Tidier Multinomial Logit

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```
setwd("/Users/sarahklain/Documents/R_2015/wf_ce/CE/demog")

#install.packages("support.CEs")
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.2.4
```

```
library(ggthemes)
```

```
## Warning: replacing previous import by 'grid::arrow' when loading 'ggthemes'

## Warning: replacing previous import by 'grid::unit' when loading 'ggthemes'

## Warning: replacing previous import by 'scales::alpha' when loading
## 'ggthemes'
```

```
library(viridis)
suppressMessages(library(dplyr))
library(knitr)
library(tidyr)
library(broom)
#library(support.CEs)
library(survival)
library(mlogit)
```

```
## Loading required package: Formula
## Loading required package: maxLik
## Loading required package: miscTools
##
## Please cite the 'maxLik' package as:
## Henningsen, Arne and Toomet, Ott (2011). maxLik: A package for maximum likelihood estimation in R. C
##
## If you have questions, suggestions, or comments regarding the 'maxLik' package, please use a forum o
## https://r-forge.r-project.org/projects/maxlik/
```

```
library(stargazer)
```

```
##
## Please cite as:
##
##  Hlavac, Marek (2015). stargazer: Well-Formatted Regression and Summary Statistics Tables.
##  R package version 5.2. http://CRAN.R-project.org/package=stargazer
```

Conditional Logit

Format data with demographic information using Tidyr. To make a unique row for each observation including demographic data I added column obs1-obs24 in excel.

These are columns 69-92 in cer_2016_01_08_dem2.csv

```
ce_d <- read.csv("cer_2016_01_08_dem2.csv")
ce_d_s <- summary(ce_d[11:20])
# str(ce_d)
# knitr:: kable(ce_d_s, align = 'c', format = 'markdown', digits = 4)

#str(ce_d)
#head(ce_d)
dem_long <- tidyr::gather(ce_d, "obs", "obs1_24", 69:92)
#str(dem_long)
#summary(dem_long$ID)
#View(dem_long)
# 9624 observations

#I deleted NAs in excel

# write.csv(dem_long, "dem_long.csv")
```

I copied and pasted the demographic data from dem_long.csv into dswf_ml_dem2.csv

Make table of variable means

```
wfml_d <- read.csv("dswf_ml_dem2.csv")
w_tbl <- tbl_df(wfml_d)

# tbl2 <- dplyr::select(w_tbl, ASC: coast_rec)
# View(tbl2)

# tbl3 <- dplyr::summarise_each(tbl2, funs(mean))

# knitr:: kable(tbl3, align = 'c', format = 'markdown', digits = 4)
```

Multinomial logit model

```
wfml_d <- read.csv("dswf_ml_dem2.csv")

wfml_d2 <- mlogit.data(wfml_d, shape = "long", choice = "choice",
                       varying = 16:28, sep = "",
                       alt.levels = c(1, 2, 3),
                       alt.var = "ALT", id = "id")
```

```
## Warning in mlogit.data(wfml_d, shape = "long", choice = "choice", varying =
## 16:28, : variable ALT exists and will be replaced
```

```r
# head(wfml_d2, 3)

ml.bl.st.mi1 <- mlogit(choice ~ small.loss + small.gain + big.gain +
                   municipal + private + cooperative +  mi4 + mi8 +
                   mi10 + bill  | -1, wfml_d2)

summary(ml.bl.st.mi1)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + private + cooperative + mi4 + mi8 + mi10 + bill |
##     -1, data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## nr method
## 5 iterations, 0h:0m:0s
## g'(-H)^-1g = 1.49E-07
## gradient close to zero
##
## Coefficients :
##              Estimate Std. Error  t-value  Pr(>|t|)
## small.loss   1.328649   0.074989  17.7180 < 2.2e-16 ***
## small.gain   2.868386   0.092282  31.0829 < 2.2e-16 ***
## big.gain     3.739393   0.107598  34.7534 < 2.2e-16 ***
## municipal   -0.155583   0.076756  -2.0270  0.042665 *
## private     -0.486025   0.079067  -6.1470 7.895e-10 ***
## cooperative -0.315341   0.100031  -3.1524  0.001619 **
## mi4          0.214478   0.077932   2.7521  0.005921 **
## mi8          0.343995   0.075872   4.5339 5.791e-06 ***
## mi10         0.839584   0.109167   7.6908 1.465e-14 ***
## bill        -0.072229   0.005429 -13.3045 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -2016.5
```

```r
-1 * coef(ml.bl.st.mi1)[1:10]/coef(ml.bl.st.mi1)[10]
```

```
##  small.loss  small.gain    big.gain   municipal     private cooperative
##   18.394861   39.712196   51.771101   -2.154016   -6.728911   -4.365826
##         mi4         mi8        mi10        bill
##    2.969403    4.762542   11.623856   -1.000000
```

```r
AIC(ml.bl.st.mi1)
```

```
## [1] 4052.907
```

```r
#these outputs are the same as when I used support.CEs package
#from Croissant: coef(ml.Train)[-1]/coef(ml.Train)[1]
#divide by bill coefficient to obtain WTP associated with each attribute and level

#calc confidence intervals for WTP
# Exponeniate to make these confidence intervals for the odds ratio
exp(confint(ml.bl.st.mi1))
```

```
##                   2.5 %     97.5 %
## small.loss    3.2598254  4.3737648
## small.gain   14.6951420 21.0996275
## big.gain     34.0729895 51.9499707
## municipal     0.7363699  0.9948696
## private       0.5267693  0.7181642
## cooperative   0.5996573  0.8875553
## mi4           1.0636796  1.4437182
## mi8           1.2156612  1.6367336
## mi10          1.8694035  2.8678074
## bill          0.9204709  0.9402694
```

Base: -30 biodiv, muni, mi1

```r
ml.bl.pr.m1 <- mlogit(choice ~ small.loss + small.gain + big.gain +
                    municipal + state + cooperative +  mi4 + mi8 +
                    mi10 + bill  | -1, wfml_d2)

summary(ml.bl.pr.m1)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill |
##     -1, data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## nr method
## 5 iterations, 0h:0m:0s
## g'(-H)^-1g = 9.04E-08
## gradient close to zero
##
## Coefficients :
##               Estimate Std. Error  t-value  Pr(>|t|)
## small.loss   1.2014503  0.0766236  15.6799 < 2.2e-16 ***
## small.gain   2.7021713  0.0902094  29.9544 < 2.2e-16 ***
## big.gain     3.5484831  0.1046925  33.8943 < 2.2e-16 ***
## municipal    0.1540434  0.0763415   2.0178 0.0436100 *
## state        0.2523805  0.0740748   3.4071 0.0006566 ***
## cooperative  0.0523997  0.0912655   0.5741 0.5658695
## mi4          0.0760983  0.0757092   1.0051 0.3148296
```

```
## mi8          0.2122526  0.0747441   2.8397 0.0045153 **
## mi10         0.6956839  0.1047829   6.6393 3.152e-11 ***
## bill        -0.0744172  0.0053812 -13.8291 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -2030.5
```

```
-1 * coef(ml.bl.pr.m1)[1:10]/coef(ml.bl.pr.m1)[10]
```

```
##  small.loss  small.gain    big.gain   municipal       state cooperative
##  16.1447832  36.3110913  47.6836134   2.0699966   3.3914252   0.7041333
##         mi4         mi8        mi10        bill
##   1.0225893   2.8521962   9.3484239  -1.0000000
```

```
AIC(ml.bl.pr.m1)
```

```
## [1] 4080.915
```

```
ml.sl.pr.m1 <- mlogit(choice ~ big.loss + small.gain + big.gain +
                    state + municipal + cooperative +  mi4 + mi8 +
                    mi10 + bill  | -1, wfml_d2)

summary(ml.sl.pr.m1)
```

```
##
## Call:
## mlogit(formula = choice ~ big.loss + small.gain + big.gain +
##     state + municipal + cooperative + mi4 + mi8 + mi10 + bill |
##     -1, data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## nr method
## 5 iterations, 0h:0m:0s
## g'(-H)^-1g = 6.63E-07
## gradient close to zero
##
## Coefficients :
##               Estimate Std. Error  t-value  Pr(>|t|)
## big.loss    -1.4205759  0.0974666 -14.5750 < 2.2e-16 ***
## small.gain   1.6996754  0.0749003  22.6925 < 2.2e-16 ***
## big.gain     2.6511850  0.0968176  27.3833 < 2.2e-16 ***
## state        0.6598198  0.0739705   8.9200 < 2.2e-16 ***
## municipal    0.5783788  0.0766636   7.5444 4.552e-14 ***
## cooperative  0.2989053  0.0995161   3.0036  0.002668 **
## mi4          0.6164658  0.0780994   7.8933 2.887e-15 ***
## mi8          0.7196326  0.0783226   9.1881 < 2.2e-16 ***
## mi10         1.2429830  0.1142411  10.8803 < 2.2e-16 ***
## bill        -0.0612718  0.0053831 -11.3823 < 2.2e-16 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -2028.9
```

```
-1 * coef(ml.sl.pr.m1)[1:10]/coef(ml.sl.pr.m1)[10]
```

```
##    big.loss  small.gain    big.gain       state   municipal cooperative
##  -23.184816   27.739920   43.269237   10.768731    9.439557    4.878348
##         mi4         mi8        mi10        bill
##   10.061164   11.744920   20.286372   -1.000000
```

```
AIC(ml.sl.pr.m1)
```

```
## [1] 4077.759
```

Multinomial logit, baseline: small gain, state, 1 mi

```
ml.sg.st.mi1 <- mlogit(choice ~ big.loss + small.loss + big.gain +
                   municipal + private + cooperative +  mi4 + mi8 +
                   mi10 + bill  | -1, wfml_d2)

summary(ml.sg.st.mi1)
```

```
##
## Call:
## mlogit(formula = choice ~ big.loss + small.loss + big.gain +
##     municipal + private + cooperative + mi4 + mi8 + mi10 + bill |
##     -1, data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## nr method
## 5 iterations, 0h:0m:0s
## g'(-H)^-1g = 9.99E-07
## gradient close to zero
##
## Coefficients :
##               Estimate Std. Error  t-value  Pr(>|t|)
## big.loss    -2.5267194  0.1039796 -24.3001 < 2.2e-16 ***
## small.loss  -0.8587206  0.0689706 -12.4505 < 2.2e-16 ***
## big.gain     1.5384066  0.0821242  18.7327 < 2.2e-16 ***
## municipal    0.7772021  0.0787954   9.8636 < 2.2e-16 ***
## private      0.2197892  0.0726180   3.0266 0.0024728 **
## cooperative  0.3346420  0.0986862   3.3910 0.0006965 ***
## mi4          1.2343673  0.0827442  14.9179 < 2.2e-16 ***
## mi8          1.3016825  0.0805583  16.1583 < 2.2e-16 ***
## mi10         1.8581450  0.1066412  17.4243 < 2.2e-16 ***
## bill        -0.0169580  0.0048393  -3.5042 0.0004580 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -2317.8
```

```
AIC(ml.sg.st.mi1)
```

```
## [1] 4655.653
```

```
-1 * coef(ml.sg.st.mi1)[1:10]/coef(ml.sg.st.mi1)[10]
```

```
##    big.loss  small.loss    big.gain   municipal     private cooperative
##  -148.99879   -50.63812    90.71871    45.83104    12.96081    19.73360
##         mi4         mi8        mi10        bill
##    72.78973    76.75926   109.57345    -1.00000
```

Explore with demographic variables

```
ml.bl.st.mi1.dem <- mlogit(choice ~ small.loss + small.gain +
                       big.gain +
                       municipal + private +
                       cooperative +
                       mi4 + mi8 + mi10 + bill +
                       age:ASC + female:ASC +
                       white:ASC + univ_degr:ASC +
                       income:ASC + wages:ASC +
                       self.emp:ASC + pol_dem:ASC +
                       pol_ind:ASC + pol_rep:ASC +
                       coast_rec:ASC
                     | 1, wfml_d2)

summary(ml.bl.st.mi1.dem)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + private + cooperative + mi4 + mi8 + mi10 + bill +
##     age:ASC + female:ASC + white:ASC + univ_degr:ASC + income:ASC +
##     wages:ASC + self.emp:ASC + pol_dem:ASC + pol_ind:ASC + pol_rep:ASC +
##     coast_rec:ASC | 1, data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## nr method
## 5 iterations, 0h:0m:0s
## g'(-H)^-1g = 4.52E-07
## gradient close to zero
##
## Coefficients :
##                  Estimate Std. Error  t-value  Pr(>|t|)
## 2:(intercept) -0.0459744  0.0628305  -0.7317  0.464339
```

```
## 3:(intercept)  0.1589707  0.3719058   0.4274  0.669052
## small.loss     1.4956821  0.0961231  15.5601 < 2.2e-16 ***
## small.gain     3.0555266  0.1138552  26.8370 < 2.2e-16 ***
## big.gain       3.9148382  0.1255505  31.1814 < 2.2e-16 ***
## municipal     -0.0453323  0.0902503  -0.5023  0.615459
## private       -0.4145051  0.0850782  -4.8720 1.104e-06 ***
## cooperative   -0.2512120  0.1045780  -2.4022  0.016299 *
## mi4            0.3357082  0.0905389   3.7079  0.000209 ***
## mi8            0.4663470  0.0881779   5.2887 1.232e-07 ***
## mi10           0.9705291  0.1198765   8.0961 6.661e-16 ***
## bill          -0.0706400  0.0056360 -12.5338 < 2.2e-16 ***
## age:ASC       -0.0011757  0.0055857  -0.2105  0.833289
## ASC:female     0.1443150  0.1243814   1.1603  0.245942
## ASC:white      0.3327572  0.1501271   2.2165  0.026657 *
## ASC:univ_degr -0.1753969  0.1340234  -1.3087  0.190635
## ASC:income    -0.0233500  0.0242073  -0.9646  0.334752
## ASC:wages     -0.0912478  0.1349245  -0.6763  0.498858
## ASC:self.emp   0.1180486  0.2298464   0.5136  0.607533
## ASC:pol_dem   -0.2958184  0.2347159  -1.2603  0.207552
## ASC:pol_ind   -0.2056018  0.2364543  -0.8695  0.384563
## ASC:pol_rep   -0.2555626  0.2947730  -0.8670  0.385952
## ASC:coast_rec -0.0350914  0.1267363  -0.2769  0.781868
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -2006
## McFadden R^2:  0.34188
## Likelihood ratio test : chisq = 2084.1 (p.value = < 2.22e-16)
```

```
#stargazer(ml.wfml.dem2, type = "text")
# knitr:: kable(ml.wfml.dem2, align = 'c', format = 'markdown', digits = 4)

coef(ml.bl.st.mi1.dem)[1:21]/coef(ml.bl.st.mi1.dem)[12]
```

```
## 2:(intercept) 3:(intercept)    small.loss    small.gain      big.gain
##    0.65082691   -2.25043547  -21.17331479  -43.25493010  -55.41959761
##     municipal       private   cooperative           mi4           mi8
##    0.64173795    5.86785636    3.55623063   -4.75238377   -6.60174492
##          mi10          bill       age:ASC    ASC:female     ASC:white
##  -13.73909488    1.00000000    0.01664372   -2.04296480   -4.71060913
## ASC:univ_degr    ASC:income     ASC:wages  ASC:self.emp   ASC:pol_dem
##    2.48297012    0.33055008    1.29173048   -1.67113069    4.18769185
##   ASC:pol_ind
##    2.91055876
```

```
AIC(ml.bl.st.mi1.dem)
```

```
## [1] 4058.008
```

```
ml.bl.pr.mi1.dem2 <- mlogit(choice ~ small.loss + small.gain +
                        big.gain +
                        municipal + state +
```

```
                        cooperative +
                        mi4 + mi8 + mi10 + bill +
                        age:ASC + female:ASC +
                        white:ASC + univ_degr:ASC +
                        coast_rec:ASC
                      | 1, wfml_d2)

summary(ml.bl.pr.mi1.dem2)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill +
##     age:ASC + female:ASC + white:ASC + univ_degr:ASC + coast_rec:ASC |
##     1, data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## nr method
## 5 iterations, 0h:0m:0s
## g'(-H)^-1g = 4.34E-07
## gradient close to zero
##
## Coefficients :
##                   Estimate  Std. Error  t-value  Pr(>|t|)
## 2:(intercept) -0.04589166  0.06279967  -0.7308 0.4649241
## 3:(intercept)  0.97025046  0.26861428   3.6121 0.0003038 ***
## small.loss     1.49627485  0.09612753  15.5655 < 2.2e-16 ***
## small.gain     3.05528757  0.11383194  26.8403 < 2.2e-16 ***
## big.gain       3.91457853  0.12552865  31.1847 < 2.2e-16 ***
## municipal      0.36977424  0.08624735   4.2874 1.808e-05 ***
## state          0.41459066  0.08505109   4.8746 1.090e-06 ***
## cooperative    0.16335743  0.09743435   1.6766 0.0936228 .
## mi4            0.33721872  0.09050055   3.7262 0.0001944 ***
## mi8            0.46838834  0.08812021   5.3153 1.065e-07 ***
## mi10           0.97175657  0.11980857   8.1109 4.441e-16 ***
## bill          -0.07061699  0.00563389 -12.5343 < 2.2e-16 ***
## age:ASC       -0.00043308  0.00554104  -0.0782 0.9377023
## ASC:female     0.14500172  0.12348671   1.1742 0.2403032
## ASC:white      0.32767649  0.14960545   2.1903 0.0285046 *
## ASC:univ_degr -0.20249293  0.13168932  -1.5377 0.1241327
## ASC:coast_rec -0.04563721  0.12617118  -0.3617 0.7175697
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -2007.9
## McFadden R^2:  0.34125
## Likelihood ratio test : chisq = 2080.3 (p.value = < 2.22e-16)
```

```
AIC(ml.bl.pr.mi1.dem2)
```

```
## [1] 4049.827
```

```
coef(ml.bl.pr.mi1.dem2)[1:21]/coef(ml.bl.pr.mi1.dem2)[12]
```

```
## 2:(intercept) 3:(intercept)    small.loss    small.gain      big.gain
##   0.649867118 -13.739617973 -21.188595694 -43.265616027 -55.433947877
##     municipal         state   cooperative           mi4           mi8
##  -5.236335290  -5.870976163  -2.313287873  -4.775320015  -6.632799584
##          mi10          bill       age:ASC    ASC:female     ASC:white
## -13.760945774   1.000000000   0.006132755  -2.053354529  -4.640193375
## ASC:univ_degr ASC:coast_rec          <NA>          <NA>          <NA>
##   2.867481720   0.646263926            NA            NA            NA
##          <NA>
##            NA
```

```
ml.bl.pr.mi1.dem3 <- mlogit(choice ~ small.loss + small.gain +
                        big.gain +
                        municipal + state +
                        cooperative +
                        mi4 + mi8 + mi10 + bill +
                        age:ASC + female:ASC +
                        white:ASC + univ_degr:ASC +
                        income:ASC +
                        self.emp:ASC + pol_dem:ASC +
                        pol_ind:ASC + pol_rep:ASC
                       + coast_rec:ASC +
                        oper:ASC + const_st:ASC +
                        wf_rec:ASC+
                        abuse_nep:ASC + bal_r_nep:ASC +
                        crisis_r_nep:ASC + spaceship_nep:ASC +
                      # bau_nep:ASC +
                     # extract_r_ins:ASC +
                      # loss_r_ins:ASC + decade_r_mor:ASC
                      # comm_rel:ASC + wild_rel:ASC +
                    # clean_inst:ASC + tech:ASC +
                      iden_rel:ASC + kin_rel:ASC +
                        right_r_mor:ASC + health_rel:ASC +
                        other_rel:ASC + kin_met:ASC +
                        resp_met:ASC + iden_met:ASC +
                        other_met:ASC
                      | 1, wfml_d2)

summary(ml.bl.pr.mi1.dem3)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill +
##     age:ASC + female:ASC + white:ASC + univ_degr:ASC + income:ASC +
##     self.emp:ASC + pol_dem:ASC + pol_ind:ASC + pol_rep:ASC +
##     coast_rec:ASC + oper:ASC + const_st:ASC + wf_rec:ASC + abuse_nep:ASC +
##     bal_r_nep:ASC + crisis_r_nep:ASC + spaceship_nep:ASC + iden_rel:ASC +
##     kin_rel:ASC + right_r_mor:ASC + health_rel:ASC + other_rel:ASC +
```

```
##     kin_met:ASC + resp_met:ASC + iden_met:ASC + other_met:ASC |
##     1, data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40694 0.48762 0.10543
##
## nr method
## 6 iterations, 0h:0m:1s
## g'(-H)^-1g = 9.34E-05
## successive function values within tolerance limits
##
## Coefficients :
##                      Estimate Std. Error  t-value  Pr(>|t|)
## 2:(intercept)     -0.0588518  0.0647275  -0.9092 0.3632317
## 3:(intercept)      1.6567222  1.0560874   1.5687 0.1167095
## small.loss         1.5119394  0.0981960  15.3972 < 2.2e-16 ***
## small.gain         3.1480577  0.1188750  26.4821 < 2.2e-16 ***
## big.gain           4.0094337  0.1301979  30.7949 < 2.2e-16 ***
## municipal          0.4001165  0.0888131   4.5051 6.633e-06 ***
## state              0.4131931  0.0880162   4.6945 2.672e-06 ***
## cooperative        0.1654529  0.1006505   1.6438 0.1002102
## mi4                0.3170381  0.0934491   3.3926 0.0006923 ***
## mi8                0.4716216  0.0915238   5.1530 2.564e-07 ***
## mi10               0.9958006  0.1244885   7.9991 1.332e-15 ***
## bill              -0.0740815  0.0058852 -12.5877 < 2.2e-16 ***
## age:ASC            0.0028410  0.0063443   0.4478 0.6542905
## ASC:female         0.0311329  0.1482260   0.2100 0.8336392
## ASC:white          0.1493938  0.1709931   0.8737 0.3822909
## ASC:univ_degr     -0.2897996  0.1454602  -1.9923 0.0463387 *
## ASC:income        -0.0154997  0.0283090  -0.5475 0.5840230
## ASC:self.emp       0.4180972  0.2413660   1.7322 0.0832357 .
## ASC:pol_dem       -0.8401194  0.2763560  -3.0400 0.0023659 **
## ASC:pol_ind       -0.8806189  0.2774015  -3.1745 0.0015008 **
## ASC:pol_rep       -1.2027916  0.3357024  -3.5829 0.0003398 ***
## ASC:coast_rec      0.2533261  0.1409423   1.7974 0.0722762 .
## ASC:oper          -0.0358968  0.1604462  -0.2237 0.8229664
## ASC:const_st      -0.2120193  0.0693620  -3.0567 0.0022378 **
## ASC:wf_rec         0.7186942  0.1156470   6.2145 5.147e-10 ***
## ASC:abuse_nep      0.5923054  0.1074424   5.5128 3.532e-08 ***
## ASC:bal_r_nep      0.1978522  0.0896857   2.2061 0.0273797 *
## ASC:crisis_r_nep  -0.1700878  0.0900005  -1.8899 0.0587774 .
## ASC:spaceship_nep -0.1302804  0.0861544  -1.5122 0.1304898
## ASC:iden_rel       0.0411723  0.1004633   0.4098 0.6819348
## ASC:kin_rel       -0.3154271  0.1035519  -3.0461 0.0023185 **
## ASC:right_r_mor    0.1300248  0.0900297   1.4442 0.1486708
## ASC:heh_rel       -0.1255930  0.0726441  -1.7289 0.0838305 .
## ASC:other_rel     -0.0018374  0.1142058  -0.0161 0.9871635
## ASC:kin_met        0.1029166  0.0977093   1.0533 0.2922063
## ASC:resp_met      -0.1081652  0.1086998  -0.9951 0.3196965
## ASC:iden_met      -0.2171225  0.0864767  -2.5108 0.0120471 *
## ASC:other_met     -0.2871348  0.0851786  -3.3710 0.0007490 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Log-Likelihood: -1827
## McFadden R^2:  0.38395
## Likelihood ratio test : chisq = 2277.3 (p.value = < 2.22e-16)
```

```
-1 * coef(ml.bl.pr.mi1.dem3)[1:21]/coef(ml.bl.pr.mi1.dem3)[12]
```

```
## 2:(intercept) 3:(intercept)    small.loss    small.gain      big.gain
##   -0.79441987   22.36351577   20.40914329   42.49453421   54.12194811
##     municipal         state   cooperative           mi4           mi8
##    5.40103368    5.57754963    2.23339131    4.27958716    6.36625533
##          mi10          bill       age:ASC    ASC:female     ASC:white
##   13.44196499   -1.00000000    0.03835031    0.42025176    2.01661499
## ASC:univ_degr    ASC:income  ASC:self.emp   ASC:pol_dem   ASC:pol_ind
##   -3.91190422   -0.20922499    5.64374861  -11.34047891  -11.88716819
##   ASC:pol_rep
##  -16.23606482
```

```
AIC(ml.bl.pr.mi1.dem3)
```

```
## [1] 3729.997
```

```
ml.bl.pr.mi1.dem4 <- mlogit(choice ~ small.loss + small.gain +
                        big.gain +
                        municipal + state +
                        cooperative +
                        mi4 + mi8 + mi10 + bill +
                        age:ASC + female:ASC +
                        white:ASC + univ_degr:ASC +
                        income:ASC +
                        pol_dem:ASC + pol_ind:ASC + pol_rep:ASC
                       + coast_rec:ASC + mean_nep:ASC +
                        oper:ASC + wf_rec:ASC+ other_met:ASC
                      | 1, wfml_d2)

summary(ml.bl.pr.mi1.dem4)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill +
##     age:ASC + female:ASC + white:ASC + univ_degr:ASC + income:ASC +
##     pol_dem:ASC + pol_ind:ASC + pol_rep:ASC + coast_rec:ASC +
##     mean_nep:ASC + oper:ASC + wf_rec:ASC + other_met:ASC | 1,
##     data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## nr method
## 6 iterations, 0h:0m:0s
```

```
## g'(-H)^-1g = 2.56E-05
## successive function values within tolerance limits
##
## Coefficients :
##                 Estimate Std. Error  t-value  Pr(>|t|)
## 2:(intercept) -0.0537967  0.0634709  -0.8476 0.3966719
## 3:(intercept)  4.2302118  0.6410672   6.5987 4.148e-11 ***
## small.loss     1.5062385  0.0964122  15.6229 < 2.2e-16 ***
## small.gain     3.1127274  0.1160632  26.8193 < 2.2e-16 ***
## big.gain       3.9767143  0.1274818  31.1944 < 2.2e-16 ***
## municipal      0.3742310  0.0871641   4.2934 1.760e-05 ***
## state          0.4038563  0.0861207   4.6894 2.740e-06 ***
## cooperative    0.1649009  0.0986717   1.6712 0.0946806 .
## mi4            0.3310272  0.0914404   3.6201 0.0002944 ***
## mi8            0.4751645  0.0894162   5.3141 1.072e-07 ***
## mi10           0.9841896  0.1216295   8.0917 6.661e-16 ***
## bill          -0.0731195  0.0057508 -12.7146 < 2.2e-16 ***
## age:ASC        0.0040537  0.0059954   0.6761 0.4989493
## ASC:female    -0.0173727  0.1303144  -0.1333 0.8939452
## ASC:white      0.1555914  0.1631370   0.9537 0.3402116
## ASC:univ_degr -0.2285136  0.1399946  -1.6323 0.1026156
## ASC:income     0.0090142  0.0259244   0.3477 0.7280570
## ASC:pol_dem   -0.7414285  0.2561247  -2.8948 0.0037941 **
## ASC:pol_ind   -0.7483160  0.2585134  -2.8947 0.0037953 **
## ASC:pol_rep   -1.0074616  0.3180685  -3.1674 0.0015379 **
## ASC:coast_rec  0.1696622  0.1347107   1.2595 0.2078657
## ASC:mean_nep   0.6319409  0.0945269   6.6853 2.304e-11 ***
## ASC:oper      -0.1360061  0.1520495  -0.8945 0.3710620
## ASC:wf_rec     0.8275663  0.1022103   8.0967 6.661e-16 ***
## ASC:other_met -0.3283684  0.0723632  -4.5378 5.685e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -1911.6
## McFadden R^2:  0.37286
## Likelihood ratio test : chisq = 2273 (p.value = < 2.22e-16)
```

```
AIC(ml.bl.pr.mi1.dem4)
```

```
## [1] 3873.154
```

```
ml.bl.pr.mi1.dem5 <- mlogit(choice ~ small.loss + small.gain +
                        big.gain +
                        municipal + state +
                        cooperative +
                        mi4 + mi8 + mi10 + bill +
                        age:ASC + female:ASC +
                        white:ASC + univ_degr:ASC +
                        income:ASC +
                        self.emp:ASC + pol_dem:ASC +
                        pol_ind:ASC + pol_rep:ASC
                       + coast_rec:ASC + mean_nep:ASC +
                        oper:ASC + const_st:ASC +
```

```
                        wf_rec:ASC+ crisis_r_nep:ASC + spaceship_nep:ASC +
                        right_r_mor:ASC + health_rel:ASC +
                        other_rel:ASC + kin_met:ASC + iden_met:ASC +
                        other_met:ASC
                      | 1, wfml_d2)

summary(ml.bl.pr.mi1.dem5)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill +
##     age:ASC + female:ASC + white:ASC + univ_degr:ASC + income:ASC +
##     self.emp:ASC + pol_dem:ASC + pol_ind:ASC + pol_rep:ASC +
##     coast_rec:ASC + mean_nep:ASC + oper:ASC + const_st:ASC +
##     wf_rec:ASC + crisis_r_nep:ASC + spaceship_nep:ASC + right_r_mor:ASC +
##     health_rel:ASC + other_rel:ASC + kin_met:ASC + iden_met:ASC +
##     other_met:ASC | 1, data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40774 0.48641 0.10585
##
## nr method
## 6 iterations, 0h:0m:0s
## g'(-H)^-1g = 8.26E-05
## successive function values within tolerance limits
##
## Coefficients :
##                     Estimate Std. Error  t-value  Pr(>|t|)
## 2:(intercept)     -0.0578253  0.0645662  -0.8956 0.3704687
## 3:(intercept)      2.6449035  0.9183319   2.8801 0.0039753 **
## small.loss         1.5128551  0.0980963  15.4221 < 2.2e-16 ***
## small.gain         3.1375221  0.1182686  26.5288 < 2.2e-16 ***
## big.gain           4.0110069  0.1299213  30.8726 < 2.2e-16 ***
## municipal          0.3880496  0.0885646   4.3815 1.178e-05 ***
## state              0.4142617  0.0877889   4.7188 2.372e-06 ***
## cooperative        0.1753313  0.1004127   1.7461 0.0807924 .
## mi4                0.3102860  0.0931341   3.3316 0.0008635 ***
## mi8                0.4699116  0.0911627   5.1546 2.541e-07 ***
## mi10               0.9988777  0.1240523   8.0521 8.882e-16 ***
## bill              -0.0738435  0.0058643 -12.5921 < 2.2e-16 ***
## age:ASC            0.0014509  0.0062511   0.2321 0.8164555
## ASC:female        -0.0352649  0.1466333  -0.2405 0.8099449
## ASC:white          0.1362956  0.1684717   0.8090 0.4185082
## ASC:univ_degr     -0.2094016  0.1445390  -1.4488 0.1474060
## ASC:income        -0.0178761  0.0275422  -0.6490 0.5163116
## ASC:self.emp       0.3992032  0.2345489   1.7020 0.0887546 .
## ASC:pol_dem       -0.9381944  0.2713135  -3.4580 0.0005443 ***
## ASC:pol_ind       -0.8521711  0.2725793  -3.1263 0.0017701 **
## ASC:pol_rep       -1.1286583  0.3305447  -3.4145 0.0006389 ***
## ASC:coast_rec      0.2650299  0.1382824   1.9166 0.0552907 .
## ASC:mean_nep       1.3154580  0.2468610   5.3287 9.890e-08 ***
```

```
## ASC:oper          -0.0566653  0.1593045  -0.3557 0.7220622
## ASC:const_st      -0.2463609  0.0660760  -3.7284 0.0001927 ***
## ASC:wf_rec         0.7432786  0.1117655   6.6503 2.924e-11 ***
## ASC:crisis_r_nep  -0.5097151  0.1291290  -3.9473 7.903e-05 ***
## ASC:spaceship_nep -0.3686568  0.1118122  -3.2971 0.0009769 ***
## ASC:right_r_mor    0.1697401  0.0826579   2.0535 0.0400217 *
## ASC:heh_rel       -0.0864093  0.0716184  -1.2065 0.2276159
## ASC:other_rel     -0.0669783  0.1115125  -0.6006 0.5480835
## ASC:kin_met        0.1654837  0.0906281   1.8260 0.0678556 .
## ASC:iden_met      -0.2265461  0.0800715  -2.8293 0.0046650 **
## ASC:other_met     -0.2973336  0.0827038  -3.5952 0.0003242 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -1840.6
## McFadden R^2:  0.38306
## Likelihood ratio test : chisq = 2285.6 (p.value = < 2.22e-16)
```

```
AIC(ml.bl.pr.mi1.dem5)
```

```
## [1] 3749.136
```

```
ml.bl.pr.mi1.dem6 <- mlogit(choice ~ small.loss + small.gain +
                        big.gain +
                        municipal + state +
                        cooperative +
                        mi4 + mi8 + mi10 + bill +
                        age:ASC + female:ASC +
                        white:ASC + univ_degr:ASC +
                        income:ASC + coast_rec:ASC
                        + oper:ASC + const_st:ASC +
                        wf_rec:ASC
                      | 1, wfml_d2)

summary(ml.bl.pr.mi1.dem6)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill +
##     age:ASC + female:ASC + white:ASC + univ_degr:ASC + income:ASC +
##     coast_rec:ASC + oper:ASC + const_st:ASC + wf_rec:ASC | 1,
##     data = wfml_d2, method = "nr", print.level = 0)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40603 0.48806 0.10591
##
## nr method
## 6 iterations, 0h:0m:0s
## g'(-H)^-1g = 2.62E-06
## successive function values within tolerance limits
##
```

```
## Coefficients :
##                  Estimate Std. Error  t-value  Pr(>|t|)
## 2:(intercept) -0.0469108  0.0633088  -0.7410 0.4587028
## 3:(intercept)  2.3411519  0.4841910   4.8352 1.330e-06 ***
## small.loss     1.5102476  0.0970171  15.5668 < 2.2e-16 ***
## small.gain     3.1092652  0.1158000  26.8503 < 2.2e-16 ***
## big.gain       3.9664989  0.1272646  31.1673 < 2.2e-16 ***
## municipal      0.3908966  0.0870489   4.4905 7.104e-06 ***
## state          0.4029916  0.0859479   4.6888 2.748e-06 ***
## cooperative    0.1624341  0.0985479   1.6483 0.0992961 .
## mi4            0.3482962  0.0913544   3.8126 0.0001375 ***
## mi8            0.4882832  0.0893511   5.4648 4.635e-08 ***
## mi10           0.9903488  0.1213384   8.1619 2.220e-16 ***
## bill          -0.0718610  0.0057303 -12.5404 < 2.2e-16 ***
## age:ASC        0.0043331  0.0057688   0.7511 0.4525788
## ASC:female     0.2874809  0.1284755   2.2376 0.0252451 *
## ASC:white      0.3552805  0.1555475   2.2841 0.0223678 *
## ASC:univ_degr -0.2870024  0.1373803  -2.0891 0.0366980 *
## ASC:income    -0.0405453  0.0252842  -1.6036 0.1088065
## ASC:coast_rec  0.0928330  0.1306455   0.7106 0.4773497
## ASC:oper      -0.0925042  0.1502074  -0.6158 0.5379980
## ASC:const_st  -0.3160672  0.0598655  -5.2796 1.294e-07 ***
## ASC:wf_rec     0.6626088  0.1025460   6.4616 1.036e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -1945.4
## McFadden R^2:  0.35904
## Likelihood ratio test : chisq = 2179.5 (p.value = < 2.22e-16)
```

```
AIC(ml.bl.pr.mi1.dem6)
```

```
## [1] 3932.773
```

Mixed Logit

```
#mixed logits take ~5 min to run
mx.bl.st.mi1 <- mlogit(choice ~ small.loss + small.gain + big.gain +
                    municipal + private + cooperative +
                    mi4 + mi8 + mi10 + bill,
                  wfml_d2, panel = TRUE, rpar = c(small.loss = "n", small.gain = "n", big.gain = "n", mu

summary(mx.bl.st.mi1)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + private + cooperative + mi4 + mi8 + mi10 + bill,
##     data = wfml_d2, rpar = c(small.loss = "n", small.gain = "n",
##         big.gain = "n", municipal = "n", private = "n", cooperative = "n",
##         mi4 = "n", mi8 = "n", mi10 = "n", bill = "n"), R = 100,
```

```
##     correlation = TRUE, halton = NA, panel = TRUE)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## bfgs method
## 72 iterations, 0h:4m:16s
## g'(-H)^-1g = 6.72E-07
## gradient close to zero
##
## Coefficients :
##                           Estimate Std. Error t-value  Pr(>|t|)
## 2:(intercept)           -0.056609   0.155751 -0.3635 0.7162636
## 3:(intercept)           -0.180799   0.256877 -0.7038 0.4815347
## small.loss               3.274092   0.274394 11.9321 < 2.2e-16 ***
## small.gain               8.716214   0.616562 14.1368 < 2.2e-16 ***
## big.gain                11.741587   0.817741 14.3586 < 2.2e-16 ***
## municipal               -0.086129   0.235953 -0.3650 0.7150912
## private                 -1.429678   0.293209 -4.8760 1.083e-06 ***
## cooperative              0.630470   0.329757  1.9119 0.0558864 .
## mi4                      0.869276   0.233811  3.7179 0.0002009 ***
## mi8                      1.505133   0.246378  6.1091 1.002e-09 ***
## mi10                     2.168809   0.393743  5.5082 3.625e-08 ***
## bill                    -0.221700   0.023386 -9.4801 < 2.2e-16 ***
## small.loss.small.loss    2.649275   0.309234  8.5672 < 2.2e-16 ***
## small.loss.small.gain    4.655032   0.441377 10.5466 < 2.2e-16 ***
## small.loss.big.gain      6.605068   0.567345 11.6421 < 2.2e-16 ***
## small.loss.municipal     0.875056   0.279456  3.1313 0.0017404 **
## small.loss.private      -0.191772   0.278920 -0.6876 0.4917354
## small.loss.cooperative   0.731397   0.346235  2.1124 0.0346497 *
## small.loss.mi4          -0.066439   0.251232 -0.2645 0.7914297
## small.loss.mi8          -0.133378   0.264188 -0.5049 0.6136565
## small.loss.mi10          0.218145   0.397678  0.5485 0.5833171
## small.loss.bill          0.011442   0.021072  0.5430 0.5871389
## small.gain.small.gain    3.603300   0.345994 10.4144 < 2.2e-16 ***
## small.gain.big.gain      4.942490   0.464208 10.6471 < 2.2e-16 ***
## small.gain.municipal    -1.870878   0.273097 -6.8506 7.353e-12 ***
## small.gain.private      -1.128610   0.290237 -3.8886 0.0001008 ***
## small.gain.cooperative  -0.129295   0.270520 -0.4780 0.6326843
## small.gain.mi4          -0.690966   0.240540 -2.8726 0.0040715 **
## small.gain.mi8          -0.707794   0.228748 -3.0942 0.0019734 **
## small.gain.mi10         -0.580960   0.311873 -1.8628 0.0624893 .
## small.gain.bill          0.047852   0.017861  2.6791 0.0073812 **
## big.gain.big.gain        1.679519   0.295685  5.6801 1.346e-08 ***
## big.gain.municipal       0.086846   0.244966  0.3545 0.7229483
## big.gain.private         0.246165   0.255242  0.9644 0.3348271
## big.gain.cooperative     0.217940   0.293451  0.7427 0.4576768
## big.gain.mi4             2.098766   0.285977  7.3389 2.154e-13 ***
## big.gain.mi8             2.328950   0.274422  8.4867 < 2.2e-16 ***
## big.gain.mi10            3.390404   0.424994  7.9775 1.554e-15 ***
## big.gain.bill            0.068354   0.019965  3.4238 0.0006176 ***
## municipal.municipal     -0.531964   0.222892 -2.3866 0.0170028 *
## municipal.private        1.696182   0.293967  5.7700 7.929e-09 ***
```

```
## municipal.cooperative   -0.938272   0.293410 -3.1978 0.0013847 **
## municipal.mi4            0.208082   0.217494  0.9567 0.3387059
## municipal.mi8           -0.135475   0.214269 -0.6323 0.5272132
## municipal.mi10          -0.504363   0.352289 -1.4317 0.1522363
## municipal.bill          -0.043072   0.018527 -2.3248 0.0200832 *
## private.private           1.309536   0.260263  5.0316 4.865e-07 ***
## private.cooperative       0.014762   0.289043  0.0511 0.9592680
## private.mi4               0.127550   0.256300  0.4977 0.6187230
## private.mi8              -0.188975   0.224636 -0.8412 0.4002093
## private.mi10              0.408062   0.361547  1.1287 0.2590431
## private.bill              0.068652   0.021144  3.2469 0.0011667 **
## cooperative.cooperative -0.405760   0.241816 -1.6780 0.0933530 .
## cooperative.mi4           0.012814   0.202003  0.0634 0.9494198
## cooperative.mi8          -0.318019   0.234525 -1.3560 0.1750935
## cooperative.mi10         -0.896337   0.369115 -2.4283 0.0151681 *
## cooperative.bill          0.075902   0.019640  3.8647 0.0001112 ***
## mi4.mi4                   0.954320   0.239953  3.9771 6.976e-05 ***
## mi4.mi8                   1.386271   0.251184  5.5189 3.411e-08 ***
## mi4.mi10                  2.652123   0.393271  6.7438 1.543e-11 ***
## mi4.bill                  0.037600   0.020668  1.8192 0.0688750 .
## mi8.mi8                  -0.637837   0.199976 -3.1896 0.0014248 **
## mi8.mi10                 -1.540382   0.349203 -4.4111 1.028e-05 ***
## mi8.bill                  0.190568   0.023813  8.0027 1.110e-15 ***
## mi10.mi10                -0.106348   0.396069 -0.2685 0.7883086
## mi10.bill                 0.094347   0.023932  3.9423 8.072e-05 ***
## bill.bill                -0.016334   0.019137 -0.8535 0.3933689
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -1502
## McFadden R^2:  0.50722
## Likelihood ratio test : chisq = 3092.1 (p.value = < 2.22e-16)
##
## random coefficients
##             Min.    1st Qu.      Median        Mean     3rd Qu. Max.
## small.loss  -Inf  1.4871835  3.27409234  3.27409234  5.06100120  Inf
## small.gain  -Inf  4.7457033  8.71621405  8.71621405 12.68672475  Inf
## big.gain    -Inf  6.0632034 11.74158688 11.74158688 17.41997033  Inf
## municipal   -Inf -1.5258822 -0.08612911 -0.08612911  1.35362398  Inf
## private     -Inf -3.0767397 -1.42967841 -1.42967841  0.21738292  Inf
## cooperative -Inf -0.2344486  0.63046984  0.63046984  1.49538827  Inf
## mi4         -Inf -0.7630907  0.86927562  0.86927562  2.50164194  Inf
## mi8         -Inf -0.4528115  1.50513277  1.50513277  3.46307700  Inf
## mi10        -Inf -1.0321476  2.16880947  2.16880947  5.36976650  Inf
## bill        -Inf -0.3953996 -0.22170004 -0.22170004 -0.04800045  Inf
```

```
-1 * (coef(mx.bl.st.mi1)[3:12]/coef(mx.bl.st.mi1)[12])
```

```
##  small.loss  small.gain    big.gain   municipal     private cooperative
##  14.7681180  39.3153473  52.9615913  -0.3884939  -6.4487062   2.8437967
##         mi4         mi8        mi10        bill
##   3.9209539   6.7890505   9.7826301  -1.0000000
```

```r
AIC(mx.bl.st.mi1)
```

```
## [1] 3138.048
```

```r
mx.bl.pr.mi1 <- mlogit(choice ~ small.loss + small.gain + big.gain +
                   municipal + state + cooperative +
                   mi4 + mi8 + mi10 + bill,
                 wfml_d2, panel = TRUE, rpar = c(small.loss = "n", small.gain = "n", big.gain = "n", mu

summary(mx.bl.pr.mi1)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill,
##     data = wfml_d2, rpar = c(small.loss = "n", small.gain = "n",
##         big.gain = "n", municipal = "n", state = "n", cooperative = "n",
##         mi4 = "n", mi8 = "n", mi10 = "n", bill = "n"), R = 100,
##     correlation = TRUE, halton = NA, panel = TRUE)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## bfgs method
## 85 iterations, 0h:4m:44s
## g'(-H)^-1g = 5.28E-07
## gradient close to zero
##
## Coefficients :
##                           Estimate Std. Error t-value  Pr(>|t|)
## 2:(intercept)            0.1144309  0.1415593  0.8084 0.4188831
## 3:(intercept)            0.2477905  0.2492790  0.9940 0.3202087
## small.loss               2.8737908  0.2552226 11.2599 < 2.2e-16 ***
## small.gain               7.9971519  0.5645545 14.1654 < 2.2e-16 ***
## big.gain                10.7885855  0.7451769 14.4779 < 2.2e-16 ***
## municipal                0.9479894  0.2381149  3.9812 6.856e-05 ***
## state                    1.1149425  0.2432239  4.5840 4.561e-06 ***
## cooperative              1.4012779  0.3627289  3.8632 0.0001119 ***
## mi4                      0.7838173  0.2276085  3.4437 0.0005738 ***
## mi8                      1.4278034  0.2546702  5.6065 2.065e-08 ***
## mi10                     2.0018851  0.3729636  5.3675 7.983e-08 ***
## bill                    -0.2033005  0.0218055 -9.3233 < 2.2e-16 ***
## small.loss.small.loss    2.6620851  0.3654484  7.2844 3.231e-13 ***
## small.loss.small.gain    3.9951493  0.4127026  9.6805 < 2.2e-16 ***
## small.loss.big.gain      5.7452806  0.5404744 10.6301 < 2.2e-16 ***
## small.loss.municipal     0.1516053  0.2689197  0.5638 0.5729197
## small.loss.state         0.9457828  0.2866811  3.2991 0.0009700 ***
## small.loss.cooperative   0.8600331  0.3594674  2.3925 0.0167331 *
## small.loss.mi4           1.1088758  0.2898225  3.8261 0.0001302 ***
## small.loss.mi8           0.8979323  0.3008524  2.9846 0.0028392 **
## small.loss.mi10          1.7014336  0.4131630  4.1181 3.821e-05 ***
## small.loss.bill          0.0507529  0.0227281  2.2330 0.0255458 *
```

```
## small.gain.small.gain    3.5584135  0.3767969  9.4439 < 2.2e-16 ***
## small.gain.big.gain      4.8790989  0.4561584 10.6961 < 2.2e-16 ***
## small.gain.municipal     0.1493796  0.2503721  0.5966 0.5507543
## small.gain.state        -0.2702000  0.2440668 -1.1071 0.2682619
## small.gain.cooperative  -0.1406340  0.3410923 -0.4123 0.6801161
## small.gain.mi4          -0.7815337  0.2290873 -3.4115 0.0006460 ***
## small.gain.mi8          -0.9681849  0.2569501 -3.7680 0.0001646 ***
## small.gain.mi10         -0.5221600  0.3842630 -1.3589 0.1741906
## small.gain.bill          0.0199495  0.0189156  1.0547 0.2915837
## big.gain.big.gain        0.3573224  0.2351433  1.5196 0.1286129
## big.gain.municipal       1.9965961  0.2549821  7.8303 4.885e-15 ***
## big.gain.state           1.2496111  0.2394465  5.2187 1.801e-07 ***
## big.gain.cooperative     1.0042603  0.2870756  3.4982 0.0004683 ***
## big.gain.mi4             0.4788236  0.2275939  2.1039 0.0353915 *
## big.gain.mi8             0.6269826  0.2395116  2.6178 0.0088511 **
## big.gain.mi10            1.2489665  0.3616511  3.4535 0.0005533 ***
## big.gain.bill           -0.0308214  0.0171216 -1.8001 0.0718386 .
## municipal.municipal      1.0828083  0.2392201  4.5264 5.999e-06 ***
## municipal.state          1.2329112  0.2492725  4.9460 7.574e-07 ***
## municipal.cooperative    0.7948139  0.2955111  2.6896 0.0071532 **
## municipal.mi4           -0.8918146  0.2195487 -4.0620 4.865e-05 ***
## municipal.mi8           -1.3272198  0.2479511 -5.3527 8.663e-08 ***
## municipal.mi10          -2.1208560  0.3426780 -6.1891 6.052e-10 ***
## municipal.bill          -0.0293615  0.0179799 -1.6330 0.1024653
## state.state              0.4730487  0.2207638  2.1428 0.0321306 *
## state.cooperative        0.5620670  0.2961893  1.8977 0.0577407 .
## state.mi4               -0.2822774  0.2485310 -1.1358 0.2560471
## state.mi8               -0.1405540  0.2299819 -0.6112 0.5410987
## state.mi10               0.3246847  0.3233491  1.0041 0.3153157
## state.bill               0.0982696  0.0208193  4.7201 2.357e-06 ***
## cooperative.cooperative -0.6086022  0.2729823 -2.2295 0.0257835 *
## cooperative.mi4          0.6686855  0.2470335  2.7069 0.0067922 **
## cooperative.mi8         -0.2255299  0.2416343 -0.9334 0.3506382
## cooperative.mi10        -0.8838430  0.3118301 -2.8344 0.0045916 **
## cooperative.bill         0.1978816  0.0219492  9.0154 < 2.2e-16 ***
## mi4.mi4                  0.5003632  0.2463885  2.0308 0.0422763 *
## mi4.mi8                  1.0847407  0.2696878  4.0222 5.765e-05 ***
## mi4.mi10                 1.0989862  0.3658559  3.0039 0.0026656 **
## mi4.bill                -0.0085982  0.0238688 -0.3602 0.7186765
## mi8.mi8                  0.1201396  0.2953058  0.4068 0.6841320
## mi8.mi10                 0.6116001  0.4248670  1.4395 0.1500062
## mi8.bill                -0.0378691  0.0236811 -1.5991 0.1097927
## mi10.mi10               -0.6105353  0.2778813 -2.1971 0.0280127 *
## mi10.bill               -0.0681184  0.0180542 -3.7730 0.0001613 ***
## bill.bill                0.0057994  0.0208623  0.2780 0.7810242
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -1495.2
## McFadden R^2:  0.50946
## Likelihood ratio test : chisq = 3105.7 (p.value = < 2.22e-16)
##
## random coefficients
##             Min.    1st Qu.     Median       Mean     3rd Qu. Max.
```

```
## small.loss  -Inf  1.0782417  2.8737908  2.8737908  4.66933987  Inf
## small.gain  -Inf  4.3885671  7.9971519  7.9971519 11.60573662  Inf
## big.gain    -Inf  5.6989118 10.7885855 10.7885855 15.87825913  Inf
## municipal   -Inf -0.5907002  0.9479894  0.9479894  2.48667900  Inf
## state       -Inf -0.2792927  1.1149425  1.1149425  2.50917759  Inf
## cooperative -Inf  0.2163972  1.4012779  1.4012779  2.58615865  Inf
## mi4         -Inf -0.5034142  0.7838173  0.7838173  2.07104880  Inf
## mi8         -Inf -0.1043427  1.4278034  1.4278034  2.95994949  Inf
## mi10        -Inf -0.3410958  2.0018851  2.0018851  4.34486598  Inf
## bill        -Inf -0.3682152 -0.2033005 -0.2033005 -0.03838583  Inf
```

```
-1 * (coef(mx.bl.pr.mi1)[3:12]/coef(mx.bl.pr.mi1)[12])
```

```
##  small.loss  small.gain    big.gain   municipal       state cooperative
##   14.135677   39.336599   53.067176    4.662995    5.484208    6.892642
##         mi4         mi8        mi10        bill
##    3.855461    7.023117    9.846925   -1.000000
```

```
AIC(mx.bl.pr.mi1)
```

```
## [1] 3124.433
```

```
exp(confint(mx.bl.pr.mi1))
```

```
##                                2.5 %       97.5 %
## 2:(intercept)           8.495741e-01 1.479763e+00
## 3:(intercept)           7.860088e-01 2.088338e+00
## small.loss              1.073558e+01 2.919559e+01
## small.gain              9.830356e+02 8.988115e+03
## big.gain                1.124935e+04 2.087944e+05
## municipal               1.618165e+00 4.115194e+00
## state                   1.893131e+00 4.911860e+00
## cooperative             1.994398e+00 8.266519e+00
## mi4                     1.401738e+00 3.420962e+00
## mi8                     2.531113e+00 6.868514e+00
## mi10                    3.564022e+00 1.537712e+01
## bill                    7.818920e-01 8.516646e-01
## small.loss.small.loss   6.999365e+00 2.932237e+01
## small.loss.small.gain   2.419793e+01 1.220013e+02
## small.loss.big.gain     1.084154e+02 9.019786e+02
## small.loss.municipal    6.869680e-01 1.971270e+00
## small.loss.state        1.467996e+00 4.516185e+00
## small.loss.cooperative  1.168230e+00 4.780649e+00
## small.loss.mi4          1.717439e+00 5.349042e+00
## small.loss.mi8          1.361072e+00 4.426425e+00
## small.loss.mi10         2.439148e+00 1.231993e+01
## small.loss.bill         1.006226e+00 1.099988e+00
## small.gain.small.gain   1.677526e+01 7.347328e+01
## small.gain.big.gain     5.378770e+01 3.215500e+02
## small.gain.municipal    7.108166e-01 1.896670e+00
## small.gain.state        4.730462e-01 1.231413e+00
## small.gain.cooperative  4.452308e-01 1.695359e+00
```

```
## small.gain.mi4          2.921358e-01 7.171066e-01
## small.gain.mi8          2.295125e-01 6.284040e-01
## small.gain.mi10         2.793467e-01 1.259836e+00
## small.gain.bill         9.830213e-01 1.058681e+00
## big.gain.big.gain       9.016310e-01 2.266405e+00
## big.gain.municipal      4.467551e+00 1.213813e+01
## big.gain.state          2.182137e+00 5.578487e+00
## big.gain.cooperative    1.555197e+00 4.791857e+00
## big.gain.mi4            1.033290e+00 2.521615e+00
## big.gain.mi8            1.170637e+00 2.993421e+00
## big.gain.mi10           1.716253e+00 7.083652e+00
## big.gain.bill           9.376494e-01 1.002740e+00
## municipal.municipal     1.847707e+00 4.719350e+00
## municipal.state         2.105064e+00 5.592780e+00
## municipal.cooperative   1.240634e+00 3.951144e+00
## municipal.mi4           2.665690e-01 6.303331e-01
## municipal.mi8           1.631321e-01 4.311736e-01
## municipal.mi10          6.126831e-02 2.347534e-01
## municipal.bill          9.374411e-01 1.005896e+00
## state.state             1.041185e+00 2.473757e+00
## state.cooperative       9.817159e-01 3.134869e+00
## state.mi4               4.632960e-01 1.227322e+00
## state.mi8               5.536015e-01 1.363701e+00
## state.mi10              7.341309e-01 2.607619e+00
## state.bill              1.059148e+00 1.149210e+00
## cooperative.cooperative 3.186577e-01 9.290742e-01
## cooperative.mi4         1.202628e+00 3.167245e+00
## cooperative.mi8         4.970203e-01 1.281543e+00
## cooperative.mi10        2.242444e-01 7.613460e-01
## cooperative.bill        1.167497e+00 1.272395e+00
## mi4.mi4                 1.017604e+00 2.673199e+00
## mi4.mi8                 1.743967e+00 5.019443e+00
## mi4.mi10                1.465098e+00 6.147532e+00
## mi4.bill                9.461255e-01 1.038922e+00
## mi8.mi8                 6.321370e-01 2.011596e+00
## mi8.mi10                8.016174e-01 4.238986e+00
## mi8.bill                9.191708e-01 1.008582e+00
## mi10.mi10               3.150032e-01 9.362264e-01
## mi10.bill               9.016725e-01 9.677970e-01
## bill.bill               9.655186e-01 1.047796e+00
```

```
mx.bl.pr.mi1.dem <- mlogit(choice ~ small.loss + small.gain + big.gain +
                     municipal + state + cooperative +
                     mi4 + mi8 + mi10 + bill
                     + age:ASC + female:ASC + white:ASC + univ_degr:ASC +
                         income:ASC + coast_rec:ASC + oper:ASC + const_st:ASC +
                         wf_rec:ASC,
                   wfml_d2, panel = TRUE, rpar = c(small.loss = "n", small.gain = "n", big.gain = "n", mu

summary(mx.bl.pr.mi1.dem)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
```

```
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill +
##     age:ASC + female:ASC + white:ASC + univ_degr:ASC + income:ASC +
##     coast_rec:ASC + oper:ASC + const_st:ASC + wf_rec:ASC, data = wfml_d2,
##     rpar = c(small.loss = "n", small.gain = "n", big.gain = "n",
##         municipal = "n", state = "n", cooperative = "n", mi4 = "n",
##         mi8 = "n", mi10 = "n", bill = "n"), R = 100, correlation = TRUE,
##     halton = NA, panel = TRUE)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40603 0.48806 0.10591
##
## bfgs method
## 80 iterations, 0h:4m:28s
## g'(-H)^-1g = 7.39E-07
## gradient close to zero
##
## Coefficients :
##                           Estimate Std. Error  t-value  Pr(>|t|)
## 2:(intercept)            0.0825325  0.1525361   0.5411 0.5884604
## 3:(intercept)            2.5486338  1.0665132   2.3897 0.0168627 *
## small.loss               3.3358738  0.2999630  11.1209 < 2.2e-16 ***
## small.gain               8.6849692  0.6244240  13.9088 < 2.2e-16 ***
## big.gain                11.6195854  0.8437786  13.7709 < 2.2e-16 ***
## municipal                1.2308809  0.2696840   4.5642 5.015e-06 ***
## state                    1.1801441  0.2799789   4.2151 2.496e-05 ***
## cooperative              1.4863542  0.3646614   4.0760 4.582e-05 ***
## mi4                      0.6584866  0.2563415   2.5688 0.0102055 *
## mi8                      1.4247737  0.2659822   5.3567 8.478e-08 ***
## mi10                     2.1653235  0.3978276   5.4429 5.243e-08 ***
## bill                    -0.2673891  0.0249405 -10.7211 < 2.2e-16 ***
## age:ASC                  0.0423154  0.0135981   3.1119 0.0018591 **
## ASC:female              -0.7211903  0.2839740  -2.5396 0.0110968 *
## ASC:white                0.1705475  0.3629352   0.4699 0.6384180
## ASC:univ_degr           -0.5394070  0.3041592  -1.7734 0.0761565 .
## ASC:income               0.1507054  0.0548681   2.7467 0.0060201 **
## ASC:coast_rec           -0.2745804  0.2977919  -0.9221 0.3565001
## ASC:oper                 1.1554287  0.3278059   3.5247 0.0004239 ***
## ASC:const_st            -0.7917131  0.1827184  -4.3330 1.471e-05 ***
## ASC:wf_rec               0.2184478  0.2330198   0.9375 0.3485197
## small.loss.small.loss    2.9767465  0.3884615   7.6629 1.821e-14 ***
## small.loss.small.gain    5.3840662  0.5137526  10.4799 < 2.2e-16 ***
## small.loss.big.gain      7.5109928  0.6658573  11.2802 < 2.2e-16 ***
## small.loss.municipal     0.6219172  0.2909090   2.1378 0.0325296 *
## small.loss.state         0.5921414  0.3232248   1.8320 0.0669544 .
## small.loss.cooperative   0.6995287  0.3824675   1.8290 0.0674013 .
## small.loss.mi4           0.3625627  0.2960119   1.2248 0.2206412
## small.loss.mi8           0.5017919  0.3064931   1.6372 0.1015877
## small.loss.mi10          1.8912761  0.4840723   3.9070 9.344e-05 ***
## small.loss.bill          0.0779882  0.0251007   3.1070 0.0018899 **
## small.gain.small.gain    4.1191303  0.4213625   9.7757 < 2.2e-16 ***
## small.gain.big.gain      5.3581999  0.5596341   9.5745 < 2.2e-16 ***
## small.gain.municipal    -0.1788175  0.2903326  -0.6159 0.5379568
## small.gain.state        -0.3720430  0.2765942  -1.3451 0.1785974
```

```
## small.gain.cooperative   0.2811372  0.3563615   0.7889 0.4301645
## small.gain.mi4          -1.6743454  0.2988723  -5.6022 2.116e-08 ***
## small.gain.mi8          -2.1284462  0.3114039  -6.8350 8.200e-12 ***
## small.gain.mi10         -2.1966821  0.4054896  -5.4174 6.049e-08 ***
## small.gain.bill         -0.0523410  0.0209624  -2.4969 0.0125285 *
## big.gain.big.gain        1.8340807  0.3735730   4.9096 9.128e-07 ***
## big.gain.municipal       0.8051272  0.2637773   3.0523 0.0022710 **
## big.gain.state           1.4445288  0.3050879   4.7348 2.193e-06 ***
## big.gain.cooperative     1.4623027  0.3480336   4.2016 2.650e-05 ***
## big.gain.mi4             0.7295997  0.2432450   2.9994 0.0027047 **
## big.gain.mi8             1.1479247  0.2821681   4.0682 4.737e-05 ***
## big.gain.mi10            2.5176822  0.4542137   5.5429 2.974e-08 ***
## big.gain.bill            0.0328620  0.0213269   1.5409 0.1233474
## municipal.municipal      2.5019498  0.2880671   8.6853 < 2.2e-16 ***
## municipal.state          1.3688724  0.2681942   5.1040 3.325e-07 ***
## municipal.cooperative    1.1392340  0.3452103   3.3001 0.0009664 ***
## municipal.mi4           -0.2668274  0.2414451  -1.1051 0.2691048
## municipal.mi8           -0.2466306  0.2656649  -0.9284 0.3532249
## municipal.mi10          -0.0659399  0.3748541  -0.1759 0.8603660
## municipal.bill          -0.0854279  0.0202934  -4.2096 2.558e-05 ***
## state.state              0.2924171  0.2235039   1.3083 0.1907610
## state.cooperative       -0.6293663  0.2914163  -2.1597 0.0307974 *
## state.mi4                1.2062046  0.2571612   4.6905 2.726e-06 ***
## state.mi8               -0.1753060  0.2229527  -0.7863 0.4316963
## state.mi10              -0.3557974  0.3422789  -1.0395 0.2985742
## state.bill               0.1303154  0.0213277   6.1101 9.954e-10 ***
## cooperative.cooperative -0.2521646  0.3557101  -0.7089 0.4783836
## cooperative.mi4         -0.3153517  0.2740457  -1.1507 0.2498448
## cooperative.mi8          0.2795594  0.2633036   1.0617 0.2883546
## cooperative.mi10         0.5437054  0.3873036   1.4038 0.1603718
## cooperative.bill        -0.0024808  0.0219843  -0.1128 0.9101542
## mi4.mi4                  0.6120162  0.2441185   2.5070 0.0121745 *
## mi4.mi8                  0.4069978  0.2683660   1.5166 0.1293735
## mi4.mi10                -0.1419820  0.3706294  -0.3831 0.7016578
## mi4.bill                 0.0670206  0.0222365   3.0140 0.0025784 **
## mi8.mi8                  0.2120841  0.2384232   0.8895 0.3737193
## mi8.mi10                 0.8940927  0.3800456   2.3526 0.0186430 *
## mi8.bill                -0.1020040  0.0202516  -5.0368 4.733e-07 ***
## mi10.mi10               -0.1952222  0.3359489  -0.5811 0.5611685
## mi10.bill                0.0807540  0.0222011   3.6374 0.0002754 ***
## bill.bill                0.1821951  0.0229256   7.9472 1.998e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -1467.6
## McFadden R^2:  0.51646
## Likelihood ratio test : chisq = 3135.1 (p.value = < 2.22e-16)
##
## random coefficients
##             Min.    1st Qu.     Median       Mean     3rd Qu. Max.
## small.loss  -Inf  1.3280889  3.3358738  3.3358738  5.34365884  Inf
## small.gain  -Inf  4.1125752  8.6849692  8.6849692 13.25736318  Inf
## big.gain    -Inf  5.2747492 11.6195854 11.6195854 17.96442169  Inf
## municipal   -Inf -0.5948246  1.2308809  1.2308809  3.05658641  Inf
```

```
## state       -Inf -0.2562230  1.1801441  1.1801441  2.61651118  Inf
## cooperative -Inf  0.0612401  1.4863542  1.4863542  2.91146835  Inf
## mi4         -Inf -0.9186281  0.6584866  0.6584866  2.23560125  Inf
## mi8         -Inf -0.2922166  1.4247737  1.4247737  3.14176403  Inf
## mi10        -Inf -0.5347668  2.1653235  2.1653235  4.86541383  Inf
## bill        -Inf -0.4683833 -0.2673891 -0.2673891 -0.06639492  Inf
```

```
#-1 * ((mx.bl.pr.mi1.dem)[3:12]/coef(mx.bl.pr.mi1.dem)[12])
AIC(mx.bl.pr.mi1.dem)
```

```
## [1] 3087.189
```

```
mx.bl.pr.mi1.dem2 <- mlogit(choice ~ small.loss + small.gain + big.gain +
                    municipal + state + cooperative +
                    mi4 + mi8 + mi10 + bill
                    + age:big.gain + female:big.gain + white:big.gain + univ_degr:big.gain
                    + income:big.gain + coast_rec:big.gain + oper:big.gain +
                      const_st:big.gain + wf_rec:big.gain,
                  wfml_d2, panel = TRUE, rpar = c(small.loss = "n", small.gain = "n", big.gain = "n", mu

summary(mx.bl.pr.mi1.dem2)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill +
##     age:big.gain + female:big.gain + white:big.gain + univ_degr:big.gain +
##     income:big.gain + coast_rec:big.gain + oper:big.gain + const_st:big.gain +
##     wf_rec:big.gain, data = wfml_d2, rpar = c(small.loss = "n",
##     small.gain = "n", big.gain = "n", municipal = "n", state = "n",
##     cooperative = "n", mi4 = "n", mi8 = "n", mi10 = "n", bill = "n"),
##     R = 100, correlation = TRUE, halton = NA, panel = TRUE)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40603 0.48806 0.10591
##
## bfgs method
## 87 iterations, 0h:4m:38s
## g'(-H)^-1g = 9.29E-07
## gradient close to zero
##
## Coefficients :
##                           Estimate Std. Error  t-value  Pr(>|t|)
## 2:(intercept)            0.1029223  0.1503170   0.6847 0.4935324
## 3:(intercept)            0.3881402  0.2561567   1.5152 0.1297103
## small.loss               3.1343777  0.2778764  11.2798 < 2.2e-16 ***
## small.gain               8.1882488  0.5721533  14.3113 < 2.2e-16 ***
## big.gain                12.9725793  1.9321026   6.7142 1.891e-11 ***
## municipal                1.0855309  0.2430269   4.4667 7.943e-06 ***
## state                    1.0436562  0.2530761   4.1239 3.725e-05 ***
## cooperative              1.4690808  0.3368799   4.3608 1.296e-05 ***
## mi4                      0.6913784  0.2422170   2.8544 0.0043121 **
```

```
## mi8                      1.3099713  0.2456106   5.3335 9.632e-08 ***
## mi10                     2.0102304  0.3588597   5.6017 2.122e-08 ***
## bill                    -0.2273559  0.0226269 -10.0480 < 2.2e-16 ***
## big.gain:age            -0.0537940  0.0178680  -3.0106 0.0026070 **
## big.gain:female          0.8064892  0.3863388   2.0875 0.0368413 *
## big.gain:white          -0.1192780  0.5298164  -0.2251 0.8218775
## big.gain:univ_degr       0.8759543  0.3986546   2.1973 0.0280007 *
## big.gain:income         -0.1533261  0.0740924  -2.0694 0.0385096 *
## big.gain:coast_rec       1.0078728  0.4049309   2.4890 0.0128103 *
## big.gain:oper           -0.5512445  0.4568699  -1.2066 0.2275987
## big.gain:const_st       -0.7817161  0.2303054  -3.3943 0.0006881 ***
## big.gain:wf_rec          0.3084986  0.3242355   0.9515 0.3413686
## small.loss.small.loss    2.6556675  0.3550021   7.4807 7.394e-14 ***
## small.loss.small.gain    4.4235118  0.4397422  10.0593 < 2.2e-16 ***
## small.loss.big.gain      6.4362336  0.6042952  10.6508 < 2.2e-16 ***
## small.loss.municipal     0.2725917  0.2927975   0.9310 0.3518584
## small.loss.state         0.2634563  0.3135413   0.8403 0.4007625
## small.loss.cooperative   0.3910109  0.3796551   1.0299 0.3030519
## small.loss.mi4           1.0178721  0.3066176   3.3197 0.0009012 ***
## small.loss.mi8           0.4319730  0.2912229   1.4833 0.1379928
## small.loss.mi10          1.7442051  0.4729342   3.6881 0.0002260 ***
## small.loss.bill          0.0927924  0.0241812   3.8374 0.0001244 ***
## small.gain.small.gain    4.1277910  0.4109171  10.0453 < 2.2e-16 ***
## small.gain.big.gain      4.7216937  0.4496997  10.4997 < 2.2e-16 ***
## small.gain.municipal    -0.2539683  0.2598388  -0.9774 0.3283676
## small.gain.state        -0.0991143  0.2718990  -0.3645 0.7154650
## small.gain.cooperative   0.8522432  0.3150621   2.7050 0.0068304 **
## small.gain.mi4          -1.1597668  0.2762074  -4.1989 2.682e-05 ***
## small.gain.mi8          -0.9025723  0.2753283  -3.2782 0.0010448 **
## small.gain.mi10         -1.3171120  0.3578905  -3.6802 0.0002330 ***
## small.gain.bill         -0.0386497  0.0214697  -1.8002 0.0718288 .
## big.gain.big.gain        0.8530204  0.2969861   2.8723 0.0040755 **
## big.gain.municipal       1.0837997  0.2460887   4.4041 1.062e-05 ***
## big.gain.state           1.2770154  0.2633039   4.8500 1.235e-06 ***
## big.gain.cooperative     1.5816261  0.3717374   4.2547 2.093e-05 ***
## big.gain.mi4             0.2173509  0.2373925   0.9156 0.3598894
## big.gain.mi8             1.0888299  0.2622450   4.1520 3.296e-05 ***
## big.gain.mi10            1.9079112  0.3808479   5.0096 5.453e-07 ***
## big.gain.bill            0.0039622  0.0208055   0.1904 0.8489658
## municipal.municipal      2.1185238  0.2895815   7.3158 2.558e-13 ***
## municipal.state          1.4310738  0.2836808   5.0447 4.543e-07 ***
## municipal.cooperative    1.3086957  0.3261458   4.0126 6.005e-05 ***
## municipal.mi4           -0.0010435  0.2561759  -0.0041 0.9967500
## municipal.mi8           -0.1153441  0.2544444  -0.4533 0.6503202
## municipal.mi10          -0.2191237  0.3606148  -0.6076 0.5434267
## municipal.bill          -0.0743876  0.0212602  -3.4989 0.0004672 ***
## state.state              0.4534354  0.2298581   1.9727 0.0485326 *
## state.cooperative       -0.1124458  0.2899991  -0.3877 0.6982046
## state.mi4                0.5628930  0.2409613   2.3360 0.0194896 *
## state.mi8               -0.2171777  0.2369157  -0.9167 0.3593062
## state.mi10              -0.5896061  0.3222160  -1.8298 0.0672727 .
## state.bill               0.1181500  0.0216654   5.4534 4.942e-08 ***
## cooperative.cooperative -0.4525048  0.3158523  -1.4326 0.1519589
## cooperative.mi4         -0.8628530  0.2790680  -3.0919 0.0019887 **
```

```
## cooperative.mi8         -0.6165417  0.2635348  -2.3395 0.0193092 *
## cooperative.mi10        -0.5617276  0.3380342  -1.6617 0.0965634 .
## cooperative.bill         0.0312273  0.0220788   1.4144 0.1572566
## mi4.mi4                  1.1072503  0.2661017   4.1610 3.169e-05 ***
## mi4.mi8                  1.2037551  0.2872572   4.1905 2.783e-05 ***
## mi4.mi10                 0.8798057  0.3581153   2.4568 0.0140194 *
## mi4.bill                 0.0216671  0.0197776   1.0955 0.2732814
## mi8.mi8                 -0.1565319  0.2383736  -0.6567 0.5113954
## mi8.mi10                 0.8137431  0.3485560   2.3346 0.0195637 *
## mi8.bill                -0.0886342  0.0201520  -4.3983 1.091e-05 ***
## mi10.mi10                0.2585747  0.3587038   0.7209 0.4709965
## mi10.bill                0.0505250  0.0215787   2.3414 0.0192100 *
## bill.bill                0.1696528  0.0240667   7.0493 1.798e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -1476.8
## McFadden R^2:  0.51342
## Likelihood ratio test : chisq = 3116.6 (p.value = < 2.22e-16)
##
## random coefficients
##             Min.    1st Qu.     Median       Mean     3rd Qu. Max.
## small.loss  -Inf  1.3431572  3.1343777  3.1343777  4.92559820  Inf
## small.gain  -Inf  4.1073842  8.1882488  8.1882488 12.26911326  Inf
## big.gain    -Inf  7.5578447 12.9725793 12.9725793 18.38731385  Inf
## municipal   -Inf -0.5390755  1.0855309  1.0855309  2.71013737  Inf
## state       -Inf -0.2991676  1.0436562  1.0436562  2.38647990  Inf
## cooperative -Inf -0.0852981  1.4690808  1.4690808  3.02345966  Inf
## mi4         -Inf -0.7733258  0.6913784  0.6913784  2.15608255  Inf
## mi8         -Inf -0.0559180  1.3099713  1.3099713  2.67586064  Inf
## mi10        -Inf -0.1890040  2.0102304  2.0102304  4.20946481  Inf
## bill        -Inf -0.4061254 -0.2273559 -0.2273559 -0.04858642  Inf
```

```
#-1 * coef((mx.bl.pr.mi1.dem2)[3:12]/coef(mx.bl.pr.mi1.dem2)[12])
AIC(mx.bl.pr.mi1.dem2)
```

```
## [1] 3105.657
```

```
mx.bl.pr.mi1.dem3 <- mlogit(choice ~ small.loss + small.gain + big.gain +
                    municipal + state + cooperative +
                    mi4 + mi8 + mi10 + bill
                    + age:big.gain + female:big.gain + white:big.gain + univ_degr:big.gain
                    + income:big.gain + coast_rec:big.gain,
                  wfml_d2, panel = TRUE, rpar = c(small.loss = "n", small.gain = "n", big.gain = "n", mu

summary(mx.bl.pr.mi1.dem3)
```

```
##
## Call:
## mlogit(formula = choice ~ small.loss + small.gain + big.gain +
##     municipal + state + cooperative + mi4 + mi8 + mi10 + bill +
##     age:big.gain + female:big.gain + white:big.gain + univ_degr:big.gain +
##     income:big.gain + coast_rec:big.gain, data = wfml_d2, rpar = c(small.loss = "n",
```

```
##     small.gain = "n", big.gain = "n", municipal = "n", state = "n",
##     cooperative = "n", mi4 = "n", mi8 = "n", mi10 = "n", bill = "n"),
##     R = 100, correlation = TRUE, halton = NA, panel = TRUE)
##
## Frequencies of alternatives:
##       1       2       3
## 0.40650 0.48812 0.10538
##
## bfgs method
## 71 iterations, 0h:4m:4s
## g'(-H)^-1g = 3.43E-07
## gradient close to zero
##
## Coefficients :
##                           Estimate Std. Error  t-value  Pr(>|t|)
## 2:(intercept)             0.055196   0.134264   0.4111 0.6809965
## 3:(intercept)             0.268055   0.250657   1.0694 0.2848857
## small.loss                2.973047   0.267970  11.0947 < 2.2e-16 ***
## small.gain                7.792472   0.524016  14.8707 < 2.2e-16 ***
## big.gain                 12.632670   1.172777  10.7716 < 2.2e-16 ***
## municipal                 0.895527   0.236208   3.7913 0.0001499 ***
## state                     0.848875   0.242458   3.5011 0.0004633 ***
## cooperative               1.245671   0.326622   3.8138 0.0001368 ***
## mi4                       0.730757   0.230902   3.1648 0.0015519 **
## mi8                       1.277242   0.245320   5.2064 1.925e-07 ***
## mi10                      1.929912   0.369476   5.2234 1.757e-07 ***
## bill                     -0.202212   0.020175 -10.0229 < 2.2e-16 ***
## big.gain:age             -0.053243   0.017251  -3.0864 0.0020257 **
## big.gain:female          -0.158092   0.346638  -0.4561 0.6483376
## big.gain:white            0.036912   0.448826   0.0822 0.9344547
## big.gain:univ_degr        0.083642   0.366748   0.2281 0.8195956
## big.gain:income          -0.085608   0.068042  -1.2582 0.2083309
## big.gain:coast_rec        0.219507   0.361158   0.6078 0.5433277
## small.loss.small.loss     2.466362   0.343827   7.1733 7.323e-13 ***
## small.loss.small.gain     3.865664   0.399384   9.6791 < 2.2e-16 ***
## small.loss.big.gain       5.718120   0.519538  11.0062 < 2.2e-16 ***
## small.loss.municipal      0.113018   0.254214   0.4446 0.6566242
## small.loss.state          0.303306   0.282610   1.0732 0.2831678
## small.loss.cooperative    0.502272   0.338876   1.4822 0.1382949
## small.loss.mi4            0.618562   0.273555   2.2612 0.0237469 *
## small.loss.mi8            0.619242   0.287268   2.1556 0.0311126 *
## small.loss.mi10           1.856601   0.434107   4.2768 1.896e-05 ***
## small.loss.bill           0.020302   0.022545   0.9005 0.3678533
## small.gain.small.gain     3.489232   0.352730   9.8921 < 2.2e-16 ***
## small.gain.big.gain       4.223788   0.386618  10.9250 < 2.2e-16 ***
## small.gain.municipal     -0.197962   0.217979  -0.9082 0.3637894
## small.gain.state         -0.097357   0.228565  -0.4259 0.6701460
## small.gain.cooperative    0.088689   0.268099   0.3308 0.7407912
## small.gain.mi4           -0.637846   0.217004  -2.9393 0.0032893 **
## small.gain.mi8           -0.978782   0.252268  -3.8799 0.0001045 ***
## small.gain.mi10          -1.746899   0.328690  -5.3147 1.068e-07 ***
## small.gain.bill           0.006582   0.016909   0.3893 0.6970889
## big.gain.big.gain         0.407671   0.255432   1.5960 0.1104871
## big.gain.municipal        1.495250   0.252834   5.9140 3.340e-09 ***
```

```
## big.gain.state           1.659601   0.274869   6.0378 1.562e-09 ***
## big.gain.cooperative     1.134085   0.299405   3.7878 0.0001520 ***
## big.gain.mi4            -0.257001   0.251505  -1.0219 0.3068512
## big.gain.mi8            -0.124920   0.249837  -0.5000 0.6170727
## big.gain.mi10           -0.192348   0.336742  -0.5712 0.5678613
## big.gain.bill            0.060464   0.021226   2.8486 0.0043906 **
## municipal.municipal      0.891602   0.249642   3.5715 0.0003549 ***
## municipal.state          0.917411   0.266259   3.4456 0.0005699 ***
## municipal.cooperative    0.195878   0.282266   0.6939 0.4877149
## municipal.mi4           -0.207058   0.216185  -0.9578 0.3381743
## municipal.mi8            0.126982   0.249626   0.5087 0.6109697
## municipal.mi10           0.256311   0.363144   0.7058 0.4803056
## municipal.bill          -0.115359   0.024046  -4.7974 1.607e-06 ***
## state.state              0.549624   0.264796   2.0756 0.0379265 *
## state.cooperative        0.573401   0.276022   2.0774 0.0377667 *
## state.mi4                0.152323   0.252884   0.6023 0.5469446
## state.mi8                0.439422   0.262483   1.6741 0.0941122 .
## state.mi10               0.527807   0.316120   1.6696 0.0949906 .
## state.bill               0.128638   0.021363   6.0215 1.728e-09 ***
## cooperative.cooperative -0.015131   0.265390  -0.0570 0.9545327
## cooperative.mi4          0.849468   0.237239   3.5806 0.0003428 ***
## cooperative.mi8          1.136423   0.260768   4.3580 1.313e-05 ***
## cooperative.mi10         0.937077   0.339413   2.7609 0.0057646 **
## cooperative.bill        -0.010610   0.017229  -0.6158 0.5380216
## mi4.mi4                  0.914841   0.259034   3.5317 0.0004128 ***
## mi4.mi8                  0.810065   0.253500   3.1955 0.0013958 **
## mi4.mi10                 1.114195   0.371894   2.9960 0.0027355 **
## mi4.bill                 0.089113   0.024694   3.6087 0.0003078 ***
## mi8.mi8                 -0.427924   0.247296  -1.7304 0.0835570 .
## mi8.mi10                -0.039496   0.354168  -0.1115 0.9112061
## mi8.bill                 0.080094   0.019021   4.2109 2.543e-05 ***
## mi10.mi10               -0.886678   0.346136  -2.5616 0.0104178 *
## mi10.bill                0.096237   0.018855   5.1040 3.325e-07 ***
## bill.bill                0.034079   0.022867   1.4903 0.1361337
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -1501.3
## McFadden R^2:  0.50748
## Likelihood ratio test : chisq = 3093.6 (p.value = < 2.22e-16)
##
## random coefficients
##             Min.     1st Qu.     Median       Mean     3rd Qu. Max.
## small.loss  -Inf  1.30951171  2.9730475  2.9730475  4.63658338  Inf
## small.gain  -Inf  4.28006420  7.7924721  7.7924721 11.30488005  Inf
## big.gain    -Inf  7.82987333 12.6326700 12.6326700 17.43546668  Inf
## municipal   -Inf -0.28871441  0.8955266  0.8955266  2.07976757  Inf
## state       -Inf -0.50001617  0.8488751  0.8488751  2.19776643  Inf
## cooperative -Inf  0.31261033  1.2456709  1.2456709  2.17873152  Inf
## mi4         -Inf -0.33145628  0.7307575  0.7307575  1.79297130  Inf
## mi8         -Inf -0.01965239  1.2772422  1.2772422  2.57413682  Inf
## mi10        -Inf -0.18019514  1.9299121  1.9299121  4.04001934  Inf
## bill        -Inf -0.36584869 -0.2022123 -0.2022123 -0.03857591  Inf
```

```
#-1 * (coef(mx.bl.pr.mi1.dem3)[3:12]/coef(mx.bl.pr.mi1.dem3)[12])

AIC(mx.bl.pr.mi1.dem3)
```

```
## [1] 3148.501
```

Translate to dollar values Normalize with bill

```
# big.gain.value <- rpar(wf.mxlc, "big.gain", norm = "bill")
# summary(big.gain.value)
# med(big.gain.value)
# mean(big.gain.value)
```

Use AIC to compare models

```
AIC(ml.bl.st.mi1)
```

```
## [1] 4052.907
```

```
AIC(ml.bl.pr.m1)
```

```
## [1] 4080.915
```

```
AIC(ml.sl.pr.m1)
```

```
## [1] 4077.759
```

```
AIC(ml.sg.st.mi1)
```

```
## [1] 4655.653
```

```
AIC(ml.bl.st.mi1.dem)
```

```
## [1] 4058.008
```

```
AIC(ml.bl.pr.mi1.dem2)
```

```
## [1] 4049.827
```

```
AIC(ml.bl.pr.mi1.dem2)
```

```
## [1] 4049.827
```

```
AIC(ml.bl.pr.mi1.dem3)
```

```
## [1] 3729.997
```

```
AIC(ml.bl.pr.mi1.dem5)
```

```
## [1] 3749.136
```

```
AIC(ml.bl.pr.mi1.dem6)
```

```
## [1] 3932.773
```

```
AIC(mx.bl.st.mi1)
```

```
## [1] 3138.048
```

```
AIC(mx.bl.pr.mi1)
```

```
## [1] 3124.433
```

```
AIC(mx.bl.pr.mi1.dem)
```

```
## [1] 3087.189
```

Likelihood Ratio Test

```
# lrtest(ml.bl.pr.mi1.dem6, ml.bl.pr.mi1.dem2)
```

Interact with demographics e.g., age:mi4

goodness of fit lrtest AIC

demographics test to see if panel = true or false, see how output differs find best "base" model based on AIC and lrtest