Replication code output

Rod Alence and Xichavo Alecia Ndlovu, "Political Accountability and development in Africa's resource economies," *The Extractive Industries and Society* 22 (2025): 101634.

Session

```
suppressPackageStartupMessages({
library(wordcloud)
library(stargazer)
library(marginaleffects)
library(systemfit)
library(lmtest)
library(cv)
library(dplyr)
library(ggplot2)
library(WhatIf)
})
load("exis_2025.RData")
sessionInfo()

## R version 4.4.2 (2024-10-31)
## Platform: x86_64-pc-linux-gnu
## Running under: Ubuntu 24.04.2 LTS
##
## Matrix products: default
## BLAS:   /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.12.0
## LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.12.0
##
## locale:
##  [1] LC_CTYPE=en_US.UTF-8       LC_NUMERIC=C
##  [3] LC_TIME=en_ZA.UTF-8        LC_COLLATE=en_US.UTF-8
##  [5] LC_MONETARY=en_ZA.UTF-8    LC_MESSAGES=en_US.UTF-8
##  [7] LC_PAPER=en_ZA.UTF-8       LC_NAME=C
##  [9] LC_ADDRESS=C               LC_TELEPHONE=C
## [11] LC_MEASUREMENT=en_ZA.UTF-8 LC_IDENTIFICATION=C
##
## time zone: Africa/Johannesburg
## tzcode source: system (glibc)
##
## attached base packages:
## [1] parallel  stats     graphics  grDevices utils     datasets  methods
## [8] base
##
## other attached packages:
##  [1] WhatIf_1.5-10          ggplot2_3.5.1          dplyr_1.1.4
##  [4] cv_2.0.3               doParallel_1.0.17      iterators_1.0.14
##  [7] foreach_1.5.2          systemfit_1.1-30       lmtest_0.9-40
## [10] zoo_1.8-13             car_3.1-3              carData_3.0-5
## [13] Matrix_1.7-2           marginaleffects_0.25.0 stargazer_5.2.3
```

```
## [16] wordcloud_2.6          RColorBrewer_1.1-3
##
## loaded via a namespace (and not attached):
##  [1] sandwich_3.1-1    generics_0.1.3    lpSolve_5.6.23    lattice_0.22-6
##  [5] lme4_1.1-36       magrittr_2.0.3    evaluate_1.0.3    grid_4.4.2
##  [9] Formula_1.2-5     scales_1.3.0      codetools_0.2-20  abind_1.4-8
## [13] reformulas_0.4.0  Rdpack_2.6.2      cli_3.6.4         pbmcapply_1.5.1
## [17] rlang_1.1.5       rbibutils_2.3     munsell_0.5.1     splines_4.4.2
## [21] withr_3.0.2       tools_4.4.2       nloptr_2.1.1      minqa_1.2.8
## [25] colorspace_2.1-1  boot_1.3-31       vctrs_0.6.5       R6_2.6.1
## [29] lifecycle_1.0.4   MASS_7.3-64       pkgconfig_2.0.3   gtable_0.3.6
## [33] pillar_1.10.1     data.table_1.17.0 glue_1.8.0        Rcpp_1.0.14
## [37] xfun_0.51         tibble_3.2.1      tidyselect_1.2.1  knitr_1.49
## [41] nlme_3.1-167      compiler_4.4.2
```

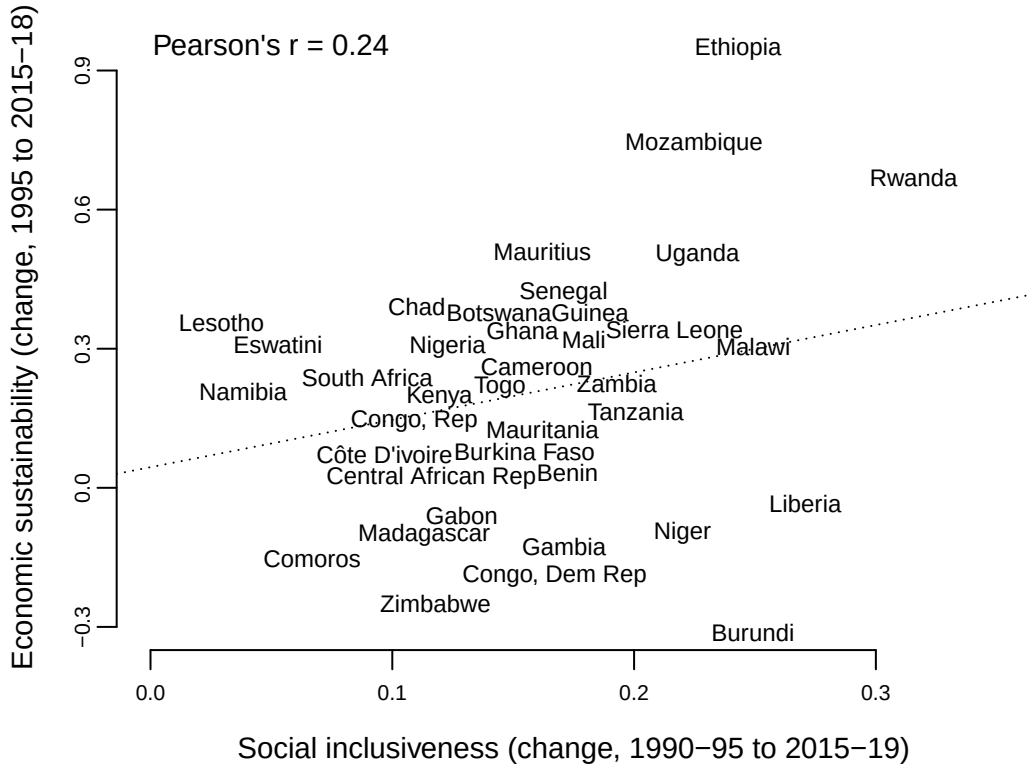
Transform data

```
## Logarithmic transformations
exis$lgdpnrPC9095 <- log(exis$gdpnrPC9095)
exis$lrentPC9095 <- log(exis$rentPC9095 + 1)
exis$lgdpPC9095 <- log(exis$gdpPC9095)

## Standardize variables
Stdize <- function(x) res <- (x - mean(x, na.rm = TRUE)) / sd(x, na.rm = TRUE)

exis$Z.lgdpnrPC9095 <- Stdize(exis$lgdpnrPC9095)
exis$Z.lrentPC9095 <- Stdize(exis$lrentPC9095)
exis$Z.incl9095 <- Stdize(exis$incl9095)
exis$Z.incl1519 <- Stdize(exis$incl1519)
exis$Z.sust95 <- Stdize(exis$sust95)
exis$Z.sust1518 <- Stdize(exis$sust1518)
exis$Z.dem_avg <- Stdize(exis$dem_avg)
exis$Z.compete_avg <- Stdize(exis$compete_avg)
exis$Z.parlinks_avg <- Stdize(exis$parlinks_avg)
exis$Z.war_avg <- Stdize(exis$war_avg)
```

Plot figure 2 (development trajectories)

```
## FIGURE 2: DEVELOPMENT TRAJECTORIES
exis$incl_change <- exis$incl1519 - exis$incl9095
exis$sust_change <- exis$sust1518 - exis$sust95
## Bivariate correlation:
cor(exis[, c("incl_change", "sust_change")], use = "complete.obs") |> round(2)

##             incl_change sust_change
## incl_change        1.00        0.24
## sust_change        0.24        1.00
```

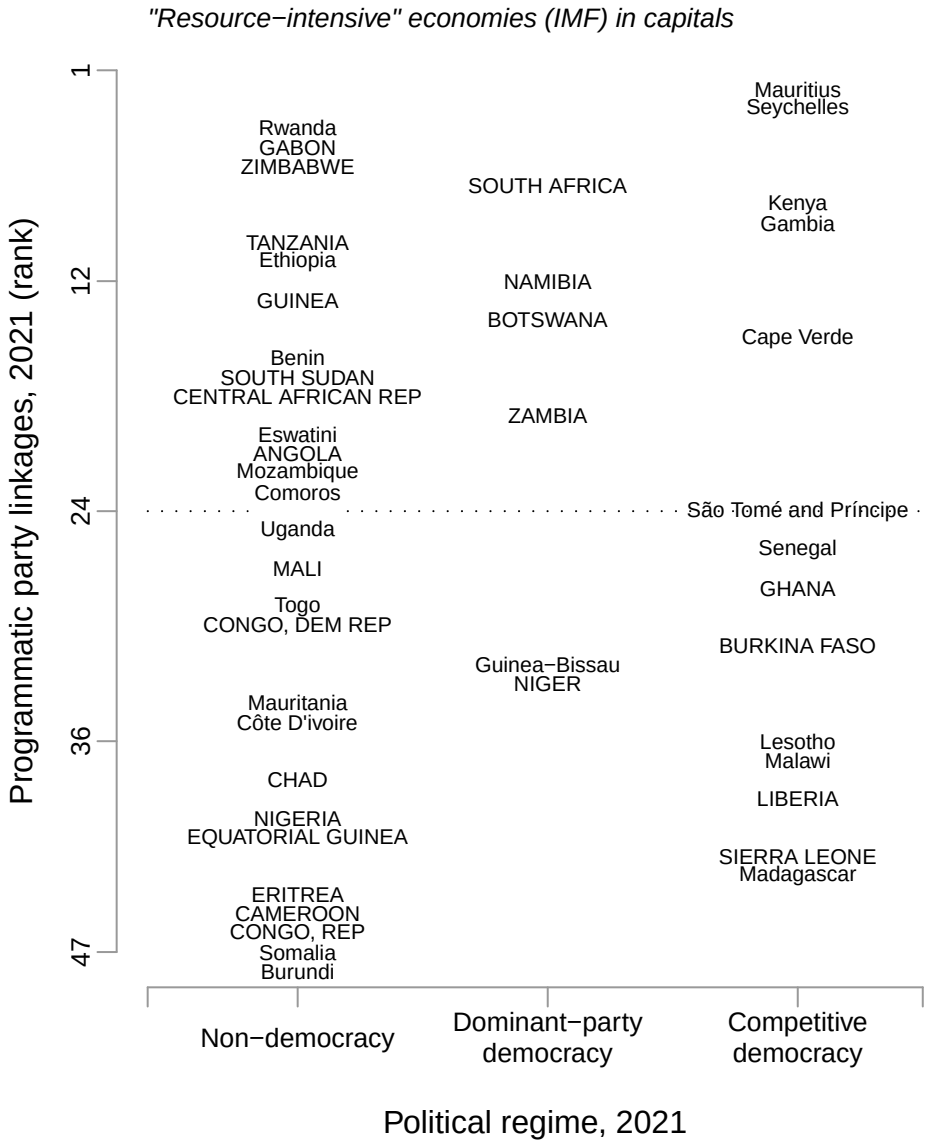
```r
## Plot figure
par(mar = c(3.1, 3.1, 0.6, 0.6),
    cex.axis = 0.7,
    cex.lab = 0.9,
    mgp = c(2, 0.5, 0))
with(exis[!is.na(exis$sust_change), ], {
  plot(incl_change, sust_change, type = "n",
       xlab = "Social inclusiveness (change, 1990-95 to 2015-19)",
       ylab = "Economic sustainability (change, 1995 to 2015-18)",
       xlim = c(0, 0.35),
       ylim = c(-0.3, 0.95),
       axes = FALSE)
  axis(side = 1, at = seq(0, 0.3, by = 0.1))
  axis(side = 2, at = seq(-0.3, 0.9, by = 0.3))
  abline(lm(sust_change ~ incl_change), lty = "dotted")
  mtext("Pearson's r = 0.24", line = -1, at = 0.05, cex = 0.9)
  textplot(incl_change, sust_change, words = country, cex = 0.75,
           show.lines = FALSE, new = FALSE)
})
```



Plot figure 3 (regime configurations)

```r
## Party-citizen links (rank)
exis$parlinks21_rank <- nrow(exis) - rank(exis$parlinks21, na.last = "keep") + 1
## Country labels that reflect "resource intensity" in all-caps
```

```r
exis$resIMF21_lab <- exis$country
exis[exis$resIMF21, "resIMF21_lab"] <- toupper(exis[exis$resIMF21, "resIMF21_lab"])
## Regime category labels
regime_labs <- c("",
                 "Non-democracy",
                 "Dominant-party\ndemocracy",
                 "Competitive\ndemocracy",
                 "")
par(mar = c(4.1, 3.1, 1.1, 0.1), cex.axis = 0.8)
plot(as.numeric(exis$polregime21), exis$parlinks21_rank,
     xlim = c(0.4, 3.5),
     ylim = c(47, 1),
     type="n",
     axes = FALSE,
     ylab = "",
     xlab = "Political regime, 2021")
segments(x0=c(0.4, 1.2), x1 = c(0.8, 3.5), y0=c(24, 24),
         lwd = 1, lty = "16")
text(exis$polregime21, exis$parlinks21_rank, labels = exis$resIMF21_lab,
     cex = 0.7)
axis(side = 2, at = c(1, 12, 24, 36, 47),
     lwd = 1, col = "grey60", lwd.ticks = 1,
     mgp = c(0.5, 0.5, 0))
axis(side = 1, at = c(0.4, 1:3, 3.5),
     labels = regime_labs,
     mgp = c(3, 0.5, 0), padj = 0.5,
     lwd = 1, col = "grey60", lwd.ticks = 1)
mtext("Programmatic party linkages, 2021 (rank)",
      side = 2, line = 2)
mtext('"Resource-intensive" economies (IMF) in capitals',
      side = 3, at = 0.4, line = 0, adj = 0, cex = 0.8, font = 3)
```



Run regressions for table 1

```
## Inclusiveness as outcome (columns 1-3)
exis_incl <- exis
exis_incl$lagged_outcome <- exis_incl$Z.incl9095  # for stargazer

incl_1 <- lm(Z.incl1519 ~ Z.lgdpnrPC9095 + Z.lrentPC9095,
             data = exis_incl)
summary(incl_1)

##
## Call:
## lm(formula = Z.incl1519 ~ Z.lgdpnrPC9095 + Z.lrentPC9095, data = exis_incl)
```

```
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.4400 -0.5882  0.1206  0.4223  2.6172
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     7.473e-16  1.146e-01   0.000    1.000
## Z.lgdpnrPC9095  6.525e-01  1.228e-01   5.314  3.4e-06 ***
## Z.lrentPC9095  -4.213e-02  1.228e-01  -0.343    0.733
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7859 on 44 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.4093, Adjusted R-squared:  0.3824
## F-statistic: 15.24 on 2 and 44 DF,  p-value: 9.34e-06
```

```
incl_2 <- lm(Z.incl1519 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095,
             data = exis_incl)
summary(incl_2)
```

```
##
## Call:
## lm(formula = Z.incl1519 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095,
##     data = exis_incl)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.13356 -0.29939  0.01685  0.26668  1.17638
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     3.520e-16  7.821e-02   0.000    1.000
## lagged_outcome  8.998e-01  1.254e-01   7.177 7.14e-09 ***
## Z.lgdpnrPC9095 -6.911e-02  1.309e-01  -0.528    0.600
## Z.lrentPC9095   4.152e-02  8.459e-02   0.491    0.626
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5362 on 43 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.7312, Adjusted R-squared:  0.7125
## F-statistic:    39 on 3 and 43 DF,  p-value: 2.472e-12
```

```
incl_3 <- lm(Z.incl1519 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
            Z.dem_avg + Z.compete_avg + Z.parlinks_avg,
             data = exis_incl)
summary(incl_3)
```

```
##
## Call:
```

```
## lm(formula = Z.incl1519 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     Z.dem_avg + Z.compete_avg + Z.parlinks_avg, data = exis_incl)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.01113 -0.31888 -0.01693  0.25799  0.81040
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     3.156e-16  6.749e-02   0.000 1.000000
## lagged_outcome  8.609e-01  1.109e-01   7.767 1.64e-09 ***
## Z.lgdpnrPC9095 -2.601e-01  1.257e-01  -2.069 0.045097 *
## Z.lrentPC9095   1.515e-01  7.921e-02   1.913 0.062977 .
## Z.dem_avg      -9.738e-02  1.046e-01  -0.931 0.357314
## Z.compete_avg   2.251e-01  1.030e-01   2.185 0.034839 *
## Z.parlinks_avg  3.434e-01  8.714e-02   3.941 0.000318 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4627 on 40 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.8138, Adjusted R-squared:  0.7859
## F-statistic: 29.14 on 6 and 40 DF,  p-value: 3.914e-13
```

```
## Sustainability as outcome (columns 4-6)
exis_sust <- exis
exis_sust$lagged_outcome <- exis_incl$Z.sust95  # for stargazer

sust_1 <- lm(Z.sust1518 ~ Z.lgdpnrPC9095 + Z.lrentPC9095,
             data = exis_sust)
summary(sust_1)
```

```
##
## Call:
## lm(formula = Z.sust1518 ~ Z.lgdpnrPC9095 + Z.lrentPC9095, data = exis_sust)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.14518 -0.38104 -0.03574  0.27559  0.93049
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.0002524  0.0848996   0.003   0.9976
## Z.lgdpnrPC9095 0.7758130  0.1039051   7.467 9.65e-09 ***
## Z.lrentPC9095  0.2094011  0.0982430   2.131   0.0401 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5211 on 35 degrees of freedom
##   (10 observations deleted due to missingness)
## Multiple R-squared:  0.7431, Adjusted R-squared:  0.7284
## F-statistic: 50.62 on 2 and 35 DF,  p-value: 4.69e-11
```

```r
sust_2 <- lm(Z.sust1518 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095,
             data = exis_sust)
summary(sust_2)
```

```
##
## Call:
## lm(formula = Z.sust1518 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095,
##     data = exis_sust)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.68166 -0.22990  0.01494  0.18612  0.74728
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.003116   0.053632   0.058   0.9540
## lagged_outcome 0.787240   0.107418   7.329 1.72e-08 ***
## Z.lgdpnrPC9095 0.191908   0.103228   1.859   0.0717 .
## Z.lrentPC9095  0.006707   0.067944   0.099   0.9219
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3292 on 34 degrees of freedom
##   (10 observations deleted due to missingness)
## Multiple R-squared:  0.9004, Adjusted R-squared:  0.8916
## F-statistic: 102.5 on 3 and 34 DF,  p-value: < 2.2e-16
```

```r
sust_3 <- lm(Z.sust1518 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
            Z.dem_avg + Z.compete_avg + Z.parlinks_avg,
             data = exis_sust)
summary(sust_3)
```

```
##
## Call:
## lm(formula = Z.sust1518 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     Z.dem_avg + Z.compete_avg + Z.parlinks_avg, data = exis_sust)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.54063 -0.14776  0.02417  0.20822  0.50939
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.013074   0.050495  -0.259   0.7974
## lagged_outcome  0.720891   0.106270   6.784 1.35e-07 ***
## Z.lgdpnrPC9095  0.122847   0.101367   1.212   0.2347
## Z.lrentPC9095   0.087899   0.073726   1.192   0.2422
## Z.dem_avg       0.006741   0.076005   0.089   0.9299
## Z.compete_avg   0.066104   0.080685   0.819   0.4189
## Z.parlinks_avg  0.178749   0.067484   2.649   0.0126 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 0.3078 on 31 degrees of freedom
##   (10 observations deleted due to missingness)
## Multiple R-squared:  0.9206, Adjusted R-squared:  0.9053
## F-statistic: 59.93 on 6 and 31 DF,  p-value: 1.087e-15
```

```
## Regression table
cov_labs <- c("Lagged outcome", "Non-rents/capita (log)",
              "Rents/capita (log)",
              "Electoral democracy", "Competitive", "Party linkages")
dv_labs <- c("Inclusiveness", "Sustainability")
table_note <- paste("OLS estimates and standard errors;",
                    "all variables standardized (z-scores).")

stargazer(incl_1, incl_2, incl_3, sust_1, sust_2, sust_3,
          type = "latex",
          title = "Predictors of development outcomes, 1990--2019",
          align = TRUE,
          keep.stat = c("n", "adj.rsq"),
          df = FALSE,
          covariate.labels = cov_labs,
          dep.var.labels = dv_labs,
          dep.var.caption = "Development outcomes",
          digits = 2,
          star.cutoffs = NA,
          omit.table.layout = "n")
```

Run (and summarize) simulations for figure 4

```
R_n <- 100       # number of replicates per profile
## Random seeds for each dimension (to avoid inducing association)
incl_seed <- 53  # random seed -- inclusiveness
sust_seed <- 22  # random seed -- sustainability
## Function to extract draws
getDraws <- function(x) x[["draw"]]

## Setting hypothetical values to use for profiles
hyp_names <- c("low", "high")
hyp_tail <- 0.18

dem_hyp <- quantile(exis$Z.dem_avg, c(hyp_tail, 1 - hyp_tail), na.rm = TRUE)
names(dem_hyp) <- hyp_names

comp_hyp <- quantile(exis$Z.compete_avg, c(hyp_tail, 1 - hyp_tail), na.rm = TRUE)
names(comp_hyp) <- hyp_names

party_hyp <- quantile(exis$Z.parlinks_avg, c(hyp_tail, 1 - hyp_tail), na.rm = TRUE)
names(party_hyp) <- hyp_names
```

Table 1: Predictors of development outcomes, 1990–2019

	Development outcomes					
	Inclusiveness			Sustainability		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged outcome		0.90	0.86		0.79	0.72
		(0.13)	(0.11)		(0.11)	(0.11)
Non-rents/capita (log)	0.65	−0.07	−0.26	0.78	0.19	0.12
	(0.12)	(0.13)	(0.13)	(0.10)	(0.10)	(0.10)
Rents/capita (log)	−0.04	0.04	0.15	0.21	0.01	0.09
	(0.12)	(0.08)	(0.08)	(0.10)	(0.07)	(0.07)
Electoral democracy			−0.10			0.01
			(0.10)			(0.08)
Competitive			0.23			0.07
			(0.10)			(0.08)
Party linkages			0.34			0.18
			(0.09)			(0.07)
Constant	0.00	0.00	0.00	0.0003	0.003	−0.01
	(0.11)	(0.08)	(0.07)	(0.08)	(0.05)	(0.05)
Observations	47	47	47	38	38	38
Adjusted R^2	0.38	0.71	0.79	0.73	0.89	0.91

```r
rent_hyp <- c(-0.31, 0.69)
names(rent_hyp) <- hyp_names

## Convert rent values back to dollars
invRents <- function(x) {
  res <- exp(mean(exis$lrentPC9095, na.rm = TRUE) +
               (x * sd(exis$lrentPC9095, na.rm = TRUE))) - 1
  return(res)
}
invRents(rent_hyp)

##       low      high
##  1.633334 20.340904

## Values for each political regime configuration (see Table 2)

## Competitive democracy with programmatic parties (upper-right)
dem_nd <- data.frame(
  lagged_outcome = 0,
  Z.lgdpnrPC9095 = 0,
  Z.dem_avg = dem_hyp["high"],
  Z.parlinks_avg = party_hyp["high"],
  Z.compete_avg = comp_hyp["high"]
)
## Dominant-party democracy (lower-right)
demDom_nd <- data.frame(
  lagged_outcome = 0,
  Z.lgdpnrPC9095 = 0,
  Z.dem_avg = dem_hyp["high"],
  Z.parlinks_avg = party_hyp["high"],
  Z.compete_avg = 0
)
## Competitive democracy (upper-left)
demComp_nd <- data.frame(
  lagged_outcome = 0,
  Z.lgdpnrPC9095 = 0,
  Z.dem_avg = dem_hyp["high"],
  Z.parlinks_avg = 0,
  Z.compete_avg = comp_hyp["high"]
)
## Non-democracy (lower-left)
nondem_nd <- data.frame(
  lagged_outcome = 0,
  Z.lgdpnrPC9095 = 0,
  Z.dem_avg = dem_hyp["low"],
  Z.parlinks_avg = party_hyp["low"],
  Z.compete_avg = comp_hyp["low"]
)

## Modify each to get "resource-poor" (P) and "resource-rich" (R) variants
dem_P_nd <- dem_nd |>
```

```
  mutate(Z.lrentPC9095 = rent_hyp["low"])
dem_R_nd <- dem_nd |>
  mutate(Z.lrentPC9095 = rent_hyp["high"])

demDom_P_nd <- demDom_nd |>
  mutate(Z.lrentPC9095 = rent_hyp["low"])
demDom_R_nd <- demDom_nd |>
  mutate(Z.lrentPC9095 = rent_hyp["high"])

demComp_P_nd <- demComp_nd |>
  mutate(Z.lrentPC9095 = rent_hyp["low"])
demComp_R_nd <- demComp_nd |>
  mutate(Z.lrentPC9095 = rent_hyp["high"])

nondem_P_nd <- nondem_nd |>
  mutate(Z.lrentPC9095 = rent_hyp["low"])
nondem_R_nd <- nondem_nd |>
  mutate(Z.lrentPC9095 = rent_hyp["high"])

## Run simulations (with marginaleffects::predictions)

## RESOURCE-POOR PROFILES:
## Competitive/programmatic
set.seed(incl_seed)
incl_dem_P_sims <- predictions(incl_3,
                               newdata = dem_P_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(incl_dem_P_sims)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.1091  0.4031  0.4669  0.4814  0.5559  0.8356
```

```
set.seed(sust_seed)
sust_dem_P_sims <- predictions(sust_3,
                               newdata = dem_P_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(sust_dem_P_sims)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.05768  0.17787  0.23407  0.23137  0.29702  0.45080
```

```
## Nondemocracy
set.seed(incl_seed)
incl_nondem_P_sims <- predictions(incl_3,
                               newdata = nondem_P_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(incl_nondem_P_sims)
```

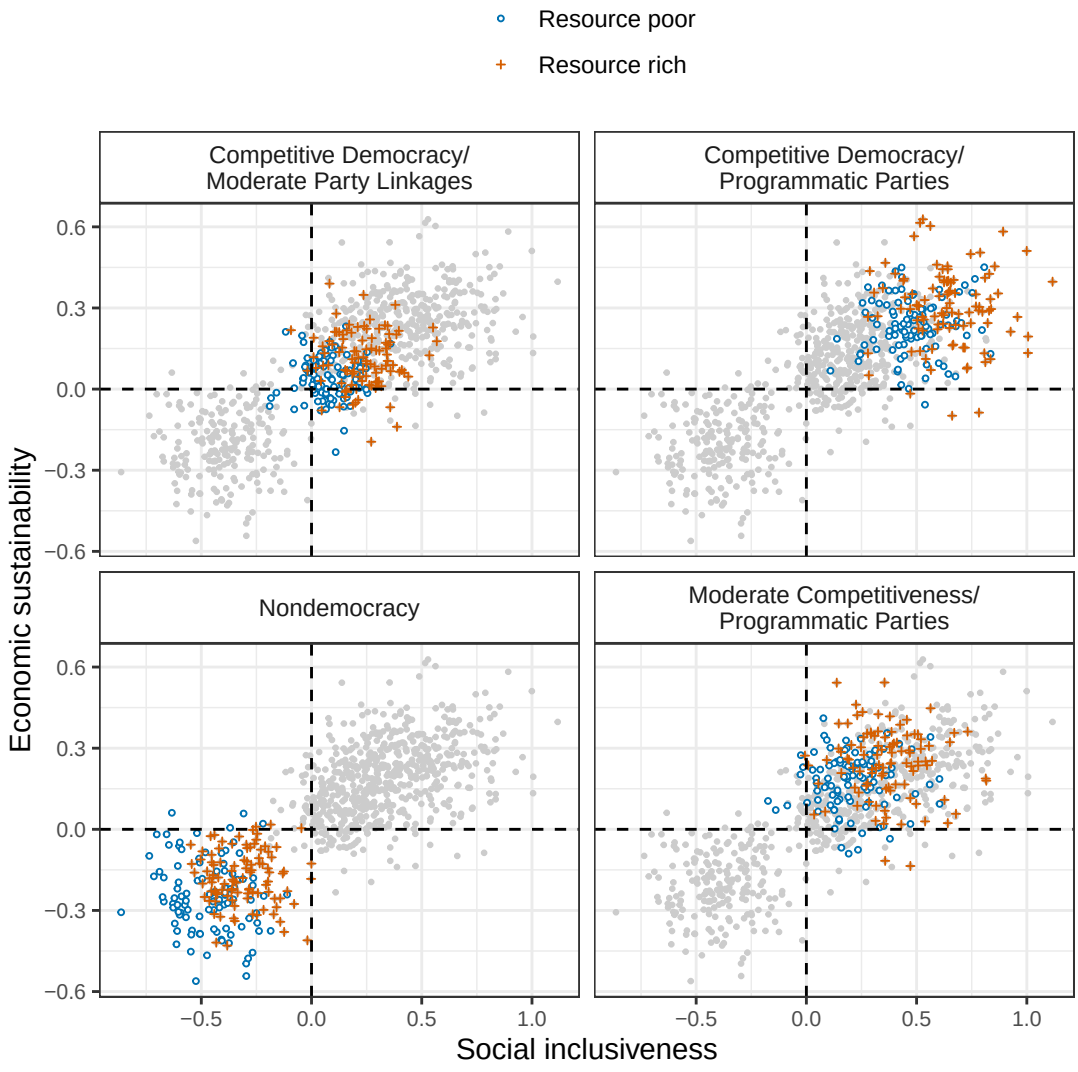
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -0.8636 -0.5940 -0.4515 -0.4666 -0.3669 -0.1106

set.seed(sust_seed)
sust_nondem_P_sims <- predictions(sust_3,
                                  newdata = nondem_P_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
set.seed(incl_seed)
summary(sust_nondem_P_sims)

##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.56130 -0.33340 -0.25669 -0.24704 -0.16407  0.06104

## Competitive/clientelistic
incl_demComp_P_sims <- predictions(incl_3,
                                   newdata = demComp_P_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(incl_demComp_P_sims)

##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.18991  0.01685  0.06671  0.07629  0.14603  0.35861

set.seed(sust_seed)
sust_demComp_P_sims <- predictions(sust_3,
                                   newdata = demComp_P_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(sust_demComp_P_sims)

##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.23305 -0.01269  0.03984  0.04148  0.09362  0.23218

## Dominant-programmatic
set.seed(incl_seed)
incl_demDom_P_sims <- predictions(incl_3,
                                  newdata = demDom_P_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(incl_demDom_P_sims)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -0.1739  0.1172  0.1898  0.2091  0.2920  0.6045

set.seed(sust_seed)
sust_demDom_P_sims <- predictions(sust_3,
                                  newdata = demDom_P_nd) |>
  inferences(method = "simulation", R = R_n) |>
```

```
  posterior_draws() |>
  getDraws()
summary(sust_demDom_P_sims)

##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.09016  0.10468  0.18847  0.17532  0.24222  0.41085

## RESOURCE-RICH PROFILES:
## Competitive/programmatic
set.seed(incl_seed)
incl_dem_R_sims <- predictions(incl_3,
                               newdata = dem_R_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(incl_dem_R_sims)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.2792  0.5233  0.6392  0.6377  0.7516  1.1168

set.seed(sust_seed)
sust_dem_R_sims <- predictions(sust_3,
                               newdata = dem_R_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(sust_dem_R_sims)

##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.09853  0.22560  0.29845  0.30026  0.39815  0.62803

## Nondemocracy
set.seed(incl_seed)
incl_nondem_R_sims <- predictions(incl_3,
                               newdata = nondem_R_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(incl_nondem_R_sims)

##       Min.    1st Qu.     Median       Mean    3rd Qu.       Max.
## -0.5478838 -0.4238595 -0.3009169 -0.3102875 -0.2211665 -0.0006446

set.seed(sust_seed)
sust_nondem_R_sims <- predictions(sust_3,
                               newdata = nondem_R_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(sust_nondem_R_sims)

##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -0.42990 -0.23766 -0.18023 -0.17816 -0.11049  0.01747
```

```r
set.seed(incl_seed)

## Competitive/clientelistic
incl_demComp_R_sims <- predictions(incl_3,
                                   newdata = demComp_R_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(incl_demComp_R_sims)

##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
## -0.09316  0.15335  0.23468  0.23265  0.31716  0.56820

set.seed(sust_seed)
sust_demComp_R_sims <- predictions(sust_3,
                                   newdata = demComp_R_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(sust_demComp_R_sims)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -0.1948  0.0460  0.1075  0.1104  0.1859  0.3900

## Dominant-programmatic
set.seed(incl_seed)
incl_demDom_R_sims <- predictions(incl_3,
                                  newdata = demDom_R_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(incl_demDom_R_sims)

##       Min.    1st Qu.     Median       Mean    3rd Qu.       Max.
## -0.006543  0.260430  0.356230  0.365490  0.469936  0.816148

set.seed(sust_seed)
sust_demDom_R_sims <- predictions(sust_3,
                                   newdata = demDom_R_nd) |>
  inferences(method = "simulation", R = R_n) |>
  posterior_draws() |>
  getDraws()
summary(sust_demDom_R_sims)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -0.1357  0.1659  0.2520  0.2442  0.3347  0.5428
```

Plot figure 4 (simulated development outcomes)

```
bo_pal <- c("#4A5AB5", "B5A54A")  # color palette
## Faceted data frame with simulations
facet_polrent <- data.frame(
  type = factor(rep(1:4, each = R_n * 2),
                labels = c("Competitive Democracy/\nModerate Party Linkages",
                           "Competitive Democracy/\nProgrammatic Parties",
                           "Nondemocracy",
                           "Moderate Competitiveness/\nProgrammatic Parties")),
  rent = factor(rep(rep(1:2, each = R_n), 4),
                labels = c("Resource poor", "Resource rich")),
  incl = c(incl_demComp_P_sims, incl_demComp_R_sims,
           incl_dem_P_sims, incl_dem_R_sims,
           incl_nondem_P_sims, incl_nondem_R_sims,
           incl_demDom_P_sims, incl_demDom_R_sims),
  sust = c(sust_demComp_P_sims, sust_demComp_R_sims,
           sust_dem_P_sims, sust_dem_R_sims,
           sust_nondem_P_sims, sust_nondem_R_sims,
           sust_demDom_P_sims, sust_demDom_R_sims)
)

ggplot(data = facet_polrent, aes(x = incl, y = sust)) +
  geom_point(data = select(facet_polrent, -type), color= "grey80", size = 0.5) +
  geom_point(size=0.7, fill = "white",
             aes(shape = rent, color = rent)) +
  geom_hline(yintercept=0, linetype = "dashed") +
  geom_vline(xintercept=0, linetype = "dashed") +
  scale_shape_manual(values=c(21, 3))+
  scale_color_manual(values =  c("Resource poor" = "#0072B2",
                                 "Resource rich" = "#D55E00")) +
  facet_wrap(~ type, nrow = 2) +
  theme_bw() +
  theme(legend.title = element_blank(),
        strip.background = element_rect(fill = "white"),
        strip.text = element_text(size = 9),
        legend.text = element_text(size = 9),
        legend.position = "top",
        legend.direction = "vertical",
        axis.text = element_text(size = 8)) +
  xlab("Social inclusiveness") +
  ylab("Economic sustainability")
```



Check the plausibility of "counterfactual" profiles

All profiles fall within the convex hull of the data except the last one (`dem_R_nd`): a resource-rich democracy with high values on both electoral competitiveness and programmatic party-citizen linkages.

```
## Non-democracy
(nondem_P_cf <- whatif(~ Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
                         Z.parlinks_avg,
                       data = exis, cfact = nondem_P_nd,
                       distance = "euclidian"))

## Preprocessing data ...
## Performing convex hull test ...
## Calculating distances ....
## Calculating the geometric variance...
## Calculating cumulative frequencies ...
```

```
## Finishing up ...

##
## Call:
## whatif(formula = ~Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
##     Z.parlinks_avg, data = exis, cfact = nondem_P_nd, distance = "euclidian")
##
## Counterfactual in Convex Hull, True or False:
##  Counterfactual In Hull
##                1    TRUE
##
## Percent Data Nearby Counterfactual:
##  Counterfactual Percent Nearby
##                1      0.3829787
##
## Geometric Variance of Covariates:
## 3.914894

(nondem_R_cf <- whatif(~ Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
                         Z.parlinks_avg,
                       data = exis, cfact = nondem_R_nd,
                       distance = "euclidian"))

## Preprocessing data ...
## Performing convex hull test ...
## Calculating distances ....
## Calculating the geometric variance...
## Calculating cumulative frequencies ...
## Finishing up ...

##
## Call:
## whatif(formula = ~Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
##     Z.parlinks_avg, data = exis, cfact = nondem_R_nd, distance = "euclidian")
##
## Counterfactual in Convex Hull, True or False:
##  Counterfactual In Hull
##                1    TRUE
##
## Percent Data Nearby Counterfactual:
##  Counterfactual Percent Nearby
##                1      0.4042553
##
## Geometric Variance of Covariates:
## 3.914894

## Competitive democracy
(demComp_P_cf <- whatif(~ Z.lrentPC9095 +
                          Z.dem_avg + Z.compete_avg +
                        Z.parlinks_avg,
                        data = exis, cfact = demComp_P_nd,
                        distance = "euclidian"))
```

```
## Preprocessing data ...
## Performing convex hull test ...
## Calculating distances ....
## Calculating the geometric variance...
## Calculating cumulative frequencies ...
## Finishing up ...

##
## Call:
## whatif(formula = ~Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
##     Z.parlinks_avg, data = exis, cfact = demComp_P_nd, distance = "euclidian")
##
## Counterfactual in Convex Hull, True or False:
##  Counterfactual In Hull
##               1    TRUE
##
## Percent Data Nearby Counterfactual:
##  Counterfactual Percent Nearby
##               1      0.3404255
##
## Geometric Variance of Covariates:
## 3.914894

(demComp_R_cf <- whatif(~ Z.lrentPC9095 +
                          Z.dem_avg + Z.compete_avg +
                        Z.parlinks_avg,
                        data = exis, cfact = demComp_R_nd,
                        distance = "euclidian"))

## Preprocessing data ...
## Performing convex hull test ...
## Calculating distances ....
## Calculating the geometric variance...
## Calculating cumulative frequencies ...
## Finishing up ...

##
## Call:
## whatif(formula = ~Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
##     Z.parlinks_avg, data = exis, cfact = demComp_R_nd, distance = "euclidian")
##
## Counterfactual in Convex Hull, True or False:
##  Counterfactual In Hull
##               1    TRUE
##
## Percent Data Nearby Counterfactual:
##  Counterfactual Percent Nearby
##               1      0.2553191
##
## Geometric Variance of Covariates:
## 3.914894
```

```r
## Dominant-party democracy
(demDom_P_cf <- whatif(~ Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
                        Z.parlinks_avg,
                      data = exis, cfact = demDom_P_nd,
                      distance = "euclidian"))
```

```
## Preprocessing data ...
## Performing convex hull test ...
## Calculating distances ....
## Calculating the geometric variance...
## Calculating cumulative frequencies ...
## Finishing up ...
```

```
##
## Call:
## whatif(formula = ~Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
##     Z.parlinks_avg, data = exis, cfact = demDom_P_nd, distance = "euclidian")
##
## Counterfactual in Convex Hull, True or False:
##  Counterfactual In Hull
##                1    TRUE
##
## Percent Data Nearby Counterfactual:
##  Counterfactual Percent Nearby
##                1      0.2553191
##
## Geometric Variance of Covariates:
## 3.914894
```

```r
(demDom_R_cf <- whatif(~ Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
                        Z.parlinks_avg,
                      data = exis, cfact = demDom_R_nd,
                      distance = "euclidian",
                      return.distance = TRUE))
```

```
## Preprocessing data ...
## Performing convex hull test ...
## Calculating distances ....
## Calculating the geometric variance...
## Calculating cumulative frequencies ...
## Finishing up ...
```

```
##
## Call:
## whatif(formula = ~Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
##     Z.parlinks_avg, data = exis, cfact = demDom_R_nd, distance = "euclidian",
##     return.distance = TRUE)
##
## Counterfactual in Convex Hull, True or False:
##  Counterfactual In Hull
##                1    TRUE
##
## Percent Data Nearby Counterfactual:
```

```
##  Counterfactual Percent Nearby
##               1      0.1489362
##
## Geometric Variance of Covariates:
## 3.914894

## Full democracy
(dem_P_cf <- whatif(~ Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
                        Z.parlinks_avg,
                    data = exis, cfact = dem_P_nd,
                    distance = "euclidian"))

## Preprocessing data ...
## Performing convex hull test ...
## Calculating distances ....
## Calculating the geometric variance...
## Calculating cumulative frequencies ...
## Finishing up ...

##
## Call:
## whatif(formula = ~Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
##     Z.parlinks_avg, data = exis, cfact = dem_P_nd, distance = "euclidian")
##
## Counterfactual in Convex Hull, True or False:
##  Counterfactual In Hull
##               1    TRUE
##
## Percent Data Nearby Counterfactual:
##  Counterfactual Percent Nearby
##               1      0.2553191
##
## Geometric Variance of Covariates:
## 3.914894

(dem_R_cf <- whatif(~ Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
                        Z.parlinks_avg,
                    data = exis, cfact = dem_R_nd,
                    distance = "euclidian",
                    return.distance = TRUE))

## Preprocessing data ...
## Performing convex hull test ...
## Calculating distances ....
## Calculating the geometric variance...
## Calculating cumulative frequencies ...
## Finishing up ...

##
## Call:
## whatif(formula = ~Z.lrentPC9095 + Z.dem_avg + Z.compete_avg +
##     Z.parlinks_avg, data = exis, cfact = dem_R_nd, distance = "euclidian",
##     return.distance = TRUE)
```

```
##
## Counterfactual in Convex Hull, True or False:
##  Counterfactual In Hull
##               1   FALSE
##
## Percent Data Nearby Counterfactual:
##  Counterfactual Percent Nearby
##               1      0.2340426
##
## Geometric Variance of Covariates:
## 3.914894
```

Report alternative specifications mentioned in the article

Robustness: War

```
## War-years as a predictor (4a) and "no-war" subset (4b)
## Inclusiveness
incl_4a <- lm(Z.incl1519 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
            Z.dem_avg + Z.compete_avg + Z.parlinks_avg + Z.war_avg,
             data = exis_incl)
summary(incl_4a)  # include proportion war years as predictor

##
## Call:
## lm(formula = Z.incl1519 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     Z.dem_avg + Z.compete_avg + Z.parlinks_avg + Z.war_avg, data = exis_incl)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.99603 -0.26015  0.04636  0.28081  0.67915
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     2.419e-16  6.529e-02   0.000 1.000000
## lagged_outcome  9.079e-01  1.099e-01   8.258 4.29e-10 ***
## Z.lgdpnrPC9095 -2.801e-01  1.221e-01  -2.295 0.027217 *
## Z.lrentPC9095   1.618e-01  7.681e-02   2.107 0.041597 *
## Z.dem_avg      -4.851e-02  1.043e-01  -0.465 0.644305
## Z.compete_avg   2.242e-01  9.967e-02   2.249 0.030215 *
## Z.parlinks_avg  3.354e-01  8.440e-02   3.974 0.000296 ***
## Z.war_avg       1.437e-01  7.421e-02   1.936 0.060087 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4476 on 39 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.8302, Adjusted R-squared:  0.7997
## F-statistic: 27.23 on 7 and 39 DF,  p-value: 3.9e-13
```

```r
incl_4b <- lm(Z.incl1519 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
            Z.dem_avg + Z.compete_avg + Z.parlinks_avg,
             data = subset(exis_incl, war_avg == 0))
summary(incl_4b)  # subset sample to countries with no civil war

##
## Call:
## lm(formula = Z.incl1519 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     Z.dem_avg + Z.compete_avg + Z.parlinks_avg, data = subset(exis_incl,
##     war_avg == 0))
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.9306 -0.2435  0.0203  0.2966  0.6257
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.16010    0.08065  -1.985   0.0582 .
## lagged_outcome  0.95684    0.12224   7.827 3.49e-08 ***
## Z.lgdpnrPC9095 -0.17175    0.12851  -1.336   0.1934
## Z.lrentPC9095   0.15918    0.09449   1.685   0.1045
## Z.dem_avg      -0.04742    0.10749  -0.441   0.6629
## Z.compete_avg   0.24092    0.10192   2.364   0.0262 *
## Z.parlinks_avg  0.27632    0.11574   2.387   0.0248 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4224 on 25 degrees of freedom
## Multiple R-squared:  0.8831, Adjusted R-squared:  0.855
## F-statistic: 31.48 on 6 and 25 DF,  p-value: 1.733e-10

## Sustainability
sust_4a <- lm(Z.sust1518 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
            Z.dem_avg + Z.compete_avg + Z.parlinks_avg + Z.war_avg,
             data = exis_sust)
summary(sust_4a)  # include proportion war years as predictor

##
## Call:
## lm(formula = Z.sust1518 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     Z.dem_avg + Z.compete_avg + Z.parlinks_avg + Z.war_avg, data = exis_sust)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.61089 -0.10959  0.02184  0.18931  0.47021
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     0.01441    0.05552   0.259   0.7971
## lagged_outcome  0.73302    0.10620   6.902 1.16e-07 ***
## Z.lgdpnrPC9095  0.15252    0.10400   1.466   0.1529
## Z.lrentPC9095   0.06480    0.07598   0.853   0.4005
```

```
## Z.dem_avg       0.02446    0.07711   0.317   0.7533
## Z.compete_avg   0.06226    0.08031   0.775   0.4442
## Z.parlinks_avg  0.16815    0.06773   2.483   0.0189 *
## Z.war_avg       0.13036    0.11239   1.160   0.2552
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3061 on 30 degrees of freedom
##   (10 observations deleted due to missingness)
## Multiple R-squared:  0.924, Adjusted R-squared:  0.9063
## F-statistic: 52.14 on 7 and 30 DF,  p-value: 4.634e-15
```

```
sust_4b <- lm(Z.sust1518 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
            Z.dem_avg + Z.compete_avg + Z.parlinks_avg,
             data = subset(exis_incl, war_avg == 0))
summary(sust_4b)  # subset sample to countries with no civil war
```

```
##
## Call:
## lm(formula = Z.sust1518 ~ lagged_outcome + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     Z.dem_avg + Z.compete_avg + Z.parlinks_avg, data = subset(exis_incl,
##     war_avg == 0))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.63194 -0.21617  0.06111  0.18805  0.58604
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.05786    0.07666  -0.755  0.45920
## lagged_outcome  0.53567    0.13993   3.828  0.00105 **
## Z.lgdpnrPC9095  0.22649    0.13966   1.622  0.12054
## Z.lrentPC9095   0.22887    0.09475   2.415  0.02541 *
## Z.dem_avg       0.03540    0.10176   0.348  0.73155
## Z.compete_avg   0.10239    0.10490   0.976  0.34068
## Z.parlinks_avg  0.29830    0.11628   2.565  0.01846 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3684 on 20 degrees of freedom
##   (5 observations deleted due to missingness)
## Multiple R-squared:  0.8978, Adjusted R-squared:  0.8671
## F-statistic: 29.28 on 6 and 20 DF,  p-value: 6.763e-09
```

Interactions and cross-validation

Using leave-one-out (LOO) cross-validation, none of the interaction models substantially outperformed the additive models used in table 1.

```r
## Outcome: Inclusiveness
## Additive
incl_add <- lm(Z.incl1519 ~  Z.incl9095 + Z.lgdpnrPC9095 + Z.lrentPC9095 +
                     (Z.dem_avg + Z.parlinks_avg + Z.compete_avg),
                data = exis)
summary(incl_add)

##
## Call:
## lm(formula = Z.incl1519 ~ Z.incl9095 + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     (Z.dem_avg + Z.parlinks_avg + Z.compete_avg), data = exis)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.01113 -0.31888 -0.01693  0.25799  0.81040
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     3.156e-16  6.749e-02   0.000 1.000000
## Z.incl9095      8.609e-01  1.109e-01   7.767 1.64e-09 ***
## Z.lgdpnrPC9095 -2.601e-01  1.257e-01  -2.069 0.045097 *
## Z.lrentPC9095   1.515e-01  7.921e-02   1.913 0.062977 .
## Z.dem_avg      -9.738e-02  1.046e-01  -0.931 0.357314
## Z.parlinks_avg  3.434e-01  8.714e-02   3.941 0.000318 ***
## Z.compete_avg   2.251e-01  1.030e-01   2.185 0.034839 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4627 on 40 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.8138, Adjusted R-squared:  0.7859
## F-statistic: 29.14 on 6 and 40 DF,  p-value: 3.914e-13

(incl_add_mse <- cv(incl_add, k = "loo")[["CV crit"]][1])

## [1] 0.2586452

## Political interactions only
incl_intP <- lm(Z.incl1519 ~ Z.incl9095 + Z.lgdpnrPC9095 + Z.lrentPC9095 +
                      (Z.dem_avg * Z.parlinks_avg * Z.compete_avg),
                    data = exis)
summary(incl_intP)

##
## Call:
## lm(formula = Z.incl1519 ~ Z.incl9095 + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     (Z.dem_avg * Z.parlinks_avg * Z.compete_avg), data = exis)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.77357 -0.27322 -0.00918  0.24236  0.76735
##
```

```
## Coefficients:
##                                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)                           -0.27197    0.12062  -2.255   0.0303 *
## Z.incl9095                             0.82047    0.11152   7.357 1.12e-08 ***
## Z.lgdpnrPC9095                        -0.31130    0.11860  -2.625   0.0126 *
## Z.lrentPC9095                          0.14573    0.07533   1.935   0.0609 .
## Z.dem_avg                              0.04275    0.15231   0.281   0.7806
## Z.parlinks_avg                         0.12471    0.15629   0.798   0.4301
## Z.compete_avg                         -0.10426    0.20323  -0.513   0.6111
## Z.dem_avg:Z.parlinks_avg               0.32572    0.14283   2.280   0.0286 *
## Z.dem_avg:Z.compete_avg                0.27639    0.13084   2.112   0.0417 *
## Z.parlinks_avg:Z.compete_avg          -0.37780    0.23105  -1.635   0.1107
## Z.dem_avg:Z.parlinks_avg:Z.compete_avg  0.27461    0.14229   1.930   0.0615 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4187 on 36 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.8628, Adjusted R-squared:  0.8247
## F-statistic: 22.64 on 10 and 36 DF,  p-value: 1.244e-12

(incl_intP_mse <- cv(incl_intP, k = "loo")[["CV crit"]][1])

## [1] 0.298409

## Rent interactions only
incl_intR <- lm(Z.incl1519 ~ Z.incl9095 + Z.lgdpnrPC9095 + Z.lrentPC9095 *
                      (Z.dem_avg + Z.compete_avg + Z.parlinks_avg),
                    data = exis)
summary(incl_intR)

##
## Call:
## lm(formula = Z.incl1519 ~ Z.incl9095 + Z.lgdpnrPC9095 + Z.lrentPC9095 *
##     (Z.dem_avg + Z.compete_avg + Z.parlinks_avg), data = exis)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.04267 -0.27472  0.02272  0.24552  0.82715
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                   -0.04655    0.07844  -0.593  0.55649
## Z.incl9095                     0.83046    0.11462   7.245 1.34e-08 ***
## Z.lgdpnrPC9095                -0.28355    0.13066  -2.170  0.03649 *
## Z.lrentPC9095                  0.08499    0.09455   0.899  0.37452
## Z.dem_avg                     -0.03843    0.12128  -0.317  0.75313
## Z.compete_avg                  0.11889    0.13008   0.914  0.36666
## Z.parlinks_avg                 0.32504    0.09171   3.544  0.00109 **
## Z.lrentPC9095:Z.dem_avg       -0.01757    0.10700  -0.164  0.87050
## Z.lrentPC9095:Z.compete_avg   -0.16997    0.16788  -1.012  0.31788
## Z.lrentPC9095:Z.parlinks_avg -0.04446    0.07749  -0.574  0.56964
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4682 on 37 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.8236, Adjusted R-squared:  0.7808
## F-statistic:  19.2 on 9 and 37 DF,  p-value: 2.1e-11

(incl_intR_mse <- cv(incl_intR, k = "loo")[["CV crit"]][1])

## [1] 0.2904771

## "All" interactions
incl_intA <- lm(Z.incl1519 ~ Z.incl9095 + Z.lgdpnrPC9095 + Z.lrentPC9095 *
                      (Z.dem_avg * Z.parlinks_avg * Z.compete_avg),
                    data = exis)
summary(incl_intA)

##
## Call:
## lm(formula = Z.incl1519 ~ Z.incl9095 + Z.lgdpnrPC9095 + Z.lrentPC9095 *
##     (Z.dem_avg * Z.parlinks_avg * Z.compete_avg), data = exis)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.80438 -0.26266  0.03357  0.25712  0.64175
##
## Coefficients:
##                                                    Estimate Std. Error
## (Intercept)                                         -0.6843     0.5581
## Z.incl9095                                           0.8373     0.1163
## Z.lgdpnrPC9095                                      -0.3592     0.1291
## Z.lrentPC9095                                       -0.3844     0.7397
## Z.dem_avg                                            0.4622     0.4979
## Z.parlinks_avg                                      -0.3143     0.6429
## Z.compete_avg                                       -0.7300     0.7253
## Z.dem_avg:Z.parlinks_avg                             0.9437     0.7891
## Z.dem_avg:Z.compete_avg                              0.7519     0.7176
## Z.parlinks_avg:Z.compete_avg                        -1.1585     0.8956
## Z.lrentPC9095:Z.dem_avg                              0.4669     0.6690
## Z.lrentPC9095:Z.parlinks_avg                        -0.6236     0.8252
## Z.lrentPC9095:Z.compete_avg                         -0.8194     0.9526
## Z.dem_avg:Z.parlinks_avg:Z.compete_avg               0.9478     1.0428
## Z.lrentPC9095:Z.dem_avg:Z.parlinks_avg               0.4141     1.0501
## Z.lrentPC9095:Z.dem_avg:Z.compete_avg                0.6303     0.9437
## Z.lrentPC9095:Z.parlinks_avg:Z.compete_avg          -0.6226     1.1784
## Z.lrentPC9095:Z.dem_avg:Z.parlinks_avg:Z.compete_avg  0.8091     1.3555
##                                                    t value Pr(>|t|)
## (Intercept)                                         -1.226   0.2300
## Z.incl9095                                           7.199 6.33e-08 ***
## Z.lgdpnrPC9095                                      -2.782   0.0094 **
## Z.lrentPC9095                                       -0.520   0.6072
```

```
## Z.dem_avg                                              0.928   0.3609
## Z.parlinks_avg                                        -0.489   0.6286
## Z.compete_avg                                         -1.007   0.3225
## Z.dem_avg:Z.parlinks_avg                               1.196   0.2414
## Z.dem_avg:Z.compete_avg                                1.048   0.3034
## Z.parlinks_avg:Z.compete_avg                          -1.294   0.2060
## Z.lrentPC9095:Z.dem_avg                                0.698   0.4908
## Z.lrentPC9095:Z.parlinks_avg                          -0.756   0.4560
## Z.lrentPC9095:Z.compete_avg                           -0.860   0.3968
## Z.dem_avg:Z.parlinks_avg:Z.compete_avg                 0.909   0.3709
## Z.lrentPC9095:Z.dem_avg:Z.parlinks_avg                 0.394   0.6962
## Z.lrentPC9095:Z.dem_avg:Z.compete_avg                  0.668   0.5095
## Z.lrentPC9095:Z.parlinks_avg:Z.compete_avg            -0.528   0.6013
## Z.lrentPC9095:Z.dem_avg:Z.parlinks_avg:Z.compete_avg   0.597   0.5552
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4312 on 29 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.8828, Adjusted R-squared:  0.8141
## F-statistic: 12.85 on 17 and 29 DF,  p-value: 3.175e-09

(incl_intA_mse <- cv(incl_intA, k = "loo")[["CV crit"]][1])

## [1] 0.4531978

## Outcome: Sustainability
## Additive
sust_add <- lm(Z.sust1518 ~ Z.sust95 + Z.lgdpnrPC9095 + Z.lrentPC9095 +
                     (Z.dem_avg + Z.parlinks_avg + Z.compete_avg),
               data = exis)
summary(sust_add)

##
## Call:
## lm(formula = Z.sust1518 ~ Z.sust95 + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     (Z.dem_avg + Z.parlinks_avg + Z.compete_avg), data = exis)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.54063 -0.14776  0.02417  0.20822  0.50939
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.013074   0.050495  -0.259   0.7974
## Z.sust95        0.720891   0.106270   6.784 1.35e-07 ***
## Z.lgdpnrPC9095  0.122847   0.101367   1.212   0.2347
## Z.lrentPC9095   0.087899   0.073726   1.192   0.2422
## Z.dem_avg       0.006741   0.076005   0.089   0.9299
## Z.parlinks_avg  0.178749   0.067484   2.649   0.0126 *
## Z.compete_avg   0.066104   0.080685   0.819   0.4189
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3078 on 31 degrees of freedom
##   (10 observations deleted due to missingness)
## Multiple R-squared:  0.9206, Adjusted R-squared:  0.9053
## F-statistic: 59.93 on 6 and 31 DF,  p-value: 1.087e-15
```

```
(sust_add_mse <- cv(sust_add, k = "loo")[["CV crit"]][1])
```

```
## [1] 0.1177431
```

```
## Political interactions only
sust_intP <- lm(Z.sust1518 ~ Z.sust95 + Z.lgdpnrPC9095 + Z.lrentPC9095 +
                      (Z.dem_avg * Z.parlinks_avg * Z.compete_avg),
                    data = exis)
summary(sust_intP)
```

```
##
## Call:
## lm(formula = Z.sust1518 ~ Z.sust95 + Z.lgdpnrPC9095 + Z.lrentPC9095 +
##     (Z.dem_avg * Z.parlinks_avg * Z.compete_avg), data = exis)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.57123 -0.18543  0.03731  0.20519  0.51326
##
## Coefficients:
##                                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)                             -0.077145   0.097142  -0.794    0.434
## Z.sust95                                 0.726533   0.113594   6.396 7.51e-07
## Z.lgdpnrPC9095                           0.098549   0.110893   0.889    0.382
## Z.lrentPC9095                            0.086487   0.083952   1.030    0.312
## Z.dem_avg                                0.088563   0.148459   0.597    0.556
## Z.parlinks_avg                           0.156222   0.124787   1.252    0.221
## Z.compete_avg                           -0.075438   0.189305  -0.399    0.693
## Z.dem_avg:Z.parlinks_avg                 0.021342   0.125678   0.170    0.866
## Z.dem_avg:Z.compete_avg                  0.108674   0.113877   0.954    0.348
## Z.parlinks_avg:Z.compete_avg             0.018226   0.178619   0.102    0.919
## Z.dem_avg:Z.parlinks_avg:Z.compete_avg   0.003199   0.108297   0.030    0.977
##
## (Intercept)
## Z.sust95                                ***
## Z.lgdpnrPC9095
## Z.lrentPC9095
## Z.dem_avg
## Z.parlinks_avg
## Z.compete_avg
## Z.dem_avg:Z.parlinks_avg
## Z.dem_avg:Z.compete_avg
## Z.parlinks_avg:Z.compete_avg
## Z.dem_avg:Z.parlinks_avg:Z.compete_avg
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3177 on 27 degrees of freedom
##   (10 observations deleted due to missingness)
## Multiple R-squared:  0.9263, Adjusted R-squared:  0.8991
## F-statistic: 33.96 on 10 and 27 DF,  p-value: 1.036e-12
```

```
(sust_intP_mse <- cv(sust_intP, k = "loo")[["CV crit"]][1])
```

```
## [1] 0.1432978
```

```
## Rent interactions only
sust_intR <- lm(Z.sust1518 ~ Z.sust95 + Z.lgdpnrPC9095 + Z.lrentPC9095 *
                      (Z.dem_avg + Z.compete_avg + Z.parlinks_avg),
                    data = exis)
summary(sust_intR)
```

```
##
## Call:
## lm(formula = Z.sust1518 ~ Z.sust95 + Z.lgdpnrPC9095 + Z.lrentPC9095 *
##     (Z.dem_avg + Z.compete_avg + Z.parlinks_avg), data = exis)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.57110 -0.09961  0.01709  0.13936  0.60223
##
## Coefficients:
##                                Estimate Std. Error t value Pr(>|t|)
## (Intercept)                   0.0005566  0.0535908   0.010   0.9918
## Z.sust95                      0.6280498  0.1022172   6.144 1.24e-06 ***
## Z.lgdpnrPC9095                0.2461032  0.1095348   2.247   0.0327 *
## Z.lrentPC9095                 0.1873985  0.0782420   2.395   0.0235 *
## Z.dem_avg                    -0.0561679  0.0910257  -0.617   0.5422
## Z.compete_avg                 0.1477872  0.0962328   1.536   0.1358
## Z.parlinks_avg                0.1804156  0.0621121   2.905   0.0071 **
## Z.lrentPC9095:Z.dem_avg       0.1328415  0.0830586   1.599   0.1210
## Z.lrentPC9095:Z.compete_avg   0.0306459  0.1204225   0.254   0.8010
## Z.lrentPC9095:Z.parlinks_avg -0.1085102  0.0509422  -2.130   0.0421 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2793 on 28 degrees of freedom
##   (10 observations deleted due to missingness)
## Multiple R-squared:  0.941, Adjusted R-squared:  0.922
## F-statistic: 49.58 on 9 and 28 DF,  p-value: 7.587e-15
```

```
(sust_intR_mse <- cv(sust_intR, k = "loo")[["CV crit"]][1])
```

```
## [1] 0.1345655
```

```
## "All" interactions
sust_intA <- lm(Z.sust1518 ~ Z.sust95 + Z.lgdpnrPC9095 + Z.lrentPC9095 *
                      (Z.dem_avg * Z.parlinks_avg * Z.compete_avg),
```

```
                     data = exis)
summary(sust_intA)

##
## Call:
## lm(formula = Z.sust1518 ~ Z.sust95 + Z.lgdpnrPC9095 + Z.lrentPC9095 *
##     (Z.dem_avg * Z.parlinks_avg * Z.compete_avg), data = exis)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.56569 -0.13079  0.01764  0.11385  0.37133
##
## Coefficients:
##                                                      Estimate Std. Error
## (Intercept)                                           0.18915    0.37984
## Z.sust95                                              0.67751    0.11446
## Z.lgdpnrPC9095                                        0.19215    0.12383
## Z.lrentPC9095                                         0.45105    0.49994
## Z.dem_avg                                            -0.11739    0.34220
## Z.parlinks_avg                                        0.32791    0.43163
## Z.compete_avg                                         0.27544    0.48827
## Z.dem_avg:Z.parlinks_avg                             -0.48120    0.55641
## Z.dem_avg:Z.compete_avg                              -0.12962    0.49150
## Z.parlinks_avg:Z.compete_avg                          0.66402    0.62512
## Z.lrentPC9095:Z.dem_avg                              -0.29768    0.47964
## Z.lrentPC9095:Z.parlinks_avg                          0.27476    0.57570
## Z.lrentPC9095:Z.compete_avg                           0.64297    0.65945
## Z.dem_avg:Z.parlinks_avg:Z.compete_avg               -0.27793    0.71032
## Z.lrentPC9095:Z.dem_avg:Z.parlinks_avg                0.18004    0.73910
## Z.lrentPC9095:Z.dem_avg:Z.compete_avg                -0.39215    0.65752
## Z.lrentPC9095:Z.parlinks_avg:Z.compete_avg            0.05576    0.81068
## Z.lrentPC9095:Z.dem_avg:Z.parlinks_avg:Z.compete_avg -0.17486    0.93330
##                                                      t value Pr(>|t|)
## (Intercept)                                            0.498    0.624
## Z.sust95                                               5.919 8.65e-06 ***
## Z.lgdpnrPC9095                                         1.552    0.136
## Z.lrentPC9095                                          0.902    0.378
## Z.dem_avg                                             -0.343    0.735
## Z.parlinks_avg                                         0.760    0.456
## Z.compete_avg                                          0.564    0.579
## Z.dem_avg:Z.parlinks_avg                              -0.865    0.397
## Z.dem_avg:Z.compete_avg                               -0.264    0.795
## Z.parlinks_avg:Z.compete_avg                           1.062    0.301
## Z.lrentPC9095:Z.dem_avg                               -0.621    0.542
## Z.lrentPC9095:Z.parlinks_avg                           0.477    0.638
## Z.lrentPC9095:Z.compete_avg                            0.975    0.341
## Z.dem_avg:Z.parlinks_avg:Z.compete_avg                -0.391    0.700
## Z.lrentPC9095:Z.dem_avg:Z.parlinks_avg                 0.244    0.810
## Z.lrentPC9095:Z.dem_avg:Z.compete_avg                 -0.596    0.558
## Z.lrentPC9095:Z.parlinks_avg:Z.compete_avg             0.069    0.946
## Z.lrentPC9095:Z.dem_avg:Z.parlinks_avg:Z.compete_avg  -0.187    0.853
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2808 on 20 degrees of freedom
##   (10 observations deleted due to missingness)
## Multiple R-squared:  0.9574, Adjusted R-squared:  0.9211
## F-statistic: 26.42 on 17 and 20 DF,  p-value: 4.332e-10

(sust_intA_mse <- cv(sust_intA, k = "loo")[["CV crit"]][1])

## [1] 0.245435
```

Seemingly unrelated regression

A chi-squared test shows that seemingly unrelated regression does not improve upon ordinary least squares, and the correlation of residuals for inclusiveness and sustainability is less than 0.02.

```
incl <- incl1519 ~ incl9095 + lgdpnrPC9095 + lrentPC9095 + dem_avg +
  parlinks_avg + compete_avg
sust <- sust1518 ~ sust95 + lgdpnrPC9095 + lrentPC9095 + dem_avg +
  parlinks_avg + compete_avg
sur_sys <- list(incl = incl, sust = sust)

sur_res1 <- systemfit(sur_sys, data = subset(exis, !is.na(sust1518)),
                      method = "SUR")
summary(sur_res1)

##
## systemfit results
## method: SUR
##
##         N DF     SSR detRCov   OLS-R2 McElroy-R2
## system 76 62 1.85517 8.5e-05 0.919503   0.886842
##
##       N DF      SSR      MSE     RMSE       R2   Adj R2
## incl 38 31 0.045098 0.001455 0.038142 0.811531 0.775053
## sust 38 31 1.810074 0.058389 0.241639 0.920636 0.905276
##
## The covariance matrix of the residuals used for estimation
##             incl        sust
## incl 0.001454777 0.000172934
## sust 0.000172934 0.058389392
##
## The covariance matrix of the residuals
##             incl        sust
## incl 0.001454785 0.000176503
## sust 0.000176503 0.058389495
##
## The correlations of the residuals
##           incl      sust
## incl 1.0000000 0.0191507
```

```
## sust 0.0191507 1.0000000
##
##
## SUR estimates for 'incl' (equation 1)
## Model Formula: incl1519 ~ incl9095 + lgdpnrPC9095 + lrentPC9095 + dem_avg +
##     parlinks_avg + compete_avg
##
##                  Estimate  Std. Error  t value   Pr(>|t|)
## (Intercept)   0.46460857  0.06565096  7.07695 5.9874e-08 ***
## incl9095      0.49242952  0.10597661  4.64659 5.8995e-05 ***
## lgdpnrPC9095 -0.01819551  0.01382594 -1.31604   0.197809
## lrentPC9095   0.00918108  0.00380764  2.41123   0.022015 *
## dem_avg      -0.02555818  0.02445332 -1.04518   0.304020
## parlinks_avg  0.04141862  0.00903048  4.58654 6.9999e-05 ***
## compete_avg   0.08961843  0.03562612  2.51553   0.017280 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.038142 on 31 degrees of freedom
## Number of observations: 38 Degrees of Freedom: 31
## SSR: 0.045098 MSE: 0.001455 Root MSE: 0.038142
## Multiple R-Squared: 0.811531 Adjusted R-Squared: 0.775053
##
##
## SUR estimates for 'sust' (equation 2)
## Model Formula: sust1518 ~ sust95 + lgdpnrPC9095 + lrentPC9095 + dem_avg + parlinks_avg +
##     compete_avg
##
##                Estimate Std. Error t value   Pr(>|t|)
## (Intercept)  2.3544689  0.6847180 3.43860  0.0016886 **
## sust95       0.6963689  0.1025321 6.79172 1.3191e-07 ***
## lgdpnrPC9095 0.1020780  0.0845790 1.20690  0.2366017
## lrentPC9095  0.0328806  0.0276635 1.18860  0.2436250
## dem_avg      0.0137421  0.1541695 0.08914  0.9295470
## parlinks_avg 0.1501547  0.0567200 2.64730  0.0126394 *
## compete_avg  0.1847158  0.2259997 0.81733  0.4199786
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.241639 on 31 degrees of freedom
## Number of observations: 38 Degrees of Freedom: 31
## SSR: 1.810074 MSE: 0.058389 Root MSE: 0.241639
## Multiple R-Squared: 0.920636 Adjusted R-Squared: 0.905276
```

```
sur_res_lm <- systemfit(sur_sys, data = subset(exis, !is.na(sust1518)),
                        method = "OLS")
lrtest(sur_res1, sur_res_lm)  # likelihood-ratio test (SUR vs. OLS)
```

```
## Likelihood ratio test
##
## Model 1: sur_res1
## Model 2: sur_res_lm
```

```
##   #Df LogLik Df Chisq Pr(>Chisq)
## 1  17 78.001
## 2  15 78.001 -2 3e-04     0.9999
```