Consumer WTP for Carbon Offsets

Choice Probaility by Information Treatment

```
## `summarise()` has grouped output by 'framing_effect', 'scenario'. You can
## override using the `.groups` argument.
```

```
## # A tibble: 10 x 5
## # Groups:   scenario [10]
##    scenario MetOffice     UN baseline consequence
##       <int>     <dbl>  <dbl>    <dbl>       <dbl>
##  1        1    0.0772 0.0603   0.0698      0.0742
##  2        2    0.0713 0.0545   0.0601      0.0742
##  3        3    0.0693 0.0564   0.0698      0.0781
##  4        4    0.0594 0.0486   0.0504      0.0840
##  5        5    0.0624 0.0564   0.0620      0.0781
##  6        6    0.0782 0.0681   0.0659      0.0723
##  7        7    0.0693 0.0661   0.0678      0.0840
##  8        8    0.0624 0.0700   0.0620      0.0723
##  9        9    0.0663 0.0467   0.0562      0.0684
## 10       10    0.0574 0.0506   0.0620      0.0801
```

The above table presents the choice probability of the opt-out option being the best option by information treatment. The probability differences between different information treatments does not appear to be large. Evan when the probaiblity of selecting opt out is larger with consequence framing, the difference at about 0.01 percentage points.

Summary of PCA

for Q9

Factor loadings for Q9:

```
## Standard deviations (1, .., p=15):
##  [1] 2.4449246 1.8707724 0.8688969 0.8126817 0.7717738 0.7367027 0.6726539
##  [8] 0.6458357 0.6225510 0.6218641 0.5661055 0.5478628 0.4985988 0.4942617
## [15] 0.4597596
##
## Rotation (n x k) = (15 x 15):
##               PC1        PC2         PC3          PC4         PC5          PC6
## Q9_1  -0.28055790 0.08969099 -0.01809095  0.465105846  0.51736702 -0.391487380
## Q9_2  -0.30165609 0.06243437 -0.10447931  0.149123245 -0.23976862 -0.633688311
## Q9_3  -0.25534486 0.09965919 -0.38960705  0.641873715 -0.24371138  0.487245142
## Q9_4  -0.29517817 0.08744077  0.11523794 -0.129574023  0.60172841  0.175649519
```

```
## Q9_5  -0.34338927 0.10756369 -0.04558215 -0.216140393 -0.09240375  0.075432130
## Q9_6  -0.32765725 0.13341929  0.05339357 -0.307194312 -0.07027835 -0.033500916
## Q9_7  -0.32313276 0.14438537 -0.09702601 -0.197636025 -0.35408946 -0.108806247
## Q9_8  -0.32109315 0.13885569 -0.06691886 -0.167509966  0.12766305  0.246003811
## Q9_9  -0.31698934 0.13629589  0.03659775 -0.168437063 -0.06257662  0.104621120
## Q9_10 -0.05207092 0.32532352  0.79583861  0.278754931 -0.18758423  0.170994200
## Q9_11  0.13201110 0.39330701  0.19513463  0.058173856 -0.04648334 -0.164470230
## Q9_12  0.15527865 0.39005636 -0.13350031 -0.004979848 -0.12122042 -0.157379077
## Q9_13  0.15097224 0.41115573 -0.21287112 -0.030238104  0.15830757  0.008792343
## Q9_14  0.19498997 0.39490021 -0.16733819 -0.068710882  0.12661099  0.056474782
## Q9_15  0.19905515 0.38044631 -0.20235622 -0.096555857  0.03413161  0.049771980
##               PC7          PC8         PC9        PC10         PC11
## Q9_1   0.30600170 -0.364141155  0.09499251 -0.17099886 -0.046270325
## Q9_2  -0.09093742  0.568195464 -0.18730801  0.12902158  0.149283271
## Q9_3  -0.20166199 -0.000446123 -0.05026494 -0.01202977  0.006464309
## Q9_4  -0.52428739  0.320105704 -0.04109848  0.04828097 -0.263000358
## Q9_5  -0.05989655 -0.117864172 -0.12898073 -0.24114062 -0.161168202
## Q9_6  -0.10940430 -0.158723003  0.12650254 -0.40527713  0.296833851
## Q9_7  -0.03680158 -0.238665332 -0.02268343 -0.18526720 -0.277665005
## Q9_8   0.22057898  0.073073913  0.22851066  0.27064837  0.673824843
## Q9_9   0.42159352 -0.065495041 -0.11366383  0.59286695 -0.399578636
## Q9_10  0.16084983  0.219072722  0.06352699 -0.17351881 -0.028797163
## Q9_11 -0.44746529 -0.481320939 -0.33850675  0.37578837  0.240881406
## Q9_12 -0.19488636  0.018588709  0.77030072  0.12263453 -0.203512537
## Q9_13  0.11777418  0.116921542  0.03148230  0.02520948 -0.027020537
## Q9_14  0.14575234  0.060335128 -0.28453726 -0.18123943  0.016416713
## Q9_15  0.20012005  0.197718389 -0.24381991 -0.22433203 -0.014356284
##               PC12         PC13        PC14        PC15
## Q9_1   0.073959534  0.004850394 -0.03400913 -0.04868215
## Q9_2  -0.012465223 -0.036640130 -0.02273799  0.07586218
## Q9_3   0.012794469 -0.094540477  0.10227418  0.03641470
## Q9_4   0.082998576  0.102227821  0.10281705 -0.06148196
## Q9_5  -0.141995619 -0.220146631 -0.78114317  0.10217376
## Q9_6  -0.035272983 -0.458210195  0.48048566  0.15481320
## Q9_7   0.001066073  0.643258239  0.19542458 -0.25849760
## Q9_8   0.093130890  0.289081548 -0.18050518 -0.09969326
## Q9_9   0.076586110 -0.270051422  0.19351380  0.11842329
## Q9_10 -0.046216945  0.064318958 -0.02519886 -0.01468974
## Q9_11  0.026520867 -0.049810662 -0.04571043 -0.07882435
## Q9_12  0.215115088 -0.073956449 -0.12117409  0.10891120
## Q9_13 -0.820675102 -0.012164001  0.09103065 -0.15795875
## Q9_14  0.182198317  0.287118068  0.04539293  0.70528961
## Q9_15  0.442218904 -0.236378965 -0.01639274 -0.56648333
```

Importance of components:

```
## Importance of components:
##                            PC1    PC2     PC3     PC4     PC5     PC6     PC7
## Standard deviation     2.4449 1.8708 0.86890 0.81268 0.77177 0.73670 0.67265
## Proportion of Variance 0.3985 0.2333 0.05033 0.04403 0.03971 0.03618 0.03016
## Cumulative Proportion  0.3985 0.6318 0.68216 0.72619 0.76590 0.80208 0.83225
##                            PC8     PC9    PC10    PC11    PC12    PC13    PC14
## Standard deviation     0.64584 0.62255 0.62186 0.56611 0.54786 0.49860 0.49426
## Proportion of Variance 0.02781 0.02584 0.02578 0.02137 0.02001 0.01657 0.01629
```

```
## Cumulative Proportion  0.86005 0.88589 0.91167 0.93304 0.95305 0.96962 0.98591
##                           PC15
## Standard deviation     0.45976
## Proportion of Variance 0.01409
## Cumulative Proportion  1.00000
```

for Q10

Factor loadings for Q10:

```
## Standard deviations (1, .., p=13):
##  [1] 3.0450201 0.8133522 0.6909953 0.6552695 0.6336439 0.5355692 0.5154163
##  [8] 0.4956216 0.4868869 0.4713560 0.4280445 0.4228192 0.3722779
##
## Rotation (n x k) = (13 x 13):
##              PC1          PC2         PC3         PC4         PC5         PC6
## Q10_1  0.2390361  0.699421565  0.07516256  0.09251933 -0.46544205  0.08653526
## Q10_2  0.2707082  0.465197906  0.07375957 -0.15583464  0.02421393 -0.27794445
## Q10_3  0.2745820  0.200535143  0.01159933 -0.39953268  0.53671993 -0.08686160
## Q10_4  0.2886799  0.004467465 -0.03767438 -0.25207699  0.38020008  0.19102908
## Q10_5  0.2655558  0.087559382 -0.59124583  0.35370410  0.18850290  0.51873708
## Q10_6  0.2832510 -0.120810474 -0.37585763  0.08093827 -0.08456392 -0.26214102
## Q10_7  0.2829975 -0.255275900 -0.17374929 -0.19373162 -0.16106438 -0.42547667
## Q10_8  0.2812398 -0.184794951 -0.28440972  0.04259160 -0.27827343 -0.21999799
## Q10_9  0.2889450 -0.122221900  0.18379364  0.12084258  0.09842844 -0.12963826
## Q10_10 0.2600478 -0.032261266  0.38318345  0.72239962  0.28816650 -0.23228115
## Q10_11 0.2909976 -0.198363004  0.30746045 -0.13504967 -0.13551275  0.26037770
## Q10_12 0.2906152 -0.206234882  0.31714171 -0.09595646 -0.14719757  0.32221894
## Q10_13 0.2840109 -0.186358836  0.09857721 -0.09525121 -0.26708769  0.24820092
##                PC7         PC8          PC9         PC10         PC11
## Q10_1  -0.13298826  0.31618566 -0.134622560  0.27564788 -0.05850282
## Q10_2   0.16164825 -0.51513390  0.366503161 -0.38222722  0.12660976
## Q10_3   0.03031972  0.16509997 -0.384077518 -0.09734531 -0.29831017
## Q10_4  -0.20866184  0.22223398  0.092914335  0.21791106  0.58341664
## Q10_5  -0.05375803 -0.14104966  0.132213997 -0.11841717 -0.28800562
## Q10_6   0.51487982  0.16267651  0.213439468  0.31391936  0.26580148
## Q10_7  -0.22497287  0.33118235  0.287591106 -0.07948103 -0.46108164
## Q10_8  -0.47604436 -0.26455928 -0.456503957 -0.18966292  0.32200370
## Q10_9   0.11671740 -0.48938556 -0.244114996  0.61058376 -0.25358993
## Q10_10 -0.05259386  0.25351118  0.004264633 -0.22794495  0.07931562
## Q10_11 -0.10564149 -0.03707151  0.327672655  0.04347687  0.01446710
## Q10_12 -0.14878911 -0.09003989  0.156674014 -0.01394474 -0.09552083
## Q10_13  0.56286352  0.13688723 -0.381753451 -0.37315666  0.03702411
##                PC12         PC13
## Q10_1  -0.008778289 -0.008571299
## Q10_2  -0.112789275  0.045572740
## Q10_3   0.389909642 -0.053186685
## Q10_4  -0.418594895  0.077426853
## Q10_5  -0.057724302 -0.044117054
## Q10_6   0.409585403  0.086066627
## Q10_7  -0.342425891  0.029691237
## Q10_8   0.173481472 -0.058795814
## Q10_9  -0.275155286 -0.033929715
```

```
## Q10_10  0.017885707 -0.005207989
## Q10_11  0.267885105 -0.695180660
## Q10_12  0.290907181  0.699280707
## Q10_13 -0.330283135 -0.043423673
```

Importance of components:

```
## Importance of components:
##                            PC1     PC2     PC3     PC4     PC5     PC6     PC7
## Standard deviation     3.0450 0.81335 0.69100 0.65527 0.63364 0.53557 0.51542
## Proportion of Variance 0.7132 0.05089 0.03673 0.03303 0.03088 0.02206 0.02043
## Cumulative Proportion  0.7132 0.76413 0.80086 0.83389 0.86477 0.88684 0.90727
##                            PC8     PC9    PC10    PC11    PC12    PC13
## Standard deviation     0.4956 0.48689 0.47136 0.42804 0.42282 0.37228
## Proportion of Variance 0.0189 0.01824 0.01709 0.01409 0.01375 0.01066
## Cumulative Proportion  0.9262 0.94440 0.96149 0.97559 0.98934 1.00000
```

Basic Logit Model

Basic Logit Model Coefficients

```
##
## Model estimated on: Mon Oct 07 04:21:19 AM 2024
##
## Call:
## gmnl(formula = f, data = dt, model = "mnl", method = "nr")
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:0m:8s
##
## Coefficients:
##                      Estimate Std. Error  z-value  Pr(>|z|)
## I                 -0.9858758  0.0355302 -27.7476 < 2.2e-16 ***
## price             -0.0318596  0.0018653 -17.0803 < 2.2e-16 ***
## location_EU       -0.0193157  0.0179737  -1.0747    0.2825
## location_UK        0.1726739  0.0178102   9.6952 < 2.2e-16 ***
## certificate_NGO    0.0993108  0.0182718   5.4352 5.474e-08 ***
## certificate_UK     0.3372772  0.0185896  18.1433 < 2.2e-16 ***
## project_renewable  0.1324178  0.0209696   6.3148 2.706e-10 ***
## project_landfill  -0.2605849  0.0230259 -11.3170 < 2.2e-16 ***
## project_manure    -0.1361997  0.0209358  -6.5056 7.740e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by Newton-Raphson maximisation
## Log Likelihood: -20883
## Number of observations: 12760
## Number of iterations: 4
## Exit of MLE: gradient close to zero (gradtol)
```

Basic Logit Model Willingness to Pay

```
##
## Willigness-to-pay respect to:  price
##
##                    Estimate Std. Error  t-value  Pr(>|t|)
## I                 -30.94442    2.76300 -11.1996 < 2.2e-16 ***
## location_EU        -0.60628    0.56778  -1.0678    0.2856
## location_UK         5.41985    0.64571   8.3936 < 2.2e-16 ***
## certificate_NGO     3.11714    0.60496   5.1526 2.569e-07 ***
## certificate_UK     10.58637    0.94537  11.1981 < 2.2e-16 ***
## project_renewable   4.15630    0.68590   6.0597 1.364e-09 ***
## project_landfill   -8.17917    0.89143  -9.1753 < 2.2e-16 ***
## project_manure     -4.27500    0.66996  -6.3809 1.760e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Mixed Logit Model

Mixed Logit Model Coefficients

```
##
## Model estimated on: Mon Oct 07 04:21:19 AM 2024
##
## Call:
## gmnl(formula = f, data = dt, model = "mixl", ranp = randpar,
##     R = 2000, haltons = NA, panel = T, method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:9m:8s
##
## Coefficients:
##                        Estimate Std. Error  z-value  Pr(>|z|)
## I                    -1.4857544  0.0473657 -31.3677 < 2.2e-16 ***
## price                -0.0545757  0.0026568 -20.5420 < 2.2e-16 ***
## location_EU           0.0284154  0.0264183   1.0756    0.2821
## location_UK           0.3646805  0.0256519  14.2165 < 2.2e-16 ***
## certificate_NGO       0.1994266  0.0252803   7.8886 3.109e-15 ***
## certificate_UK        0.6780877  0.0294640  23.0141 < 2.2e-16 ***
## project_renewable     0.3256955  0.0301148  10.8151 < 2.2e-16 ***
## project_landfill     -0.3924930  0.0319928 -12.2682 < 2.2e-16 ***
## project_manure       -0.1786808  0.0286841  -6.2293 4.686e-10 ***
## sd.location_EU        0.9962610  0.0365881  27.2291 < 2.2e-16 ***
## sd.location_UK        1.0581997  0.0354755  29.8291 < 2.2e-16 ***
## sd.certificate_NGO    0.9540021  0.0373045  25.5734 < 2.2e-16 ***
## sd.certificate_UK     0.9802209  0.0376732  26.0191 < 2.2e-16 ***
## sd.project_renewable  1.0999047  0.0417274  26.3593 < 2.2e-16 ***
## sd.project_landfill   0.8566907  0.0454703  18.8407 < 2.2e-16 ***
```

```
## sd.project_manure     1.0135622  0.0398894  25.4093 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -19140
## Number of observations: 12760
## Number of iterations: 15
## Exit of MLE: successive function values within relative tolerance limit (reltol)
## Simulation based on 2000 draws
```

Mixed Logit Model Willingness to Pay

```
##
## Willigness-to-pay respect to:  price
##
##                       Estimate Std. Error  t-value  Pr(>|t|)
## I                    -27.22371    2.09822 -12.9747 < 2.2e-16 ***
## location_EU            0.52066    0.48327   1.0774    0.2813
## location_UK            6.68210    0.61056  10.9441 < 2.2e-16 ***
## certificate_NGO        3.65413    0.51049   7.1581 8.180e-13 ***
## certificate_UK        12.42471    0.90650  13.7062 < 2.2e-16 ***
## project_renewable      5.96777    0.61968   9.6304 < 2.2e-16 ***
## project_landfill      -7.19171    0.69916 -10.2862 < 2.2e-16 ***
## project_manure        -3.27400    0.51388  -6.3711 1.877e-10 ***
## sd.location_EU        18.25465    1.18157  15.4495 < 2.2e-16 ***
## sd.location_UK        19.38956    1.20583  16.0798 < 2.2e-16 ***
## sd.certificate_NGO    17.48033    1.13580  15.3903 < 2.2e-16 ***
## sd.certificate_UK     17.96074    1.18609  15.1428 < 2.2e-16 ***
## sd.project_renewable  20.15373    1.32680  15.1898 < 2.2e-16 ***
## sd.project_landfill   15.69728    1.18394  13.2585 < 2.2e-16 ***
## sd.project_manure     18.57166    1.22403  15.1726 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mixed logit + co2 consumption

mixed logit + co2 consumption Coefficients

```
##
## Model estimated on: Mon Oct 07 04:21:19 AM 2024
##
## Call:
## gmnl(formula = f, data = dt, model = "mixl", ranp = randpar,
##     R = 2000, haltons = NA, mvar = mvarlist_ctr_e, panel = T,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
```

```
##
## The estimation took: 0h:11m:5s
##
## Coefficients:
##                               Estimate Std. Error  z-value  Pr(>|z|)
## I                           -1.4841299  0.0473942 -31.3146 < 2.2e-16 ***
## price                       -0.0544868  0.0026573 -20.5049 < 2.2e-16 ***
## location_EU                  0.1202787  0.0416379   2.8887  0.003869 **
## location_UK                  0.5346643  0.0400068  13.3643 < 2.2e-16 ***
## certificate_NGO              0.3844766  0.0398204   9.6553 < 2.2e-16 ***
## certificate_UK               0.8285776  0.0443191  18.6957 < 2.2e-16 ***
## project_renewable            0.4304609  0.0458127   9.3961 < 2.2e-16 ***
## project_landfill            -0.3864832  0.0498745  -7.7491 9.326e-15 ***
## project_manure              -0.1101728  0.0445627  -2.4723  0.013424 *
## location_EU.co2_value       -0.0589423  0.0196884  -2.9938  0.002756 **
## location_UK.co2_value       -0.1101075  0.0184108  -5.9806 2.223e-09 ***
## certificate_NGO.co2_value   -0.1161840  0.0189272  -6.1385 8.333e-10 ***
## certificate_UK.co2_value    -0.0970795  0.0196414  -4.9426 7.709e-07 ***
## project_renewable.co2_value -0.0679105  0.0207652  -3.2704  0.001074 **
## project_landfill.co2_value  -0.0033873  0.0233214  -0.1452  0.884519
## project_manure.co2_value    -0.0411087  0.0212114  -1.9380  0.052618 .
## sd.location_EU               0.9913626  0.0365897  27.0941 < 2.2e-16 ***
## sd.location_UK               1.0472969  0.0354664  29.5293 < 2.2e-16 ***
## sd.certificate_NGO           0.9399533  0.0371896  25.2746 < 2.2e-16 ***
## sd.certificate_UK            0.9754482  0.0377048  25.8707 < 2.2e-16 ***
## sd.project_renewable         1.0948287  0.0417437  26.2274 < 2.2e-16 ***
## sd.project_landfill          0.8579764  0.0454988  18.8571 < 2.2e-16 ***
## sd.project_manure            1.0152387  0.0400308  25.3614 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -19112
## Number of observations: 12760
## Number of iterations: 16
## Exit of MLE: successive function values within relative tolerance limit (reltol)
## Simulation based on 2000 draws
```

mixed logit + co2 consumption Willingness to Pay

```
##
## Willigness-to-pay respect to:  price
##
##                               Estimate Std. Error  t-value  Pr(>|t|)
## I                           -27.238347   2.103180 -12.9510 < 2.2e-16 ***
## location_EU                   2.207484   0.767305   2.8769  0.004016 **
## location_UK                   9.812733   0.918774  10.6802 < 2.2e-16 ***
## certificate_NGO               7.056327   0.830533   8.4961 < 2.2e-16 ***
## certificate_UK               15.206947   1.198931  12.6838 < 2.2e-16 ***
## project_renewable             7.900281   0.923096   8.5585 < 2.2e-16 ***
## project_landfill             -7.093155   0.990860  -7.1586 8.151e-13 ***
## project_manure               -2.022010   0.809718  -2.4972  0.012519 *
## location_EU.co2_value        -1.081772   0.364865  -2.9649  0.003028 **
```

```
## location_UK.co2_value        -2.020812   0.353397  -5.7183 1.076e-08 ***
## certificate_NGO.co2_value    -2.132334   0.365046  -5.8413 5.180e-09 ***
## certificate_UK.co2_value     -1.781707   0.373193  -4.7742 1.804e-06 ***
## project_renewable.co2_value  -1.246366   0.386446  -3.2252  0.001259 **
## project_landfill.co2_value   -0.062167   0.428022  -0.1452  0.884520
## project_manure.co2_value     -0.754470   0.390925  -1.9300  0.053611 .
## sd.location_EU               18.194551   1.181468  15.3999 < 2.2e-16 ***
## sd.location_UK               19.221118   1.201362  15.9994 < 2.2e-16 ***
## sd.certificate_NGO           17.251032   1.126791  15.3099 < 2.2e-16 ***
## sd.certificate_UK            17.902473   1.186401  15.0897 < 2.2e-16 ***
## sd.project_renewable         20.093472   1.327763  15.1333 < 2.2e-16 ***
## sd.project_landfill          15.746504   1.188411  13.2500 < 2.2e-16 ***
## sd.project_manure            18.632751   1.230321  15.1446 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mixed logit + framing effect

mixed logit + framing effect Coefficients

```
##
## Model estimated on: Mon Oct 07 04:21:19 AM 2024
##
## Call:
## gmnl(formula = f, data = dt, model = "mixl", ranp = randpar,
##     R = 2000, haltons = NA, mvar = mvarlist_ctrl_f, panel = T,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:11m:22s
##
## Coefficients:
##                                              Estimate Std. Error  z-value  Pr(>|z|)
## I                                           -1.4850536  0.0473799 -31.3435 < 2.2e-16 ***
## price                                       -0.0545301  0.0026564 -20.5278 < 2.2e-16 ***
## location_EU                                  0.1834123  0.0565269   3.2447  0.001176 **
## location_UK                                  0.4627507  0.0546832   8.4624 < 2.2e-16 ***
## certificate_NGO                              0.2225981  0.0532694   4.1787 2.931e-05 ***
## certificate_UK                               0.7164220  0.0582117  12.3072 < 2.2e-16 ***
## project_renewable                            0.4111243  0.0610524   6.7340 1.651e-11 ***
## project_landfill                            -0.3312214  0.0679441  -4.8749 1.089e-06 ***
## project_manure                              -0.1994954  0.0606669  -3.2884  0.001008 **
## location_EU.framing_effectconsequence       -0.1806139  0.0779416  -2.3173  0.020488 *
## location_EU.framing_effectMetOffice         -0.2184431  0.0668474  -3.2678  0.001084 **
## location_EU.framing_effectUN                -0.1581170  0.0768674  -2.0570  0.039685 *
## location_UK.framing_effectconsequence       -0.1778934  0.0755777  -2.3538  0.018584 *
## location_UK.framing_effectMetOffice         -0.1277126  0.0645486  -1.9785  0.047867 *
## location_UK.framing_effectUN                -0.0676335  0.0744449  -0.9085  0.363612
```

```
## certificate_NGO.framing_effectconsequence    0.0053600  0.0751224   0.0713  0.943119
## certificate_NGO.framing_effectMetOffice     -0.0574727  0.0642173  -0.8950  0.370802
## certificate_NGO.framing_effectUN             0.0042701  0.0742580   0.0575  0.954145
## certificate_UK.framing_effectconsequence    -0.0834558  0.0782196  -1.0669  0.285997
## certificate_UK.framing_effectMetOffice      -0.0557992  0.0669387  -0.8336  0.404514
## certificate_UK.framing_effectUN             -0.0122547  0.0783365  -0.1564  0.875689
## project_renewable.framing_effectconsequence -0.0089901  0.0848322  -0.1060  0.915602
## project_renewable.framing_effectMetOffice   -0.2140503  0.0712909  -3.0025  0.002678 **
## project_renewable.framing_effectUN          -0.0029457  0.0830442  -0.0355  0.971704
## project_landfill.framing_effectconsequence   0.0374578  0.0943182   0.3971  0.691262
## project_landfill.framing_effectMetOffice    -0.1635743  0.0809530  -2.0206  0.043320 *
## project_landfill.framing_effectUN           -0.0054386  0.0925247  -0.0588  0.953128
## project_manure.framing_effectconsequence     0.0362658  0.0835285   0.4342  0.664163
## project_manure.framing_effectMetOffice       0.0061140  0.0721796   0.0847  0.932495
## project_manure.framing_effectUN              0.0616927  0.0833197   0.7404  0.459037
## sd.location_EU                               0.9916569  0.0366558  27.0532 < 2.2e-16 ***
## sd.location_UK                               1.0560417  0.0355103  29.7390 < 2.2e-16 ***
## sd.certificate_NGO                           0.9533116  0.0373019  25.5567 < 2.2e-16 ***
## sd.certificate_UK                            0.9803464  0.0377394  25.9768 < 2.2e-16 ***
## sd.project_renewable                         1.0922665  0.0418023  26.1293 < 2.2e-16 ***
## sd.project_landfill                          0.8532267  0.0455488  18.7322 < 2.2e-16 ***
## sd.project_manure                            1.0120643  0.0398917  25.3703 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -19128
## Number of observations: 12760
## Number of iterations: 16
## Exit of MLE: successive function values within relative tolerance limit (reltol)
## Simulation based on 2000 draws
```

mixed logit + framing effect Willingness to Pay

```
##
## Willigness-to-pay respect to:  price
##
##                                              Estimate Std. Error  t-value  Pr(>|t|)
## I                                          -27.233632   2.100394 -12.9660 < 2.2e-16 ***
## location_EU                                  3.363504   1.045897   3.2159 0.0013003 **
## location_UK                                  8.486147   1.110347   7.6428 2.132e-14 ***
## certificate_NGO                              4.082111   1.004535   4.0637 4.830e-05 ***
## certificate_UK                              13.138094   1.311959  10.0141 < 2.2e-16 ***
## project_renewable                            7.539395   1.174778   6.4177 1.383e-10 ***
## project_landfill                            -6.074098   1.290732  -4.7059 2.527e-06 ***
## project_manure                              -3.658444   1.109756  -3.2966 0.0009786 ***
## location_EU.framing_effectconsequence       -3.312184   1.439199  -2.3014 0.0213686 *
## location_EU.framing_effectMetOffice         -4.005914   1.243499  -3.2215 0.0012753 **
## location_EU.framing_effectUN                -2.899627   1.415649  -2.0483 0.0405339 *
## location_UK.framing_effectconsequence       -3.262295   1.393650  -2.3408 0.0192410 *
## location_UK.framing_effectMetOffice         -2.342055   1.189668  -1.9687 0.0489919 *
## location_UK.framing_effectUN                -1.240296   1.366135  -0.9079 0.3639380
## certificate_NGO.framing_effectconsequence    0.098294   1.377653   0.0713 0.9431202
```

```
## certificate_NGO.framing_effectMetOffice      -1.053963   1.178975  -0.8940 0.3713404
## certificate_NGO.framing_effectUN              0.078306   1.361830   0.0575 0.9541463
## certificate_UK.framing_effectconsequence     -1.530454   1.436485  -1.0654 0.2866877
## certificate_UK.framing_effectMetOffice       -1.023272   1.228565  -0.8329 0.4049006
## certificate_UK.framing_effectUN              -0.224733   1.436566  -0.1564 0.8756883
## project_renewable.framing_effectconsequence  -0.164865   1.555681  -0.1060 0.9156015
## project_renewable.framing_effectMetOffice    -3.925358   1.321281  -2.9709 0.0029695 **
## project_renewable.framing_effectUN           -0.054019   1.522896  -0.0355 0.9717038
## project_landfill.framing_effectconsequence    0.686920   1.730509   0.3969 0.6914067
## project_landfill.framing_effectMetOffice     -2.999705   1.490494  -2.0126 0.0441612 *
## project_landfill.framing_effectUN            -0.099735   1.696752  -0.0588 0.9531274
## project_manure.framing_effectconsequence      0.665060   1.532756   0.4339 0.6643622
## project_manure.framing_effectMetOffice        0.112122   1.323711   0.0847 0.9324978
## project_manure.framing_effectUN               1.131350   1.529368   0.7398 0.4594515
## sd.location_EU                               18.185485   1.178945  15.4252 < 2.2e-16 ***
## sd.location_UK                               19.366203   1.206294  16.0543 < 2.2e-16 ***
## sd.certificate_NGO                           17.482289   1.136149  15.3873 < 2.2e-16 ***
## sd.certificate_UK                            17.978067   1.187793  15.1357 < 2.2e-16 ***
## sd.project_renewable                         20.030512   1.323758  15.1315 < 2.2e-16 ***
## sd.project_landfill                          15.646884   1.184011  13.2152 < 2.2e-16 ***
## sd.project_manure                            18.559725   1.224073  15.1623 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mixed logit + co2 consumption + framing effect

mixed logit + co2 consumption + framing effect Coefficients

```
##
## Model estimated on: Mon Oct 07 04:21:19 AM 2024
##
## Call:
## gmnl(formula = f, data = dt, model = "mixl", ranp = randpar,
##     R = 2000, haltons = NA, mvar = mvarlist_ctrl_ef, panel = T,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:11m:29s
##
## Coefficients:
##                                                Estimate  Std. Error  z-value  Pr(>|z|)
## I                                            -1.48342075  0.04742020 -31.2825 < 2.2e-16 ***
## price                                        -0.05444378  0.00265716 -20.4895 < 2.2e-16 ***
## location_EU                                   0.27096125  0.06440584   4.2071 2.587e-05 ***
## location_UK                                   0.62597031  0.06206529  10.0857 < 2.2e-16 ***
## certificate_NGO                               0.40590326  0.06104415   6.6493 2.944e-11 ***
## certificate_UK                                0.86540767  0.06655847  13.0022 < 2.2e-16 ***
## project_renewable                             0.51720395  0.06988312   7.4010 1.352e-13 ***
```

```
## project_landfill                              -0.32652869  0.07763382  -4.2060 2.599e-05 ***
## project_manure                                -0.13760197  0.06931582  -1.9851  0.047128 *
## location_EU.co2_value                         -0.05817123  0.01969407  -2.9537  0.003139 **
## location_EU.framing_effectconsequence         -0.17380139  0.07793679  -2.2300  0.025745 *
## location_EU.framing_effectMetOffice           -0.21679907  0.06686230  -3.2425  0.001185 **
## location_EU.framing_effectUN                  -0.15509103  0.07689329  -2.0170  0.043699 *
## location_UK.co2_value                         -0.10914014  0.01843639  -5.9198 3.223e-09 ***
## location_UK.framing_effectconsequence         -0.17258197  0.07561872  -2.2823  0.022474 *
## location_UK.framing_effectMetOffice           -0.12210422  0.06457887  -1.8908  0.058654 .
## location_UK.framing_effectUN                  -0.05700486  0.07439191  -0.7663  0.443511
## certificate_NGO.co2_value                     -0.11562304  0.01893290  -6.1070 1.015e-09 ***
## certificate_NGO.framing_effectconsequence      0.00415171  0.07510762   0.0553  0.955918
## certificate_NGO.framing_effectMetOffice       -0.05292553  0.06421762  -0.8242  0.409849
## certificate_NGO.framing_effectUN               0.00038918  0.07418675   0.0052  0.995814
## certificate_UK.co2_value                      -0.09727752  0.01963019  -4.9555 7.214e-07 ***
## certificate_UK.framing_effectconsequence      -0.07977620  0.07821613  -1.0199  0.307754
## certificate_UK.framing_effectMetOffice        -0.05209319  0.06696968  -0.7779  0.436650
## certificate_UK.framing_effectUN               -0.01142996  0.07829506  -0.1460  0.883933
## project_renewable.co2_value                   -0.06674746  0.02076018  -3.2152  0.001304 **
## project_renewable.framing_effectconsequence -0.01402175  0.08483109  -0.1653  0.868716
## project_renewable.framing_effectMetOffice     -0.21627556  0.07128935  -3.0338  0.002415 **
## project_renewable.framing_effectUN            -0.00893805  0.08297689  -0.1077  0.914220
## project_landfill.co2_value                    -0.00260460  0.02330356  -0.1118  0.911007
## project_landfill.framing_effectconsequence     0.03516618  0.09436451   0.3727  0.709399
## project_landfill.framing_effectMetOffice      -0.16360535  0.08097141  -2.0205  0.043328 *
## project_landfill.framing_effectUN             -0.00592276  0.09249619  -0.0640  0.948944
## project_manure.co2_value                      -0.04095976  0.02118996  -1.9330  0.053239 .
## project_manure.framing_effectconsequence       0.04300060  0.08360151   0.5144  0.607006
## project_manure.framing_effectMetOffice         0.01363501  0.07229196   0.1886  0.850398
## project_manure.framing_effectUN                0.07275393  0.08338167   0.8725  0.382913
## sd.location_EU                                 0.98687155  0.03666827  26.9135 < 2.2e-16 ***
## sd.location_UK                                 1.04526477  0.03550663  29.4386 < 2.2e-16 ***
## sd.certificate_NGO                             0.93948230  0.03720766  25.2497 < 2.2e-16 ***
## sd.certificate_UK                              0.97555051  0.03778346  25.8195 < 2.2e-16 ***
## sd.project_renewable                           1.08731461  0.04182832  25.9947 < 2.2e-16 ***
## sd.project_landfill                            0.85454267  0.04557075  18.7520 < 2.2e-16 ***
## sd.project_manure                              1.01391111  0.04004516  25.3192 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -19100
## Number of observations: 12760
## Number of iterations: 16
## Exit of MLE: successive function values within relative tolerance limit (reltol)
## Simulation based on 2000 draws
```

mixed logit + co2 consumption + framing effect Willingness to Pay

```
##
## Willigness-to-pay respect to:  price
##
##                                          Estimate  Std. Error  t-value  Pr(>|t|)
```

```
## I                                          -27.2468375   2.1055407 -12.9405 < 2.2e-16 ***
## location_EU                                  4.9769002   1.2021757   4.1399 3.474e-05 ***
## location_UK                                 11.4975547   1.3032321   8.8223 < 2.2e-16 ***
## certificate_NGO                              7.4554574   1.1944882   6.2415 4.333e-10 ***
## certificate_UK                              15.8954377   1.5257533  10.4181 < 2.2e-16 ***
## project_renewable                            9.4997808   1.3622350   6.9737 3.088e-12 ***
## project_landfill                            -5.9975393   1.4651182  -4.0936 4.248e-05 ***
## project_manure                              -2.5274141   1.2691064  -1.9915  0.046427 *
## location_EU.co2_value                       -1.0684642   0.3650763  -2.9267  0.003426 **
## location_EU.framing_effectconsequence       -3.1923095   1.4407479  -2.2157  0.026710 *
## location_EU.framing_effectMetOffice         -3.9820725   1.2456188  -3.1969  0.001389 **
## location_EU.framing_effectUN                -2.8486457   1.4183072  -2.0085  0.044592 *
## location_UK.co2_value                       -2.0046393   0.3538303  -5.6655 1.466e-08 ***
## location_UK.framing_effectconsequence       -3.1699118   1.3959835  -2.2707  0.023163 *
## location_UK.framing_effectMetOffice         -2.2427580   1.1913958  -1.8825  0.059773 .
## location_UK.framing_effectUN                -1.0470410   1.3669483  -0.7660  0.443694
## certificate_NGO.co2_value                   -2.1237145   0.3652698  -5.8141 6.096e-09 ***
## certificate_NGO.framing_effectconsequence    0.0762568   1.3795647   0.0553  0.955919
## certificate_NGO.framing_effectMetOffice     -0.9721135   1.1806135  -0.8234  0.410282
## certificate_NGO.framing_effectUN             0.0071483   1.3626348   0.0052  0.995814
## certificate_UK.co2_value                    -1.7867519   0.3732646  -4.7868 1.694e-06 ***
## certificate_UK.framing_effectconsequence    -1.4652952   1.4384814  -1.0186  0.308374
## certificate_UK.framing_effectMetOffice      -0.9568253   1.2308983  -0.7773  0.436959
## certificate_UK.framing_effectUN             -0.2099407   1.4380709  -0.1460  0.883931
## project_renewable.co2_value                 -1.2259887   0.3863975  -3.1729  0.001509 **
## project_renewable.framing_effectconsequence -0.2575454   1.5581309  -0.1653  0.868715
## project_renewable.framing_effectMetOffice   -3.9724569   1.3239246  -3.0005  0.002695 **
## project_renewable.framing_effectUN          -0.1641703   1.5240839  -0.1077  0.914220
## project_landfill.co2_value                  -0.0478402   0.4280280  -0.1118  0.911007
## project_landfill.framing_effectconsequence   0.6459173   1.7340536   0.3725  0.709528
## project_landfill.framing_effectMetOffice    -3.0050331   1.4932958  -2.0123  0.044183 *
## project_landfill.framing_effectUN           -0.1087867   1.6989163  -0.0640  0.948944
## project_manure.co2_value                    -0.7523313   0.3908042  -1.9251  0.054219 .
## project_manure.framing_effectconsequence     0.7898166   1.5368335   0.5139  0.607305
## project_manure.framing_effectMetOffice       0.2504421   1.3279712   0.1886  0.850414
## project_manure.framing_effectUN              1.3363131   1.5334790   0.8714  0.383522
## sd.location_EU                              18.1264342   1.1790382  15.3739 < 2.2e-16 ***
## sd.location_UK                              19.1989760   1.2019257  15.9735 < 2.2e-16 ***
## sd.certificate_NGO                          17.2560089   1.1276482  15.3027 < 2.2e-16 ***
## sd.certificate_UK                           17.9184944   1.1883939  15.0779 < 2.2e-16 ***
## sd.project_renewable                        19.9713295   1.3250501  15.0721 < 2.2e-16 ***
## sd.project_landfill                         15.6958741   1.1885285  13.2061 < 2.2e-16 ***
## sd.project_manure                           18.6230853   1.2307462  15.1315 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mixed logit + 1 PCA + reduced demographic controls

Here we included the first component for Q9 and Q10. Q9 was about respondents' attitude towards carbon offsetting, and Q10 was about respondents' attitude towards climate change.

mixed logit + 1 PCA + reduced demographic controls Coefficients

```
##
## Model estimated on: Mon Oct 07 04:21:19 AM 2024
##
## Call:
## gmnl(formula = f, data = dt, model = "mixl", ranp = randpar,
##     R = 2000, haltons = NA, mvar = mvarlist_p1rd, panel = T,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:13m:13s
##
## Coefficients:
##                                     Estimate Std. Error  z-value  Pr(>|z|)
## I                                -1.4711318  0.0470862 -31.2433 < 2.2e-16 ***
## price                            -0.0534216  0.0026242 -20.3576 < 2.2e-16 ***
## location_EU                      -0.0716676  0.0613853  -1.1675 0.2430066
## location_UK                       0.0682094  0.0597824   1.1410 0.2538864
## certificate_NGO                  -0.0447442  0.0605683  -0.7387 0.4600654
## certificate_UK                    0.4214421  0.0633364   6.6540 2.852e-11 ***
## project_renewable                 0.2335597  0.0665911   3.5074 0.0004526 ***
## project_landfill                 -0.5678528  0.0756911  -7.5022 6.284e-14 ***
## project_manure                   -0.3953378  0.0675444  -5.8530 4.828e-09 ***
## location_EU.Q9_PC1                0.1480736  0.0112566  13.1544 < 2.2e-16 ***
## location_EU.Q10_PC1               0.0163508  0.0085165   1.9199 0.0548701 .
## location_EU.age_group35_54        0.0672644  0.0573731   1.1724 0.2410351
## location_EU.age_group55_          0.1275764  0.0690481   1.8476 0.0646538 .
## location_EU.is_women             -0.0530282  0.0488310  -1.0860 0.2775002
## location_EU.income_level30_50k    0.0902792  0.0564558   1.5991 0.1097953
## location_EU.income_level50_       0.0606796  0.0597242   1.0160 0.3096302
## location_UK.Q9_PC1                0.1324837  0.0096710  13.6990 < 2.2e-16 ***
## location_UK.Q10_PC1               0.0505695  0.0083971   6.0223 1.720e-09 ***
## location_UK.age_group35_54        0.2758192  0.0556639   4.9551 7.230e-07 ***
## location_UK.age_group55_          0.4529337  0.0669721   6.7630 1.351e-11 ***
## location_UK.is_women             -0.0218456  0.0472297  -0.4625 0.6436944
## location_UK.income_level30_50k    0.0667817  0.0539580   1.2377 0.2158425
## location_UK.income_level50_       0.0329016  0.0587074   0.5604 0.5751835
## certificate_NGO.Q9_PC1            0.1778751  0.0096570  18.4192 < 2.2e-16 ***
## certificate_NGO.Q10_PC1           0.0117613  0.0085113   1.3818 0.1670183
## certificate_NGO.age_group35_54    0.1440032  0.0565811   2.5451 0.0109254 *
## certificate_NGO.age_group55_      0.1394675  0.0670220   2.0809 0.0374411 *
## certificate_NGO.is_women          0.0763620  0.0476177   1.6036 0.1087921
## certificate_NGO.income_level30_50k 0.2260231  0.0544364   4.1521 3.295e-05 ***
## certificate_NGO.income_level50_   0.0250550  0.0594743   0.4213 0.6735547
## certificate_UK.Q9_PC1             0.1740773  0.0113652  15.3166 < 2.2e-16 ***
## certificate_UK.Q10_PC1            0.0088780  0.0086809   1.0227 0.3064460
## certificate_UK.age_group35_54     0.1840347  0.0579621   3.1751 0.0014979 **
## certificate_UK.age_group55_       0.2507865  0.0702035   3.5723 0.0003539 ***
## certificate_UK.is_women           0.0830581  0.0495476   1.6763 0.0936737 .
```

```
## certificate_UK.income_level30_50k     0.1034993  0.0567570   1.8236 0.0682200 .
## certificate_UK.income_level50_        -0.0124741  0.0611482  -0.2040 0.8383555
## project_renewable.Q9_PC1               0.1644134  0.0109319  15.0398 < 2.2e-16 ***
## project_renewable.Q10_PC1              0.0126051  0.0092558   1.3619 0.1732427
## project_renewable.age_group35_54       0.0049313  0.0616525   0.0800 0.9362484
## project_renewable.age_group55_        -0.0323288  0.0748415  -0.4320 0.6657676
## project_renewable.is_women             0.0290841  0.0525242   0.5537 0.5797659
## project_renewable.income_level30_50k   0.1771882  0.0608107   2.9138 0.0035710 **
## project_renewable.income_level50_     -0.0016563  0.0647719  -0.0256 0.9795988
## project_landfill.Q9_PC1                0.1300392  0.0132899   9.7848 < 2.2e-16 ***
## project_landfill.Q10_PC1              -0.0362017  0.0106185  -3.4093 0.0006513 ***
## project_landfill.age_group35_54        0.0195956  0.0700768   0.2796 0.7797608
## project_landfill.age_group55_          0.1190224  0.0834389   1.4265 0.1537348
## project_landfill.is_women              0.0139578  0.0598250   0.2333 0.8155199
## project_landfill.income_level30_50k    0.3090963  0.0685859   4.5067 6.584e-06 ***
## project_landfill.income_level50_       0.1248785  0.0744890   1.6765 0.0936461 .
## project_manure.Q9_PC1                  0.1329198  0.0109925  12.0919 < 2.2e-16 ***
## project_manure.Q10_PC1                -0.0318445  0.0094800  -3.3591 0.0007820 ***
## project_manure.age_group35_54          0.2113001  0.0631510   3.3460 0.0008200 ***
## project_manure.age_group55_            0.3265078  0.0752158   4.3409 1.419e-05 ***
## project_manure.is_women                0.0158226  0.0531558   0.2977 0.7659585
## project_manure.income_level30_50k     -0.0192052  0.0608966  -0.3154 0.7524784
## project_manure.income_level50_         0.1417034  0.0663671   2.1351 0.0327493 *
## sd.location_EU                         0.8973768  0.0354098  25.3426 < 2.2e-16 ***
## sd.location_UK                         0.9583327  0.0348402  27.5065 < 2.2e-16 ***
## sd.certificate_NGO                     0.8304623  0.0368514  22.5354 < 2.2e-16 ***
## sd.certificate_UK                      0.8436596  0.0369979  22.8029 < 2.2e-16 ***
## sd.project_renewable                   0.9989764  0.0409759  24.3796 < 2.2e-16 ***
## sd.project_landfill                    0.7805923  0.0446009  17.5017 < 2.2e-16 ***
## sd.project_manure                      0.9581622  0.0390964  24.5077 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -18659
## Number of observations: 12760
## Number of iterations: 17
## Exit of MLE: successive function values within relative tolerance limit (reltol)
## Simulation based on 2000 draws
```

mixed logit + 1 PCA + reduced demographic controls Willingness to Pay

```
##
## Willigness-to-pay respect to:  price
##
##                                    Estimate Std. Error  t-value  Pr(>|t|)
## I                                -27.538148   2.135697 -12.8942 < 2.2e-16 ***
## location_EU                       -1.341548   1.152817  -1.1637 0.2445405
## location_UK                        1.276813   1.124188   1.1358 0.2560550
## certificate_NGO                   -0.837567   1.133494  -0.7389 0.4599524
## certificate_UK                     7.888984   1.283482   6.1465 7.919e-10 ***
## project_renewable                  4.372008   1.264865   3.4565 0.0005472 ***
## project_landfill                 -10.629649   1.529255  -6.9509 3.630e-12 ***
```

```
## project_manure                          -7.400337   1.288038  -5.7454 9.169e-09 ***
## location_EU.Q9_PC1                       2.771794   0.256416  10.8097 < 2.2e-16 ***
## location_EU.Q10_PC1                      0.306071   0.160310   1.9092 0.0562301 .
## location_EU.age_group35_54               1.259125   1.075472   1.1708 0.2416935
## location_EU.age_group55_                 2.388105   1.298144   1.8396 0.0658227 .
## location_EU.is_women                    -0.992635   0.915404  -1.0844 0.2782016
## location_EU.income_level30_50k           1.689939   1.060816   1.5931 0.1111479
## location_EU.income_level50_              1.135864   1.119577   1.0145 0.3103220
## location_UK.Q9_PC1                       2.479966   0.217113  11.4225 < 2.2e-16 ***
## location_UK.Q10_PC1                      0.946611   0.166111   5.6987 1.207e-08 ***
## location_UK.age_group35_54               5.163065   1.079247   4.7840 1.719e-06 ***
## location_UK.age_group55_                 8.478476   1.329811   6.3757 1.821e-10 ***
## location_UK.is_women                    -0.408928   0.884297  -0.4624 0.6437707
## location_UK.income_level30_50k           1.250087   1.011280   1.2361 0.2164050
## location_UK.income_level50_              0.615886   1.099221   0.5603 0.5752795
## certificate_NGO.Q9_PC1                   3.329648   0.247269  13.4657 < 2.2e-16 ***
## certificate_NGO.Q10_PC1                  0.220159   0.159800   1.3777 0.1682898
## certificate_NGO.age_group35_54           2.695599   1.069291   2.5209 0.0117048 *
## certificate_NGO.age_group55_             2.610695   1.262347   2.0681 0.0386280 *
## certificate_NGO.is_women                 1.429422   0.894336   1.5983 0.1099751
## certificate_NGO.income_level30_50k       4.230931   1.042585   4.0581 4.947e-05 ***
## certificate_NGO.income_level50_          0.469005   1.113284   0.4213 0.6735503
## certificate_UK.Q9_PC1                    3.258557   0.273821  11.9003 < 2.2e-16 ***
## certificate_UK.Q10_PC1                   0.166188   0.162893   1.0202 0.3076219
## certificate_UK.age_group35_54            3.444949   1.101134   3.1285 0.0017567 **
## certificate_UK.age_group55_              4.694477   1.340453   3.5022 0.0004615 ***
## certificate_UK.is_women                  1.554766   0.930781   1.6704 0.0948426 .
## certificate_UK.income_level30_50k        1.937405   1.067587   1.8148 0.0695619 .
## certificate_UK.income_level50_          -0.233503   1.144813  -0.2040 0.8383803
## project_renewable.Q9_PC1                 3.077657   0.261138  11.7855 < 2.2e-16 ***
## project_renewable.Q10_PC1                0.235955   0.173907   1.3568 0.1748483
## project_renewable.age_group35_54         0.092310   1.154068   0.0800 0.9362481
## project_renewable.age_group55_          -0.605164   1.401989  -0.4316 0.6659981
## project_renewable.is_women               0.544426   0.983483   0.5536 0.5798739
## project_renewable.income_level30_50k     3.316790   1.148304   2.8884 0.0038718 **
## project_renewable.income_level50_       -0.031005   1.212483  -0.0256 0.9795991
## project_landfill.Q9_PC1                  2.434207   0.279716   8.7024 < 2.2e-16 ***
## project_landfill.Q10_PC1                -0.677660   0.202316  -3.3495 0.0008095 ***
## project_landfill.age_group35_54          0.366811   1.311893   0.2796 0.7797810
## project_landfill.age_group55_            2.227984   1.566035   1.4227 0.1548258
## project_landfill.is_women                0.261277   1.119968   0.2333 0.8155363
## project_landfill.income_level30_50k      5.785981   1.321332   4.3789 1.193e-05 ***
## project_landfill.income_level50_         2.337604   1.399864   1.6699 0.0949433 .
## project_manure.Q9_PC1                    2.488129   0.240874  10.3296 < 2.2e-16 ***
## project_manure.Q10_PC1                  -0.596097   0.180451  -3.3034 0.0009553 ***
## project_manure.age_group35_54            3.955331   1.200588   3.2945 0.0009860 ***
## project_manure.age_group55_              6.111907   1.439743   4.2451 2.185e-05 ***
## project_manure.is_women                  0.296184   0.995227   0.2976 0.7660048
## project_manure.income_level30_50k       -0.359502   1.140010  -0.3153 0.7524962
## project_manure.income_level50_           2.652549   1.250398   2.1214 0.0338912 *
## sd.location_EU                          16.798015   1.126126  14.9166 < 2.2e-16 ***
## sd.location_UK                          17.939051   1.155221  15.5287 < 2.2e-16 ***
## sd.certificate_NGO                      15.545442   1.071100  14.5135 < 2.2e-16 ***
## sd.certificate_UK                       15.792481   1.111124  14.2131 < 2.2e-16 ***
```

```
## sd.project_renewable                  18.699860   1.281550  14.5916 < 2.2e-16 ***
## sd.project_landfill                   14.611924   1.153759  12.6646 < 2.2e-16 ***
## sd.project_manure                     17.935858   1.208255  14.8444 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mixed logit + 1 PCA + full demographic controls

mixed logit + 1 PCA + full demographic controls Coefficients

```
##
## Model estimated on: Mon Oct 07 04:21:19 AM 2024
##
## Call:
## gmnl(formula = f, data = dt, model = "mixl", ranp = randpar,
##     R = 2000, haltons = NA, mvar = mvarlist_p1d, panel = T, method = "bhhh",
##     iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:14m:58s
##
## Coefficients:
##                                            Estimate Std. Error  z-value  Pr(>|z|)
## I                                         -1.4727833  0.0471786 -31.2172 < 2.2e-16 ***
## price                                     -0.0534836  0.0026282 -20.3496 < 2.2e-16 ***
## location_EU                               -0.1688291  0.0738343  -2.2866 0.0222195 *
## location_UK                               -0.0846037  0.0733067  -1.1541 0.2484564
## certificate_NGO                           -0.1540683  0.0737501  -2.0891 0.0367025 *
## certificate_UK                             0.3237267  0.0765803   4.2273 2.365e-05 ***
## project_renewable                          0.0314535  0.0820255   0.3835 0.7013784
## project_landfill                          -0.6170930  0.0932228  -6.6195 3.603e-11 ***
## project_manure                            -0.5298389  0.0816746  -6.4872 8.745e-11 ***
## location_EU.Q9_PC1                         0.1473564  0.0113086  13.0304 < 2.2e-16 ***
## location_EU.Q10_PC1                        0.0198155  0.0088795   2.2316 0.0256409 *
## location_EU.age_group35_54                 0.0489675  0.0585837   0.8359 0.4032359
## location_EU.age_group55_                   0.0984165  0.0723708   1.3599 0.1738642
## location_EU.is_women                      -0.0686057  0.0493867  -1.3892 0.1647862
## location_EU.diet_typeFlexitarian           0.0542922  0.0655004   0.8289 0.4071710
## location_EU.diet_typeVegan_Vegetarian      0.0730181  0.0895442   0.8154 0.4148192
## location_EU.education_levelDegree          0.1235515  0.0564093   2.1903 0.0285047 *
## location_EU.education_levelPostgraduate    0.2010328  0.0732221   2.7455 0.0060415 **
## location_EU.income_level30_50k             0.0564943  0.0572416   0.9869 0.3236696
## location_EU.income_level50_                0.0108059  0.0626164   0.1726 0.8629873
## location_EU.where_liveRuralarea            0.1496577  0.0812051   1.8430 0.0653349 .
## location_EU.where_liveTownorsuburb         0.0599403  0.0593090   1.0106 0.3121863
## location_UK.Q9_PC1                         0.1317376  0.0097356  13.5315 < 2.2e-16 ***
## location_UK.Q10_PC1                        0.0505439  0.0087253   5.7928 6.922e-09 ***
## location_UK.age_group35_54                 0.2448521  0.0566583   4.3216 1.549e-05 ***
```

```
## location_UK.age_group55_                          0.3891973  0.0699554   5.5635 2.644e-08 ***
## location_UK.is_women                              -0.0437331  0.0478971  -0.9131 0.3612100
## location_UK.diet_typeFlexitarian                   0.1159443  0.0639415   1.8133 0.0697872 .
## location_UK.diet_typeVegan_Vegetarian             -0.0080852  0.0838060  -0.0965 0.9231427
## location_UK.education_levelDegree                  0.1232595  0.0542371   2.2726 0.0230501 *
## location_UK.education_levelPostgraduate            0.1668650  0.0675815   2.4691 0.0135456 *
## location_UK.income_level30_50k                     0.0363111  0.0545483   0.6657 0.5056227
## location_UK.income_level50_                       -0.0091580  0.0608328  -0.1505 0.8803362
## location_UK.where_liveRuralarea                    0.2999273  0.0784888   3.8213 0.0001328 ***
## location_UK.where_liveTownorsuburb                 0.1313594  0.0572444   2.2947 0.0217497 *
## certificate_NGO.Q9_PC1                             0.1759651  0.0097111  18.1200 < 2.2e-16 ***
## certificate_NGO.Q10_PC1                            0.0179079  0.0088897   2.0145 0.0439623 *
## certificate_NGO.age_group35_54                     0.1249974  0.0574054   2.1774 0.0294471 *
## certificate_NGO.age_group55_                       0.1126851  0.0697883   1.6147 0.1063819
## certificate_NGO.is_women                           0.0490792  0.0483892   1.0143 0.3104598
## certificate_NGO.diet_typeFlexitarian               0.1061031  0.0644431   1.6465 0.0996684 .
## certificate_NGO.diet_typeVegan_Vegetarian          0.1177743  0.0866399   1.3594 0.1740344
## certificate_NGO.education_levelDegree              0.1997779  0.0548070   3.6451 0.0002673 ***
## certificate_NGO.education_levelPostgraduate        0.2470841  0.0684824   3.6080 0.0003086 ***
## certificate_NGO.income_level30_50k                 0.1838475  0.0552257   3.3290 0.0008715 ***
## certificate_NGO.income_level50_                   -0.0464867  0.0620331  -0.7494 0.4536246
## certificate_NGO.where_liveRuralarea                0.1765168  0.0791527   2.2301 0.0257422 *
## certificate_NGO.where_liveTownorsuburb             0.0133789  0.0580130   0.2306 0.8176110
## certificate_UK.Q9_PC1                              0.1746352  0.0114407  15.2644 < 2.2e-16 ***
## certificate_UK.Q10_PC1                             0.0106815  0.0089962   1.1873 0.2350950
## certificate_UK.age_group35_54                      0.1639817  0.0590385   2.7775 0.0054772 **
## certificate_UK.age_group55_                        0.2316467  0.0734444   3.1540 0.0016103 **
## certificate_UK.is_women                            0.0693809  0.0502813   1.3799 0.1676317
## certificate_UK.diet_typeFlexitarian                0.0067585  0.0675281   0.1001 0.9202779
## certificate_UK.diet_typeVegan_Vegetarian           0.1154501  0.0861797   1.3396 0.1803611
## certificate_UK.education_levelDegree              0.0875038  0.0573130   1.5268 0.1268179
## certificate_UK.education_levelPostgraduate         0.1699388  0.0740988   2.2934 0.0218246 *
## certificate_UK.income_level30_50k                  0.0833300  0.0576535   1.4454 0.1483569
## certificate_UK.income_level50_                    -0.0451192  0.0638468  -0.7067 0.4797664
## certificate_UK.where_liveRuralarea                 0.0772370  0.0822696   0.9388 0.3478194
## certificate_UK.where_liveTownorsuburb              0.0908993  0.0598019   1.5200 0.1285090
## project_renewable.Q9_PC1                           0.1637452  0.0110257  14.8512 < 2.2e-16 ***
## project_renewable.Q10_PC1                          0.0070980  0.0096599   0.7348 0.4624664
## project_renewable.age_group35_54                  -0.0213323  0.0625706  -0.3409 0.7331552
## project_renewable.age_group55_                    -0.0945701  0.0776768  -1.2175 0.2234206
## project_renewable.is_women                         0.0168489  0.0534887   0.3150 0.7527623
## project_renewable.diet_typeFlexitarian             0.1633424  0.0711798   2.2948 0.0217454 *
## project_renewable.diet_typeVegan_Vegetarian       -0.1837924  0.0933406  -1.9691 0.0489473 *
## project_renewable.education_levelDegree            0.0863554  0.0604687   1.4281 0.1532630
## project_renewable.education_levelPostgraduate      0.1532887  0.0771055   1.9880 0.0468074 *
## project_renewable.income_level30_50k               0.1544283  0.0615394   2.5094 0.0120929 *
## project_renewable.income_level50_                 -0.0290229  0.0672972  -0.4313 0.6662766
## project_renewable.where_liveRuralarea              0.2752755  0.0863368   3.1884 0.0014307 **
## project_renewable.where_liveTownorsuburb           0.2374112  0.0643063   3.6919 0.0002226 ***
## project_landfill.Q9_PC1                            0.1296153  0.0133415   9.7152 < 2.2e-16 ***
## project_landfill.Q10_PC1                          -0.0359450  0.0111403  -3.2266 0.0012529 **
## project_landfill.age_group35_54                    0.0047166  0.0711777   0.0663 0.9471663
## project_landfill.age_group55_                      0.0987194  0.0871582   1.1326 0.2573628
## project_landfill.is_women                          0.0092124  0.0608415   0.1514 0.8796474
```

```
## project_landfill.diet_typeFlexitarian          0.0319855  0.0817057   0.3915 0.6954484
## project_landfill.diet_typeVegan_Vegetarian    -0.0524271  0.1056151  -0.4964 0.6196136
## project_landfill.education_levelDegree         0.0058718  0.0689052   0.0852 0.9320897
## project_landfill.education_levelPostgraduate   0.1938577  0.0865534   2.2397 0.0251074 *
## project_landfill.income_level30_50k            0.2986102  0.0695270   4.2949 1.748e-05 ***
## project_landfill.income_level50_               0.0921466  0.0775597   1.1881 0.2348048
## project_landfill.where_liveRuralarea           0.0910904  0.0987649   0.9223 0.3563743
## project_landfill.where_liveTownorsuburb        0.0458569  0.0733798   0.6249 0.5320197
## project_manure.Q9_PC1                          0.1311105  0.0110271  11.8898 < 2.2e-16 ***
## project_manure.Q10_PC1                        -0.0340950  0.0098260  -3.4699 0.0005207 ***
## project_manure.age_group35_54                  0.1886532  0.0642723   2.9352 0.0033331 **
## project_manure.age_group55_                    0.2987246  0.0785930   3.8009 0.0001442 ***
## project_manure.is_women                        0.0024668  0.0538960   0.0458 0.9634934
## project_manure.diet_typeFlexitarian            0.0745241  0.0732118   1.0179 0.3087137
## project_manure.diet_typeVegan_Vegetarian       0.0909872  0.0963097   0.9447 0.3447938
## project_manure.education_levelDegree           0.0535371  0.0611998   0.8748 0.3816873
## project_manure.education_levelPostgraduate    -0.0149761  0.0792165  -0.1891 0.8500511
## project_manure.income_level30_50k             -0.0170076  0.0619410  -0.2746 0.7836403
## project_manure.income_level50_                 0.1549584  0.0693506   2.2344 0.0254556 *
## project_manure.where_liveRuralarea             0.0889589  0.0887224   1.0027 0.3160225
## project_manure.where_liveTownorsuburb          0.1758487  0.0649595   2.7071 0.0067884 **
## sd.location_EU                                 0.8943937  0.0354462  25.2324 < 2.2e-16 ***
## sd.location_UK                                 0.9493549  0.0349262  27.1817 < 2.2e-16 ***
## sd.certificate_NGO                             0.8229090  0.0370178  22.2301 < 2.2e-16 ***
## sd.certificate_UK                              0.8432134  0.0371726  22.6837 < 2.2e-16 ***
## sd.project_renewable                           0.9959131  0.0413398  24.0909 < 2.2e-16 ***
## sd.project_landfill                            0.7810325  0.0446577  17.4893 < 2.2e-16 ***
## sd.project_manure                              0.9582536  0.0392109  24.4385 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -18626
## Number of observations: 12760
## Number of iterations: 18
## Exit of MLE: successive function values within relative tolerance limit (reltol)
## Simulation based on 2000 draws
```

mixed logit + 1 PCA + full demographic controls Willingness to Pay

```
##
## Willigness-to-pay respect to:  price
##
##                                          Estimate Std. Error  t-value  Pr(>|t|)
## I                                      -27.537081   2.136764 -12.8873 < 2.2e-16 ***
## location_EU                             -3.156649   1.394635  -2.2634 0.0236096 *
## location_UK                             -1.581862   1.370098  -1.1546 0.2482702
## certificate_NGO                         -2.880662   1.383737  -2.0818 0.0373609 *
## certificate_UK                           6.052818   1.483799   4.0793 4.518e-05 ***
## project_renewable                        0.588097   1.533520   0.3835 0.7013531
## project_landfill                       -11.537978   1.850089  -6.2364 4.476e-10 ***
## project_manure                          -9.906561   1.574183  -6.2931 3.111e-10 ***
## location_EU.Q9_PC1                       2.755167   0.256598  10.7373 < 2.2e-16 ***
```

```
## location_EU.Q10_PC1                              0.370497   0.167262   2.2151 0.0267553 *
## location_EU.age_group35_54                       0.915561   1.095929   0.8354 0.4034811
## location_EU.age_group55_                         1.840123   1.355833   1.3572 0.1747210
## location_EU.is_women                            -1.282742   0.925806  -1.3855 0.1658874
## location_EU.diet_typeFlexitarian                 1.015117   1.226704   0.8275 0.4079448
## location_EU.diet_typeVegan_Vegetarian            1.365242   1.674834   0.8152 0.4149859
## location_EU.education_levelDegree                2.310080   1.062898   2.1734 0.0297518 *
## location_EU.education_levelPostgraduate          3.758772   1.385647   2.7126 0.0066748 **
## location_EU.income_level30_50k                   1.056291   1.071792   0.9855 0.3243602
## location_EU.income_level50_                      0.202041   1.170741   0.1726 0.8629855
## location_EU.where_liveRuralarea                  2.798196   1.527369   1.8320 0.0669459 .
## location_EU.where_liveTownorsuburb               1.120722   1.110930   1.0088 0.3130637
## location_UK.Q9_PC1                               2.463138   0.217485  11.3256 < 2.2e-16 ***
## location_UK.Q10_PC1                              0.945035   0.171738   5.5028 3.739e-08 ***
## location_UK.age_group35_54                       4.578076   1.088042   4.2076 2.581e-05 ***
## location_UK.age_group55_                         7.276942   1.361464   5.3449 9.045e-08 ***
## location_UK.is_women                            -0.817690   0.896435  -0.9122 0.3616858
## location_UK.diet_typeFlexitarian                 2.167847   1.201152   1.8048 0.0711050 .
## location_UK.diet_typeVegan_Vegetarian           -0.151172   1.567094  -0.0965 0.9231499
## location_UK.education_levelDegree                2.304621   1.021799   2.2555 0.0241048 *
## location_UK.education_levelPostgraduate          3.119926   1.273302   2.4503 0.0142752 *
## location_UK.income_level30_50k                   0.678920   1.020072   0.6656 0.5056917
## location_UK.income_level50_                     -0.171229   1.137482  -0.1505 0.8803438
## location_UK.where_liveRuralarea                  5.607832   1.498114   3.7433 0.0001816 ***
## location_UK.where_liveTownorsuburb               2.456067   1.078760   2.2767 0.0228012 *
## certificate_NGO.Q9_PC1                           3.290074   0.246775  13.3323 < 2.2e-16 ***
## certificate_NGO.Q10_PC1                          0.334830   0.167286   2.0015 0.0453346 *
## certificate_NGO.age_group35_54                   2.337115   1.080988   2.1620 0.0306168 *
## certificate_NGO.age_group55_                     2.106908   1.309706   1.6087 0.1076847
## certificate_NGO.is_women                         0.917648   0.905843   1.0130 0.3110446
## certificate_NGO.diet_typeFlexitarian             1.983843   1.211010   1.6382 0.1013856
## certificate_NGO.diet_typeVegan_Vegetarian        2.202063   1.623586   1.3563 0.1750051
## certificate_NGO.education_levelDegree            3.735308   1.042189   3.5841 0.0003382 ***
## certificate_NGO.education_levelPostgraduate      4.619808   1.304402   3.5417 0.0003975 ***
## certificate_NGO.income_level30_50k               3.437454   1.048018   3.2800 0.0010382 **
## certificate_NGO.income_level50_                 -0.869176   1.161316  -0.7484 0.4541945
## certificate_NGO.where_liveRuralarea              3.300390   1.489028   2.2165 0.0266592 *
## certificate_NGO.where_liveTownorsuburb           0.250149   1.084735   0.2306 0.8176189
## certificate_UK.Q9_PC1                            3.265209   0.275241  11.8631 < 2.2e-16 ***
## certificate_UK.Q10_PC1                           0.199715   0.168713   1.1838 0.2365099
## certificate_UK.age_group35_54                    3.066017   1.116236   2.7467 0.0060190 **
## certificate_UK.age_group55_                      4.331169   1.394815   3.1052 0.0019015 **
## certificate_UK.is_women                          1.297235   0.942214   1.3768 0.1685759
## certificate_UK.diet_typeFlexitarian              0.126365   1.262648   0.1001 0.9202812
## certificate_UK.diet_typeVegan_Vegetarian         2.158606   1.617224   1.3348 0.1819549
## certificate_UK.education_levelDegree            1.636086   1.075053   1.5219 0.1280428
## certificate_UK.education_levelPostgraduate       3.177397   1.395726   2.2765 0.0228149 *
## certificate_UK.income_level30_50k                1.558047   1.081202   1.4410 0.1495755
## certificate_UK.income_level50_                  -0.843607   1.194982  -0.7060 0.4802145
## certificate_UK.where_liveRuralarea               1.444124   1.539997   0.9377 0.3483758
## certificate_UK.where_liveTownorsuburb            1.699572   1.122301   1.5144 0.1299336
## project_renewable.Q9_PC1                         3.061595   0.261637  11.7017 < 2.2e-16 ***
## project_renewable.Q10_PC1                        0.132713   0.180857   0.7338 0.4630683
## project_renewable.age_group35_54                -0.398856   1.170196  -0.3408 0.7332197
```

```
## project_renewable.age_group55_                  -1.768207   1.457307  -1.2133 0.2250003
## project_renewable.is_women                       0.315029   1.000114   0.3150 0.7527669
## project_renewable.diet_typeFlexitarian           3.054064   1.341283   2.2770 0.0227879 *
## project_renewable.diet_typeVegan_Vegetarian     -3.436423   1.753402  -1.9599 0.0500121 .
## project_renewable.education_levelDegree          1.614613   1.134786   1.4228 0.1547839
## project_renewable.education_levelPostgraduate    2.866087   1.447569   1.9799 0.0477113 *
## project_renewable.income_level30_50k             2.887394   1.157685   2.4941 0.0126273 *
## project_renewable.income_level50_               -0.542649   1.258767  -0.4311 0.6663986
## project_renewable.where_liveRuralarea            5.146911   1.638967   3.1403 0.0016875 **
## project_renewable.where_liveTownorsuburb         4.438950   1.226255   3.6199 0.0002947 ***
## project_landfill.Q9_PC1                          2.423456   0.280254   8.6474 < 2.2e-16 ***
## project_landfill.Q10_PC1                        -0.672075   0.211727  -3.1743 0.0015022 **
## project_landfill.age_group35_54                  0.088188   1.330845   0.0663 0.9471669
## project_landfill.age_group55_                    1.845788   1.632648   1.1305 0.2582451
## project_landfill.is_women                        0.172247   1.137627   0.1514 0.8796532
## project_landfill.diet_typeFlexitarian            0.598042   1.527777   0.3914 0.6954676
## project_landfill.diet_typeVegan_Vegetarian      -0.980246   1.975035  -0.4963 0.6196699
## project_landfill.education_levelDegree           0.109787   1.288312   0.0852 0.9320882
## project_landfill.education_levelPostgraduate     3.624618   1.628295   2.2260 0.0260128 *
## project_landfill.income_level30_50k              5.583207   1.334876   4.1826 2.882e-05 ***
## project_landfill.income_level50_                 1.722893   1.453497   1.1853 0.2358817
## project_landfill.where_liveRuralarea             1.703146   1.847797   0.9217 0.3566762
## project_landfill.where_liveTownorsuburb          0.857401   1.372717   0.6246 0.5322326
## project_manure.Q9_PC1                            2.451413   0.240261  10.2031 < 2.2e-16 ***
## project_manure.Q10_PC1                          -0.637484   0.187084  -3.4075 0.0006557 ***
## project_manure.age_group35_54                    3.527308   1.216780   2.8989 0.0037449 **
## project_manure.age_group55_                      5.585347   1.495799   3.7340 0.0001884 ***
## project_manure.is_women                          0.046123   1.007733   0.0458 0.9634942
## project_manure.diet_typeFlexitarian              1.393400   1.369449   1.0175 0.3089207
## project_manure.diet_typeVegan_Vegetarian         1.701216   1.802128   0.9440 0.3451676
## project_manure.education_levelDegree             1.000999   1.145274   0.8740 0.3821039
## project_manure.education_levelPostgraduate      -0.280013   1.481217  -0.1890 0.8500592
## project_manure.income_level30_50k               -0.317997   1.158176  -0.2746 0.7836487
## project_manure.income_level50_                   2.897304   1.306276   2.2180 0.0265556 *
## project_manure.where_liveRuralarea               1.663291   1.660446   1.0017 0.3164820
## project_manure.where_liveTownorsuburb            3.287897   1.226833   2.6800 0.0073625 **
## sd.location_EU                                  16.722753   1.122716  14.8949 < 2.2e-16 ***
## sd.location_UK                                  17.750381   1.148078  15.4610 < 2.2e-16 ***
## sd.certificate_NGO                              15.386182   1.066759  14.4233 < 2.2e-16 ***
## sd.certificate_UK                               15.765820   1.112889  14.1666 < 2.2e-16 ***
## sd.project_renewable                            18.620894   1.282344  14.5210 < 2.2e-16 ***
## sd.project_landfill                             14.603205   1.153770  12.6570 < 2.2e-16 ***
## sd.project_manure                               17.916762   1.208898  14.8207 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

mixed logit + co2 consumption + framing effect + 2 PCA

We included the first two coponents for Q9 and Q10. Q9 was about respondents' attitude towards carbon offsetting, and Q10 was about respondents' attitude towards climate change.

mixed logit + co2 consumption + framing effect + PCA Coefficients

```
##
## Model estimated on: Mon Oct 07 04:21:22 AM 2024
##
## Call:
## gmnl(formula = f, data = dt, model = "mixl", ranp = randpar,
##     R = 2000, haltons = NA, mvar = mvarlist_efp2, panel = T,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:12m:41s
##
## Coefficients:
##                                                Estimate  Std. Error  z-value  Pr(>|z|)
## I                                           -1.47026893  0.04710388 -31.2133 < 2.2e-16 ***
## price                                       -0.05330761  0.00262404 -20.3151 < 2.2e-16 ***
## location_EU                                  0.18282667  0.06308018   2.8983 0.0037517 **
## location_UK                                  0.51058058  0.06046379   8.4444 < 2.2e-16 ***
## certificate_NGO                              0.34060404  0.05977900   5.6977 1.214e-08 ***
## certificate_UK                               0.78764548  0.06486768  12.1423 < 2.2e-16 ***
## project_renewable                            0.44341837  0.06801322   6.5196 7.050e-11 ***
## project_landfill                            -0.31562954  0.07654430  -4.1235 3.732e-05 ***
## project_manure                              -0.15798678  0.06842806  -2.3088 0.0209546 *
## location_EU.co2_value                       -0.02796770  0.01963489  -1.4244 0.1543342
## location_EU.framing_effectconsequence       -0.15510579  0.07683989  -2.0186 0.0435332 *
## location_EU.framing_effectMetOffice         -0.18505632  0.06553088  -2.8240 0.0047435 **
## location_EU.framing_effectUN                -0.15126992  0.07558761  -2.0013 0.0453651 *
## location_EU.Q9_PC1                           0.14335968  0.01161698  12.3405 < 2.2e-16 ***
## location_EU.Q9_PC2                           0.01077460  0.01330820   0.8096 0.4181578
## location_EU.Q10_PC1                          0.01744954  0.00803994   2.1704 0.0299798 *
## location_EU.Q10_PC2                         -0.02402029  0.02754465  -0.8720 0.3831814
## location_UK.co2_value                       -0.06851555  0.01833944  -3.7360 0.0001870 ***
## location_UK.framing_effectconsequence       -0.18084067  0.07393196  -2.4460 0.0144434 *
## location_UK.framing_effectMetOffice         -0.06763793  0.06300574  -1.0735 0.2830378
## location_UK.framing_effectUN                -0.07001446  0.07294355  -0.9598 0.3371335
## location_UK.Q9_PC1                           0.12095150  0.00994165  12.1661 < 2.2e-16 ***
## location_UK.Q9_PC2                           0.03224580  0.01248039   2.5837 0.0097742 **
## location_UK.Q10_PC1                          0.06476559  0.00791481   8.1828 2.220e-16 ***
## location_UK.Q10_PC2                         -0.02782876  0.02700235  -1.0306 0.3027261
## certificate_NGO.co2_value                   -0.08220766  0.01879864  -4.3731 1.225e-05 ***
## certificate_NGO.framing_effectconsequence   -0.03539828  0.07363322  -0.4807 0.6307027
## certificate_NGO.framing_effectMetOffice     -0.05219881  0.06263252  -0.8334 0.4046113
## certificate_NGO.framing_effectUN            -0.05901687  0.07274143  -0.8113 0.4171796
## certificate_NGO.Q9_PC1                       0.16602530  0.00990059  16.7692 < 2.2e-16 ***
## certificate_NGO.Q9_PC2                       0.04915647  0.01266824   3.8803 0.0001043 ***
## certificate_NGO.Q10_PC1                      0.00699579  0.00795140   0.8798 0.3789580
## certificate_NGO.Q10_PC2                     -0.08155623  0.02770034  -2.9442 0.0032376 **
## certificate_UK.co2_value                    -0.06361963  0.01969105  -3.2309 0.0012341 **
## certificate_UK.framing_effectconsequence    -0.10930028  0.07689856  -1.4214 0.1552131
```

```
## certificate_UK.framing_effectMetOffice      -0.02719546  0.06552118  -0.4151 0.6780953
## certificate_UK.framing_effectUN             -0.06767551  0.07674313  -0.8818 0.3778609
## certificate_UK.Q9_PC1                        0.16535170  0.01169977  14.1329 < 2.2e-16 ***
## certificate_UK.Q9_PC2                        0.04873628  0.01352402   3.6037 0.0003137 ***
## certificate_UK.Q10_PC1                       0.01174857  0.00816681   1.4386 0.1502711
## certificate_UK.Q10_PC2                      -0.04333585  0.02809553  -1.5424 0.1229652
## project_renewable.co2_value                 -0.03588449  0.02072241  -1.7317 0.0833314 .
## project_renewable.framing_effectconsequence -0.02527322  0.08299680  -0.3045 0.7607406
## project_renewable.framing_effectMetOffice   -0.19577489  0.06960092  -2.8128 0.0049109 **
## project_renewable.framing_effectUN          -0.06470120  0.08115502  -0.7973 0.4253033
## project_renewable.Q9_PC1                     0.15475482  0.01124535  13.7617 < 2.2e-16 ***
## project_renewable.Q9_PC2                     0.04210708  0.01403949   2.9992 0.0027070 **
## project_renewable.Q10_PC1                    0.00225653  0.00868780   0.2597 0.7950679
## project_renewable.Q10_PC2                   -0.11151279  0.03076743  -3.6244 0.0002897 ***
## project_landfill.co2_value                   0.00838006  0.02356438   0.3556 0.7221223
## project_landfill.framing_effectconsequence  -0.01331815  0.09311875  -0.1430 0.8862718
## project_landfill.framing_effectMetOffice    -0.17762941  0.07957091  -2.2323 0.0255924 *
## project_landfill.framing_effectUN           -0.07160144  0.09113310  -0.7857 0.4320551
## project_landfill.Q9_PC1                      0.12716720  0.01371040   9.2752 < 2.2e-16 ***
## project_landfill.Q9_PC2                      0.02149214  0.01614772   1.3310 0.1831986
## project_landfill.Q10_PC1                    -0.03255943  0.01000728  -3.2536 0.0011396 **
## project_landfill.Q10_PC2                     0.02634585  0.03395836   0.7758 0.4378506
## project_manure.co2_value                    -0.01701421  0.02113548  -0.8050 0.4208156
## project_manure.framing_effectconsequence     0.00237170  0.08295967   0.0286 0.9771927
## project_manure.framing_effectMetOffice       0.00076716  0.07124809   0.0108 0.9914090
## project_manure.framing_effectUN              0.01433529  0.08237748   0.1740 0.8618501
## project_manure.Q9_PC1                        0.12142771  0.01125334  10.7904 < 2.2e-16 ***
## project_manure.Q9_PC2                        0.04088936  0.01474357   2.7734 0.0055479 **
## project_manure.Q10_PC1                      -0.02272610  0.00893241  -2.5442 0.0109519 *
## project_manure.Q10_PC2                       0.00906077  0.03033887   0.2987 0.7652053
## sd.location_EU                               0.89410009  0.03535782  25.2872 < 2.2e-16 ***
## sd.location_UK                               0.95459877  0.03469485  27.5141 < 2.2e-16 ***
## sd.certificate_NGO                           0.82379472  0.03681294  22.3779 < 2.2e-16 ***
## sd.certificate_UK                            0.83651019  0.03678613  22.7398 < 2.2e-16 ***
## sd.project_renewable                         0.98556679  0.04106756  23.9987 < 2.2e-16 ***
## sd.project_landfill                          0.78778034  0.04456832  17.6758 < 2.2e-16 ***
## sd.project_manure                            0.96377361  0.03904801  24.6818 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -18662
## Number of observations: 12760
## Number of iterations: 17
## Exit of MLE: successive function values within relative tolerance limit (reltol)
## Simulation based on 2000 draws
```

mixed logit + co2 consumption + framing effect + PCA Willingness to Pay

```
##
## Willigness-to-pay respect to:  price
##
##                                          Estimate Std. Error  t-value  Pr(>|t|)
```

```
## I                                          -27.580846   2.142034 -12.8760 < 2.2e-16 ***
## location_EU                                  3.429654   1.191303   2.8789 0.0039905 **
## location_UK                                  9.578006   1.256983   7.6198 2.531e-14 ***
## certificate_NGO                              6.389408   1.177629   5.4257 5.774e-08 ***
## certificate_UK                              14.775480   1.491935   9.9036 < 2.2e-16 ***
## project_renewable                            8.318107   1.333530   6.2377 4.442e-10 ***
## project_landfill                            -5.920910   1.474451  -4.0157 5.928e-05 ***
## project_manure                              -2.963682   1.280566  -2.3144 0.0206484 *
## location_EU.co2_value                       -0.524647   0.368991  -1.4218 0.1550718
## location_EU.framing_effectconsequence       -2.909637   1.449666  -2.0071 0.0447381 *
## location_EU.framing_effectMetOffice         -3.471480   1.243126  -2.7925 0.0052296 **
## location_EU.framing_effectUN                -2.837680   1.424070  -1.9927 0.0462992 *
## location_EU.Q9_PC1                           2.689291   0.259727  10.3543 < 2.2e-16 ***
## location_EU.Q9_PC2                           0.202121   0.249952   0.8086 0.4187216
## location_EU.Q10_PC1                          0.327337   0.151852   2.1556 0.0311129 *
## location_EU.Q10_PC2                         -0.450598   0.517448  -0.8708 0.3838588
## location_UK.co2_value                       -1.285287   0.350177  -3.6704 0.0002422 ***
## location_UK.framing_effectconsequence       -3.392399   1.395431  -2.4311 0.0150541 *
## location_UK.framing_effectMetOffice         -1.268823   1.183628  -1.0720 0.2837298
## location_UK.framing_effectUN                -1.313405   1.369500  -0.9590 0.3375387
## location_UK.Q9_PC1                           2.268935   0.216359  10.4869 < 2.2e-16 ***
## location_UK.Q9_PC2                           0.604901   0.236527   2.5574 0.0105450 *
## location_UK.Q10_PC1                          1.214941   0.163335   7.4383 1.019e-13 ***
## location_UK.Q10_PC2                         -0.522041   0.506500  -1.0307 0.3026898
## certificate_NGO.co2_value                   -1.542137   0.362346  -4.2560 2.081e-05 ***
## certificate_NGO.framing_effectconsequence   -0.664038   1.381535  -0.4807 0.6307635
## certificate_NGO.framing_effectMetOffice     -0.979200   1.175899  -0.8327 0.4050001
## certificate_NGO.framing_effectUN            -1.107100   1.364993  -0.8111 0.4173272
## certificate_NGO.Q9_PC1                       3.114477   0.243297  12.8011 < 2.2e-16 ***
## certificate_NGO.Q9_PC2                       0.922129   0.242066   3.8094 0.0001393 ***
## certificate_NGO.Q10_PC1                      0.131234   0.149380   0.8785 0.3796596
## certificate_NGO.Q10_PC2                     -1.529917   0.524424  -2.9173 0.0035304 **
## certificate_UK.co2_value                    -1.193444   0.375289  -3.1801 0.0014724 **
## certificate_UK.framing_effectconsequence    -2.050369   1.446408  -1.4176 0.1563194
## certificate_UK.framing_effectMetOffice      -0.510161   1.229338  -0.4150 0.6781506
## certificate_UK.framing_effectUN             -1.269528   1.440945  -0.8810 0.3782971
## certificate_UK.Q9_PC1                        3.101841   0.274732  11.2904 < 2.2e-16 ***
## certificate_UK.Q9_PC2                        0.914246   0.256644   3.5623 0.0003676 ***
## certificate_UK.Q10_PC1                       0.220392   0.154042   1.4307 0.1525098
## certificate_UK.Q10_PC2                      -0.812939   0.528331  -1.5387 0.1238794
## project_renewable.co2_value                 -0.673159   0.390360  -1.7245 0.0846255 .
## project_renewable.framing_effectconsequence -0.474102   1.556996  -0.3045 0.7607487
## project_renewable.framing_effectMetOffice   -3.672551   1.317715  -2.7871 0.0053189 **
## project_renewable.framing_effectUN          -1.213733   1.523133  -0.7969 0.4255287
## project_renewable.Q9_PC1                     2.903053   0.260439  11.1468 < 2.2e-16 ***
## project_renewable.Q9_PC2                     0.789889   0.265152   2.9790 0.0028919 **
## project_renewable.Q10_PC1                    0.042330   0.163033   0.2596 0.7951399
## project_renewable.Q10_PC2                   -2.091874   0.588773  -3.5529 0.0003810 ***
## project_landfill.co2_value                   0.157202   0.442095   0.3556 0.7221524
## project_landfill.framing_effectconsequence  -0.249836   1.746707  -0.1430 0.8862645
## project_landfill.framing_effectMetOffice    -3.332159   1.501104  -2.2198 0.0264320 *
## project_landfill.framing_effectUN           -1.343175   1.710854  -0.7851 0.4324005
## project_landfill.Q9_PC1                      2.385536   0.285899   8.3440 < 2.2e-16 ***
## project_landfill.Q9_PC2                      0.403172   0.303358   1.3290 0.1838382
```

```
## project_landfill.Q10_PC1                     -0.610784   0.190778  -3.2016 0.0013669 **
## project_landfill.Q10_PC2                      0.494223   0.637304   0.7755 0.4380503
## project_manure.co2_value                     -0.319170   0.396783  -0.8044 0.4211682
## project_manure.framing_effectconsequence      0.044491   1.556292   0.0286 0.9771934
## project_manure.framing_effectMetOffice        0.014391   1.336552   0.0108 0.9914090
## project_manure.framing_effectUN               0.268916   1.545507   0.1740 0.8618663
## project_manure.Q9_PC1                         2.277868   0.239144   9.5251 < 2.2e-16 ***
## project_manure.Q9_PC2                         0.767045   0.279928   2.7401 0.0061411 **
## project_manure.Q10_PC1                       -0.426320   0.169509  -2.5150 0.0119021 *
## project_manure.Q10_PC2                        0.169972   0.569061   0.2987 0.7651783
## sd.location_EU                               16.772467   1.126092  14.8944 < 2.2e-16 ***
## sd.location_UK                               17.907365   1.155327  15.4998 < 2.2e-16 ***
## sd.certificate_NGO                           15.453605   1.071233  14.4260 < 2.2e-16 ***
## sd.certificate_UK                            15.692135   1.106511  14.1816 < 2.2e-16 ***
## sd.project_renewable                         18.488295   1.277899  14.4677 < 2.2e-16 ***
## sd.project_landfill                          14.778010   1.160884  12.7300 < 2.2e-16 ***
## sd.project_manure                            18.079476   1.215182  14.8780 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

- Higher meeting consumption, i.e., higher co2 value consistently reduce the WTP.
- The framing effects is either non-significant or seems to mitigate the preference premium relative to the base line for both endosement and carbon offset approaches.

Latent Class Models, Marginal Utiltiy Without Interaction Terms

This specification allows marginal utility paramters varies by class and treating the co2 consumption, framing effect, and PCAs of as demographics.

Latent Class Treating co2 consumption + framing effect + PCA as demographics, 2 classes

The marginal utility coefficients are:

```
##
## Model estimated on: Mon Oct 07 04:21:22 AM 2024
##
## Call:
## gmnl(formula = f1, data = dt, model = "lc", Q = q, panel = TRUE,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:0m:7s
##
## Coefficients:
##                             Estimate Std. Error  z-value  Pr(>|z|)
```

```
## class.1.I                -0.3412401  0.0444907  -7.6699 1.732e-14 ***
## class.1.price            -0.0392215  0.0021731 -18.0486 < 2.2e-16 ***
## class.1.location_EU      -0.0674888  0.0210293  -3.2093  0.001331 **
## class.1.location_UK       0.1332018  0.0202700   6.5714 4.985e-11 ***
## class.1.certificate_NGO   0.0346578  0.0211352   1.6398  0.101045
## class.1.certificate_UK    0.3286375  0.0214574  15.3158 < 2.2e-16 ***
## class.1.project_renewable  0.1725005  0.0239655   7.1979 6.115e-13 ***
## class.1.project_landfill  -0.2166329  0.0279751  -7.7438 9.548e-15 ***
## class.1.project_manure    -0.1158708  0.0247819  -4.6756 2.931e-06 ***
## class.2.I                -3.4833513  0.0947536 -36.7622 < 2.2e-16 ***
## class.2.price            -0.0361526  0.0040437  -8.9406 < 2.2e-16 ***
## class.2.location_EU       0.0698498  0.0382584   1.8257  0.067890 .
## class.2.location_UK       0.4050697  0.0368772  10.9843 < 2.2e-16 ***
## class.2.certificate_NGO   0.3069834  0.0368541   8.3297 < 2.2e-16 ***
## class.2.certificate_UK    0.5321108  0.0414124  12.8491 < 2.2e-16 ***
## class.2.project_renewable  0.1321055  0.0441377   2.9930  0.002762 **
## class.2.project_landfill  -0.5899856  0.0512568 -11.5104 < 2.2e-16 ***
## class.2.project_manure    -0.3172132  0.0462331  -6.8612 6.830e-12 ***
## (class)2                 -0.1611202  0.0180500  -8.9263 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -17728
## Number of observations: 12760
## Number of iterations: 17
## Exit of MLE: successive function values within relative tolerance limit (reltol)
```

The class membership probabilities are:

```
##   Class_1   Class_2
## 0.5401931 0.4598069
```

The effects of demographics are:

```
## $Class_2
##                                  coef         se           z     p_val
## (Intercept)                -0.149983959 0.31567659 -0.47511904 0.6347021
## co2_value                  -0.062426525 0.05376809 -1.16103288 0.2456285
## framing_effectconsequence   0.084897472 0.17910269  0.47401562 0.6354888
## framing_effectMetOffice     0.029019525 0.15531606  0.18684175 0.8517847
## framing_effectUN            0.211272942 0.17884787  1.18129975 0.2374837
## Q9_PC1                     -0.004564753 0.02456431 -0.18582863 0.8525792
## Q9_PC2                      0.023945740 0.03251407  0.73647310 0.4614428
## Q10_PC1                     0.028215217 0.02405627  1.17288399 0.2408423
## Q10_PC2                    -0.010359090 0.07100578 -0.14589080 0.8840076
## age_group35_54             -0.066550842 0.14920830 -0.44602640 0.6555782
## age_group55_                0.111347702 0.17249486  0.64551315 0.5185947
## is_women                   -0.110452853 0.12078982 -0.91442188 0.3604952
## diet_typeFlexitarian       -0.183729298 0.16724314 -1.09857599 0.2719531
## diet_typeVegan_Vegetarian  -0.096426840 0.22442044 -0.42967048 0.6674354
## education_levelDegree      -0.029093947 0.13310473 -0.21857937 0.8269777
## education_levelPostgraduate -0.011785081 0.17108551 -0.06888416 0.9450818
```

```
## hh_size                      0.052519069 0.06372989  0.82408846 0.4098893
## income_level30_50k           0.031553116 0.13564570  0.23261421 0.8160610
## income_level50_              0.121105992 0.15493393  0.78166216 0.4344131
## n_children                  -0.032906571 0.09032623 -0.36430803 0.7156280
## is_shopper                  -0.008792004 0.14447281 -0.06085577 0.9514741
## where_liveRuralarea         -0.165097285 0.19340100 -0.85365268 0.3932975
## where_liveTownorsuburb      -0.025255604 0.14988913 -0.16849523 0.8661937
```

Latent Class Treating co2 consumption + framing effect + PCA as demographics, 3 classes

The marginal utility coefficients are:

```
##
## Model estimated on: Mon Oct 07 04:21:22 AM 2024
##
## Call:
## gmnl(formula = f2, data = dt, model = "lc", Q = q, panel = TRUE,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:0m:7s
##
## Coefficients:
##                              Estimate Std. Error  z-value  Pr(>|z|)
## class.1.I                  -0.4745246  0.0471349 -10.0674 < 2.2e-16 ***
## class.1.price              -0.0292255  0.0022267 -13.1249 < 2.2e-16 ***
## class.1.location_EU        -0.0160290  0.0215339  -0.7444 0.4566576
## class.1.location_UK         0.1652015  0.0207310   7.9688 1.554e-15 ***
## class.1.certificate_NGO     0.0831284  0.0215511   3.8573 0.0001147 ***
## class.1.certificate_UK      0.3615126  0.0222526  16.2459 < 2.2e-16 ***
## class.1.project_renewable   0.2162835  0.0249448   8.6705 < 2.2e-16 ***
## class.1.project_landfill   -0.2422197  0.0288237  -8.4035 < 2.2e-16 ***
## class.1.project_manure     -0.1329240  0.0257051  -5.1711 2.327e-07 ***
## class.2.I                   0.4650589  0.2682802   1.7335 0.0830101 .
## class.2.price              -0.2428531  0.0126570 -19.1872 < 2.2e-16 ***
## class.2.location_EU        -1.0364971  0.1197874  -8.6528 < 2.2e-16 ***
## class.2.location_UK         0.3849672  0.1132237   3.4001 0.0006737 ***
## class.2.certificate_NGO    -0.2754939  0.1083798  -2.5419 0.0110242 *
## class.2.certificate_UK      0.6164478  0.1292306   4.7701 1.841e-06 ***
## class.2.project_renewable  -0.5736398  0.1286163  -4.4601 8.193e-06 ***
## class.2.project_landfill   -0.4348426  0.1711899  -2.5401 0.0110815 *
## class.2.project_manure      0.0152187  0.1361393   0.1118 0.9109915
## class.3.I                  -3.8803868  0.1083355 -35.8182 < 2.2e-16 ***
## class.3.price              -0.0374090  0.0042698  -8.7614 < 2.2e-16 ***
## class.3.location_EU         0.0668430  0.0403760   1.6555 0.0978202 .
## class.3.location_UK         0.4087315  0.0387818  10.5393 < 2.2e-16 ***
## class.3.certificate_NGO     0.3206281  0.0387231   8.2800 2.220e-16 ***
## class.3.certificate_UK      0.5416737  0.0437614  12.3779 < 2.2e-16 ***
```

```
## class.3.project_renewable  0.1305824  0.0463554   2.8170 0.0048477 **
## class.3.project_landfill  -0.6003817  0.0546129 -10.9934 < 2.2e-16 ***
## class.3.project_manure    -0.3435792  0.0489108  -7.0246 2.147e-12 ***
## (class)2                  -1.6289501  0.0320951 -50.7539 < 2.2e-16 ***
## (class)3                  -0.0863485  0.0189983  -4.5451 5.492e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -16649
## Number of observations: 12760
## Number of iterations: 16
## Exit of MLE: successive function values within relative tolerance limit (reltol)
```

The class membership probabilities are:

```
##    Class_1    Class_2    Class_3
## 0.47316897 0.09280518 0.43402585
```

The effects of demographics are:

```
## $Class_2
##                                  coef         se           z       p_val
## (Intercept)                -1.200192938 0.57146938 -2.10018764 0.035712338
## co2_value                  -0.089546545 0.09870194 -0.90724197 0.364278853
## framing_effectconsequence  -0.174497590 0.33223056 -0.52523039 0.599423038
## framing_effectMetOffice     0.118729938 0.27258967  0.43556287 0.663153914
## framing_effectUN            0.136305864 0.32163340  0.42379262 0.671717058
## Q9_PC1                     -0.098124991 0.03779067 -2.59654037 0.009416784
## Q9_PC2                     -0.015006169 0.06106078 -0.24575789 0.805869654
## Q10_PC1                     0.046928028 0.04439955  1.05694825 0.290535207
## Q10_PC2                    -0.059367866 0.13124772 -0.45233445 0.651028063
## age_group35_54             -0.211556654 0.27050249 -0.78208765 0.434163065
## age_group55_               -0.155906887 0.30457468 -0.51188394 0.608732238
## is_women                   -0.181161495 0.21687437 -0.83532920 0.403532378
## diet_typeFlexitarian       -0.112570392 0.29519274 -0.38134539 0.702946979
## diet_typeVegan_Vegetarian  -0.695311606 0.47459484 -1.46506356 0.142903577
## education_levelDegree       0.144657256 0.23677899  0.61093789 0.541240698
## education_levelPostgraduate 0.124062526 0.31028794  0.39983032 0.689281494
## hh_size                    -0.065718438 0.11891431 -0.55265376 0.580500519
## income_level30_50k         -0.277385197 0.24723136 -1.12196606 0.261876872
## income_level50_            -0.059710521 0.27842045 -0.21446169 0.830187038
## n_children                 -0.001985845 0.17051358 -0.01164626 0.990707839
## is_shopper                 -0.190155187 0.25497474 -0.74578050 0.455800022
## where_liveRuralarea         0.162394440 0.36503317  0.44487584 0.656409480
## where_liveTownorsuburb      0.407572898 0.28731975  1.41853423 0.156034853
##
## $Class_3
##                                 coef         se           z      p_val
## (Intercept)                -0.03364188 0.33155043 -0.10146838 0.91917866
## co2_value                  -0.08885280 0.05636304 -1.57643724 0.11492507
## framing_effectconsequence   0.05918829 0.18762297  0.31546398 0.75240939
## framing_effectMetOffice     0.07805707 0.16339423  0.47772230 0.63284787
```

```
## framing_effectUN             0.28117046 0.18809870  1.49480277 0.13496592
## Q9_PC1                      -0.02518443 0.02709806 -0.92938128 0.35269153
## Q9_PC2                       0.01695829 0.03420063  0.49584725 0.62000219
## Q10_PC1                      0.03002545 0.02515003  1.19385338 0.23253533
## Q10_PC2                     -0.02046908 0.07429723 -0.27550256 0.78293016
## age_group35_54              -0.10412838 0.15642164 -0.66569041 0.50560901
## age_group55_                 0.14692233 0.18181488  0.80808752 0.41904020
## is_women                    -0.13264861 0.12694275 -1.04494828 0.29604687
## diet_typeFlexitarian        -0.29870212 0.17600798 -1.69709423 0.08967885
## diet_typeVegan_Vegetarian   -0.29710989 0.23311372 -1.27452768 0.20247647
## education_levelDegree        0.05773852 0.14002979  0.41233029 0.68009735
## education_levelPostgraduate  0.03462402 0.17962690  0.19275523 0.84715067
## hh_size                      0.03967065 0.06671657  0.59461468 0.55210106
## income_level30_50k           0.01121950 0.14235074  0.07881589 0.93717907
## income_level50_              0.13510254 0.16299918  0.82885414 0.40718695
## n_children                  -0.02464829 0.09437299 -0.26117950 0.79395409
## is_shopper                  -0.05943277 0.15242382 -0.38991783 0.69659731
## where_liveRuralarea         -0.10522863 0.20199565 -0.52094505 0.60240505
## where_liveTownorsuburb       0.06348247 0.15645723  0.40574965 0.68492655
```

We can't do an LC esimtation with more than 3 classes due to lack of variation and the hessian matrix would be singular.

Latent Class Models, Marginal Utiltiy With Interaction Terms

This specification interacts the marginal utility parameters with the co2 consumption, framing effect, and PCAs. This specification would be similar to the mixed logit model with the exception that the marginal utility parameters are allowed to vary by class, but without being random parameters.

Latent Class interact with co2 consumption + framing effect + PCA, 2 classes

The marginal utility coefficients are:

```
##
## Model estimated on: Mon Oct 07 04:21:22 AM 2024
##
## Call:
## gmnl(formula = f1, data = dt, model = "lc", Q = q, panel = TRUE,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:1m:26s
##
## Coefficients:
##                                                    Estimate  Std. Error  z-value  Pr(>|z|)
## class.1.I                                       -0.34444834  0.04465853  -7.7129 1.221e-14 ***
## class.1.price                                   -0.03480341  0.00428775  -8.1169 4.441e-16 ***
```

```
## class.1.location_EU                                    0.02612167  0.05200069   0.5023 0.6154332
## class.1.location_UK                                    0.28004120  0.05300178   5.2836 1.267e-07 ***
## class.1.certificate_NGO                                0.02421002  0.05397572   0.4485 0.6537669
## class.1.certificate_UK                                 0.26383806  0.05699769   4.6289 3.676e-06 ***
## class.1.project_renewable                              0.21618254  0.05873168   3.6809 0.0002325 ***
## class.1.project_landfill                              -0.31146105  0.06984478  -4.4593 8.222e-06 ***
## class.1.project_manure                                -0.27432365  0.06505697  -4.2167 2.479e-05 ***
## class.1.price:co2_value                               -0.00118238  0.00117883  -1.0030 0.3158573
## class.1.price:framing_effectconsequence               -0.01110029  0.00497544  -2.2310 0.0256799 *
## class.1.price:framing_effectMetOffice                  0.00013758  0.00418395   0.0329 0.9737675
## class.1.price:framing_effectUN                        -0.00360270  0.00492740  -0.7312 0.4646829
## class.1.location_EU:co2_value                          0.00519319  0.01502441   0.3456 0.7296058
## class.1.location_EU:framing_effectconsequence         -0.12101755  0.06532170  -1.8526 0.0639341 .
## class.1.location_EU:framing_effectMetOffice           -0.14499036  0.05475179  -2.6481 0.0080936 **
## class.1.location_EU:framing_effectUN                  -0.08368630  0.06486678  -1.2901 0.1970070
## class.1.location_UK:co2_value                         -0.06152076  0.01538081  -3.9998 6.339e-05 ***
## class.1.location_UK:framing_effectconsequence         -0.16165232  0.06728477  -2.4025 0.0162830 *
## class.1.location_UK:framing_effectMetOffice           -0.01442206  0.05611382  -0.2570 0.7971676
## class.1.location_UK:framing_effectUN                  -0.03514117  0.06516192  -0.5393 0.5896868
## class.1.certificate_NGO:co2_value                     -0.02687459  0.01607775  -1.6715 0.0946151 .
## class.1.certificate_NGO:framing_effectconsequence      0.01922058  0.06938931   0.2770 0.7817830
## class.1.certificate_NGO:framing_effectMetOffice        0.08480764  0.05703878   1.4868 0.1370566
## class.1.certificate_NGO:framing_effectUN               0.08119141  0.06727280   1.2069 0.2274715
## class.1.certificate_UK:co2_value                      -0.01253344  0.01639282  -0.7646 0.4445284
## class.1.certificate_UK:framing_effectconsequence       0.08814691  0.07180163   1.2276 0.2195803
## class.1.certificate_UK:framing_effectMetOffice         0.09729107  0.06012113   1.6183 0.1056085
## class.1.certificate_UK:framing_effectUN                0.15401325  0.07108767   2.1665 0.0302711 *
## class.1.project_renewable:co2_value                   -0.01975792  0.01698424  -1.1633 0.2447039
## class.1.project_renewable:framing_effectconsequence    0.08206402  0.07445929   1.1021 0.2704040
## class.1.project_renewable:framing_effectMetOffice     -0.06764584  0.06105159  -1.1080 0.2678570
## class.1.project_renewable:framing_effectUN             0.01889592  0.07202891   0.2623 0.7930609
## class.1.project_landfill:co2_value                     0.02645724  0.02043211   1.2949 0.1953597
## class.1.project_landfill:framing_effectconsequence     0.13853136  0.08784221   1.5770 0.1147845
## class.1.project_landfill:framing_effectMetOffice       0.02416044  0.07381056   0.3273 0.7434181
## class.1.project_landfill:framing_effectUN              0.06365703  0.08591901   0.7409 0.4587566
## class.1.project_manure:co2_value                       0.01231719  0.01911689   0.6443 0.5193751
## class.1.project_manure:framing_effectconsequence       0.19157458  0.08244454   2.3237 0.0201428 *
## class.1.project_manure:framing_effectMetOffice         0.14105372  0.06891893   2.0467 0.0406913 *
## class.1.project_manure:framing_effectUN                0.20137745  0.08087882   2.4899 0.0127791 *
## class.2.I                                             -3.51097936  0.09574295 -36.6709 < 2.2e-16 ***
## class.2.price                                         -0.01862446  0.00869673  -2.1415 0.0322298 *
## class.2.location_EU                                    0.12893971  0.10025780   1.2861 0.1984146
## class.2.location_UK                                    0.39384184  0.09500483   4.1455 3.391e-05 ***
## class.2.certificate_NGO                                0.49355358  0.09510959   5.1893 2.111e-07 ***
## class.2.certificate_UK                                 0.70810644  0.10988008   6.4444 1.161e-10 ***
## class.2.project_renewable                              0.12487839  0.10781826   1.1582 0.2467700
## class.2.project_landfill                              -0.60118947  0.13401768  -4.4859 7.261e-06 ***
## class.2.project_manure                                -0.36443608  0.12109770  -3.0094 0.0026173 **
## class.2.price:co2_value                               -0.00744175  0.00276301  -2.6933 0.0070738 **
## class.2.price:framing_effectconsequence               -0.00689547  0.00983838  -0.7009 0.4833814
## class.2.price:framing_effectMetOffice                 -0.00248212  0.00882688  -0.2812 0.7785571
## class.2.price:framing_effectUN                        -0.01938214  0.00951650  -2.0367 0.0416813 *
## class.2.location_EU:co2_value                         -0.03902193  0.03419225  -1.1413 0.2537657
## class.2.location_EU:framing_effectconsequence          0.00658105  0.11330094   0.0581 0.9536812
```

```
## class.2.location_EU:framing_effectMetOffice          0.03632315  0.10305699   0.3525 0.7244956
## class.2.location_EU:framing_effectUN                -0.07832540  0.11234401  -0.6972 0.4856823
## class.2.location_UK:co2_value                        0.00105147  0.03417404   0.0308 0.9754544
## class.2.location_UK:framing_effectconsequence        0.08002041  0.11128620   0.7191 0.4721097
## class.2.location_UK:framing_effectMetOffice         -0.03303828  0.09934509  -0.3326 0.7394659
## class.2.location_UK:framing_effectUN                 0.02523403  0.11336272   0.2226 0.8238503
## class.2.certificate_NGO:co2_value                   -0.08788468  0.03354764  -2.6197 0.0088008 **
## class.2.certificate_NGO:framing_effectconsequence    0.02147935  0.10961174   0.1960 0.8446427
## class.2.certificate_NGO:framing_effectMetOffice     -0.10791400  0.09925200  -1.0873 0.2769162
## class.2.certificate_NGO:framing_effectUN            -0.11398248  0.11259154  -1.0124 0.3113689
## class.2.certificate_UK:co2_value                    -0.05001066  0.03913932  -1.2778 0.2013340
## class.2.certificate_UK:framing_effectconsequence    -0.14405942  0.12596082  -1.1437 0.2527546
## class.2.certificate_UK:framing_effectMetOffice      -0.07019183  0.11402350  -0.6156 0.5381646
## class.2.certificate_UK:framing_effectUN             -0.21564560  0.12647060  -1.7051 0.0881749 .
## class.2.project_renewable:co2_value                  0.01438950  0.03751145   0.3836 0.7012727
## class.2.project_renewable:framing_effectconsequence  0.00847322  0.12279573   0.0690 0.9449876
## class.2.project_renewable:framing_effectMetOffice   -0.10019856  0.11088217  -0.9036 0.3661816
## class.2.project_renewable:framing_effectUN           0.11937438  0.12515622   0.9538 0.3401834
## class.2.project_landfill:co2_value                   0.07368949  0.04548708   1.6200 0.1052303
## class.2.project_landfill:framing_effectconsequence  -0.11995387  0.14902724  -0.8049 0.4208702
## class.2.project_landfill:framing_effectMetOffice    -0.17889877  0.13460242  -1.3291 0.1838182
## class.2.project_landfill:framing_effectUN           -0.05890704  0.15047583  -0.3915 0.6954486
## class.2.project_manure:co2_value                     0.04612135  0.04220569   1.0928 0.2744923
## class.2.project_manure:framing_effectconsequence    -0.05331936  0.13951895  -0.3822 0.7023385
## class.2.project_manure:framing_effectMetOffice       0.03465735  0.12676456   0.2734 0.7845462
## class.2.project_manure:framing_effectUN             -0.09170416  0.13897237  -0.6599 0.5093351
## (class)2                                            -0.16251577  0.01804042  -9.0084 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -17660
## Number of observations: 12760
## Number of iterations: 15
## Exit of MLE: successive function values within relative tolerance limit (reltol)

##      AIC      BIC
## 35485.49 36104.18
```

The class membership probabilities are:

```
##   Class_1   Class_2
## 0.5405398 0.4594602
```

The effects of demographics are:

```
## $Class_2
##                                 coef         se           z     p_val
## (Intercept)                -0.27706383 0.26928171 -1.02889955 0.3035269
## age_group35_54              0.01687408 0.14393905  0.11723074 0.9066772
## age_group55_                0.21461920 0.16138350  1.32987078 0.1835609
## is_women                   -0.05672937 0.11697192 -0.48498275 0.6276886
## diet_typeFlexitarian       -0.17437595 0.15894831 -1.09706072 0.2726148
```

```
## diet_typeVegan_Vegetarian   -0.01878985 0.20874883 -0.09001175 0.9282779
## education_levelDegree       -0.03686092 0.13211409 -0.27900827 0.7802385
## education_levelPostgraduate -0.01573016 0.16999594 -0.09253254 0.9262749
## hh_size                      0.04971871 0.06331892  0.78521101 0.4323299
## income_level30_50k           0.03911787 0.13487259  0.29003572 0.7717889
## income_level50_              0.13410448 0.15350885  0.87359447 0.3823391
## n_children                  -0.05309249 0.08930491 -0.59450803 0.5521724
## is_shopper                  -0.03132222 0.14260838 -0.21963798 0.8261531
## where_liveRuralarea         -0.11939830 0.19058367 -0.62648756 0.5309952
## where_liveTownorsuburb       0.03137536 0.14660774  0.21400888 0.8305401
```

Latent Class interact with co2 consumption + framing effect + PCA, 3 classes

The marginal utility coefficients are:

```
##
## Model estimated on: Mon Oct 07 04:21:22 AM 2024
##
## Call:
## gmnl(formula = f1, data = dt, model = "lc", Q = q, panel = TRUE,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:1m:36s
##
## Coefficients:
##                                                    Estimate  Std. Error  z-value  Pr(>|z|)
## class.1.I                                         9.4246e-01  3.0266e-01   3.1140  0.001846 **
## class.1.price                                    -1.2806e-01  2.7608e-02  -4.6387 3.507e-06 ***
## class.1.location_EU                              -2.4175e-01  2.9770e-01  -0.8121  0.416755
## class.1.location_UK                              -1.4595e-01  3.0339e-01  -0.4811  0.630474
## class.1.certificate_NGO                          -5.2612e-01  2.9135e-01  -1.8058  0.070949 .
## class.1.certificate_UK                            2.1375e-01  3.2835e-01   0.6510  0.515052
## class.1.project_renewable                        -1.5500e-01  3.1028e-01  -0.4996  0.617388
## class.1.project_landfill                         -5.8410e-01  4.5701e-01  -1.2781  0.201215
## class.1.project_manure                           -4.6515e-01  3.6559e-01  -1.2723  0.203253
## class.1.price:co2_value                          -6.4195e-02  1.1018e-02  -5.8266 5.656e-09 ***
## class.1.price:framing_effectconsequence          -4.1486e-01  1.0495e-01  -3.9528 7.724e-05 ***
## class.1.price:framing_effectMetOffice             3.5668e-03  2.9495e-02   0.1209  0.903749
## class.1.price:framing_effectUN                    7.5184e-02  3.1682e-02   2.3731  0.017641 *
## class.1.location_EU:co2_value                    -5.1618e-01  1.2591e-01  -4.0995 4.141e-05 ***
## class.1.location_EU:framing_effectconsequence    -1.4785e+00  5.7819e-01  -2.5572  0.010553 *
## class.1.location_EU:framing_effectMetOffice      -1.7969e-02  3.1090e-01  -0.0578  0.953911
## class.1.location_EU:framing_effectUN              6.5970e-01  3.7485e-01   1.7599  0.078426 .
## class.1.location_UK:co2_value                     1.2103e-01  1.3127e-01   0.9220  0.356542
## class.1.location_UK:framing_effectconsequence     1.4041e+00  6.5843e-01   2.1324  0.032971 *
## class.1.location_UK:framing_effectMetOffice       5.9197e-01  3.1197e-01   1.8975  0.057760 .
## class.1.location_UK:framing_effectUN              5.2634e-01  3.3509e-01   1.5707  0.116242
## class.1.certificate_NGO:co2_value                 1.1433e-01  1.0273e-01   1.1129  0.265733
```

```
## class.1.certificate_NGO:framing_effectconsequence    7.2350e-01  4.6665e-01   1.5504  0.121038
## class.1.certificate_NGO:framing_effectMetOffice      1.6847e-01  3.0499e-01   0.5524  0.580688
## class.1.certificate_NGO:framing_effectUN             2.4260e-01  3.3107e-01   0.7328  0.463687
## class.1.certificate_UK:co2_value                     1.5870e-01  1.4649e-01   1.0834  0.278644
## class.1.certificate_UK:framing_effectconsequence     2.6371e+00  9.9760e-01   2.6434  0.008208 **
## class.1.certificate_UK:framing_effectMetOffice       9.3959e-02  3.3512e-01   0.2804  0.779189
## class.1.certificate_UK:framing_effectUN              2.6252e-02  3.8768e-01   0.0677  0.946013
## class.1.project_renewable:co2_value                 -3.6505e-01  1.3133e-01  -2.7797  0.005441 **
## class.1.project_renewable:framing_effectconsequence -2.3363e+00  7.9826e-01  -2.9267  0.003426 **
## class.1.project_renewable:framing_effectMetOffice   -2.3689e-02  3.3737e-01  -0.0702  0.944021
## class.1.project_renewable:framing_effectUN           8.2095e-01  3.4592e-01   2.3732  0.017633 *
## class.1.project_landfill:co2_value                  -7.7735e-02  2.1836e-01  -0.3560  0.721846
## class.1.project_landfill:framing_effectconsequence  -4.6354e-01  6.5379e-01  -0.7090  0.478322
## class.1.project_landfill:framing_effectMetOffice     2.2359e-01  4.6146e-01   0.4845  0.628018
## class.1.project_landfill:framing_effectUN            4.4343e-01  4.7500e-01   0.9335  0.350553
## class.1.project_manure:co2_value                     1.8140e-01  1.2946e-01   1.4013  0.161134
## class.1.project_manure:framing_effectconsequence    -5.6272e-01  6.1190e-01  -0.9196  0.357769
## class.1.project_manure:framing_effectMetOffice       2.3315e-01  3.8354e-01   0.6079  0.543257
## class.1.project_manure:framing_effectUN              1.2914e-01  4.2719e-01   0.3023  0.762430
## class.2.I                                           -4.9159e-01  4.7498e-02 -10.3497 < 2.2e-16 ***
## class.2.price                                       -2.6927e-02  4.6463e-03  -5.7954 6.817e-09 ***
## class.2.location_EU                                  6.8386e-02  5.3860e-02   1.2697  0.204187
## class.2.location_UK                                  3.4737e-01  5.4544e-02   6.3686 1.908e-10 ***
## class.2.certificate_NGO                              6.0734e-02  5.5372e-02   1.0968  0.272716
## class.2.certificate_UK                               2.8855e-01  5.9639e-02   4.8382 1.310e-06 ***
## class.2.project_renewable                            2.8167e-01  6.2050e-02   4.5394 5.642e-06 ***
## class.2.project_landfill                            -3.2662e-01  7.2499e-02  -4.5051 6.634e-06 ***
## class.2.project_manure                              -2.9661e-01  6.7826e-02  -4.3731 1.225e-05 ***
## class.2.price:co2_value                             -4.2102e-05  1.2866e-03  -0.0327  0.973896
## class.2.price:framing_effectconsequence             -7.5795e-03  5.3534e-03  -1.4158  0.156826
## class.2.price:framing_effectMetOffice               -2.3168e-03  4.5017e-03  -0.5147  0.606794
## class.2.price:framing_effectUN                      -3.9420e-03  5.2792e-03  -0.7467  0.455246
## class.2.location_EU:co2_value                        1.5244e-02  1.5549e-02   0.9804  0.326892
## class.2.location_EU:framing_effectconsequence       -1.0652e-01  6.7123e-02  -1.5870  0.112518
## class.2.location_EU:framing_effectMetOffice         -1.6806e-01  5.6072e-02  -2.9973  0.002724 **
## class.2.location_EU:framing_effectUN                -1.0104e-01  6.5958e-02  -1.5320  0.125535
## class.2.location_UK:co2_value                       -7.2556e-02  1.5699e-02  -4.6217 3.806e-06 ***
## class.2.location_UK:framing_effectconsequence       -1.7722e-01  6.8571e-02  -2.5845  0.009753 **
## class.2.location_UK:framing_effectMetOffice         -5.0987e-02  5.7364e-02  -0.8888  0.374092
## class.2.location_UK:framing_effectUN                -6.5545e-02  6.6602e-02  -0.9841  0.325050
## class.2.certificate_NGO:co2_value                   -3.8290e-02  1.6393e-02  -2.3358  0.019503 *
## class.2.certificate_NGO:framing_effectconsequence    5.2684e-02  7.0825e-02   0.7439  0.456962
## class.2.certificate_NGO:framing_effectMetOffice      1.1083e-01  5.8297e-02   1.9012  0.057280 .
## class.2.certificate_NGO:framing_effectUN             1.1444e-01  6.8687e-02   1.6661  0.095703 .
## class.2.certificate_UK:co2_value                    -1.8145e-02  1.7014e-02  -1.0665  0.286205
## class.2.certificate_UK:framing_effectconsequence     9.0454e-02  7.4295e-02   1.2175  0.223415
## class.2.certificate_UK:framing_effectMetOffice       1.1649e-01  6.2208e-02   1.8725  0.061132 .
## class.2.certificate_UK:framing_effectUN              1.8892e-01  7.3257e-02   2.5789  0.009912 **
## class.2.project_renewable:co2_value                 -2.9870e-02  1.7588e-02  -1.6983  0.089446 .
## class.2.project_renewable:framing_effectconsequence  6.9914e-02  7.7210e-02   0.9055  0.365200
## class.2.project_renewable:framing_effectMetOffice   -7.8536e-02  6.3681e-02  -1.2333  0.217476
## class.2.project_renewable:framing_effectUN           1.4431e-02  7.5161e-02   0.1920  0.847742
## class.2.project_landfill:co2_value                   2.4840e-02  2.1069e-02   1.1790  0.238398
## class.2.project_landfill:framing_effectconsequence   1.1003e-01  9.0539e-02   1.2153  0.224267
```

```
## class.2.project_landfill:framing_effectMetOffice     2.2018e-02  7.5803e-02   0.2905  0.771459
## class.2.project_landfill:framing_effectUN            5.2984e-02  8.8231e-02   0.6005  0.548159
## class.2.project_manure:co2_value                     3.4390e-03  1.9824e-02   0.1735  0.862277
## class.2.project_manure:framing_effectconsequence     1.9544e-01  8.5460e-02   2.2869  0.022204 *
## class.2.project_manure:framing_effectMetOffice       1.5758e-01  7.1241e-02   2.2119  0.026976 *
## class.2.project_manure:framing_effectUN              2.5416e-01  8.3192e-02   3.0551  0.002250 **
## class.3.I                                           -3.8842e+00  1.0851e-01 -35.7948 < 2.2e-16 ***
## class.3.price                                       -2.2838e-02  9.3090e-03  -2.4533  0.014155 *
## class.3.location_EU                                  1.0964e-01  1.0398e-01   1.0544  0.291697
## class.3.location_UK                                  4.0228e-01  9.8569e-02   4.0812 4.481e-05 ***
## class.3.certificate_NGO                              5.4044e-01  9.8463e-02   5.4888 4.047e-08 ***
## class.3.certificate_UK                               7.4559e-01  1.1418e-01   6.5300 6.576e-11 ***
## class.3.project_renewable                            1.0558e-01  1.1194e-01   0.9432  0.345579
## class.3.project_landfill                            -6.2394e-01  1.3935e-01  -4.4774 7.555e-06 ***
## class.3.project_manure                              -3.6422e-01  1.2603e-01  -2.8898  0.003854 **
## class.3.price:co2_value                             -7.3738e-03  3.0899e-03  -2.3864  0.017014 *
## class.3.price:framing_effectconsequence             -7.1791e-03  1.0723e-02  -0.6695  0.503185
## class.3.price:framing_effectMetOffice                5.2119e-04  9.6674e-03   0.0539  0.957005
## class.3.price:framing_effectUN                      -1.1849e-02  1.0628e-02  -1.1148  0.264916
## class.3.location_EU:co2_value                       -3.6130e-02  3.6627e-02  -0.9864  0.323921
## class.3.location_EU:framing_effectconsequence        1.1301e-02  1.1936e-01   0.0947  0.924571
## class.3.location_EU:framing_effectMetOffice          4.6343e-02  1.0843e-01   0.4274  0.669092
## class.3.location_EU:framing_effectUN                -5.0398e-02  1.2002e-01  -0.4199  0.674550
## class.3.location_UK:co2_value                        1.2403e-02  3.6049e-02   0.3441  0.730801
## class.3.location_UK:framing_effectconsequence        4.6445e-02  1.1725e-01   0.3961  0.692025
## class.3.location_UK:framing_effectMetOffice         -5.3508e-02  1.0416e-01  -0.5137  0.607460
## class.3.location_UK:framing_effectUN                 1.0064e-02  1.2013e-01   0.0838  0.933234
## class.3.certificate_NGO:co2_value                   -8.1317e-02  3.5599e-02  -2.2843  0.022356 *
## class.3.certificate_NGO:framing_effectconsequence   -4.1883e-02  1.1523e-01  -0.3635  0.716252
## class.3.certificate_NGO:framing_effectMetOffice     -1.6773e-01  1.0415e-01  -1.6105  0.107286
## class.3.certificate_NGO:framing_effectUN            -1.5476e-01  1.1946e-01  -1.2954  0.195167
## class.3.certificate_UK:co2_value                    -4.7332e-02  4.1912e-02  -1.1293  0.258763
## class.3.certificate_UK:framing_effectconsequence    -1.9442e-01  1.3232e-01  -1.4693  0.141760
## class.3.certificate_UK:framing_effectMetOffice      -1.0071e-01  1.1990e-01  -0.8400  0.400912
## class.3.certificate_UK:framing_effectUN             -2.6999e-01  1.3483e-01  -2.0025  0.045233 *
## class.3.project_renewable:co2_value                  2.9007e-02  4.0387e-02   0.7182  0.472612
## class.3.project_renewable:framing_effectconsequence -8.5450e-03  1.2904e-01  -0.0662  0.947204
## class.3.project_renewable:framing_effectMetOffice   -1.1759e-01  1.1710e-01  -1.0042  0.315305
## class.3.project_renewable:framing_effectUN           1.3785e-01  1.3311e-01   1.0356  0.300375
## class.3.project_landfill:co2_value                   9.0391e-02  4.9439e-02   1.8283  0.067500 .
## class.3.project_landfill:framing_effectconsequence  -1.2499e-01  1.5964e-01  -0.7829  0.433667
## class.3.project_landfill:framing_effectMetOffice    -2.2470e-01  1.4255e-01  -1.5763  0.114953
## class.3.project_landfill:framing_effectUN           -2.8256e-02  1.6306e-01  -0.1733  0.862426
## class.3.project_manure:co2_value                     5.1839e-02  4.4595e-02   1.1624  0.245055
## class.3.project_manure:framing_effectconsequence    -7.1217e-02  1.4704e-01  -0.4843  0.628148
## class.3.project_manure:framing_effectMetOffice       1.4519e-05  1.3354e-01   0.0001  0.999913
## class.3.project_manure:framing_effectUN             -1.6684e-01  1.4920e-01  -1.1182  0.263475
## (class)2                                             1.6297e+00  3.2013e-02  50.9085 < 2.2e-16 ***
## (class)3                                             1.5476e+00  3.2200e-02  48.0636 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -16556
```

```
## Number of observations: 12760
## Number of iterations: 25
## Exit of MLE: successive function values within relative tolerance limit (reltol)

##      AIC      BIC
## 33362.41 34294.16
```

The class membership probabilities are:

```
##    Class_1    Class_2    Class_3
## 0.09256792 0.47232955 0.43510253
```

The effects of demographics are:

```
## $Class_2
##                                 coef        se           z       p_val
## (Intercept)                  1.42033718 0.4901568  2.89771992 0.003758861
## age_group35_54               0.11413038 0.2583437  0.44177730 0.658650369
## age_group55_                -0.02728599 0.2845539 -0.09589043 0.923607597
## is_women                     0.13761868 0.2099346  0.65553128 0.512125752
## diet_typeFlexitarian         0.14294429 0.2815017  0.50779199 0.611599229
## diet_typeVegan_Vegetarian    0.36951400 0.4095747  0.90218940 0.366956263
## education_levelDegree       -0.23355034 0.2348208 -0.99458983 0.319935797
## education_levelPostgraduate -0.21926346 0.3041742 -0.72084831 0.471002847
## hh_size                      0.05996884 0.1182586  0.50709904 0.612085325
## income_level30_50k           0.42410286 0.2503298  1.69417639 0.090231769
## income_level50_              0.10943850 0.2717746  0.40268110 0.687182841
## n_children                  -0.02812311 0.1659385 -0.16947910 0.865419813
## is_shopper                   0.29530823 0.2494918  1.18363886 0.236556050
## where_liveRuralarea         -0.27292285 0.3581150 -0.76210960 0.445994593
## where_liveTownorsuburb      -0.49091146 0.2804028 -1.75073649 0.079991311
##
## $Class_3
##                                 coef        se          z      p_val
## (Intercept)                  1.23982900 0.4936895  2.5113539 0.01202691
## age_group35_54               0.10524975 0.2614839  0.4025095 0.68730910
## age_group55_                 0.23870679 0.2856290  0.8357232 0.40331066
## is_women                     0.04658651 0.2110631  0.2207232 0.82530800
## diet_typeFlexitarian        -0.11556784 0.2870557 -0.4025973 0.68724452
## diet_typeVegan_Vegetarian    0.20181526 0.4150824  0.4862052 0.62682165
## education_levelDegree       -0.17302596 0.2359466 -0.7333267 0.46335921
## education_levelPostgraduate -0.17146327 0.3059652 -0.5604012 0.57520580
## hh_size                      0.10242903 0.1187729  0.8623939 0.38847079
## income_level30_50k           0.41480235 0.2519150  1.6465965 0.09964102
## income_level50_              0.23050778 0.2723096  0.8464916 0.39727854
## n_children                  -0.06707639 0.1671427 -0.4013122 0.68819030
## is_shopper                   0.20504090 0.2491996  0.8227979 0.41062294
## where_liveRuralarea         -0.33795452 0.3621879 -0.9330917 0.35077261
## where_liveTownorsuburb      -0.38035762 0.2832444 -1.3428601 0.17931729
```

Latent Class interact with co2 consumption + framing effect + PCA, 4 classes

The marginal utility coefficients are:

```
##
## Model estimated on: Mon Oct 07 04:21:23 AM 2024
##
## Call:
## gmnl(formula = f1, data = dt, model = "lc", Q = q, panel = TRUE,
##     method = "bhhh", iterlim = 5000)
##
## Frequencies of categories:
##
##        1        2        3        4        5        6
## 0.192868 0.272962 0.158307 0.243260 0.060815 0.071787
##
## The estimation took: 0h:2m:18s
##
## Coefficients:
##                                                    Estimate  Std. Error  z-value  Pr(>|z|)
## class.1.I                                         0.93491282  0.29950199   3.1216 0.0017990 **
## class.1.price                                    -0.13301316  0.02812733  -4.7290 2.257e-06 ***
## class.1.location_EU                              -0.26789962  0.30160634  -0.8882 0.3744102
## class.1.location_UK                              -0.13757511  0.30802181  -0.4466 0.6551344
## class.1.certificate_NGO                          -0.52626124  0.29546792  -1.7811 0.0748943 .
## class.1.certificate_UK                            0.22597339  0.33375718   0.6771 0.4983683
## class.1.project_renewable                        -0.18084439  0.31575655  -0.5727 0.5668251
## class.1.project_landfill                         -0.60072841  0.46240724  -1.2991 0.1938984
## class.1.project_manure                           -0.47129605  0.37074828  -1.2712 0.2036567
## class.1.price:co2_value                          -0.06197079  0.01103819  -5.6142 1.975e-08 ***
## class.1.price:framing_effectconsequence          -0.41421570  0.10503356  -3.9437 8.025e-05 ***
## class.1.price:framing_effectMetOffice             0.00820898  0.02978220   0.2756 0.7828294
## class.1.price:framing_effectUN                    0.07759499  0.03200208   2.4247 0.0153216 *
## class.1.location_EU:co2_value                    -0.50197199  0.12607206  -3.9816 6.844e-05 ***
## class.1.location_EU:framing_effectconsequence    -1.46765008  0.58029861  -2.5291 0.0114346 *
## class.1.location_EU:framing_effectMetOffice      -0.00245198  0.31285898  -0.0078 0.9937468
## class.1.location_EU:framing_effectUN              0.67170779  0.37626769   1.7852 0.0742312 .
## class.1.location_UK:co2_value                     0.11179022  0.13104250   0.8531 0.3936129
## class.1.location_UK:framing_effectconsequence     1.41364758  0.65989897   2.1422 0.0321759 *
## class.1.location_UK:framing_effectMetOffice       0.58078003  0.31414304   1.8488 0.0644902 .
## class.1.location_UK:framing_effectUN              0.53462603  0.33626351   1.5899 0.1118569
## class.1.certificate_NGO:co2_value                 0.11076307  0.10279841   1.0775 0.2812666
## class.1.certificate_NGO:framing_effectconsequence 0.73096268  0.46881158   1.5592 0.1189533
## class.1.certificate_NGO:framing_effectMetOffice   0.16831937  0.30808470   0.5463 0.5848314
## class.1.certificate_NGO:framing_effectUN          0.25631533  0.33237047   0.7712 0.4406041
## class.1.certificate_UK:co2_value                  0.15549474  0.14620484   1.0635 0.2875370
## class.1.certificate_UK:framing_effectconsequence  2.64095067  0.99853229   2.6448 0.0081731 **
## class.1.certificate_UK:framing_effectMetOffice    0.08767646  0.33704333   0.2601 0.7947603
## class.1.certificate_UK:framing_effectUN           0.01474483  0.38819659   0.0380 0.9697013
## class.1.project_renewable:co2_value              -0.34748220  0.13167445  -2.6389 0.0083163 **
## class.1.project_renewable:framing_effectconsequence -2.34183888  0.80008053  -2.9270 0.0034224 **
## class.1.project_renewable:framing_effectMetOffice  0.00048447  0.34042585   0.0014 0.9988645
## class.1.project_renewable:framing_effectUN         0.84817405  0.34909027   2.4297 0.0151126 *
## class.1.project_landfill:co2_value                -0.06490451  0.21742185  -0.2985 0.7653072
## class.1.project_landfill:framing_effectconsequence -0.47033812  0.65649764  -0.7164 0.4737226
## class.1.project_landfill:framing_effectMetOffice   0.24578345  0.46252383   0.5314 0.5951442
## class.1.project_landfill:framing_effectUN          0.42166512  0.47540490   0.8870 0.3751004
## class.1.project_manure:co2_value                   0.18562217  0.12930848   1.4355 0.1511450
```

```
## class.1.project_manure:framing_effectconsequence    -0.57002009  0.61457709  -0.9275 0.3536671
## class.1.project_manure:framing_effectMetOffice       0.24229893  0.38725424   0.6257 0.5315220
## class.1.project_manure:framing_effectUN              0.12770044  0.42925533   0.2975 0.7660902
## class.2.I                                           -2.44343672  0.13502879 -18.0957 < 2.2e-16 ***
## class.2.price                                       -0.17001480  0.01631934 -10.4180 < 2.2e-16 ***
## class.2.location_EU                                  0.00411192  0.14786648   0.0278 0.9778150
## class.2.location_UK                                 -0.76101005  0.13647254  -5.5763 2.457e-08 ***
## class.2.certificate_NGO                              0.44521879  0.18953590   2.3490 0.0188242 *
## class.2.certificate_UK                               0.99754422  0.20017246   4.9834 6.247e-07 ***
## class.2.project_renewable                            0.95981443  0.20366037   4.7128 2.443e-06 ***
## class.2.project_landfill                            -0.07199254  0.18403067  -0.3912 0.6956504
## class.2.project_manure                              -0.61913265  0.18630902  -3.3231 0.0008901 ***
## class.2.price:co2_value                              0.00681815  0.00323897   2.1050 0.0352885 *
## class.2.price:framing_effectconsequence             -0.03203964  0.02106695  -1.5208 0.1282978
## class.2.price:framing_effectMetOffice                0.07374143  0.01520333   4.8503 1.232e-06 ***
## class.2.price:framing_effectUN                       0.02124769  0.01784582   1.1906 0.2338005
## class.2.location_EU:co2_value                       -0.10385518  0.03828943  -2.7124 0.0066803 **
## class.2.location_EU:framing_effectconsequence        0.15060570  0.19773340   0.7617 0.4462627
## class.2.location_EU:framing_effectMetOffice         -0.65948526  0.15142058  -4.3553 1.329e-05 ***
## class.2.location_EU:framing_effectUN                -0.74511870  0.18599427  -4.0061 6.172e-05 ***
## class.2.location_UK:co2_value                       -0.11926238  0.03731753  -3.1959 0.0013940 **
## class.2.location_UK:framing_effectconsequence        0.91980992  0.17151947   5.3627 8.198e-08 ***
## class.2.location_UK:framing_effectMetOffice          0.01148416  0.14155518   0.0811 0.9353397
## class.2.location_UK:framing_effectUN                 0.13648422  0.16501821   0.8271 0.4081884
## class.2.certificate_NGO:co2_value                   -0.12523153  0.04881946  -2.5652 0.0103117 *
## class.2.certificate_NGO:framing_effectconsequence    0.46393518  0.24029764   1.9307 0.0535240 .
## class.2.certificate_NGO:framing_effectMetOffice     -0.87216367  0.19800859  -4.4047 1.059e-05 ***
## class.2.certificate_NGO:framing_effectUN            -0.39394530  0.24325191  -1.6195 0.1053408
## class.2.certificate_UK:co2_value                    -0.05101603  0.03893106  -1.3104 0.1900539
## class.2.certificate_UK:framing_effectconsequence     0.61884645  0.28707070   2.1557 0.0311049 *
## class.2.certificate_UK:framing_effectMetOffice      -0.61669362  0.19859699  -3.1053 0.0019012 **
## class.2.certificate_UK:framing_effectUN             -0.32899817  0.22976397  -1.4319 0.1521735
## class.2.project_renewable:co2_value                  0.06398402  0.04531591   1.4120 0.1579632
## class.2.project_renewable:framing_effectconsequence -0.18128845  0.27915812  -0.6494 0.5160725
## class.2.project_renewable:framing_effectMetOffice   -1.09244643  0.20668077  -5.2857 1.252e-07 ***
## class.2.project_renewable:framing_effectUN          -0.40674477  0.25436883  -1.5990 0.1098127
## class.2.project_landfill:co2_value                   0.03034245  0.04502547   0.6739 0.5003779
## class.2.project_landfill:framing_effectconsequence  -0.38777745  0.23151451  -1.6750 0.0939422 .
## class.2.project_landfill:framing_effectMetOffice    -0.56757497  0.18973484  -2.9914 0.0027769 **
## class.2.project_landfill:framing_effectUN            0.31108269  0.23708786   1.3121 0.1894868
## class.2.project_manure:co2_value                    -0.12415808  0.05116767  -2.4265 0.0152455 *
## class.2.project_manure:framing_effectconsequence     0.39251102  0.22111336   1.7752 0.0758719 .
## class.2.project_manure:framing_effectMetOffice      -0.28734360  0.19610194  -1.4653 0.1428454
## class.2.project_manure:framing_effectUN              0.40761864  0.22876390   1.7818 0.0747768 .
## class.3.I                                            0.03489706  0.05956543   0.5859 0.5579689
## class.3.price                                        0.00337758  0.00568987   0.5936 0.5527715
## class.3.location_EU                                  0.11711902  0.06576252   1.7809 0.0749224 .
## class.3.location_UK                                  0.63999952  0.06852087   9.3402 < 2.2e-16 ***
## class.3.certificate_NGO                              0.06467655  0.07008464   0.9228 0.3560933
## class.3.certificate_UK                               0.25603530  0.07275109   3.5193 0.0004326 ***
## class.3.project_renewable                            0.25531176  0.07785290   3.2794 0.0010402 **
## class.3.project_landfill                            -0.34558864  0.08948905  -3.8618 0.0001126 ***
## class.3.project_manure                              -0.21932096  0.08503452  -2.5792 0.0099030 **
## class.3.price:co2_value                             -0.00128335  0.00156926  -0.8178 0.4134665
```

```
## class.3.price:framing_effectconsequence              0.00103962  0.00660980   0.1573 0.8750208
## class.3.price:framing_effectMetOffice               -0.01523893  0.00554028  -2.7506 0.0059492 **
## class.3.price:framing_effectUN                      -0.00587870  0.00635099  -0.9256 0.3546357
## class.3.location_EU:co2_value                        0.05744765  0.02037925   2.8189 0.0048184 **
## class.3.location_EU:framing_effectconsequence       -0.11702320  0.08374969  -1.3973 0.1623242
## class.3.location_EU:framing_effectMetOffice         -0.05006687  0.06862186  -0.7296 0.4656315
## class.3.location_EU:framing_effectUN                 0.02117966  0.08032398   0.2637 0.7920281
## class.3.location_UK:co2_value                       -0.07380883  0.02023556  -3.6475 0.0002648 ***
## class.3.location_UK:framing_effectconsequence       -0.46288496  0.08665611  -5.3416 9.211e-08 ***
## class.3.location_UK:framing_effectMetOffice          0.01304941  0.07334704   0.1779 0.8587911
## class.3.location_UK:framing_effectUN                -0.13071717  0.08294268  -1.5760 0.1150272
## class.3.certificate_NGO:co2_value                   -0.04253414  0.02163486  -1.9660 0.0492986 *
## class.3.certificate_NGO:framing_effectconsequence   -0.07261584  0.09004715  -0.8064 0.4200006
## class.3.certificate_NGO:framing_effectMetOffice      0.27754591  0.07478347   3.7113 0.0002062 ***
## class.3.certificate_NGO:framing_effectUN             0.18687931  0.08613028   2.1697 0.0300274 *
## class.3.certificate_UK:co2_value                    -0.01970934  0.02202853  -0.8947 0.3709374
## class.3.certificate_UK:framing_effectconsequence    -0.12913475  0.09217252  -1.4010 0.1612107
## class.3.certificate_UK:framing_effectMetOffice       0.17894306  0.07653210   2.3381 0.0193798 *
## class.3.certificate_UK:framing_effectUN              0.24614985  0.08936606   2.7544 0.0058800 **
## class.3.project_renewable:co2_value                 -0.07470769  0.02235010  -3.3426 0.0008299 ***
## class.3.project_renewable:framing_effectconsequence  0.05549296  0.09762365   0.5684 0.5697378
## class.3.project_renewable:framing_effectMetOffice    0.06547472  0.08009311   0.8175 0.4136527
## class.3.project_renewable:framing_effectUN           0.09094448  0.09196528   0.9889 0.3227120
## class.3.project_landfill:co2_value                   0.01029564  0.02663912   0.3865 0.6991369
## class.3.project_landfill:framing_effectconsequence   0.24488636  0.11394096   2.1492 0.0316155 *
## class.3.project_landfill:framing_effectMetOffice     0.10546358  0.09452303   1.1157 0.2645314
## class.3.project_landfill:framing_effectUN           -0.03763644  0.10808894  -0.3482 0.7276909
## class.3.project_manure:co2_value                     0.05233896  0.02578545   2.0298 0.0423782 *
## class.3.project_manure:framing_effectconsequence     0.14339547  0.10803896   1.3273 0.1844237
## class.3.project_manure:framing_effectMetOffice       0.29754609  0.09074768   3.2788 0.0010424 **
## class.3.project_manure:framing_effectUN              0.24790486  0.10380416   2.3882 0.0169312 *
## class.4.I                                           -3.86197929  0.10750149 -35.9249 < 2.2e-16 ***
## class.4.price                                       -0.02268608  0.00926321  -2.4491 0.0143233 *
## class.4.location_EU                                  0.10705932  0.10349180   1.0345 0.3009158
## class.4.location_UK                                  0.39607308  0.09833092   4.0280 5.626e-05 ***
## class.4.certificate_NGO                              0.53933524  0.09822232   5.4910 3.997e-08 ***
## class.4.certificate_UK                               0.73211690  0.11390229   6.4276 1.296e-10 ***
## class.4.project_renewable                            0.10265946  0.11168833   0.9192 0.3580118
## class.4.project_landfill                            -0.63063714  0.13882817  -4.5426 5.557e-06 ***
## class.4.project_manure                              -0.37683191  0.12547149  -3.0033 0.0026705 **
## class.4.price:co2_value                             -0.00764752  0.00306660  -2.4938 0.0126379 *
## class.4.price:framing_effectconsequence             -0.00712198  0.01062107  -0.6706 0.5025059
## class.4.price:framing_effectMetOffice                0.00115340  0.00957836   0.1204 0.9041524
## class.4.price:framing_effectUN                      -0.01383465  0.01043882  -1.3253 0.1850692
## class.4.location_EU:co2_value                       -0.03677785  0.03636723  -1.0113 0.3118772
## class.4.location_EU:framing_effectconsequence        0.01511458  0.11875803   0.1273 0.8987250
## class.4.location_EU:framing_effectMetOffice          0.04798024  0.10788603   0.4447 0.6565143
## class.4.location_EU:framing_effectUN                -0.05617214  0.11885485  -0.4726 0.6364906
## class.4.location_UK:co2_value                        0.01134849  0.03599215   0.3153 0.7525305
## class.4.location_UK:framing_effectconsequence        0.05674605  0.11687227   0.4855 0.6272940
## class.4.location_UK:framing_effectMetOffice         -0.05057450  0.10374814  -0.4875 0.6259226
## class.4.location_UK:framing_effectUN                 0.01428942  0.11924078   0.1198 0.9046126
## class.4.certificate_NGO:co2_value                   -0.08167483  0.03547650  -2.3022 0.0213226 *
## class.4.certificate_NGO:framing_effectconsequence   -0.03326725  0.11496389  -0.2894 0.7722972
```

```
## class.4.certificate_NGO:framing_effectMetOffice     -0.16516494  0.10389199  -1.5898 0.1118854
## class.4.certificate_NGO:framing_effectUN            -0.15858245  0.11874001  -1.3355 0.1816985
## class.4.certificate_UK:co2_value                    -0.04599070  0.04183172  -1.0994 0.2715841
## class.4.certificate_UK:framing_effectconsequence    -0.18368780  0.13167757  -1.3950 0.1630213
## class.4.certificate_UK:framing_effectMetOffice      -0.09021296  0.11929826  -0.7562 0.4495312
## class.4.certificate_UK:framing_effectUN             -0.25885996  0.13360316  -1.9375 0.0526808 .
## class.4.project_renewable:co2_value                  0.02761830  0.04034589   0.6845 0.4936353
## class.4.project_renewable:framing_effectconsequence -0.00136319  0.12845506  -0.0106 0.9915329
## class.4.project_renewable:framing_effectMetOffice   -0.11048382  0.11646802  -0.9486 0.3428142
## class.4.project_renewable:framing_effectUN           0.14002259  0.13203958   1.0605 0.2889357
## class.4.project_landfill:co2_value                   0.09072550  0.04911887   1.8471 0.0647385 .
## class.4.project_landfill:framing_effectconsequence  -0.12342370  0.15860970  -0.7782 0.4364748
## class.4.project_landfill:framing_effectMetOffice    -0.21850955  0.14170483  -1.5420 0.1230724
## class.4.project_landfill:framing_effectUN           -0.02583993  0.16129189  -0.1602 0.8727188
## class.4.project_manure:co2_value                     0.05187437  0.04431592   1.1706 0.2417763
## class.4.project_manure:framing_effectconsequence    -0.06362698  0.14619326  -0.4352 0.6633990
## class.4.project_manure:framing_effectMetOffice       0.00969077  0.13279813   0.0730 0.9418271
## class.4.project_manure:framing_effectUN             -0.14273028  0.14764287  -0.9667 0.3336808
## (class)2                                             0.40326138  0.03892915  10.3589 < 2.2e-16 ***
## (class)3                                             1.27127005  0.03335901  38.1087 < 2.2e-16 ***
## (class)4                                             1.55010850  0.03213413  48.2387 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Optimization of log-likelihood by BHHH maximisation
## Log Likelihood: -16296
## Number of observations: 12760
## Number of iterations: 113
## Exit of MLE: successive function values within relative tolerance limit (reltol)

##      AIC      BIC
## 32926.45 34171.28
```

The class membership probabilities are:

```
##    Class_1    Class_2    Class_3    Class_4
## 0.09281554 0.13891684 0.33092249 0.43734512
```

The effects of demographics are:

```
## $Class_2
##                                 coef        se           z      p_val
## (Intercept)                 0.18961199 0.5777249  0.32820465 0.74275693
## age_group35_54              0.08982129 0.3011930  0.29821834 0.76553653
## age_group55_               -0.20755904 0.3381053 -0.61388867 0.53928890
## is_women                    0.11357565 0.2476398  0.45863238 0.64649818
## diet_typeFlexitarian       -0.08472921 0.3366959 -0.25164907 0.80131233
## diet_typeVegan_Vegetarian   0.25879796 0.4663583  0.55493379 0.57893995
## education_levelDegree      -0.13561100 0.2780009 -0.48780778 0.62568600
## education_levelPostgraduate 0.02813733 0.3541981  0.07943954 0.93668302
## hh_size                     0.03493024 0.1387731  0.25170762 0.80126707
## income_level30_50k          0.25311800 0.2911211  0.86945950 0.38459585
## income_level50_            -0.18657428 0.3283436 -0.56822872 0.56987967
```

```
## n_children                  -0.05636437 0.1955410 -0.28824834 0.77315665
## is_shopper                   0.52282270 0.3073336  1.70115673 0.08891356
## where_liveRuralarea         -0.02684468 0.4094247 -0.06556684 0.94772269
## where_liveTownorsuburb      -0.46631408 0.3234287 -1.44178318 0.14936355
##
## $Class_3
##                                    coef        se           z      p_val
## (Intercept)                   1.01254944 0.5053865  2.00351520 0.04512202
## age_group35_54                0.13347585 0.2667834  0.50031539 0.61685302
## age_group55_                  0.06326645 0.2945461  0.21479302 0.82992870
## is_women                      0.13753404 0.2170218  0.63373361 0.52625469
## diet_typeFlexitarian          0.22370593 0.2888025  0.77459845 0.43857697
## diet_typeVegan_Vegetarian     0.37556575 0.4178818  0.89873677 0.36879289
## education_levelDegree        -0.27207858 0.2426838 -1.12112387 0.26223514
## education_levelPostgraduate -0.31432279 0.3164033 -0.99342450 0.32050313
## hh_size                       0.07955556 0.1220602  0.65177296 0.51454765
## income_level30_50k            0.48765094 0.2578450  1.89125596 0.05859018
## income_level50_               0.23072792 0.2810215  0.82103306 0.41162744
## n_children                   -0.01210209 0.1709181 -0.07080635 0.94355188
## is_shopper                    0.20907560 0.2575477  0.81179357 0.41691009
## where_liveRuralarea          -0.36117513 0.3696592 -0.97704894 0.32854493
## where_liveTownorsuburb       -0.49192081 0.2876992 -1.70984397 0.08729473
##
## $Class_4
##                                    coef        se          z      p_val
## (Intercept)                   1.22662184 0.4926588  2.4897998 0.01278151
## age_group35_54                0.11683214 0.2608767  0.4478443 0.65426556
## age_group55_                  0.24822526 0.2850002  0.8709653 0.38377308
## is_women                      0.04018989 0.2107522  0.1906974 0.84876271
## diet_typeFlexitarian         -0.11841969 0.2862535 -0.4136882 0.67910245
## diet_typeVegan_Vegetarian     0.19630185 0.4116360  0.4768822 0.63344604
## education_levelDegree        -0.17665350 0.2354536 -0.7502689 0.45309279
## education_levelPostgraduate -0.16190327 0.3061758 -0.5287918 0.59694990
## hh_size                       0.10758422 0.1188829  0.9049596 0.36548681
## income_level30_50k            0.40740149 0.2512431  1.6215433 0.10490118
## income_level50_               0.23352192 0.2723584  0.8574066 0.39122019
## n_children                   -0.07196474 0.1673134 -0.4301193 0.66710886
## is_shopper                    0.20576885 0.2489528  0.8265377 0.40849914
## where_liveRuralarea          -0.33366663 0.3616905 -0.9225198 0.35625752
## where_liveTownorsuburb       -0.37794358 0.2822510 -1.3390335 0.18055976
```

Based on BIC, the optimal number of classes is 3. Also, we could not estiamte a model with more than 4 classes due to lack of variation, i.e., singular hessian matrix.