



Exercise 2-2

```
# Merge the two datasets by districts-units and period

data1 <- merge(x=crime_long, y=population, by.x = c("crime_month","district"),
               by.y = c("month","district"), all.y =TRUE)
```

Exercise 2-3

```
# Construct a panel data of unit over time

crime_group1 <- group_by(crime_long, crime_month, district)
crime_groupbymonthunit <- summarise(crime_group1, districtcrimes = sum(crimes))
```

```
## `summarise()` regrouping output by 'crime_month' (override with `.groups` argument)
```

```
data2 <- merge(x = data1, y = crime_groupbymonthunit, by =c("crime_month","district"), all.x = TRUE)

data_violent <- filter(data2,crime_type=="violent")
violent_group <- group_by(data_violent, crime_month, district)
data_violent <- summarise(violent_group, violentcrimes = sum(crimes))
```

```
## `summarise()` regrouping output by 'crime_month' (override with `.groups` argument)
```

```
data_property <- filter(data2,crime_type=="property")
property_group <- group_by(data_property, crime_month, district)
data_property <- summarise(property_group, propertycrimes = sum(crimes))
```

```
## `summarise()` regrouping output by 'crime_month' (override with `.groups` argument)
```

```
data3 <- merge(x = data2, y = data_violent, by = c("crime_month","district"), all.x = TRUE)
data3 <- merge(x = data3, y = data_property, by = c("crime_month","district"), all.x = TRUE)

data3$crimeper <- data3$districtcrimes / data3$tot_pop
data3$violentper <- data3$violentcrimes / data3$tot_pop
data3$propertyper <- data3$propertycrimes / data3$tot_pop
data3$blackshare <- data3$tot_black / data3$tot_pop
data3$hispshare <- data3$tot_hisp / data3$tot_pop
data3$whiteshare <- data3$tot_white / data3$tot_pop

data4 <- data3
data4 <- select(data4, -c(3:9))
data4 <- unique(data4)
```

Exercise 3

```
data5 <- merge(x = officers, y = data4, by.x = c("month","unit"),
               by.y = c("crime_month","district"), all.x = TRUE)

model1 <- lm(arrest~tenure+districtcrimes+p50_inc+blackshare+hispshare+whiteshare-1, data = data5)
summary(model1)
```

```
##
## Call:
## lm(formula = arrest ~ tenure + districtcrimes + p50_inc + blackshare +
##     hispshare + whiteshare - 1, data = data5)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5505 -0.5079 -0.4668  0.4945  5.5395
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## tenure          2.879e-05  8.319e-06   3.461 0.000539 ***
## districtcrimes -1.364e-05  1.772e-06  -7.701 1.35e-14 ***
## p50_inc         7.210e-07  9.019e-08   7.994 1.30e-15 ***
## blackshare      5.028e-01  3.683e-03 136.515  < 2e-16 ***
## hispshare       5.173e-01  4.441e-03 116.470  < 2e-16 ***
## whiteshare      5.152e-01  9.470e-03  54.399  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 0.7073 on 1077899 degrees of freedom
##   (31 observations deleted due to missingness)
## Multiple R-squared:  0.3317, Adjusted R-squared:  0.3317
## F-statistic: 8.917e+04 on 6 and 1077899 DF,  p-value: < 2.2e-16
```

Exercise 4

```
model2 <- lm(arrest~tenure+districtcrimes+p50_inc+blackshare+hispshare+
               whiteshare+factor(unit)+factor(month)-1, data = data5)
summary(model2)
```

```
##
## Call:
## lm(formula = arrest ~ tenure + districtcrimes + p50_inc + blackshare +
##     hispshare + whiteshare + factor(unit) + factor(month) - 1,
##     data = data5)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5282 -0.5003 -0.4920  0.5008  5.5163
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## tenure                 -3.810e-06  8.525e-06  -0.447   0.6549
## districtcrimes         -6.320e-06  5.305e-06  -1.191   0.2335
## p50_inc                -4.910e-07  6.505e-07  -0.755   0.4504
## blackshare             -9.201e-02  1.043e-01  -0.882   0.3775
## hispshare              -1.398e-01  2.028e-01  -0.690   0.4904
## whiteshare             -1.013e-01  1.818e-01  -0.557   0.5773
## factor(unit)1           6.362e-01  1.061e-01   5.996 2.03e-09 ***
## factor(unit)2           6.118e-01  9.824e-02   6.227 4.74e-10 ***
## factor(unit)3           6.162e-01  1.006e-01   6.127 8.94e-10 ***
## factor(unit)4           6.361e-01  1.251e-01   5.084 3.70e-07 ***
## factor(unit)5           6.204e-01  1.009e-01   6.147 7.90e-10 ***
## factor(unit)6           6.223e-01  9.905e-02   6.283 3.32e-10 ***
## factor(unit)7           6.151e-01  1.010e-01   6.089 1.14e-09 ***
## factor(unit)8           6.596e-01  1.581e-01   4.171 3.03e-05 ***
## factor(unit)9           6.393e-01  1.486e-01   4.303 1.68e-05 ***
## factor(unit)10          6.439e-01  1.576e-01   4.084 4.42e-05 ***
## factor(unit)11          6.248e-01  1.098e-01   5.688 1.28e-08 ***
## factor(unit)12          6.366e-01  1.393e-01   4.569 4.90e-06 ***
## factor(unit)13          6.331e-01  1.395e-01   4.538 5.67e-06 ***
## factor(unit)14          6.606e-01  1.539e-01   4.292 1.77e-05 ***
## factor(unit)15          6.159e-01  1.022e-01   6.028 1.66e-09 ***
## factor(unit)16          6.435e-01  1.478e-01   4.354 1.34e-05 ***
## factor(unit)17          6.373e-01  1.408e-01   4.527 5.98e-06 ***
## factor(unit)18          6.402e-01  1.274e-01   5.025 5.02e-07 ***
## factor(unit)19          6.451e-01  1.365e-01   4.728 2.27e-06 ***
## factor(unit)20          6.207e-01  1.259e-01   4.931 8.18e-07 ***
## factor(unit)21          5.995e-01  8.690e-02   6.898 5.26e-12 ***
## factor(unit)22          6.355e-01  1.137e-01   5.588 2.30e-08 ***
## factor(unit)23          6.252e-01  1.341e-01   4.663 3.12e-06 ***
```

```
## factor(unit)24           6.208e-01  1.216e-01   5.105 3.31e-07 ***
## factor(unit)25           6.582e-01  1.650e-01   3.990 6.61e-05 ***
## factor(month)2007-02-01  2.747e-03  1.112e-02   0.247   0.8049
## factor(month)2007-03-01  5.425e-03  1.098e-02   0.494   0.6213
## factor(month)2007-04-01 -4.433e-03  1.100e-02  -0.403   0.6868
## factor(month)2007-05-01  9.642e-03  1.105e-02   0.872   0.3830
## factor(month)2007-06-01 -1.518e-02  1.100e-02  -1.380   0.1675
## factor(month)2007-07-01 -2.476e-03  1.107e-02  -0.224   0.8230
## factor(month)2007-08-01 -9.283e-03  1.101e-02  -0.843   0.3992
## factor(month)2007-09-01  2.832e-03  1.096e-02   0.258   0.7962
## factor(month)2007-10-01  5.532e-03  1.098e-02   0.504   0.6145
## factor(month)2007-11-01  3.270e-03  1.088e-02   0.300   0.7638
## factor(month)2007-12-01 -8.522e-03  1.089e-02  -0.783   0.4339
## factor(month)2008-01-01 -1.580e-02  1.090e-02  -1.450   0.1470
## factor(month)2008-02-01 -7.936e-03  1.096e-02  -0.724   0.4691
## factor(month)2008-03-01 -7.042e-03  1.090e-02  -0.646   0.5182
## factor(month)2008-04-01  7.880e-03  1.089e-02   0.723   0.4695
## factor(month)2008-05-01  1.890e-02  1.091e-02   1.732   0.0833 .
## factor(month)2008-06-01  1.043e-03  1.088e-02   0.096   0.9237
## factor(month)2008-07-01 -1.992e-05  1.092e-02  -0.002   0.9985
## factor(month)2008-08-01  1.040e-03  1.093e-02   0.095   0.9242
## factor(month)2008-09-01  9.368e-03  1.086e-02   0.863   0.3882
## factor(month)2008-10-01 -3.356e-03  1.085e-02  -0.309   0.7571
## factor(month)2008-11-01 -1.542e-03  1.083e-02  -0.142   0.8868
## factor(month)2008-12-01  1.093e-02  1.088e-02   1.005   0.3149
## factor(month)2009-01-01 -6.007e-03  1.086e-02  -0.553   0.5801
## factor(month)2009-02-01 -5.783e-03  1.092e-02  -0.530   0.5964
## factor(month)2009-03-01 -8.894e-03  1.085e-02  -0.820   0.4124
## factor(month)2009-04-01 -4.911e-03  1.087e-02  -0.452   0.6515
## factor(month)2009-05-01 -1.545e-03  1.086e-02  -0.142   0.8869
## factor(month)2009-06-01  4.206e-03  1.086e-02   0.387   0.6986
## factor(month)2009-07-01  5.471e-03  1.087e-02   0.503   0.6147
## factor(month)2009-08-01 -4.667e-03  1.087e-02  -0.429   0.6678
## factor(month)2009-09-01 -4.795e-03  1.087e-02  -0.441   0.6592
## factor(month)2009-10-01 -1.586e-03  1.087e-02  -0.146   0.8840
## factor(month)2009-11-01 -5.210e-03  1.088e-02  -0.479   0.6322
## factor(month)2009-12-01 -9.886e-03  1.095e-02  -0.902   0.3668
## factor(month)2010-01-01  1.815e-03  1.094e-02   0.166   0.8682
## factor(month)2010-02-01  3.620e-03  1.116e-02   0.324   0.7457
## factor(month)2010-03-01 -8.878e-03  1.099e-02  -0.808   0.4192
## factor(month)2010-04-01  7.082e-03  1.100e-02   0.644   0.5198
## factor(month)2010-05-01 -3.414e-03  1.101e-02  -0.310   0.7565
## factor(month)2010-06-01 -5.868e-03  1.102e-02  -0.532   0.5944
## factor(month)2010-07-01 -1.353e-02  1.102e-02  -1.228   0.2196
## factor(month)2010-08-01  9.875e-03  1.103e-02   0.895   0.3708
## factor(month)2010-09-01  2.215e-03  1.103e-02   0.201   0.8408
## factor(month)2010-10-01 -2.548e-03  1.103e-02  -0.231   0.8172
## factor(month)2010-11-01 -9.175e-03  1.110e-02  -0.827   0.4084
## factor(month)2010-12-01 -4.759e-03  1.122e-02  -0.424   0.6715
## factor(month)2011-01-01 -8.207e-03  1.119e-02  -0.733   0.4633
## factor(month)2011-02-01 -5.389e-03  1.145e-02  -0.471   0.6378
## factor(month)2011-03-01 -4.549e-03  1.121e-02  -0.406   0.6849
## factor(month)2011-04-01 -1.189e-03  1.120e-02  -0.106   0.9154
## factor(month)2011-05-01 -5.307e-04  1.117e-02  -0.048   0.9621
```

```
## factor(month)2011-06-01  1.207e-04  1.115e-02   0.011   0.9914
## factor(month)2011-07-01  4.004e-03  1.113e-02   0.360   0.7191
## factor(month)2011-08-01 -1.043e-04  1.114e-02  -0.009   0.9925
## factor(month)2011-09-01 -1.135e-02  1.101e-02  -1.031   0.3027
## factor(month)2011-10-01  1.049e-02  1.100e-02   0.954   0.3399
## factor(month)2011-11-01 -6.974e-03  1.106e-02  -0.631   0.5283
## factor(month)2011-12-01  2.879e-04  1.109e-02   0.026   0.9793
## factor(month)2012-01-01 -1.045e-02  1.113e-02  -0.939   0.3477
## factor(month)2012-02-01  2.973e-03  1.121e-02   0.265   0.7909
## factor(month)2012-03-01  1.820e-03  1.105e-02   0.165   0.8692
## factor(month)2012-04-01  4.576e-03  1.114e-02   0.411   0.6812
## factor(month)2012-05-01  4.361e-03  1.107e-02   0.394   0.6936
## factor(month)2012-06-01 -2.065e-03  1.107e-02  -0.187   0.8520
## factor(month)2012-07-01  6.781e-04  1.107e-02   0.061   0.9512
## factor(month)2012-08-01 -5.126e-03  1.111e-02  -0.461   0.6445
## factor(month)2012-09-01  2.322e-03  1.117e-02   0.208   0.8353
## factor(month)2012-10-01 -1.458e-02  1.117e-02  -1.305   0.1919
## factor(month)2012-11-01  3.463e-03  1.125e-02   0.308   0.7582
## factor(month)2012-12-01 -1.687e-02  1.130e-02  -1.494   0.1352
## factor(month)2013-01-01  3.795e-03  1.131e-02   0.335   0.7373
## factor(month)2013-02-01 -8.078e-03  1.156e-02  -0.699   0.4847
## factor(month)2013-03-01 -1.585e-02  1.137e-02  -1.395   0.1631
## factor(month)2013-04-01  3.512e-03  1.133e-02   0.310   0.7565
## factor(month)2013-05-01  1.411e-02  1.123e-02   1.257   0.2088
## factor(month)2013-06-01  7.059e-03  1.125e-02   0.628   0.5303
## factor(month)2013-07-01  1.753e-02  1.122e-02   1.563   0.1180
## factor(month)2013-08-01 -2.732e-03  1.122e-02  -0.244   0.8076
## factor(month)2013-09-01  3.037e-03  1.130e-02   0.269   0.7882
## factor(month)2013-10-01 -8.699e-03  1.134e-02  -0.767   0.4430
## factor(month)2013-11-01 -5.810e-03  1.144e-02  -0.508   0.6117
## factor(month)2013-12-01  3.319e-03  1.155e-02   0.287   0.7738
## factor(month)2014-01-01 -1.496e-02  1.171e-02  -1.278   0.2011
## factor(month)2014-02-01  2.499e-03  1.186e-02   0.211   0.8331
## factor(month)2014-03-01 -4.441e-03  1.155e-02  -0.385   0.7005
## factor(month)2014-04-01 -1.862e-02  1.148e-02  -1.622   0.1049
## factor(month)2014-05-01 -5.901e-03  1.137e-02  -0.519   0.6038
## factor(month)2014-06-01 -1.761e-03  1.130e-02  -0.156   0.8762
## factor(month)2014-07-01  5.575e-03  1.126e-02   0.495   0.6206
## factor(month)2014-08-01 -1.113e-03  1.130e-02  -0.098   0.9215
## factor(month)2014-09-01  1.055e-03  1.134e-02   0.093   0.9259
## factor(month)2014-10-01 -1.730e-03  1.133e-02  -0.153   0.8787
## factor(month)2014-11-01 -8.539e-03  1.154e-02  -0.740   0.4591
## factor(month)2014-12-01 -7.021e-03  1.153e-02  -0.609   0.5427
## factor(month)2015-01-01 -4.922e-03  1.157e-02  -0.425   0.6705
## factor(month)2015-02-01 -9.308e-03  1.196e-02  -0.778   0.4363
## factor(month)2015-03-01  4.154e-03  1.153e-02   0.360   0.7187
## factor(month)2015-04-01 -3.524e-03  1.156e-02  -0.305   0.7604
## factor(month)2015-05-01 -6.722e-03  1.142e-02  -0.589   0.5561
## factor(month)2015-06-01 -7.111e-03  1.143e-02  -0.622   0.5340
## factor(month)2015-07-01 -8.631e-03  1.138e-02  -0.758   0.4483
## factor(month)2015-08-01 -5.341e-03  1.136e-02  -0.470   0.6383
## factor(month)2015-09-01 -1.012e-03  1.147e-02  -0.088   0.9297
## factor(month)2015-10-01 -8.335e-03  1.147e-02  -0.727   0.4673
## factor(month)2015-11-01  2.320e-03  1.162e-02   0.200   0.8418
```

```
## factor(month)2015-12-01 -7.373e-03  1.161e-02  -0.635   0.5253
## factor(month)2016-01-01 -5.344e-03  1.166e-02  -0.458   0.6467
## factor(month)2016-02-01 -7.099e-03  1.180e-02  -0.601   0.5476
## factor(month)2016-03-01 -1.453e-02  1.155e-02  -1.258   0.2084
## factor(month)2016-04-01  9.818e-03  1.160e-02   0.846   0.3973
## factor(month)2016-05-01  9.858e-03  1.145e-02   0.861   0.3891
## factor(month)2016-06-01 -5.147e-03  1.141e-02  -0.451   0.6520
## factor(month)2016-07-01 -1.082e-02  1.138e-02  -0.951   0.3417
## factor(month)2016-08-01 -1.921e-02  1.134e-02  -1.694   0.0903 .
## factor(month)2016-09-01 -1.542e-03  1.141e-02  -0.135   0.8925
## factor(month)2016-10-01  3.118e-03  1.141e-02   0.273   0.7847
## factor(month)2016-11-01 -1.398e-02  1.155e-02  -1.210   0.2261
## factor(month)2016-12-01 -1.290e-02  1.163e-02  -1.109   0.2673
## factor(month)2017-01-01  8.784e-05  1.159e-02   0.008   0.9940
## factor(month)2017-02-01 -5.838e-03  1.179e-02  -0.495   0.6205
## factor(month)2017-03-01  6.054e-03  1.171e-02   0.517   0.6050
## factor(month)2017-04-01 -5.738e-03  1.164e-02  -0.493   0.6222
## factor(month)2017-05-01  8.410e-03  1.154e-02   0.729   0.4660
## factor(month)2017-06-01 -1.219e-02  1.151e-02  -1.059   0.2894
## factor(month)2017-07-01 -6.123e-03  1.146e-02  -0.534   0.5930
## factor(month)2017-08-01 -2.664e-03  1.148e-02  -0.232   0.8165
## factor(month)2017-09-01 -8.493e-03  1.157e-02  -0.734   0.4628
## factor(month)2017-10-01 -9.683e-03  1.155e-02  -0.839   0.4017
## factor(month)2017-11-01 -1.685e-02  1.166e-02  -1.444   0.1486
## factor(month)2017-12-01 -8.924e-03  1.166e-02  -0.765   0.4442
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7068 on 1077743 degrees of freedom
##   (31 observations deleted due to missingness)
## Multiple R-squared:  0.3328, Adjusted R-squared:  0.3327
## F-statistic:  3318 on 162 and 1077743 DF,  p-value: < 2.2e-16
```

Exercise 5

Exercise 5-1

```
# Implement a within, between, and first difference estimator

# Within estimator

data5$unit <- as.factor(data5$unit)
modelwithin <- plm(arrest~tenure+districtcrimes+p50_inc+blackshare+hispshare+whiteshare+unit-1,
              data = data5,
              index = c("month","NUID"),
              model = "within",
              effect = "individual")
```

```
# Between estimator

modelbetween <- plm(arrest~tenure+districtcrimes+p50_inc+blackshare+hispshare+whiteshare+unit-1,
                  data = data5,
```

```
                    index = c("month","NUID"),
                    model = "between")
```

```
# First difference estimator

modelfd <- plm(arrest~tenure+districtcrimes+p50_inc+blackshare+hispshare+whiteshare+unit-1,
                     data = data5,
                     index = c("month","NUID"),
                     model = "fd")
```

```
# Comparison

modelwithin$coefficients[1]
```

```
##        tenure
## -3.809782e-06
```

```
modelbetween$coefficients[1]
```

```
##        tenure
## -0.0003251969
```

```
modelfd$coefficients[1]
```

```
##        tenure
## -3.014552e-06
```

Exercise 5-2

```
# GMM approach
```