## Appendix V
## Three-person budget sets econometric analysis

The solution to the subutility $w_s(\pi_A, \pi_B)$ maximization problem is given by

$$\pi_A(p_o, m_o) = \left[\frac{g'}{(p_B/p_A)^{r'} + g'}\right]\frac{m_o}{p_A}$$

where $r' = -\rho'/(1-\rho')$, $g' = [\alpha'/(1-\alpha')]^{1/(1-\rho')}$ and $m_o = p_o\pi_o$ is the total expenditure on tokens given to *others*. The solution to the macro utility $v_s(\pi_s, w_s(\pi_o))$ maximization problem is then given by

$$\pi_s(p, m) = \left[\frac{g}{q^r + g}\right]\frac{m}{p_s}$$

where $r = -\rho/(1-\rho)$, $g = [\alpha/(1-\alpha)]^{1/(1-\rho)}$ and $q$ is a *weighted relative price of giving* defined by

$$q = \frac{(p_A/p_s) + (p_B/p_s)\left[(\alpha'/(1-\alpha'))(p_B/p_A)\right]^{1/(\rho'-1)}}{\left[\alpha' + (1-\alpha')\left[(\alpha'/(1-\alpha'))(p_B/p_A)\right]^{\rho'/(\rho'-1)}\right]^{1/\rho'}}.$$

This generates the following individual-level two-stage econometric specification for each subject $n$:

$$\frac{\pi^t_{A,n}}{m^t_{O,n}/p^t_{A,n}} = \frac{g'_n}{\left(p^t_{B,n}/p^t_{A,n}\right)^{r'_n} + g'_n} + \epsilon'^t_n \tag{1}$$

and

$$\frac{\pi^t_{s,n}}{m^t_n/p^t_s} = \frac{g_n}{(q^t_n)^{r_n} + g_n} + \epsilon^t_n \tag{2}$$

where $\epsilon^t_n$ and $\epsilon'^t_n$ are assumed to be distributed normally with mean zero and variance $\sigma^2_n$ and $\sigma'^2_n$ respectively. Note that the demands (1) and (2) are estimated as budget shares, which are bounded between zero and one, with an *i.i.d.* error term. Using nonlinear tobit maximum likelihood estimation, we first generate estimates of $\hat{g}'_n$ and $\hat{r}'_n$ using (1) and use this to infer the values of the underlying subutility parameters, $\hat{\alpha}'_n$ and $\hat{\rho}'_n$, and the elasticity of social substitution $\hat{\sigma}'_n$. Then, the estimated parameters for the subutility function are employed in estimating the parameters $\hat{g}_n$ and $\hat{r}_n$ using (2), which are then used to infer the values of the parameters of the macro utility

function $\hat{\alpha}_n$ and $\hat{\rho}_n$ and the elasticity of altruistic substitution $\hat{\sigma}_n$. Table AV1 presents the results of the estimations $\hat{a}_n$, $\hat{\rho}_n$, $\hat{\sigma}_n$, $\hat{a}'_n$, $\hat{\rho}'_n$ and $\hat{\sigma}'_n$ for the 29 subjects (44.6 percent) for whom we need to recover the underlying distributional preferences by estimating the CES model.

*[Table AV1 here]*

Table AV1. Results of individual-level three-person CES demand function estimation (macro utility function)

| ID | $\rho$ | $\alpha$ | $\sigma$ | $g$ | sd($g$) | $r$ | sd($r$) |
|---|---|---|---|---|---|---|---|
| 136 | 0.097 | 0.405 | 0.093 | 0.652 | 0.053 | -0.107 | 0.086 |
| 148 | -2.336 | 0.999 | 0.116 | 7.734 | 1.877 | 0.700 | 0.195 |
| 151 | 0.375 | 0.472 | 0.198 | 0.837 | 0.133 | -0.600 | 0.195 |
| 152 | 0.576 | 0.537 | 0.173 | 1.420 | 0.255 | -1.360 | 0.238 |
| 156 | 0.676 | 0.423 | 0.243 | 0.385 | 0.120 | -2.082 | 0.465 |
| 157 | 0.174 | 0.525 | 0.113 | 1.130 | 0.109 | -0.210 | 0.094 |
| 159 | 0.205 | 0.875 | 0.069 | 11.565 | 2.186 | -0.258 | 0.207 |
| 161 | -0.338 | 0.914 | 0.088 | 5.871 | 1.145 | 0.253 | 0.159 |
| 163 | 0.795 | 0.500 | 0.299 | 1.004 | 0.473 | -3.877 | 0.915 |
| 165 | 0.395 | 0.553 | 0.178 | 1.425 | 0.244 | -0.652 | 0.174 |
| 166 | -0.461 | 0.602 | 0.173 | 1.328 | 0.194 | 0.316 | 0.139 |
| 170 | 0.534 | 0.384 | 0.173 | 0.362 | 0.090 | -1.146 | 0.289 |
| 172 | 0.349 | 0.504 | 0.132 | 1.026 | 0.140 | -0.537 | 0.153 |
| 173 | -0.425 | 0.519 | 0.135 | 1.055 | 0.127 | 0.298 | 0.109 |
| 174 | 0.594 | 0.580 | 0.150 | 2.221 | 0.333 | -1.463 | 0.228 |
| 175 | 0.133 | 0.403 | 0.125 | 0.637 | 0.066 | -0.153 | 0.110 |
| 176 | 0.990 | 0.688 | 0.135 | 7.9E+33 | 8.0E+34 | -97.474 | 48.066 |
| 177 | -0.698 | 0.678 | 0.097 | 1.551 | 0.153 | 0.411 | 0.100 |
| 179 | -20.243 | 1.000 | 0.132 | 6.362 | 1.514 | 0.953 | 0.202 |
| 183 | 0.312 | 0.462 | 0.129 | 0.800 | 0.093 | -0.454 | 0.144 |
| 185 | -0.282 | 0.335 | 0.161 | 0.586 | 0.085 | 0.220 | 0.168 |
| 186 | 0.304 | 0.861 | 0.049 | 13.723 | 2.085 | -0.437 | 0.177 |
| 187 | 0.114 | 0.770 | 0.113 | 3.917 | 0.708 | -0.129 | 0.186 |
| 191 | -0.295 | 0.553 | 0.143 | 1.179 | 0.131 | 0.228 | 0.116 |
| 192 | 0.642 | 0.636 | 0.159 | 4.772 | 1.235 | -1.793 | 0.374 |
| 193 | 0.481 | 0.408 | 0.208 | 0.488 | 0.126 | -0.925 | 0.288 |
| 194 | 0.646 | 0.381 | 0.300 | 0.253 | 0.124 | -1.823 | 0.540 |
| 197 | -0.914 | 0.607 | 0.082 | 1.255 | 0.099 | 0.478 | 0.073 |
| 198 | 0.581 | 0.742 | 0.076 | 12.463 | 2.889 | -1.387 | 0.231 |

(sub utility function)

| ID | $\rho'$ | $\alpha'$ | $\sigma'$ | $g'$ | sd($g'$) | $r'$ | sd($r'$) |
|---|---|---|---|---|---|---|---|
| 136 | 0.121 | 0.531 | 0.134 | 1.153 | 0.095 | -0.137 | 0.102 |
| 148 | 0.544 | 0.514 | 0.224 | 1.127 | 0.209 | -1.195 | 0.319 |
| 151 | 0.655 | 0.537 | 0.255 | 1.532 | 0.315 | -1.899 | 0.461 |
| 152 | 0.247 | 0.476 | 0.407 | 0.880 | 0.285 | -0.328 | 0.435 |
| 156 | 0.562 | 0.497 | 0.241 | 0.975 | 0.171 | -1.281 | 0.295 |
| 157 | -0.079 | 0.503 | 0.118 | 1.012 | 0.070 | 0.074 | 0.082 |
| 159 | 0.400 | 0.426 | 0.320 | 0.610 | 0.187 | -0.666 | 0.418 |
| 161 | -10.891 | 0.607 | 0.136 | 1.037 | 0.095 | 0.916 | 0.145 |
| 163 | 0.889 | 0.442 | 0.397 | 0.123 | 0.299 | -8.043 | 7.124 |
| 165 | 0.427 | 0.518 | 0.241 | 1.134 | 0.195 | -0.746 | 0.274 |
| 166 | -0.055 | 0.462 | 0.174 | 0.866 | 0.089 | 0.053 | 0.146 |
| 170 | 0.341 | 0.510 | 0.121 | 1.060 | 0.084 | -0.516 | 0.101 |
| 172 | 0.626 | 0.504 | 0.117 | 1.049 | 0.093 | -1.671 | 0.179 |
| 173 | -0.269 | 0.563 | 0.198 | 1.220 | 0.146 | 0.212 | 0.125 |
| 174 | 0.636 | 0.470 | 0.194 | 0.719 | 0.134 | -1.746 | 0.312 |
| 175 | 0.173 | 0.485 | 0.110 | 0.930 | 0.060 | -0.210 | 0.080 |
| 176 | 0.926 | 0.453 | 0.309 | 0.079 | 0.737 | -12.580 | 37.706 |
| 177 | -9.359 | 0.612 | 0.031 | 1.045 | 0.020 | 0.903 | 0.036 |
| 179 | -5.123 | 0.521 | 0.050 | 1.014 | 0.039 | 0.837 | 0.058 |
| 183 | 0.341 | 0.521 | 0.123 | 1.137 | 0.087 | -0.517 | 0.110 |
| 185 | 0.099 | 0.496 | 0.206 | 0.982 | 0.118 | -0.110 | 0.149 |
| 186 | 0.247 | 0.564 | 0.234 | 1.411 | 0.331 | -0.328 | 0.329 |
| 187 | 0.452 | 0.503 | 0.165 | 1.026 | 0.119 | -0.825 | 0.152 |
| 191 | -1.714 | 0.522 | 0.071 | 1.033 | 0.045 | 0.632 | 0.060 |
| 192 | 0.421 | 0.415 | 0.263 | 0.552 | 0.190 | -0.728 | 0.487 |
| 193 | -0.364 | 0.434 | 0.220 | 0.823 | 0.112 | 0.267 | 0.200 |
| 194 | 0.646 | 0.497 | 0.273 | 0.963 | 0.208 | -1.822 | 0.427 |
| 197 | -2.390 | 0.593 | 0.068 | 1.117 | 0.048 | 0.705 | 0.062 |
| 198 | 0.978 | 0.502 | 0.019 | 1.452 | 0.153 | -44.151 | 8.534 |