

Modeling - article 1

```
## Warning in checkMatrixPackageVersion(): Package version inconsistency detected.  
## TMB was built with Matrix version 1.2.12  
## Current Matrix version is 1.2.14  
## Please re-install 'TMB' from source using install.packages('TMB', type = 'source') or ask CRAN for a
```

I am going to run the models and then try to print that to a page, in landscape orientation.

First, with the raw, untransformed data. Using the data with NA removed as things like MedHHinc have some NAs.

```
mod_1 <- lmer(CRMCPYPERC ~ 1 + (1|city_st), data = df_na)  
mod_2 <- lmer(CRMCPYPERC ~ ndvi_mean_cbg_adj + (1|city_st), data = df_na)  
mod_3 <- lmer(CRMCPYPERC ~ ndvi_mean_cbg_adj + (ndvi_mean_cbg_adj|city_st), data = df_na)  
mod_4 <- lmer(CRMCPYPERC ~ ndvi_mean_cbg_adj + MedHHinc_000 + disad + divindex + PcU18_whole + log_popden  
mod_5 <- lmer(CRMCPYPERC ~ ndvi_mean_cbg_adj + MedHHinc_000 + disad + divindex + PcU18_whole + log_popden
```

```
## Warning: Some predictor variables are on very different scales: consider  
## rescaling
```

Landscape

```
screenreg(list(mod_1, mod_2, mod_3, mod_4, mod_5))
```

```
##
## =====
##                               Model 1      Model 2      Model 3      Model 4      Model 5
## -----
## (Intercept)                  144.45 ***    304.92 ***    353.13 ***    533.03 ***    400.46 ***
##                               (5.19)         (6.85)         (13.99)        (12.50)        (15.32)
## ndvi_mean_cbg_adj            -37.23 ***    -45.79 ***    -25.94 ***    -28.39 ***
##                               (0.62)         (2.22)         (1.79)         (1.66)
## MedHHinc_000                 -0.40 ***    -0.39 ***
##                               (0.02)         (0.02)
## disad                        100.22 ***    99.86 ***
##                               (0.85)         (0.85)
## divindex                     -35.00 ***    -34.81 ***
##                               (2.61)         (2.61)
## PcU18_whole                   0.04         0.05
##                               (0.05)         (0.05)
## log_popden_cbg              -29.78 ***    -29.95 ***
##                               (0.57)         (0.57)
## PerCapitaOfficers1000        4.27
##                               (3.55)
## PCgdp15                      0.00 ***
##                               (0.00)
## clustnamecool-wet-lo        39.98 ***
##                               (7.22)
## clustnamewarm-dry-hi       -17.39
##                               (9.55)
## clustnamewarm-wet-hi       23.77 **
##                               (7.75)
## rate_violentcrime           15.37 ***
##                               (0.81)
## -----
## AIC                          751956.20    748461.39    744940.69    717459.74    717133.35
## BIC                          751983.19    748497.37    744994.67    717558.70    717286.28
## Log Likelihood               -375975.10  -374226.69  -372464.34  -358718.87  -358549.67
## Num. obs.                    59647     59647     59647     59647     59647
## Num. groups: city_st        301       301       301       301       301
```

```
## Var: city_st (Intercept)          7945.18      11838.47      52843.45      35386.27      18675.90
## Var: Residual                    17125.87      16114.56      15038.38      9505.99      9515.70
## Var: city_st ndvi_mean_cbg_adj          1155.13      766.89      620.44
## Cov: city_st (Intercept) ndvi_mean_cbg_adj      -6807.03      -4874.89      -3283.26
## =====
## *** p < 0.001, ** p < 0.01, * p < 0.05
```

Now with the grand centered variables

```
mod_6 <- lmer(CRMCPYPERC ~ 1 + (1|city_st), data = df_na)
mod_7 <- lmer(CRMCPYPERC ~ gndctr_ndvi_cbg_adj + (1|city_st), data = df_na)
mod_8 <- lmer(CRMCPYPERC ~ gndctr_ndvi_cbg_adj + (gndctr_ndvi_cbg_adj|city_st), data = df_na)
mod_9 <- lmer(CRMCPYPERC ~ gndctr_ndvi_cbg_adj + gndctr_MedHHinc000 + gndctr_disad + gndctr_diver + gndctr_...
mod_10 <- lmer(CRMCPYPERC ~ gndctr_ndvi_cbg_adj + gndctr_MedHHinc000 + gndctr_disad + gndctr_diver + gndctr_...
```

```
## Warning: Some predictor variables are on very different scales: consider
## rescaling
```

```

##
## =====
##                               Model 1      Model 2      Model 3      Model 4      Model 5
## -----
## (Intercept)                  144.45 ***    153.62 ***    167.04 ***    166.05 ***    140.49 ***
##                               (5.19)        (6.32)        (7.55)        (5.39)        (12.02)
## gndctr_ndvi_cbg_adj          -37.23 ***    -45.79 ***    -25.94 ***    -28.39 ***
##                               (0.62)        (2.22)        (1.79)        (1.66)
## gndctr_MedHHinc000           -0.40 ***    -0.39 ***
##                               (0.02)        (0.02)
## gndctr_disad                 100.22 ***    99.86 ***
##                               (0.85)        (0.85)
## gndctr_diver                 -35.00 ***    -34.81 ***
##                               (2.61)        (2.61)
## gndctr_U18                   0.04          0.05
##                               (0.05)        (0.05)
## gndctr_logpopden             -29.78 ***    -29.95 ***
##                               (0.57)        (0.57)
## gndctr_Police                 4.27
##                               (3.55)
## PCgdp15                      0.00 ***
##                               (0.00)
## clustnamecool-wet-lo         39.98 ***
##                               (7.22)
## clustnamewarm-dry-hi        -17.39
##                               (9.55)
## clustnamewarm-wet-hi        23.77 **
##                               (7.75)
## gndctr_rt_violent            15.37 ***
##                               (0.81)
## -----
## AIC                          751956.20    748461.39    744940.69    717459.74    717133.35
## BIC                          751983.19    748497.37    744994.67    717558.70    717286.28
## Log Likelihood               -375975.10  -374226.69  -372464.34  -358718.87  -358549.67
## Num. obs.                    59647      59647      59647      59647      59647
## Num. groups: city_st         301        301        301        301        301
## Var: city_st (Intercept)      7945.18    11838.47    16593.95    8429.06    2236.70
## Var: Residual                17125.87    16114.56    15038.38    9505.99    9515.70
## Var: city_st gndctr_ndvi_cbg_adj 1155.13    766.89    620.44

```

```
## Cov: city_st (Intercept) gndctr_ndvi_cbg_adj          -2112.51      -1758.22      -761.77
## =====
## *** p < 0.001, ** p < 0.01, * p < 0.05
```

Interaction

Using grand mean centered variables, level 1 and level 2, let's add the interaction between Green and Climate.

```
## Warning: Some predictor variables are on very different scales: consider
## rescaling
```

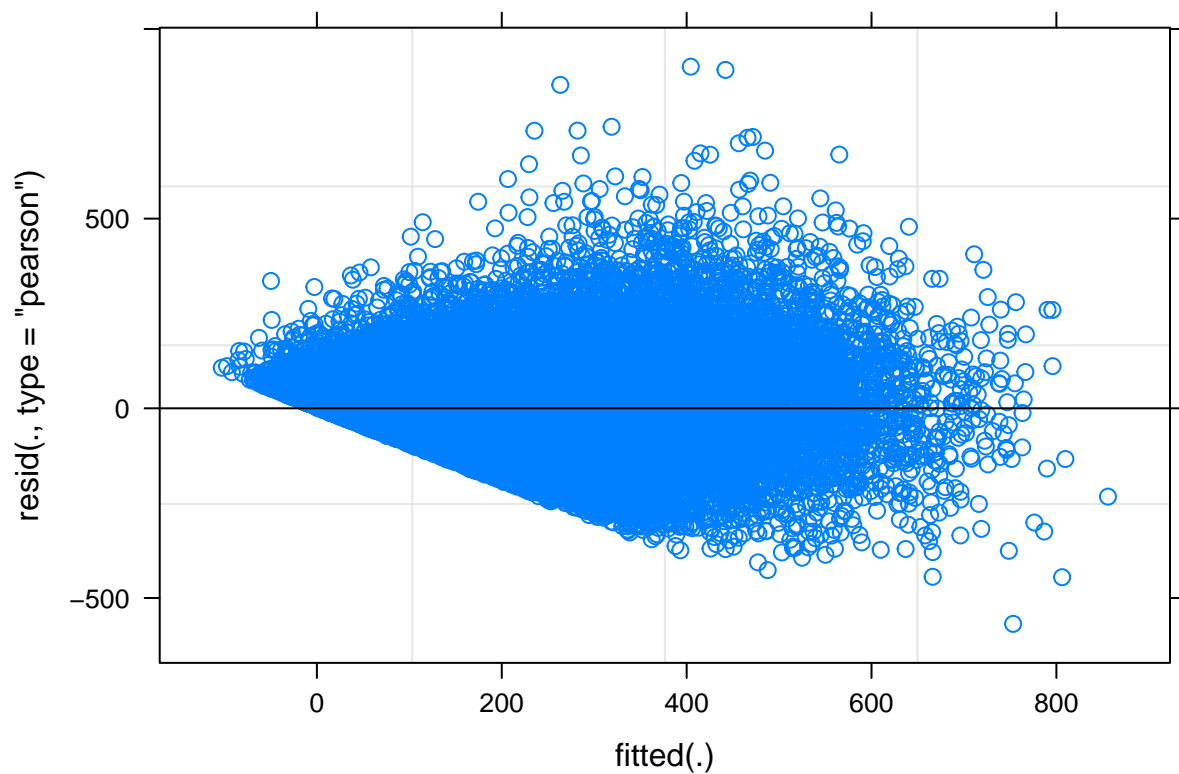
```
##
## =====
##                                     Model 1
## -----
## (Intercept)                        137.38 ***
##                                     (12.19)
## gndctr_ndvi_cbg_adj                 -25.49 ***
##                                     (3.47)
## clustnamecool-wet-lo                 52.81 ***
##                                     (8.20)
## clustnamewarm-dry-hi                -22.58 *
##                                     (9.93)
## clustnamewarm-wet-hi                 25.22 **
##                                     (8.86)
## gndctr_MedHHinc000                  -0.39 ***
##                                     (0.02)
## gndctr_disad                        99.85 ***
##                                     (0.85)
## gndctr_diver                       -34.87 ***
##                                     (2.61)
## gndctr_U18                           0.05
##                                     (0.05)
## gndctr_logpopden                   -29.98 ***
##                                     (0.57)
## gndctr_Police                       3.65
##                                     (3.55)
## PCgdp15                             0.00 ***
##                                     (0.00)
## gndctr_rt_violent                   15.41 ***
##                                     (0.81)
## gndctr_ndvi_cbg_adj:clustnamecool-wet-lo -11.17 **
##                                     (4.29)
## gndctr_ndvi_cbg_adj:clustnamewarm-dry-hi 13.01 *
##                                     (5.40)
## gndctr_ndvi_cbg_adj:clustnamewarm-wet-hi -1.94
##                                     (4.72)
## -----
## AIC                                717099.73
## BIC                                717279.66
## Log Likelihood                     -358529.87
## Num. obs.                           59647
## Num. groups: city_st                 301
## Var: city_st (Intercept)             2161.43
## Var: city_st gndctr_ndvi_cbg_adj      575.58
## Cov: city_st (Intercept) gndctr_ndvi_cbg_adj -704.04
## Var: Residual                       9515.05
## =====
## *** p < 0.001, ** p < 0.01, * p < 0.05
```

Take a look at the diagnostics.

```
summary(mod_11)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula:
## CRMCYPERC ~ gndctr_ndvi_cbg_adj * clustname + gndctr_MedHHinc000 +
##      gndctr_disad + gndctr_diver + gndctr_U18 + gndctr_logpopden +
##      gndctr_Police + PCgdp15 + gndctr_rt_violent + (gndctr_ndvi_cbg_adj |
##      city_st)
## Data: df_na
##
## REML criterion at convergence: 717059.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -5.8252 -0.5761 -0.0553  0.4835  9.2322
##
## Random effects:
##   Groups   Name                Variance Std.Dev. Corr
##   city_st  (Intercept)          2161.4   46.49
##           gndctr_ndvi_cbg_adj   575.6    23.99   -0.63
## Residual                9515.0    97.55
## Number of obs: 59647, groups:  city_st, 301
##
## Fixed effects:
##
##              Estimate Std. Error t value
## (Intercept)      1.374e+02  1.219e+01  11.273
## gndctr_ndvi_cbg_adj      -2.549e+01  3.469e+00  -7.348
## clustnamecool-wet-lo      5.281e+01  8.201e+00   6.440
## clustnamewarm-dry-hi     -2.258e+01  9.931e+00  -2.273
## clustnamewarm-wet-hi      2.522e+01  8.861e+00   2.846
## gndctr_MedHHinc000     -3.911e-01  1.977e-02 -19.785
## gndctr_disad           9.985e+01  8.483e-01 117.713
## gndctr_diver          -3.487e+01  2.605e+00 -13.385
## gndctr_U18             5.352e-02  4.922e-02   1.087
## gndctr_logpopden      -2.998e+01  5.740e-01 -52.233
## gndctr_Police          3.654e+00  3.548e+00   1.030
## PCgdp15              6.258e-04  1.630e-04   3.838
## gndctr_rt_violent       1.541e+01  8.063e-01  19.115
## gndctr_ndvi_cbg_adj:clustnamecool-wet-lo -1.117e+01  4.289e+00  -2.604
## gndctr_ndvi_cbg_adj:clustnamewarm-dry-hi  1.301e+01  5.395e+00   2.412
## gndctr_ndvi_cbg_adj:clustnamewarm-wet-hi -1.944e+00  4.724e+00  -0.412
##
## Correlation matrix not shown by default, as p = 16 > 12.
## Use print(x, correlation=TRUE) or
##   vcov(x)      if you need it
##
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
```

```
plot(mod_11)
```

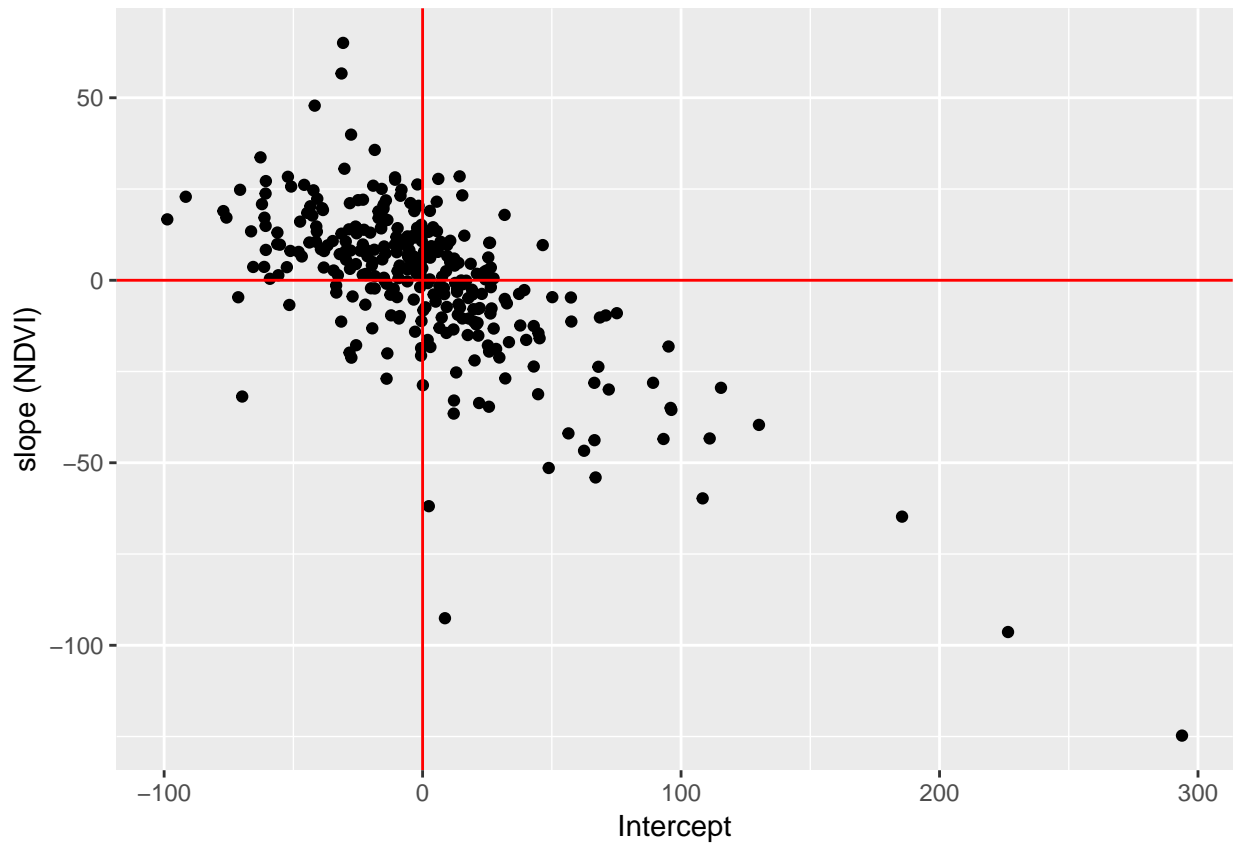



```
VarCorr(mod_11)$city_st
```

```
##               (Intercept) gndctr_ndvi_cbg_adj
## (Intercept)      2161.4291      -704.0405
## gndctr_ndvi_cbg_adj  -704.0405       575.5801
## attr(,"stddev")
##      (Intercept) gndctr_ndvi_cbg_adj
##      46.49117    23.99125
## attr(,"correlation")
##      (Intercept) gndctr_ndvi_cbg_adj
## (Intercept)      1.0000000    -0.6312106
## gndctr_ndvi_cbg_adj -0.6312106     1.0000000
```

```
RE11 <- raneef(mod_11, condVar = T)
```

```
RE11[[1]] %>% ggplot(aes(`(Intercept)`, gndctr_ndvi_cbg_adj)) + geom_point() + geom_hline(yintercept = 0)
```



The above plot shows the random effects that are applied to the mean effects (intercept and slope) from the model.

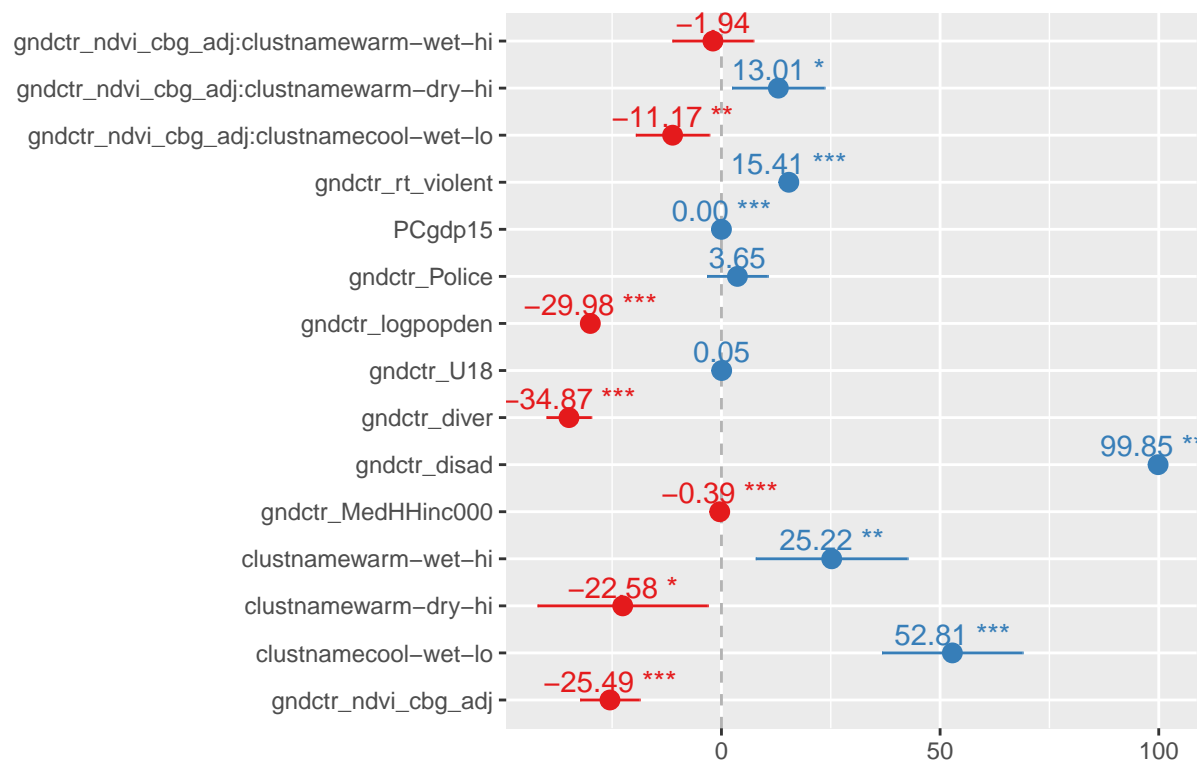
Plot the fixed effects.

```
sjp.lmer(mod_11, type = "fe", p.kr = FALSE, y.offset = 0.4)
```

```
## `sjp.lmer()` will become deprecated in the future. Please use `plot_model()` instead.
```

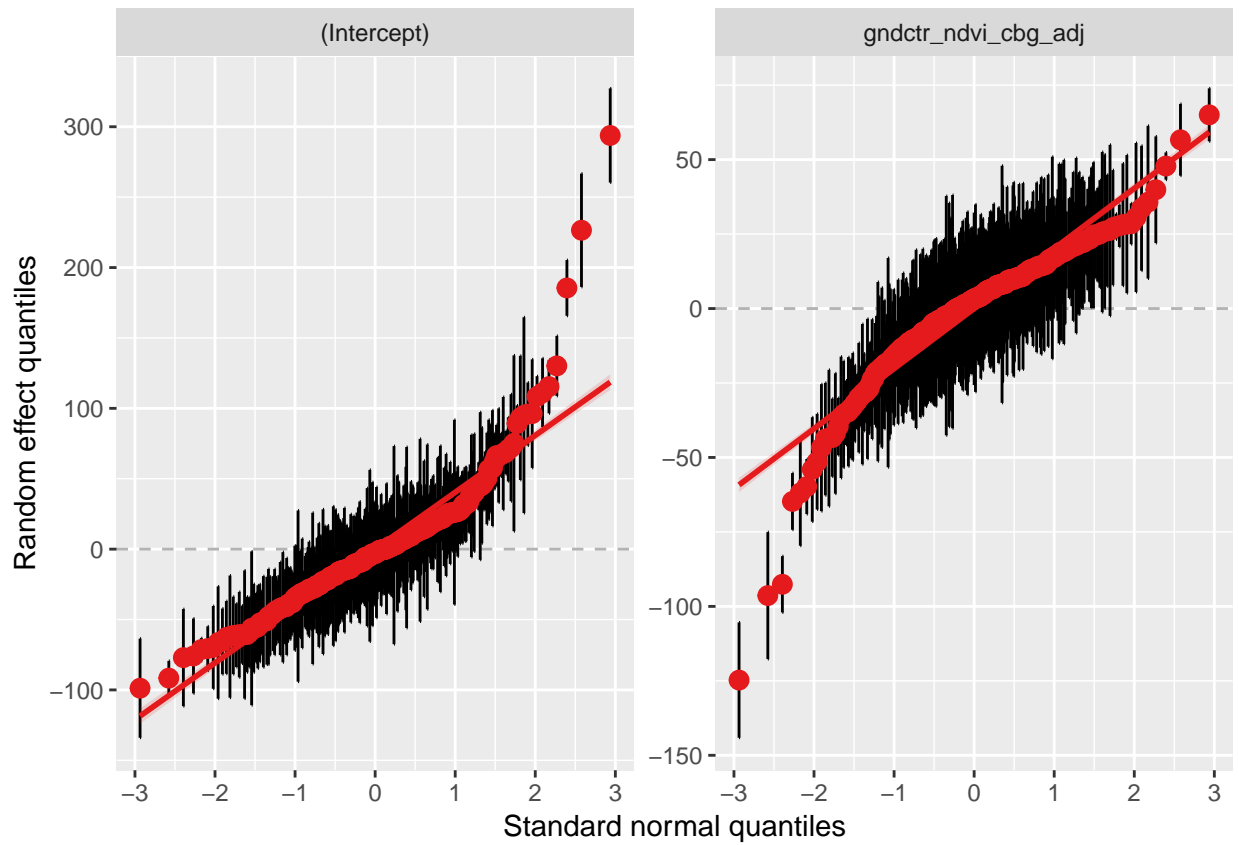
```
## Computing p-values via Wald-statistics approximation (treating t as Wald z).
```

Fixed effects

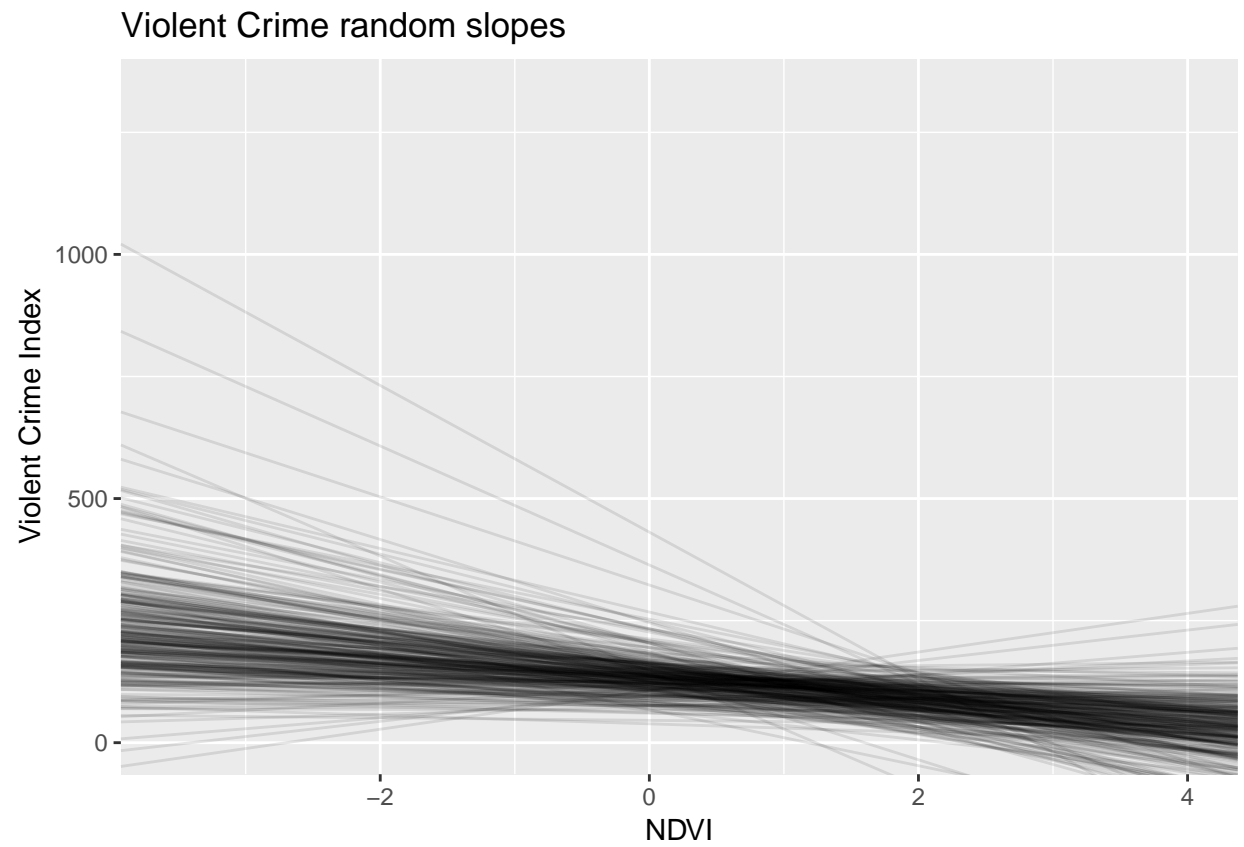


```
sjp.lmer(mod_11, type= "re.qq", p.kr = FALSE)
```

```
## Testing for normal distribution. Dots should be plotted along the line.
```



```
mod_est <- coef(mod_11)
df_na %>% ggplot(aes(gndctr_ndvi_cbg_adj, CRMCPERC)) + geom_point(alpha = 0) + geom_abline(aes(slope=g
```



The above plot is the estimated slopes for NDVI for 301 cities, based on model 11.