Confronting Theory with Experimental Data and vice versa

European University Institute

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Lectures 3-4: Distributional preferences

Background

- People often sacrifice their own payoffs in order to increase the payoffs of *anonymous* others.

- They do so even in circumstances that do not engage reciprocity motivations or strategic behavior.

- This has led economists to begin the systematic study of the *distributional preferences* that govern such behavior.

Social preferences theories

- *Social welfare*
  - persons pursue an aggregate of their own payoffs and those of others.
- *Inequality aversion*
  - persons care about differences between their own and others' payoffs.

Template for analysis

- The *dictator game* eliminates strategic behavior and reciprocity motivations and implicates only distributive preferences.

- Choices made by a person $self$ that have consequences for her own payoff and the payoffs of an anonymous $other$.

- Throughout, we denote persons $self$ and $other$ by S and O, respectively, and the associated monetary payoffs by π_S and a π_O.

Given a *nondegenerate* utility function

$$U_S = u_S(\pi_S, \pi_O)$$

that captures the possibility of giving, person $self$ is *selfish* when for any π and π^0

$$u_S(\pi) \geq u_S(\pi^0) \text{ if and only if } \pi_S \geq \pi^0_S$$

and otherwise displays some form of *altruism*.

Prototypical social preferences

Charness and Rabin (*QJE*, 2002) propose the following simple formulation

$$U_S(\pi_S, \pi_O) \equiv (\rho r + \sigma q)\pi_O + (1 - \rho r - \sigma q)\pi_S$$

where

$r = 1$ ($s = 1$) if $\pi_s > \pi_o$ ($\pi_s < \pi_o$) and zero otherwise.

Increasing the ratio ρ/σ indicates an increase in concerns for increasing aggregate payoffs rather than reducing differences in payoffs.

(i) *competitive* preferences ($\sigma \leq \rho < 0$) – utility increases in the difference $\pi_S - \pi_O$

(ii) *narrow self-interest* or *selfish* preferences ($\sigma = \rho = 0$) – utility depends only on π_S

(iii) *difference aversion* preferences ($\sigma < 0 < \rho < 1$) – utility is increasing in π_S and decreasing in the difference $\pi_S - \pi_O$

(iv) *social welfare* preferences ($0 < \sigma \leq \rho \leq 1$) – utility is increasing in both π_S and π_O.

Objections and replies

An unpublished working paper concludes

> *This puts the basis of our modeling on unobservable preferences, and raises the specter of extensive ad hoc modeling with a basis primarily in psycho babble.*

Camerer (2003) replies

> *The goal is not to explain every different finding by adjusting the utility function just so; the goal is to find parsimonious utility functions, supported by psychological intuition...*

Experimental design

In a typical dictator game, the problem faced by $self$ is simply allocating a fixed total income between $self$ and $other$.

Person $self$ divides some *endowment* m between $self$ and $other$ in any way he wishes such that

$$\pi_S + \pi_O = m.$$

The dictator game, developed by Andreoni and Miller (*Econometrica*, 2002), allows for m to be spent on π_S and π_O at *price* levels p_S and p_O such that

$$p_S \pi_S + p_O \pi_O = m.$$

This configuration creates *budget sets* over π_S and π_O that allow for the thorough testing for consistency with utility maximization.

Experimental procedures

- A graphical computer interface that allows for the efficient collection of many observations per subject.

- The graphical representation does not force subjects into discrete choices that suggest extreme prototypical preference types.

- It generates a very rich data set well-suited to studying behavior at the level of the individual subject.

Econometric specification

- Our subjects' CCEI scores are sufficiently near one to justify treating the data as utility-generated.

- If choice data satisfy GARP we would ideally like to extract a rationalizing utility function.

- Afriat's theorem tells us that if a rationalizable utility function exists, it can be chosen to be increasing, continuous, and concave.

- The constant elasticity of substitution (CES) utility function is commonly employed in demand analysis.

- The patterns observed in the nonparametric approach suggest that it is appropriate to estimate a CES demand function.

- The CES is useful because attitudes towards giving can be adjusted by means of a single parameter.

The CES utility function is given by

$$U_S = [\alpha(\pi_S)^\rho + (1-\alpha)(\pi_O)^\rho]^{1/\rho}$$

α - the relative weight on $self$ versus $other$.

ρ - the curvature of the altruistic indifference curves.

$\rho > 0$ ($\rho < 0$) indicate preference weighted towards increasing total (reducing differences in) payoffs.

The CES demand function is given by

$$\pi_s(p, m^0) = \frac{A}{p^r + A} m^0$$

where

$$r = -\rho / (\rho - 1)$$

and

$$A = [\alpha / (1 - \alpha)]^{1/(1-\rho)}.$$

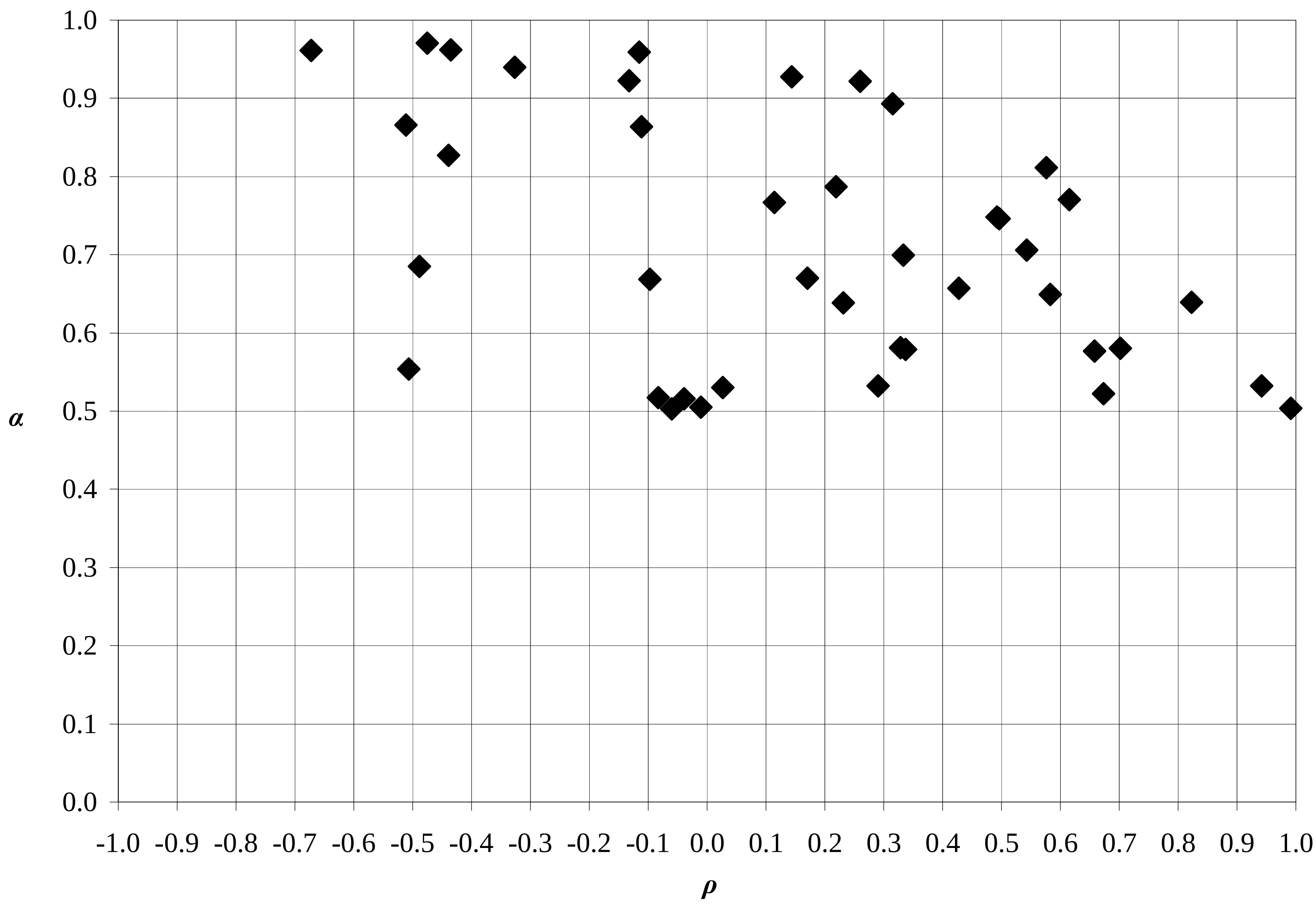
This generates the following individual-level econometric specification for each subject n:

$$\frac{\pi^i_{sn}}{m^{0i}_n} = \frac{A_n}{(p^i_n)^{r_n} + A_n} + \epsilon^i_n$$

where ϵ^i_n is assumed to be distributed normally with mean zero and variance σ^2_n.

Estimate $\hat{A}_n$ and $\hat{r}_n$ using non-linear tobit maximum likelihood, and use this to infer the values of the CES parameters $\hat{\alpha}_n$ and $\hat{\rho}_n$.

Scatterplot of the CES estimates



Distinguishing social preferences from preferences for altruism

- Distributional preferences may be divided into two qualitatively different types which we call *preferences for altruism* and *social preferences*.

- Social preferences and distributional preferences are used interchangeably in the literature and our usage is not quite standard.

- Nevertheless, the distinctions that we draw are straightforward and capture important differences.

- *Preferences for altruism*
  - tradeoffs between the payoffs to $self$ and the payoffs to $others$.
- *Social preferences*
  - tradeoffs between the payoffs to $others$ (i.e. all persons except $self$).

A common assumption used in demand analysis allows for a clear demarcation between social preferences and preferences for altruism:

Independence *For any* π_S, π'_S, *and profiles* $\pi_O = (\pi_A, \pi_B)$ *and* π'_O

$$u_S(\pi_S, \pi_O) > u_S(\pi_S, \pi'_O) \text{ if and only if } u_S(\pi'_S, \pi_O) > u_S(\pi'_S, \pi'_O).$$

If the independence property is satisfied, then the utility function $u_S(\pi_S, \pi_O)$ is (weakly) *separable*.

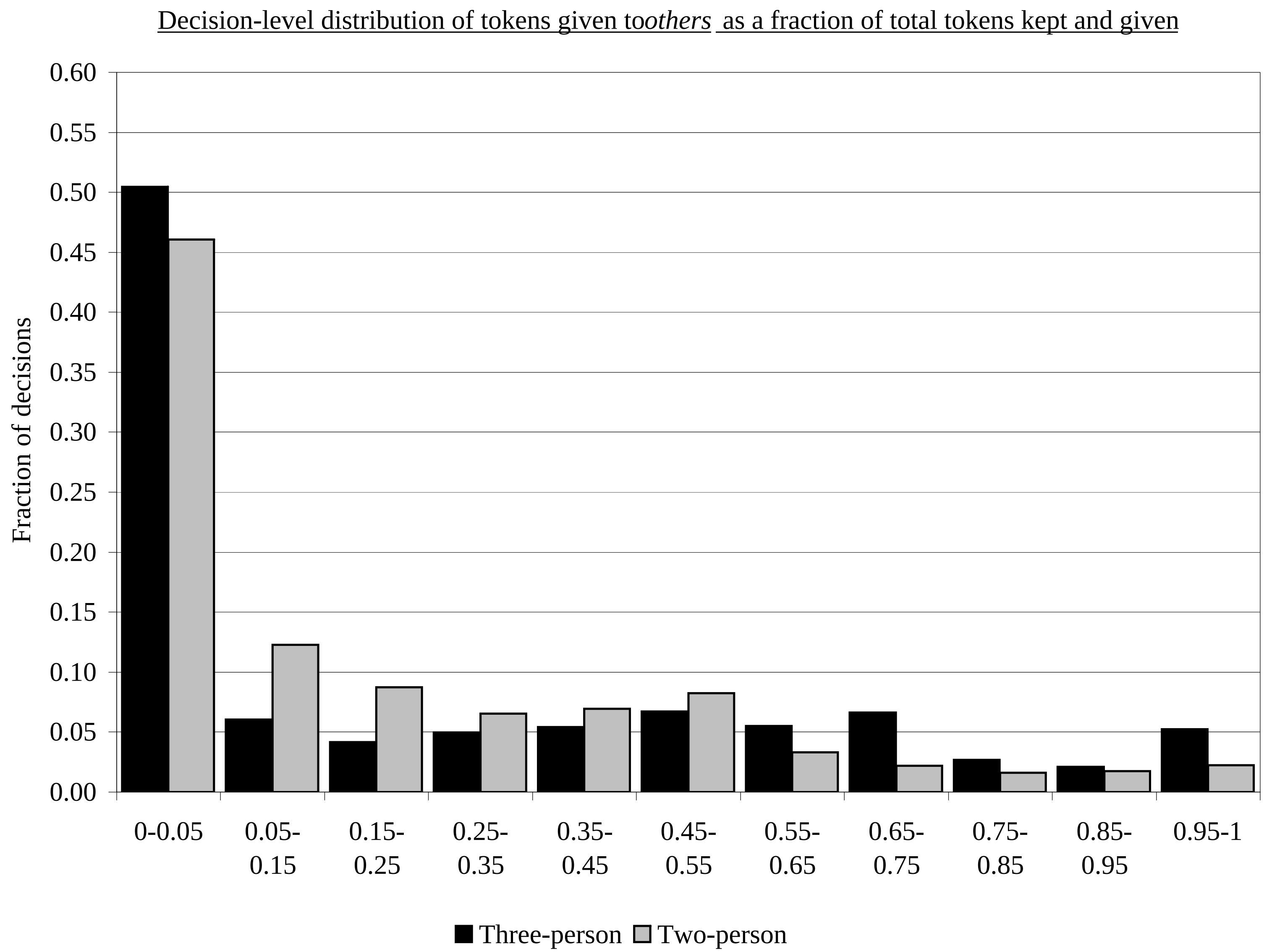
There exists a *subutility* function $w_S(\pi_O)$ and a *macro* function $v_S(\pi_S, w_S)$ with v_S strictly increasing in w_S such that

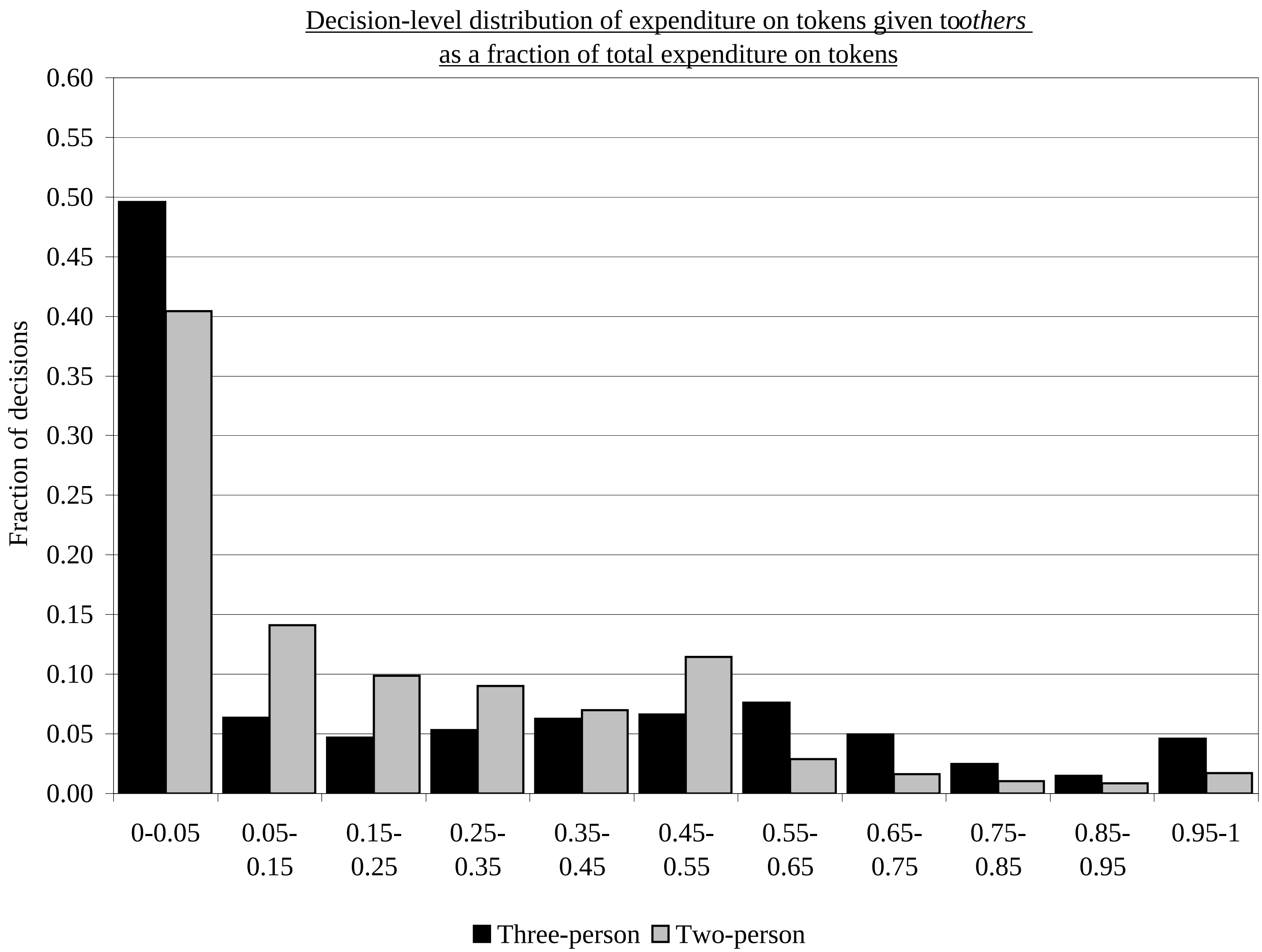
$$u_S(\pi_S, \pi_O) \equiv v_S(\pi_S, w_S(\pi_O)).$$

- This formulation makes it possible to represent distributional preferences in a particularly convenient manner.

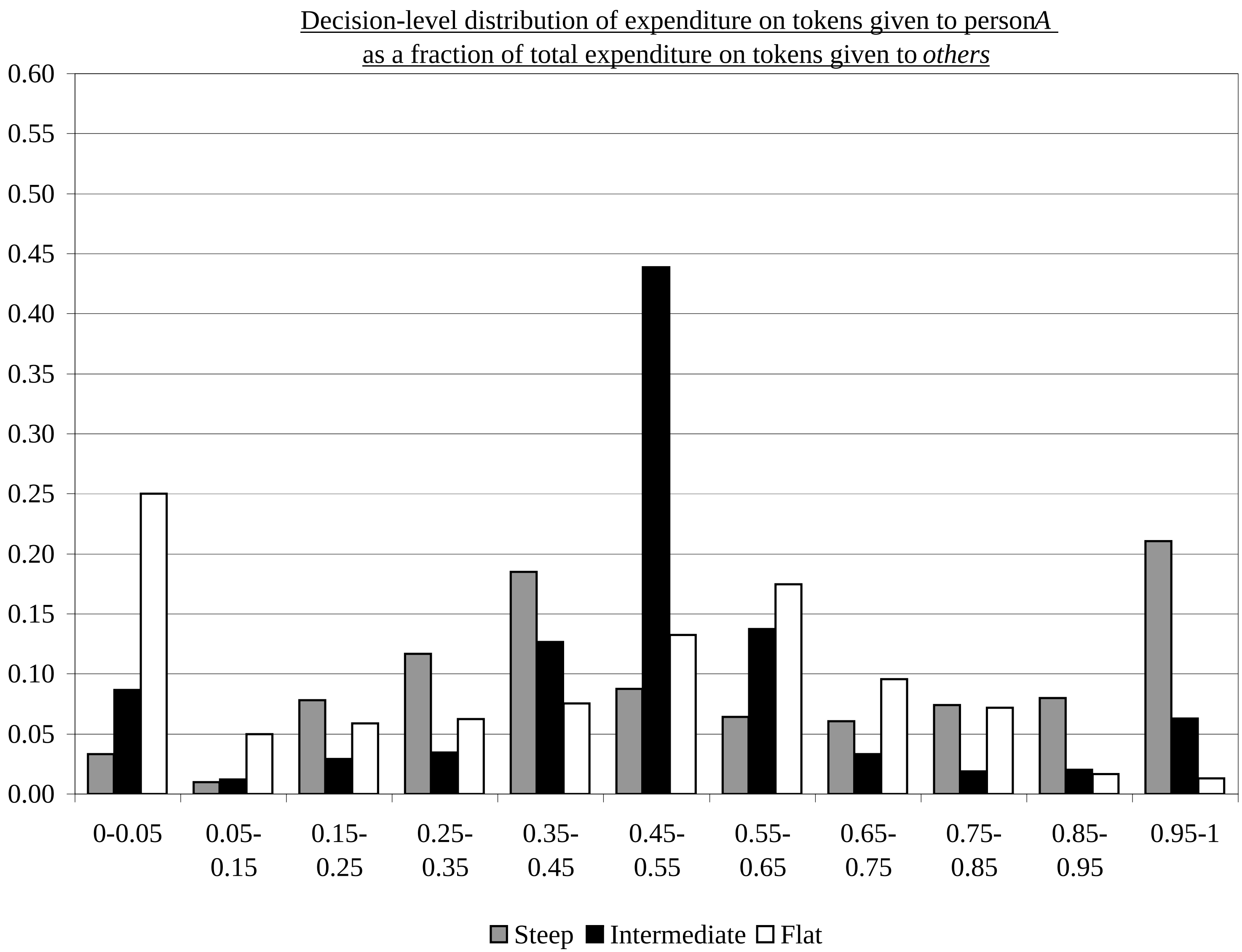
- The macro function v_S represents preferences for altruism, whereas the subutility function w_S represents social preferences.

- Separability imposes convenient (but specific and quit restrictive) patterns on demand behavior (Karni and Safra 2002).


Decision-level distribution of tokens given to *others* as a fraction of total tokens kept and given
Fraction of decisions
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0-0.05
0.05-0.15
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.55
0.55-0.65
0.65-0.75
0.75-0.85
0.85-0.95
0.95-1
Three-person
Two-person



Decision-level distribution of expenditure on tokens given to *others*
as a fraction of total expenditure on tokens
Fraction of decisions
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0-0.05
0.05-0.15
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.55
0.55-0.65
0.65-0.75
0.75-0.85
0.85-0.95
0.95-1
Three-person
Two-person


Decision-level distribution of expenditure on tokens given to person *A*
as a fraction of total expenditure on tokens given to *others*
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0-0.05
0.05-0.15
0.15-0.25
0.25-0.35
0.35-0.45
0.45-0.55
0.55-0.65
0.65-0.75
0.75-0.85
0.85-0.95
0.95-1
Steep
Intermediate
Flat

Econometric specification

Suppose that w_S and v_S are members of the CES family:

$$w_S(\pi_O) = [\alpha^0 (\pi_A)^{\rho^0} + (1 - \alpha^0)(\pi_B)^{\rho^0}]^{1/\rho^0}$$

and

$$v_S(\pi_S, w_S) = [\alpha (\pi_S)^{\rho} + (1 - \alpha) [w_s (\pi_O)]^{\rho}]^{1/\rho}$$

A family of CES functions that embed preferences for altruism and social preferences in a particularly convenient manner

$$U_S = [\alpha(\pi_S)^{\rho} + (1 - \alpha)[\alpha^0(\pi_A)^{\rho^0} + (1 - \alpha^0)(\pi_B)^{\rho^0}]^{\rho/\rho^0})]^{1/\rho}$$

The solution to the subutility maximization problem is given by

$$\pi_A(p_O, m_O) = \left[\frac{g^0}{(p_B/p_A)^{r^0} + g^0}\right]\frac{m_O}{p_A}$$

where

$$r^0 = -\rho^0/\left(1-\rho^0\right),$$

$$g^0 = \left[\alpha^0/\left(1-\alpha^0\right)\right]^{1/\left(1-\rho^0\right)}$$

and $m_O = p_O\pi_O$ is the total expenditure on tokens given to $others$.

The solution to the macro utility maximization problem is then given by

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

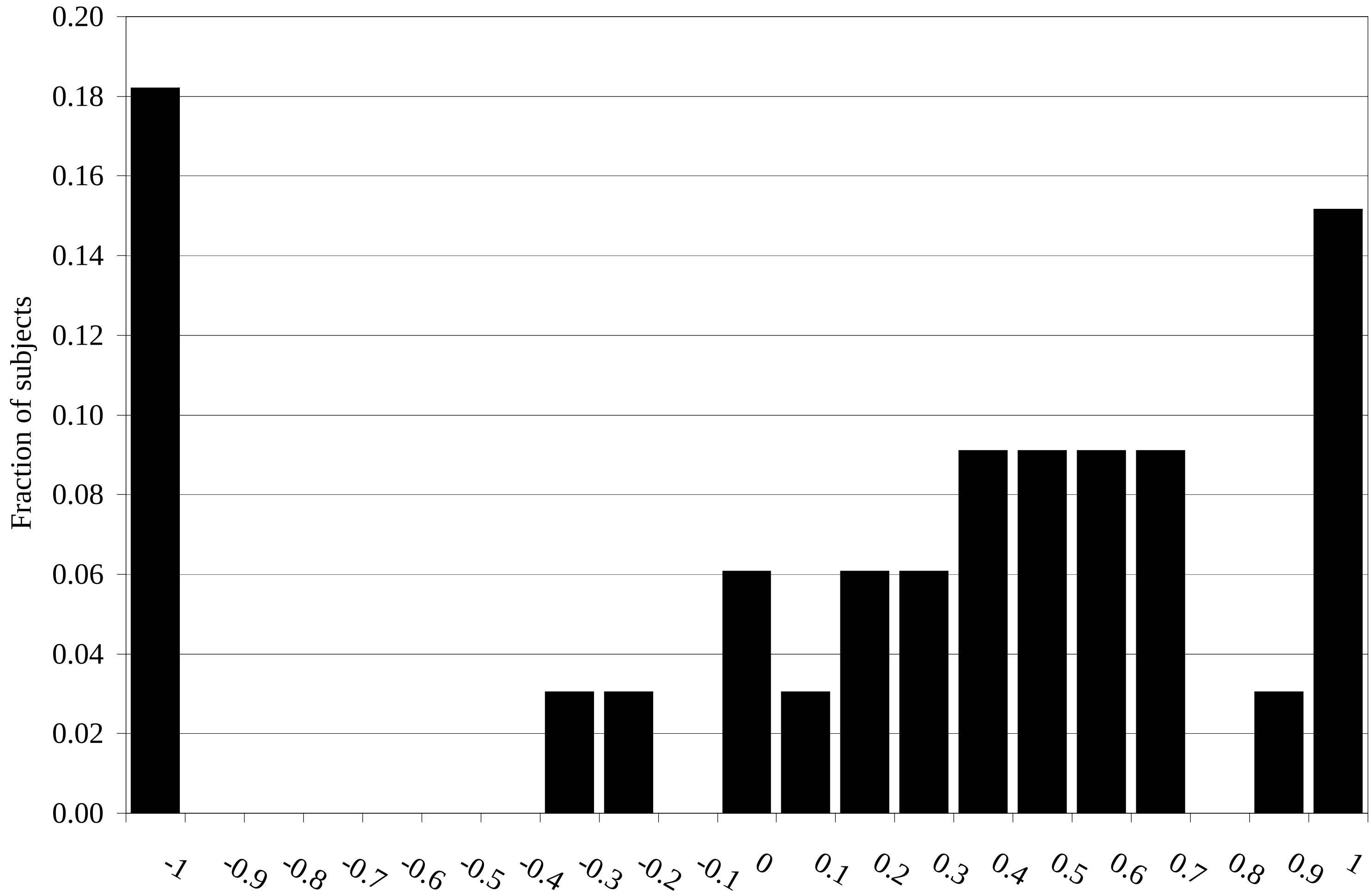
where

$$r = -\rho/(1 - \rho),$$

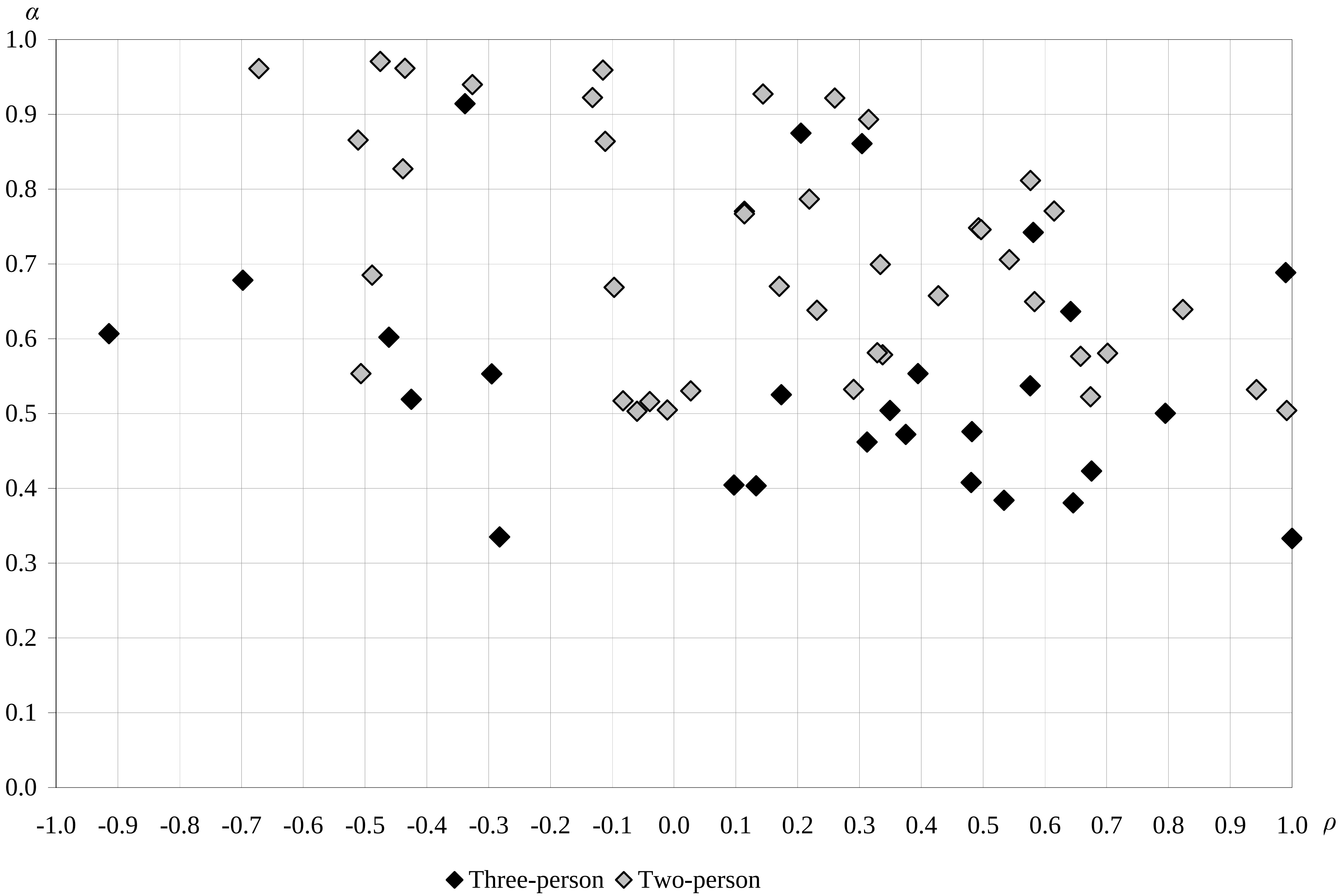
$$g = [\alpha/\,(1 - \alpha)]^{1/(1-\rho)}$$

and q is a *weighted relative price of giving*.

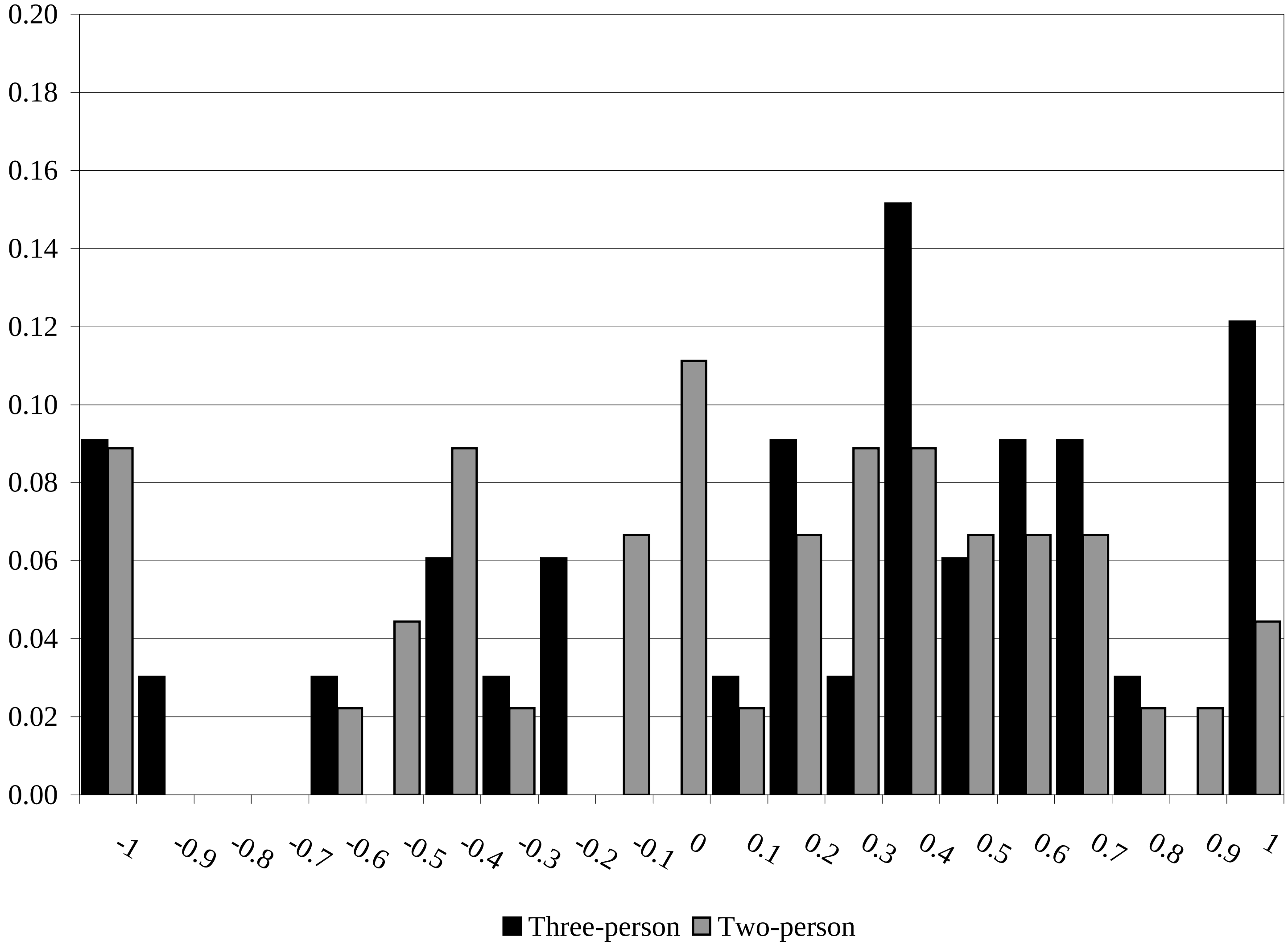
The distribution of the subutility CES parameter ρ'

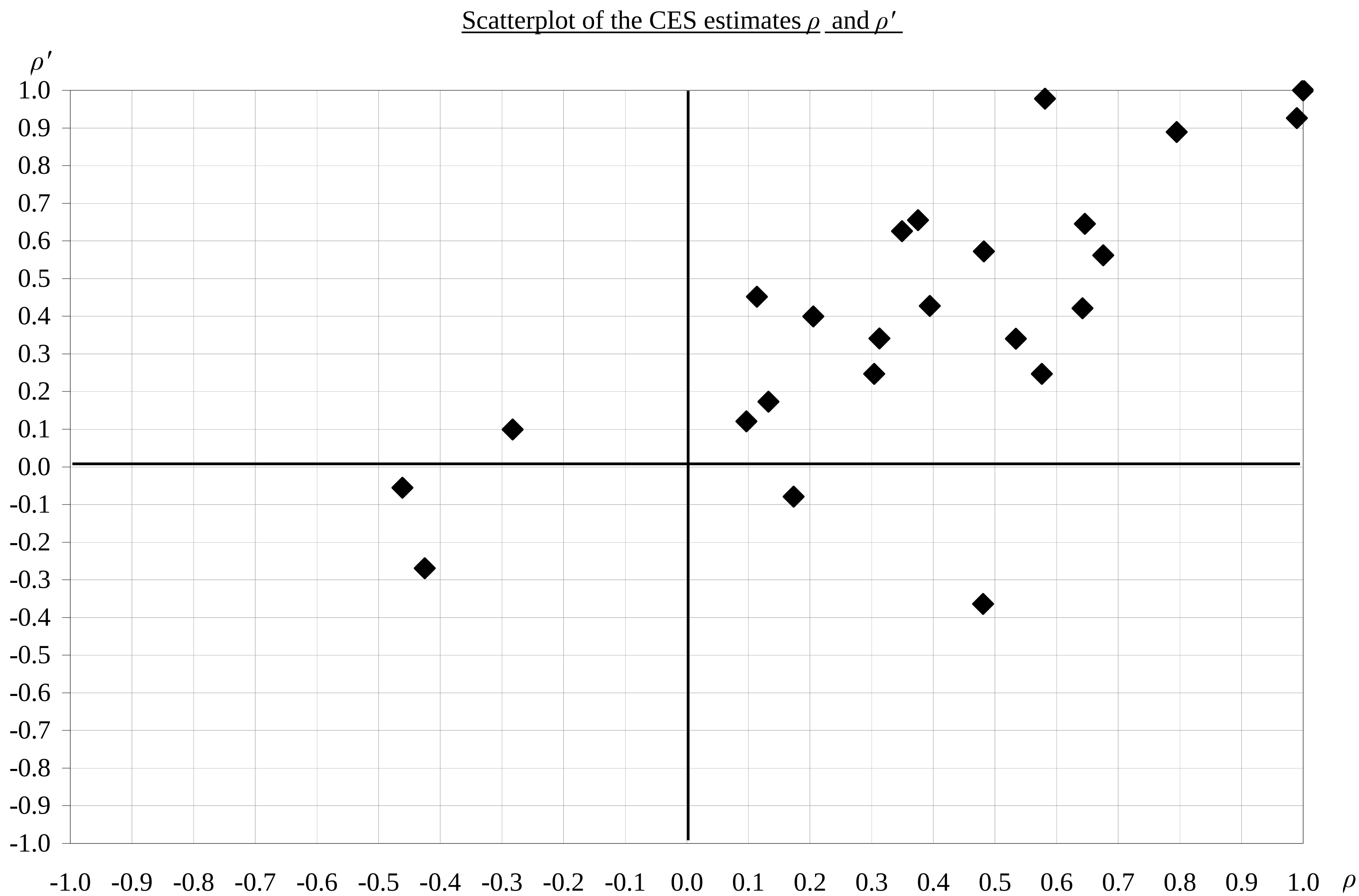


Scatterplot of the CES estimates ρ and α in the three- and two-person experiments



The distribution of the CES parameter ρ in the three- and two-person experiments




Scatterplot of the CES estimates ρ and ρ′
ρ′
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
-1.0 -0.9 -0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
ρ

- Both social preferences and preferences for altruism are highly heterogeneous, ranging from utilitarian to Rawlsian.

- In spite of this heterogeneity across subjects, there exists a strong positive within-subject correlation.

- A strong correlation between the equality-efficiency tradeoffs subjects make in their altruistic and social preferences.

Moral preferences

Consider lotteries over outcomes $[a, b]$, where a is consumption for *other* and b is consumption for *self*.

For our purposes, it suffices to consider binary lotteries with equal probabilities:

$$(.5)[a, b] + (.5)[c, d]$$

where $a, b, c, d \geq 0$. Write $\mathbb{L}$ for the space of all such lotteries, and identify $\mathbb{L}$ with the convex cone $\mathbb{R}^4_+$.

Define closed convex subcones of $\mathbb{L}$:

$$\begin{aligned}
\mathsf{R} &= \{(.5)[0,b] + (.5)[0,d]\}, \\
\mathsf{S} &= \{(.5)[a,b] + (.5)[a,b]\}, \\
\mathsf{V} &= \{(.5)[a,b] + (.5)[b,a]\}.
\end{aligned}$$

We can interpret choice in each cone by making an obvious identification:

– Risk: identify $\mathbb{R}^2_+$ with R by

$$(x, y) \mapsto (.5)[0, x] + (.5)[0, y].$$

– Social Choice: identify $\mathbb{R}^2_+$ with S by

$$(x, y) \mapsto (.5)[x, y] + (.5)[x, y].$$

– Veil of Ignorance: identify $\mathbb{R}^2_+$ with V by

$$(x, y) \mapsto (.5)[x, y] + (.5)[y, x].$$

Assumptions

Given a preference relation º on $\mathbb{L}$, write º$_{\mathsf{R}}$, º$_{\mathsf{S}}$, º$_{\mathsf{V}}$ for its restrictions to R, S, V, respectively.

[i] º is continuos, convex, strictly monotone in *self*'s consumption and weakly monotone in *other*'s consumption.

[ii] º obey the Sure Thing Principle, and so identify the lottery $(.5)[a, b] + (.5)[a, b]$ with the certain outcome $[a, b]$.

[iii] $\succsim$ satisfies *independence*:

$$[a, b] \succsim_S [a', b'] \quad \text{and} \quad [c, d] \succsim_S [c', d']$$
$$\Rightarrow \quad (.5)[a, b] + (.5)[c, d] \succsim (.5)[a', b'] + (.5)[c', d']$$

(*not* the usual independence axiom and does not have the usual consequences).

[iv] $\succsim$ or $\succsim_S$ is *self-regarding*: for each outcome $[a, b]$ there is an outcome $[0, s]$ such that $[0, s] \succsim_S [a, b]$.

[i]-[iii] are rationality requirements (should not necessarily be given any philosophical interpretation) and [iv] is a very natural moral requirement.

Result I: Every preference relation $\succsim$ on $\mathbb{L}$ that satisfies $[i]$-$[iv]$ is determined by its restrictions $\succsim_{\mathsf{R}}$ and $\succsim_{\mathsf{S}}$.

Proof: Fix an outcome $[x, y]$. Because $\succsim_{\mathsf{S}}$ is self-regarding, there is some s such that $[0, s] \succsim_{\mathsf{S}} [x, y]$.

Define the *selfish equivalent* of $[x, y]$ by

$$\sigma[x, y] = \inf\{s : [0, s] \succsim_{\mathsf{S}} [x, y]\}.$$

Monotonicity and continuity guarantee that $[0, \sigma[x, y]] \sim_{\mathsf{S}} [x, y]$, and by construction,

$$[a, b] \sim_{\mathsf{S}} [0, \sigma[a, b]] \text{ and } [c, d] \sim_{\mathsf{S}} [0, \sigma[c, d]].$$

independence guarantees that

$$(.5)[a,b] + (.5)[c,d] \sim (.5)[0,\sigma[a,b]] + (.5)[0,\sigma[0,\sigma[c,d]].$$

Hence

$$\begin{array}{rcl} (.5)[a,b] + (.5)[c,d] & \succsim & (.5)[a',b'] + (.5)[c',d'] \\ & \Updownarrow & \\ (.5)[0,\sigma[a,b]] + (.5)[0,\sigma[c,d]] & \succsim_R & (.5)[0,\sigma[a',b']] + (.5)[0,\sigma[c',d']] \end{array}$$

which decomposes preferences over $\mathbb{L}$ into preferences over S (selfish equivalents) and preferences over R, as desired.

Given a linear budget constraint, we identify choice behavior in the Social Choice environment as

- *selfish* if the choice subject to every budget constraint is of the form $[0, y]$ – giving nothing to *other*.

- *symmetric* if (a, b) is chosen subject to $px+qy \leq w$ iff (b, a) is chosen subject to the mirror-image budget constraint $qx + py \leq w$.

Result II: If the preference relation º satisfies [i]-[iii] and choice behavior in the Social Choice environment is selfish then choice behavior in the Risk environment coincides with choice behavior in the Veil of Ignorance environment.

Proof: Monotonicity and continuity guarantee that purely selfish behavior implies that $[0, y] \sim_{\mathrm{S}} [x, y]$ for every x, y. independence implies that

$$(.5)[0, y] + (.5)[0, x] \sim (.5)[x, y] + (.5)[y, x].$$

It follows immediately that º$_{\mathrm{R}}$ and º$_{\mathrm{V}}$ coincide from whence choices in the Risk and Veil of Ignorance environments coincide, as asserted.

Result III: If the preference relation $\succsim$ satisfies [i]-[iii] and choice behavior in the Social Choice environment is symmetric, then choice behavior in the Social Choice environment coincides with choice behavior in the Veil of Ignorance environment.

Proof: Suppose that (a, b) is chosen from some budget set B for the Social Choice environment, so that (b, a) is chosen in the mirror image budget set B'.

Say that (c, d) is chosen from the budget set B for the Veil of Ignorance environment, and that $(c, d) \neq (a, b)$.

Because $(c, d) \in B$, it follows that

$$(.5)[c, d] + (.5)[d, c] \text{ Â}_{\mathsf{V}} (.5)[a, b] + (.5)[b, a].$$

independence implies that

$$[c, d] \text{ Â}_{\mathsf{S}} [a, b] \text{ or } [d, c] \text{ Â}_{\mathsf{S}} [b, a],$$

which is inconsistent with the fact that (a, b) (resp. (b, a)) is chosen from the budget set B (resp. B^0).

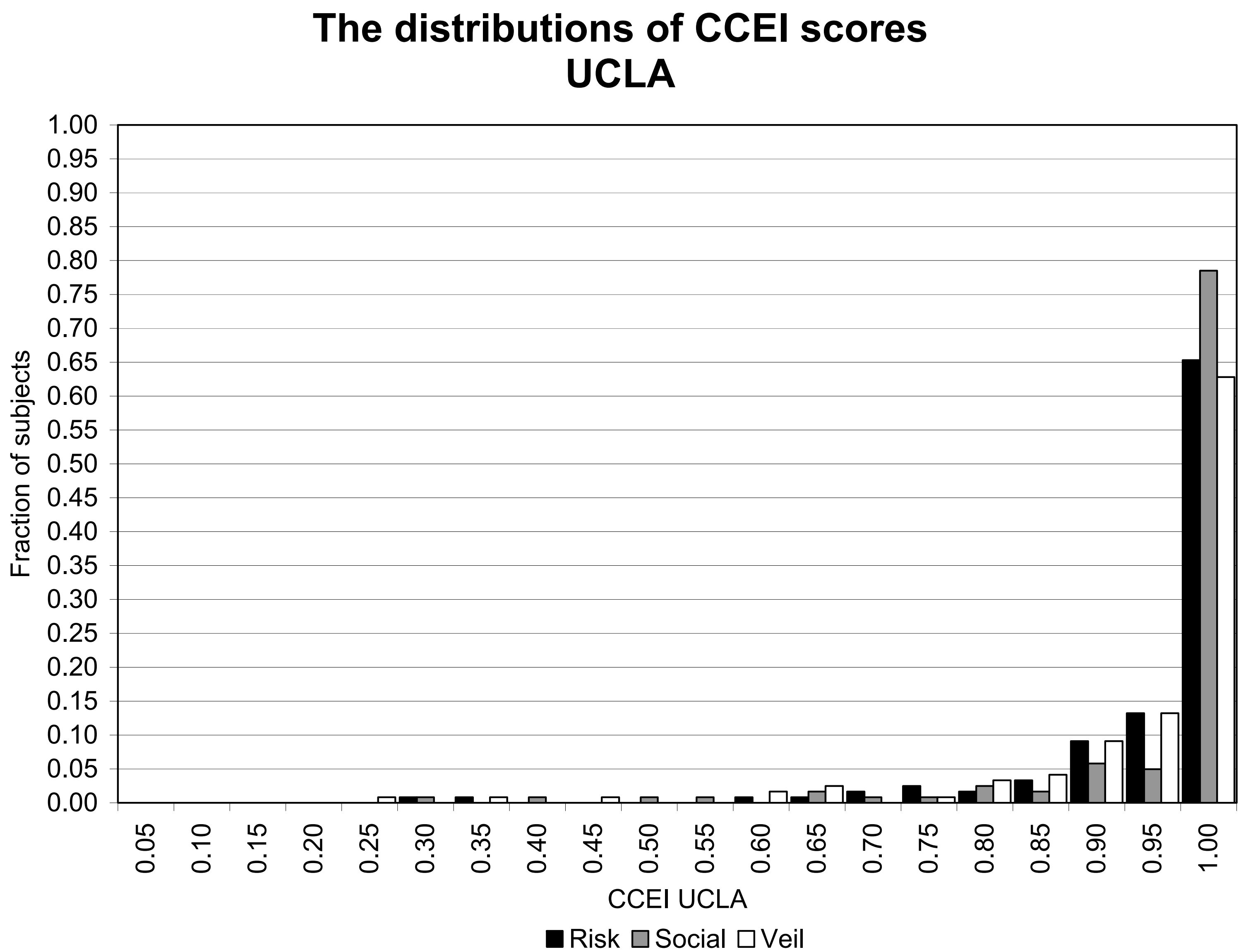
It follows that risk attitude is irrelevant in the Veil of Ignorance environment, as asserted.

Experimental analysis

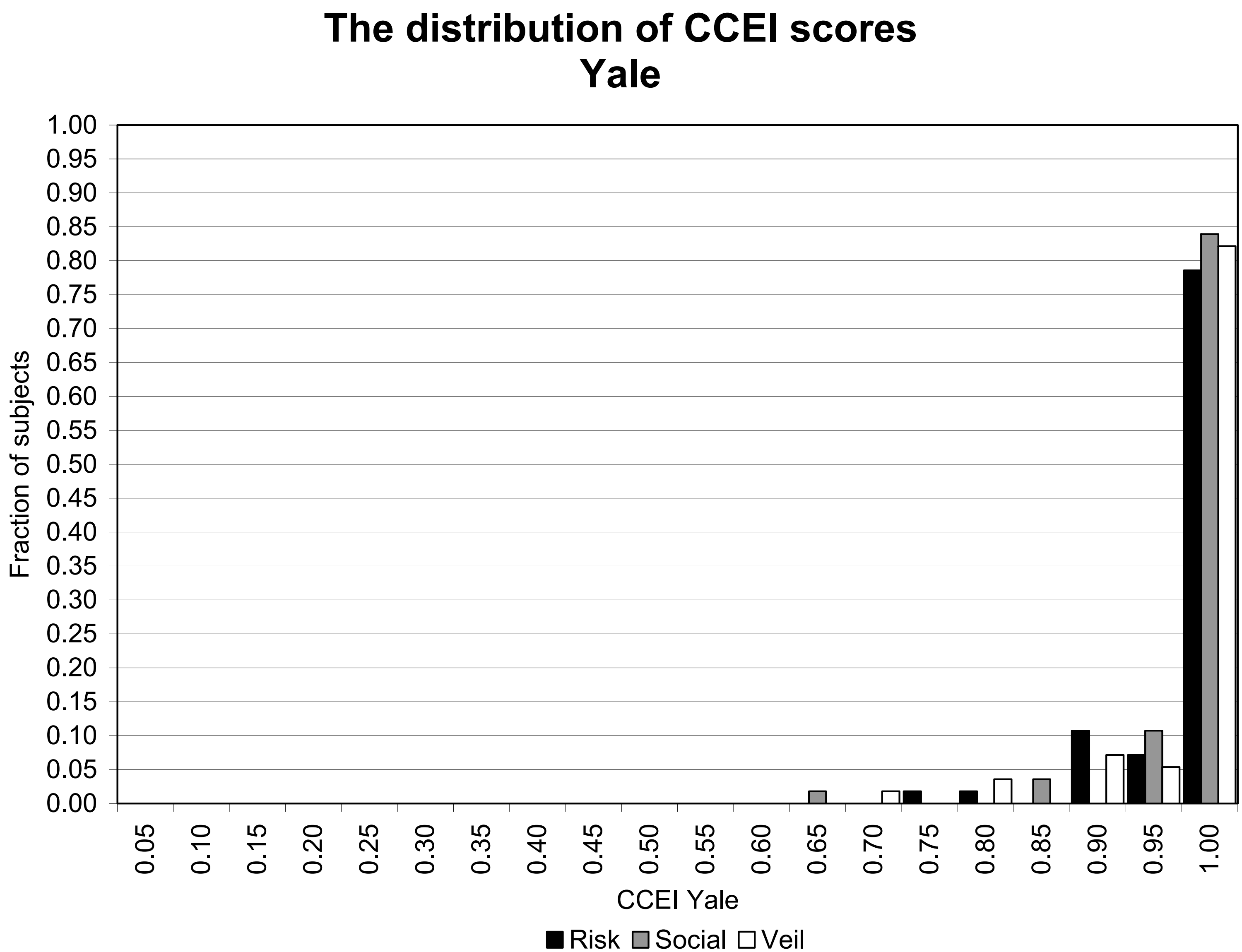
- Subjects in the experiments were recruited from all classes at UCLA and Yale Law School.

- A choice (x, y) from the budget line represents an allocation between accounts x, y (corresponding to the horizontal and vertical axes).

- Choices are made through a simple point-and-click design using a graphical computer interface.

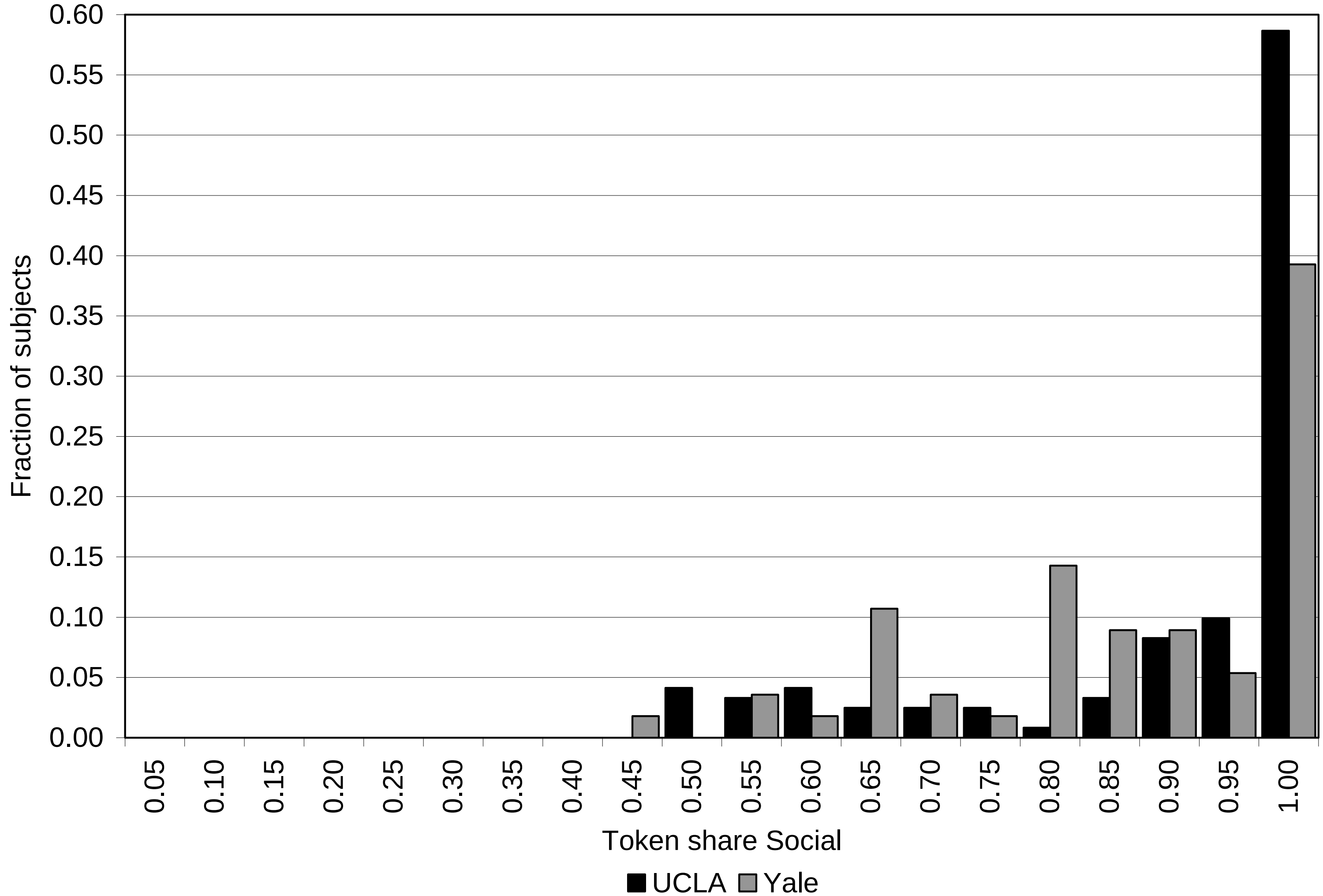


The distributions of CCEI scores
UCLA
Fraction of subjects
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
0.85
0.90
0.95
1.00
CCEI UCLA
Risk
Social
Veil

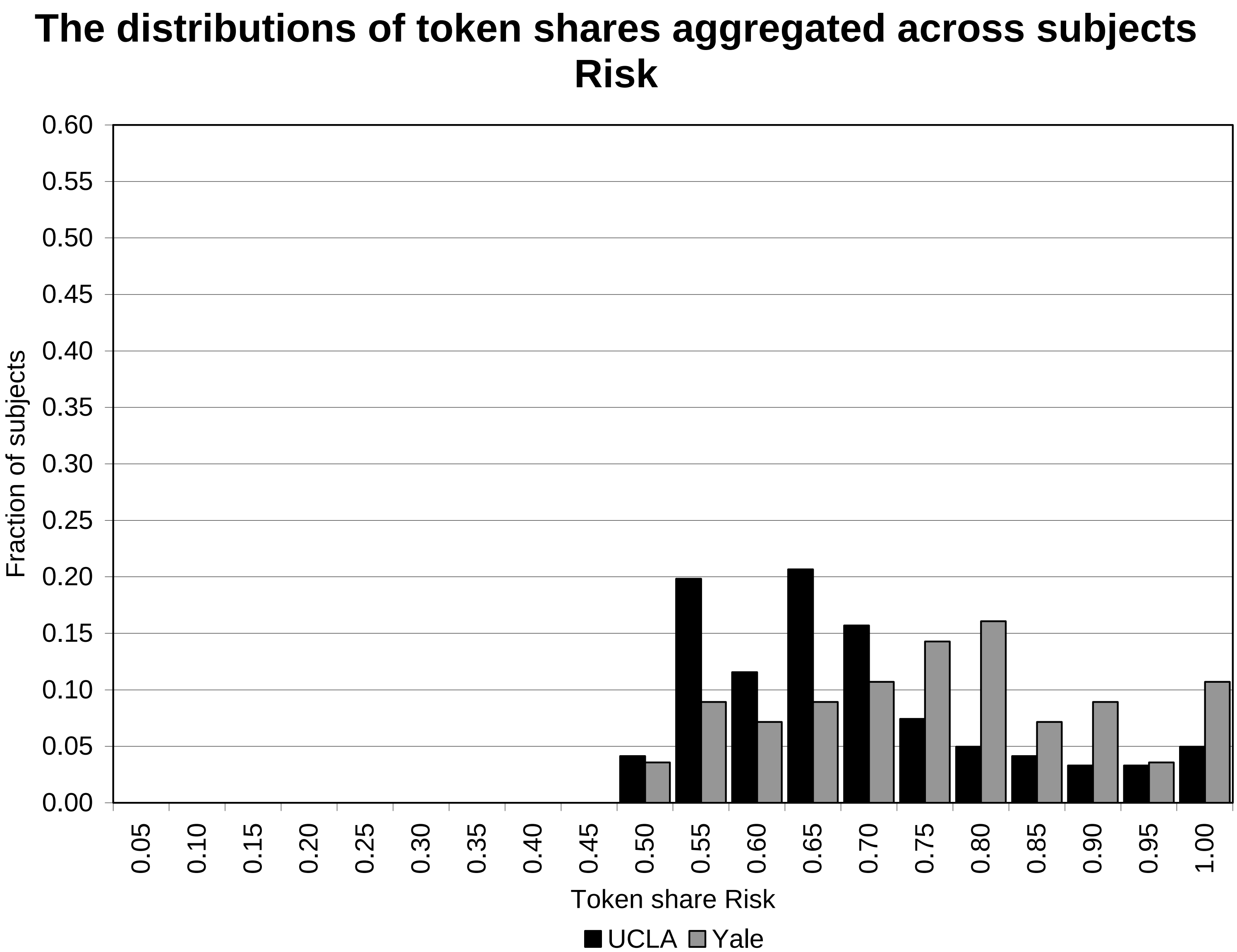


The distribution of CCEI scores
Yale
Fraction of subjects
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
0.85
0.90
0.95
1.00
CCEI Yale
Risk
Social
Veil

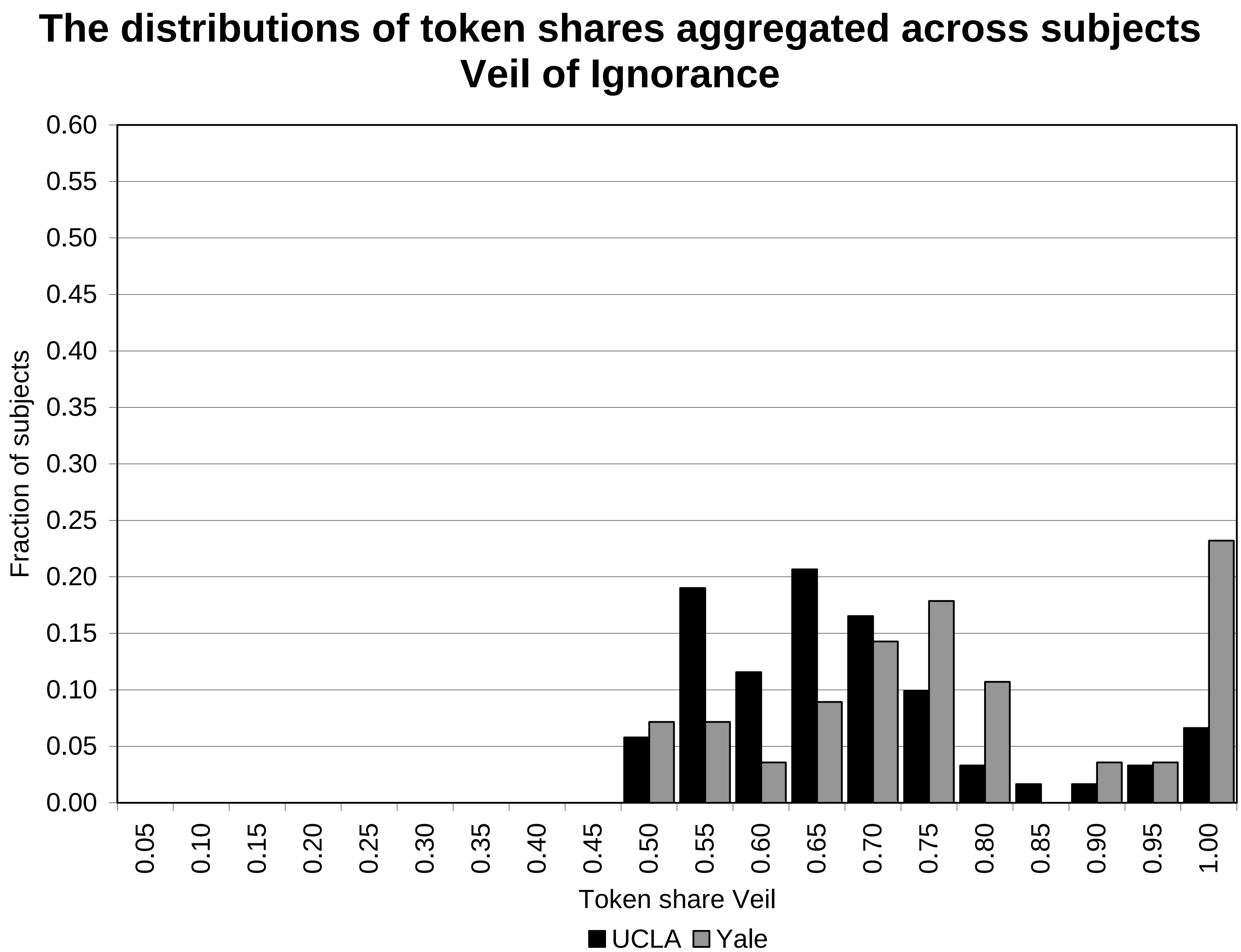
The distributions of token shares aggregated across subjects Social Choice



The tokens kept as a fraction of the sum of the tokens kept and given to other.

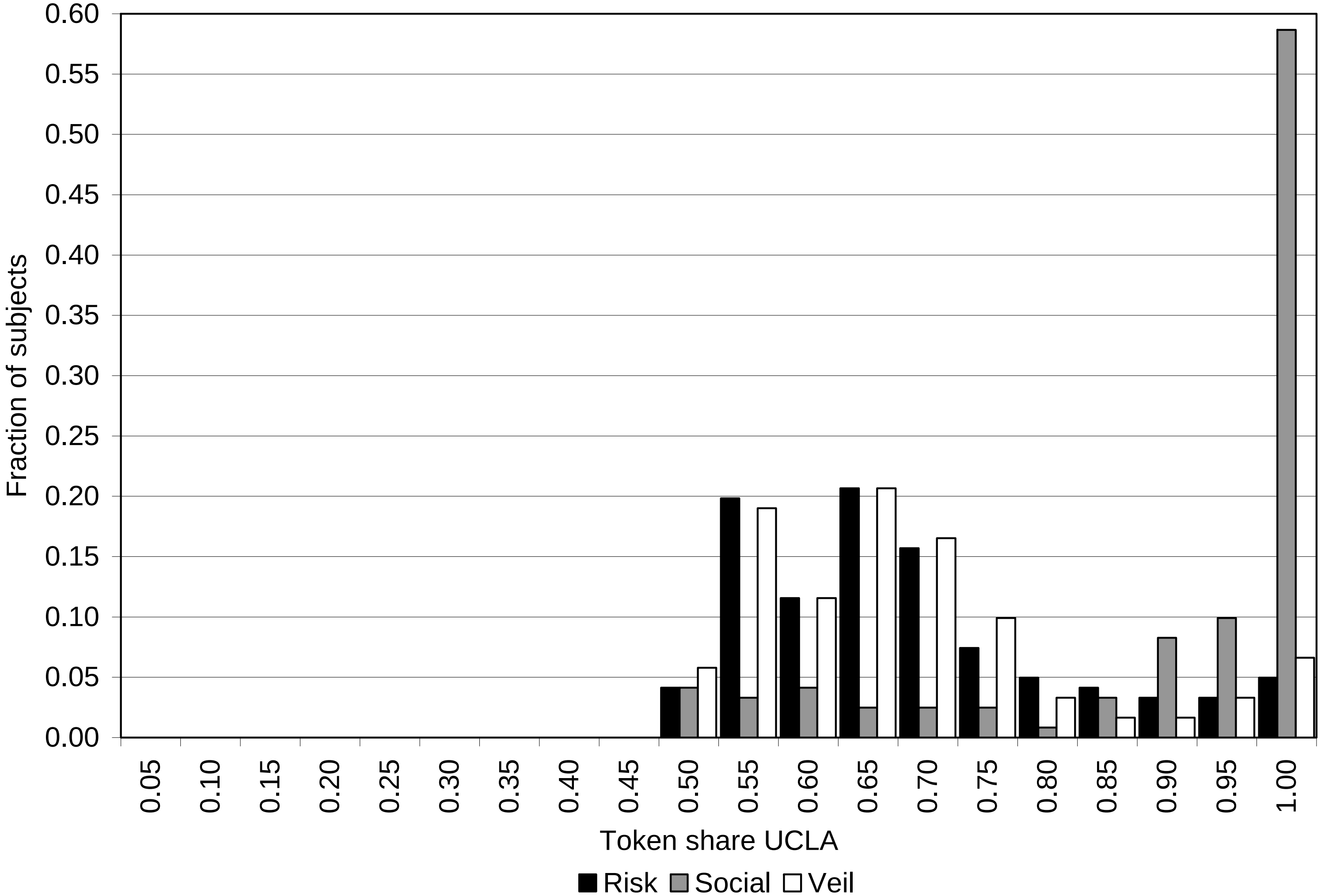


The fraction of tokens allocated to the cheaper account.

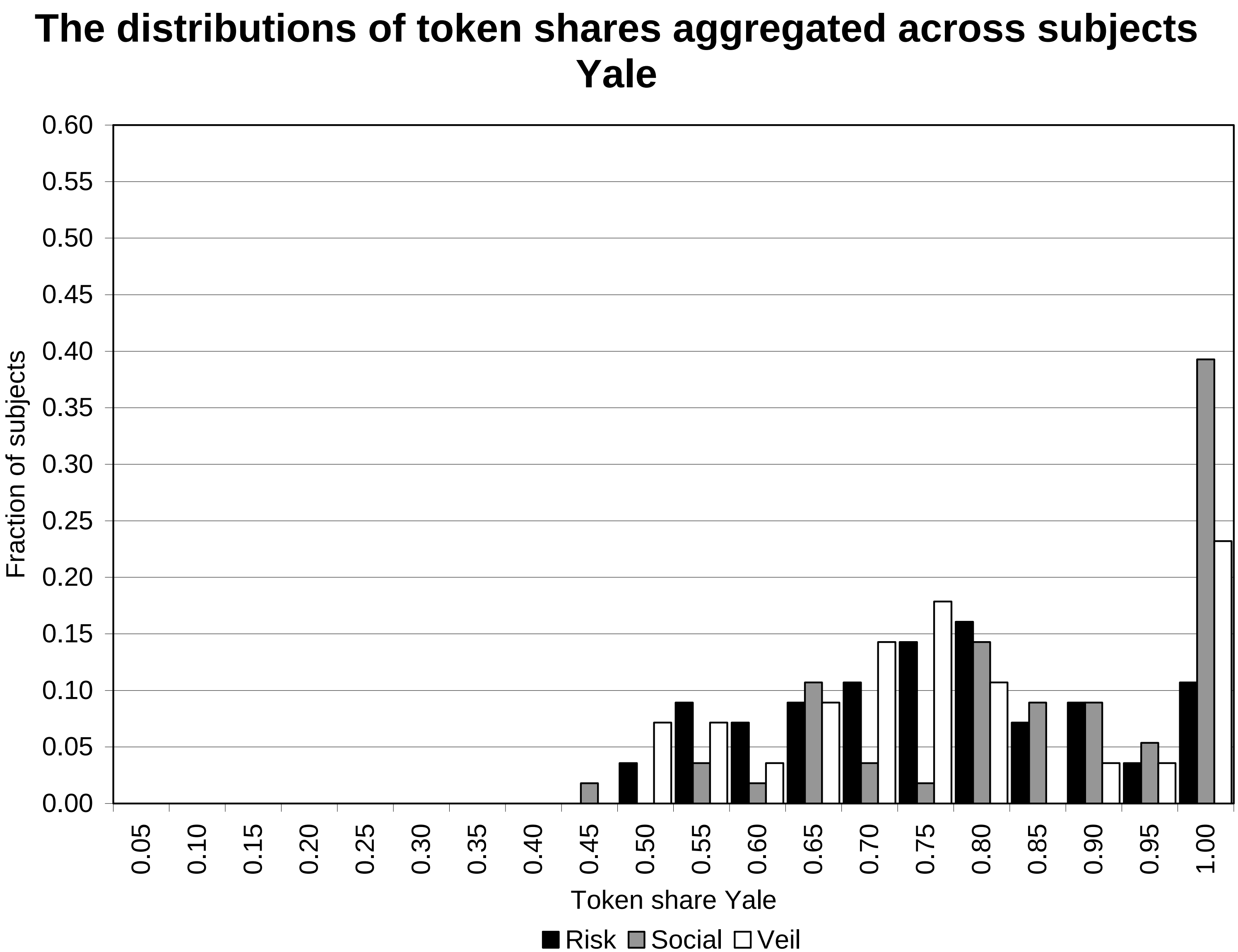


The fraction of tokens allocated to the cheaper account.

The distributions of token shares aggregated across subjects UCLA



Social: fraction of tokens kept by self. Risk and Veil: fraction of tokens allocated to the cheaper account.



Social: fraction of tokens kept by self. Risk and Veil: fraction of tokens allocated to the cheaper account.

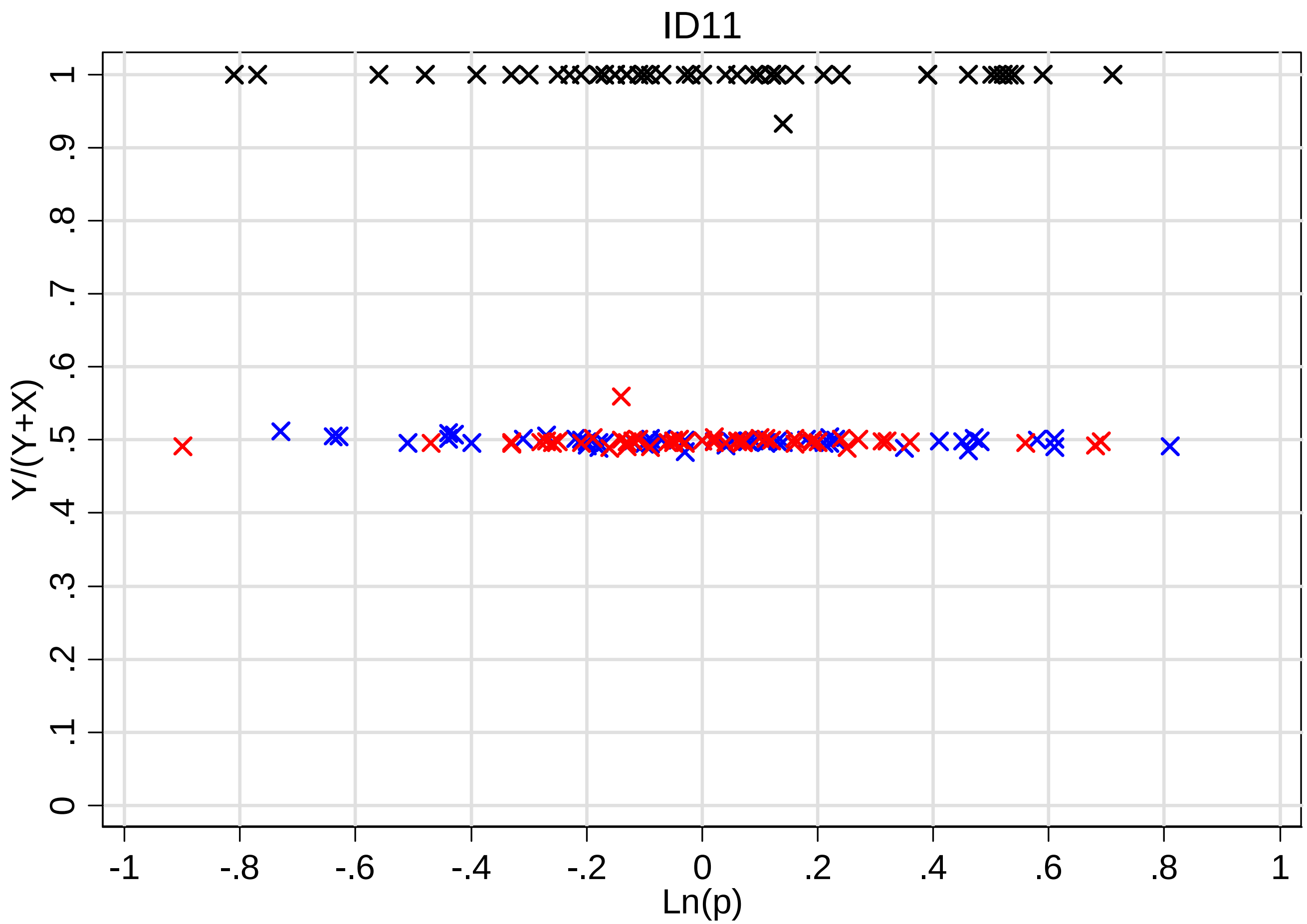
Individual behavior

- The aggregate data tell us little about the choice behavior of individual subjects.

- Scatterplots of all choices of illustrative subjects – each entry plots $y/(x+y)$ as a function of $\log(p_x/p_y)$ in a particular treatment.

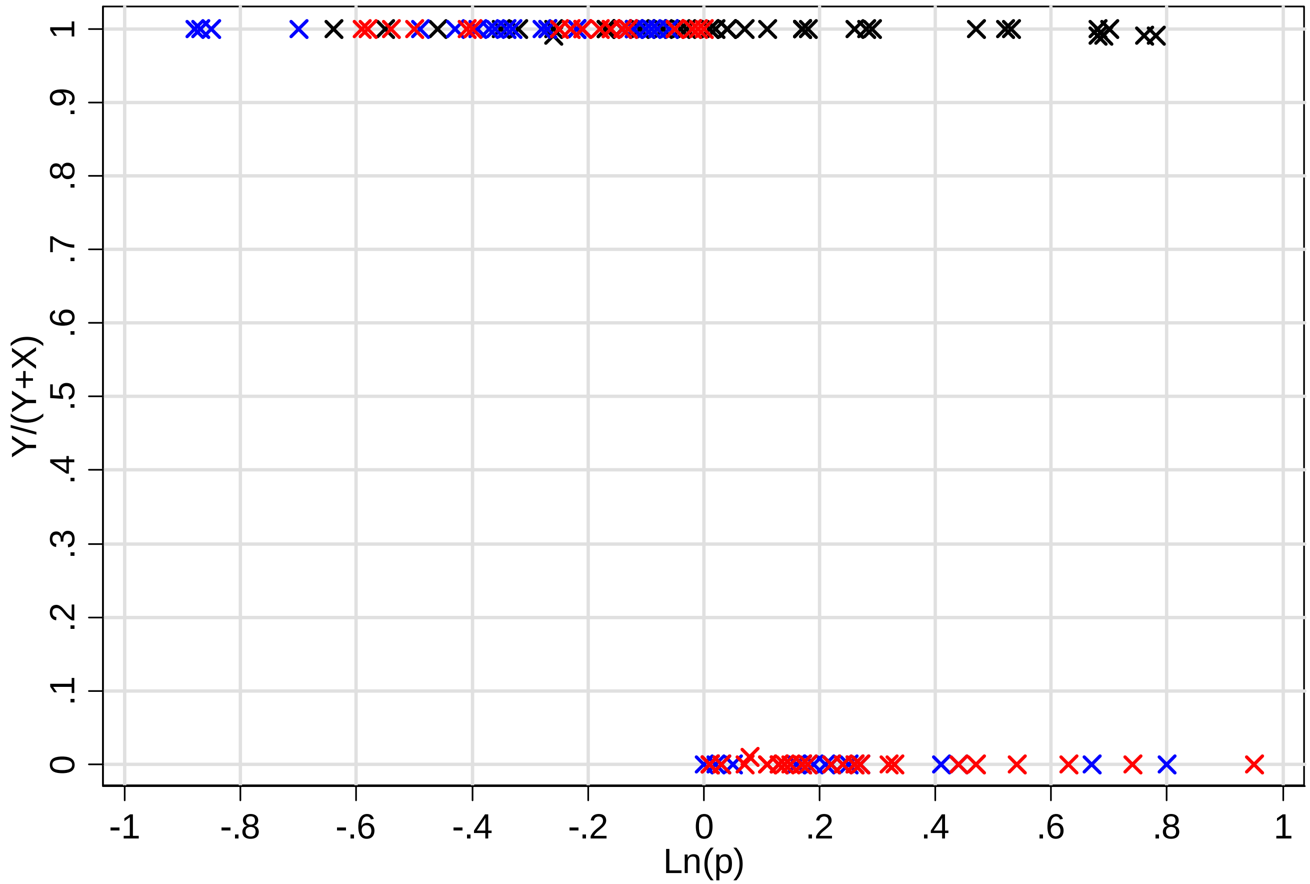
- The characteristic of all our data is striking regularity *within* subjects and heterogeneity *across* subjects.

The relationship between the log-price ratio and the token share

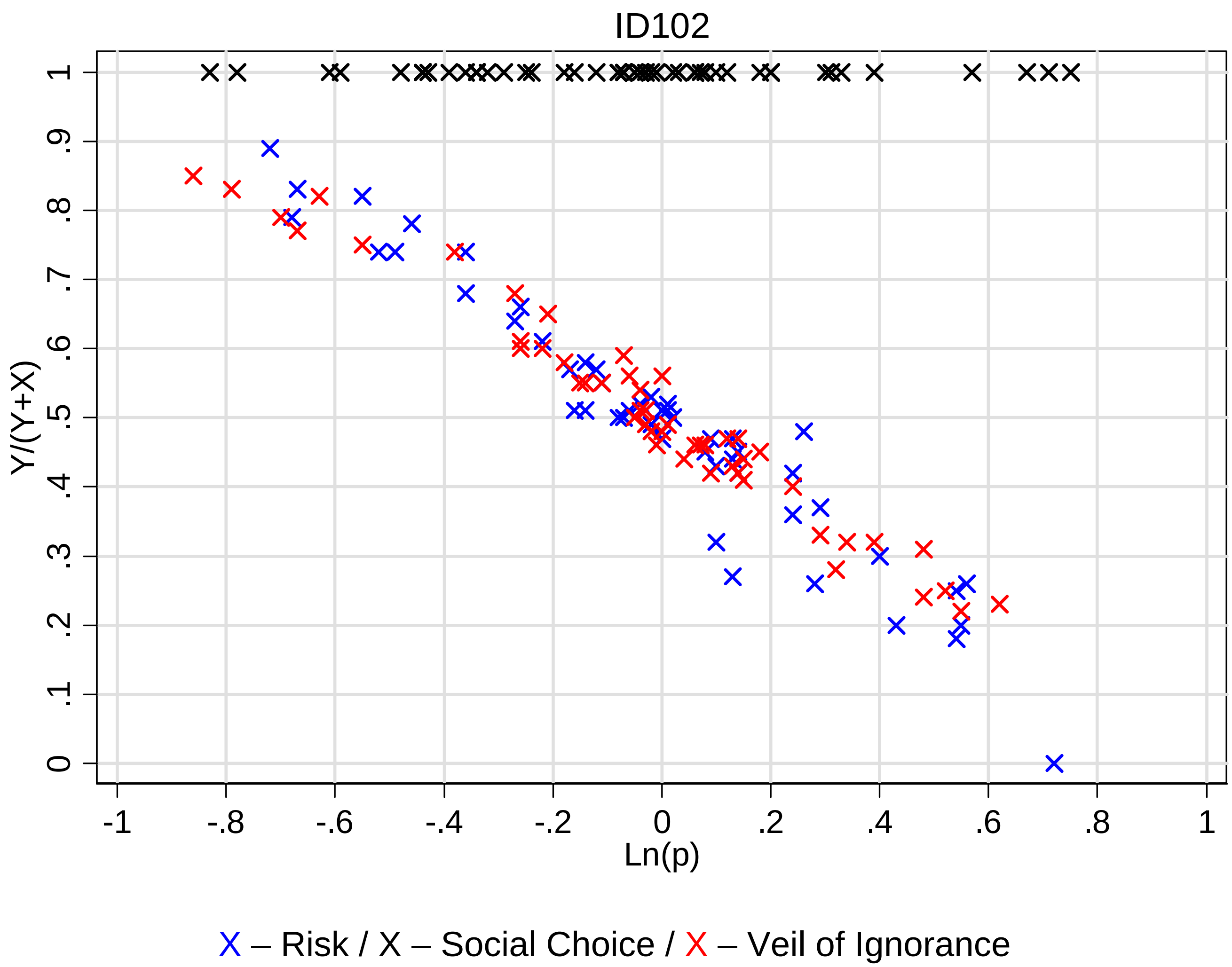


X – Risk / X – Social Choice / X – Veil of Ignorance

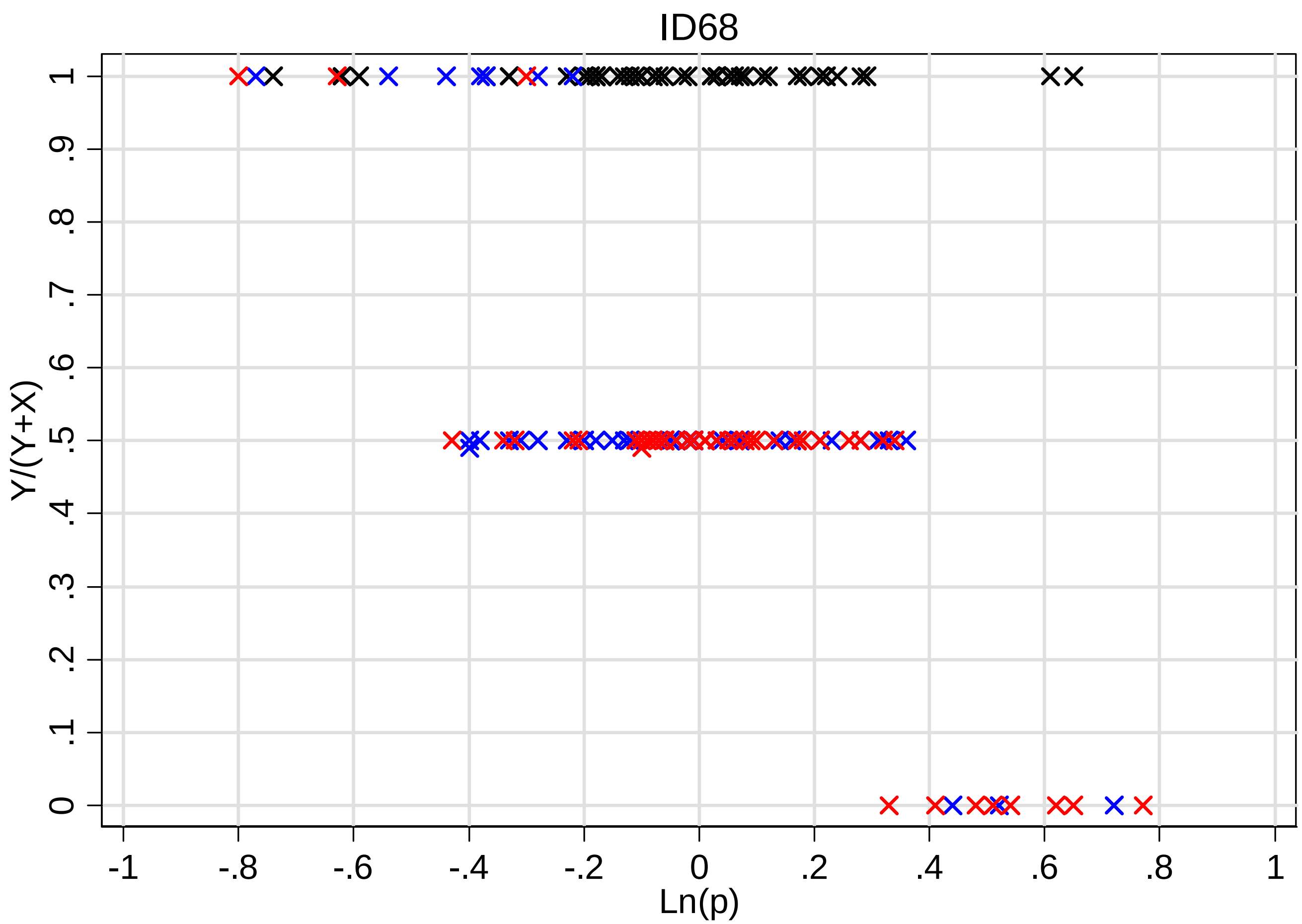
ID62



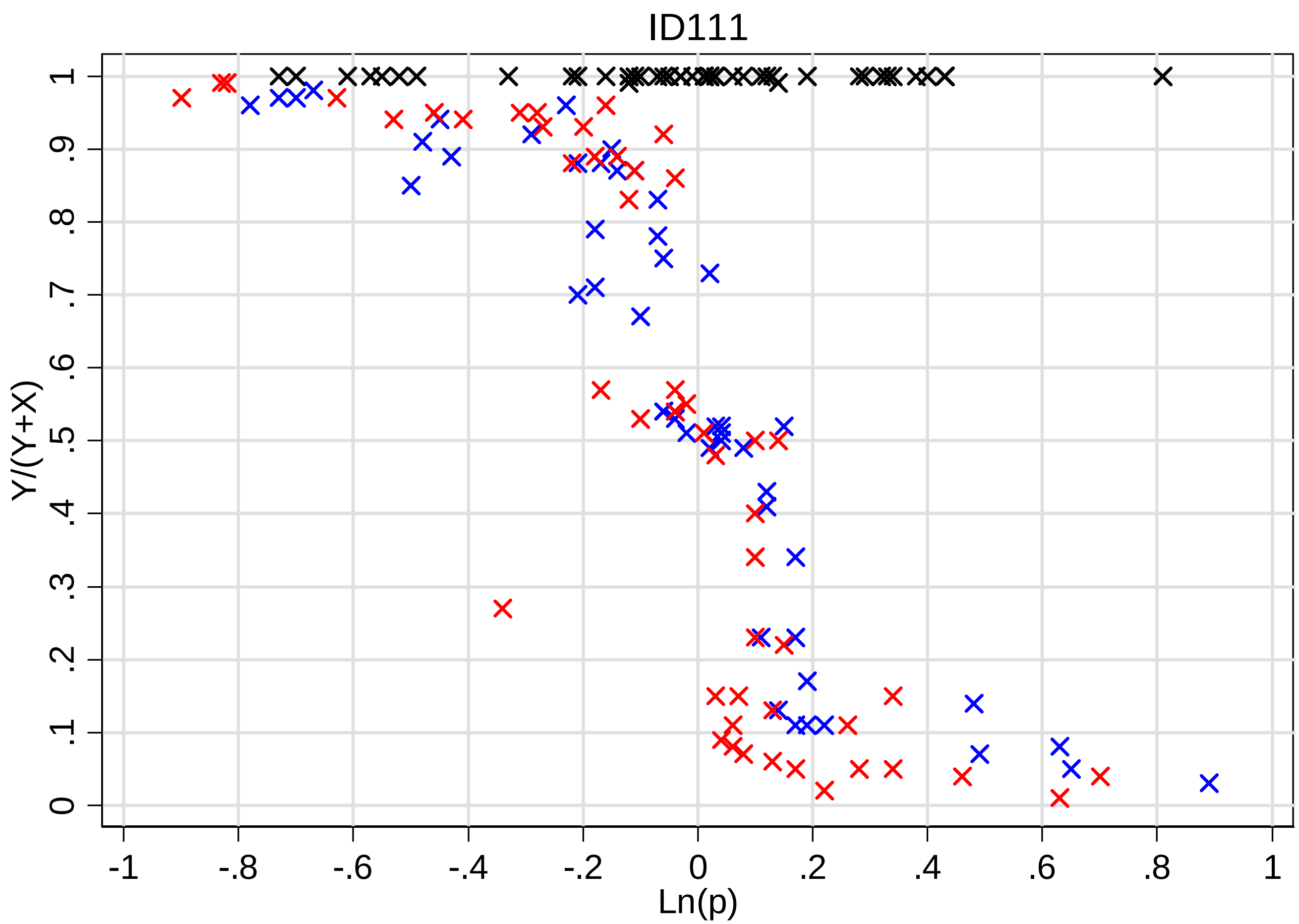
X – Risk / X – Social Choice / X – Veil of Ignorance



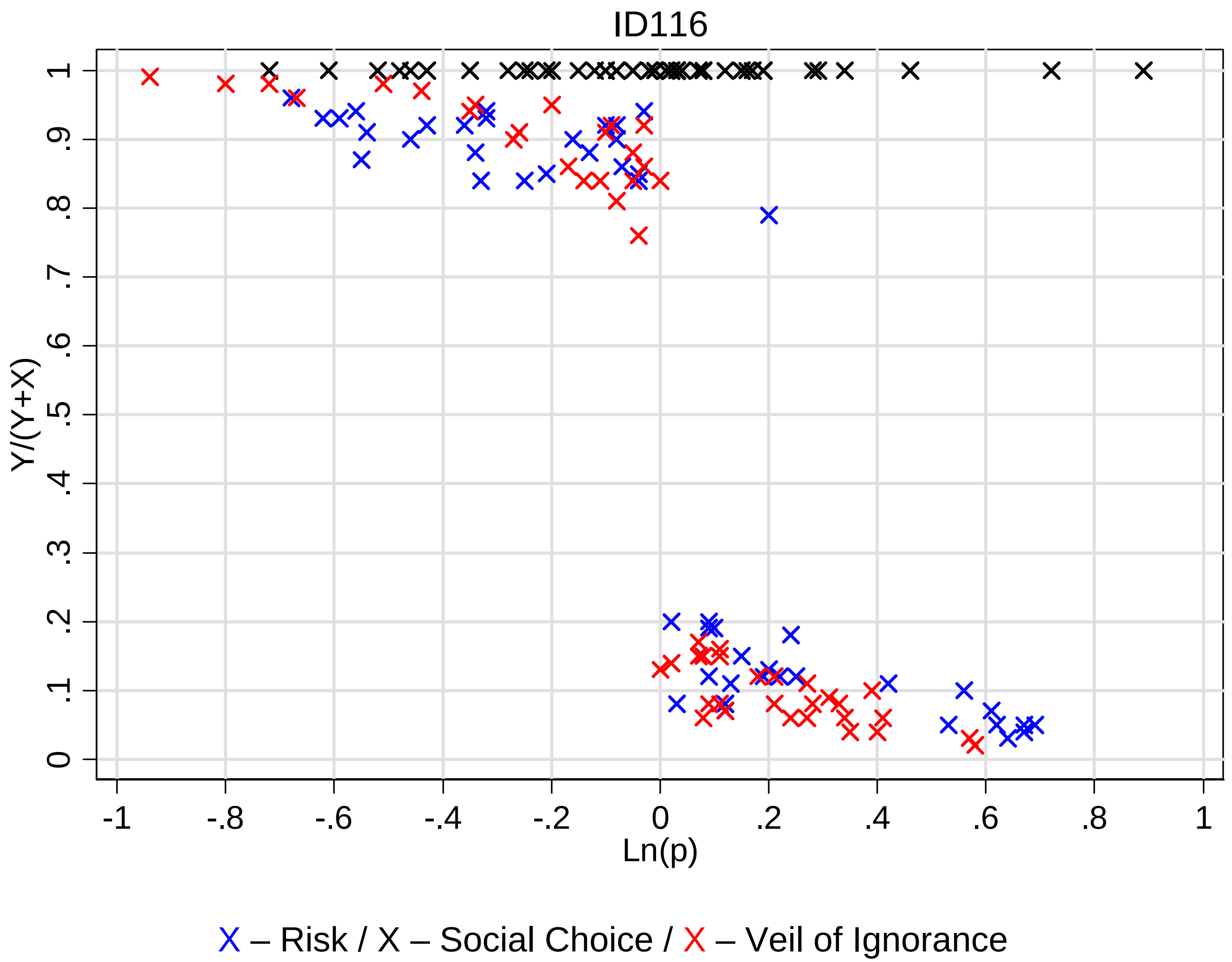
ID102
Y/(Y+X)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
-1
-.8
-.6
-.4
-.2
0
.2
.4
.6
.8
1
Ln(p)
X – Risk / X – Social Choice / X – Veil of Ignorance



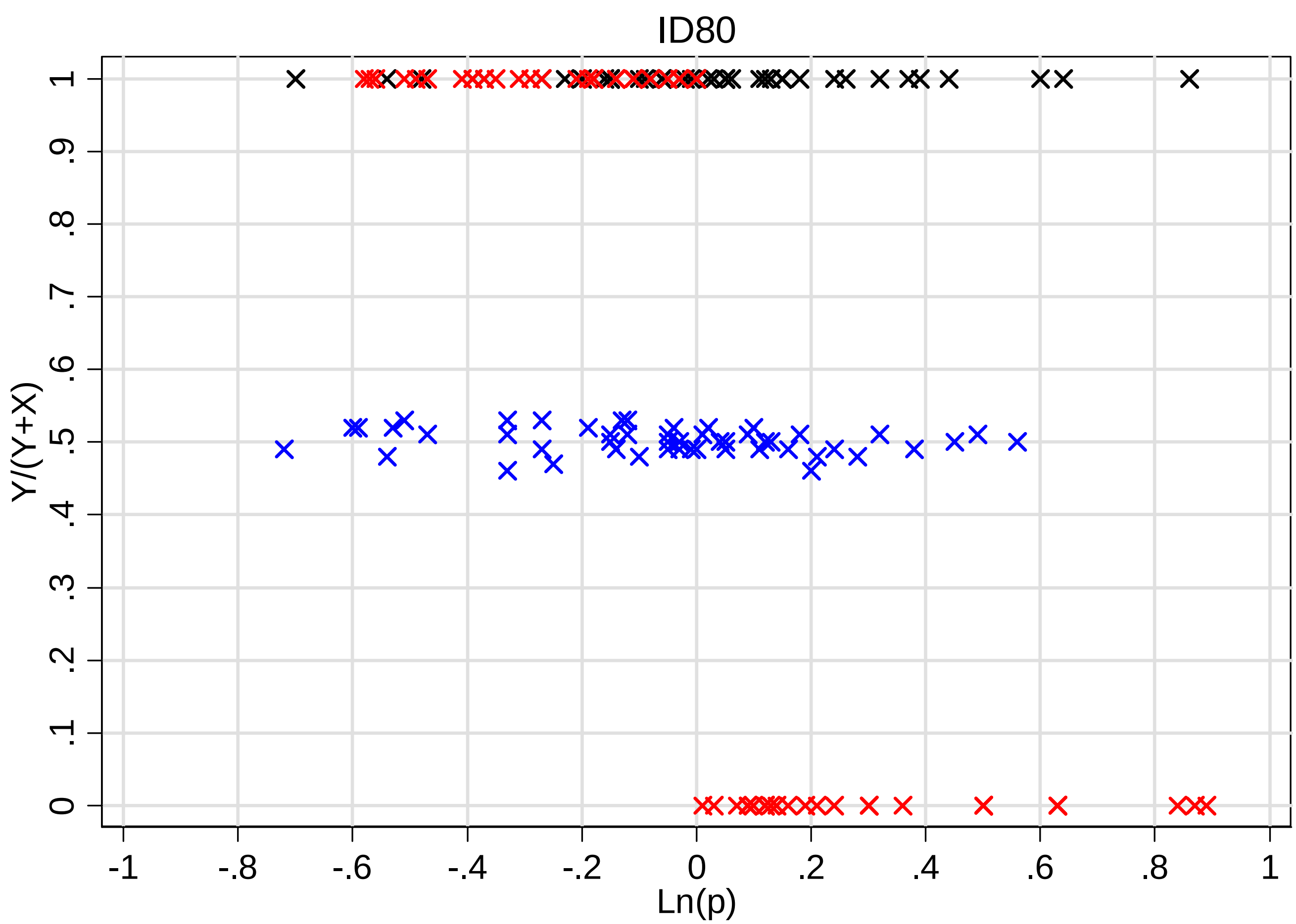
X – Risk / X – Social Choice / X – Veil of Ignorance



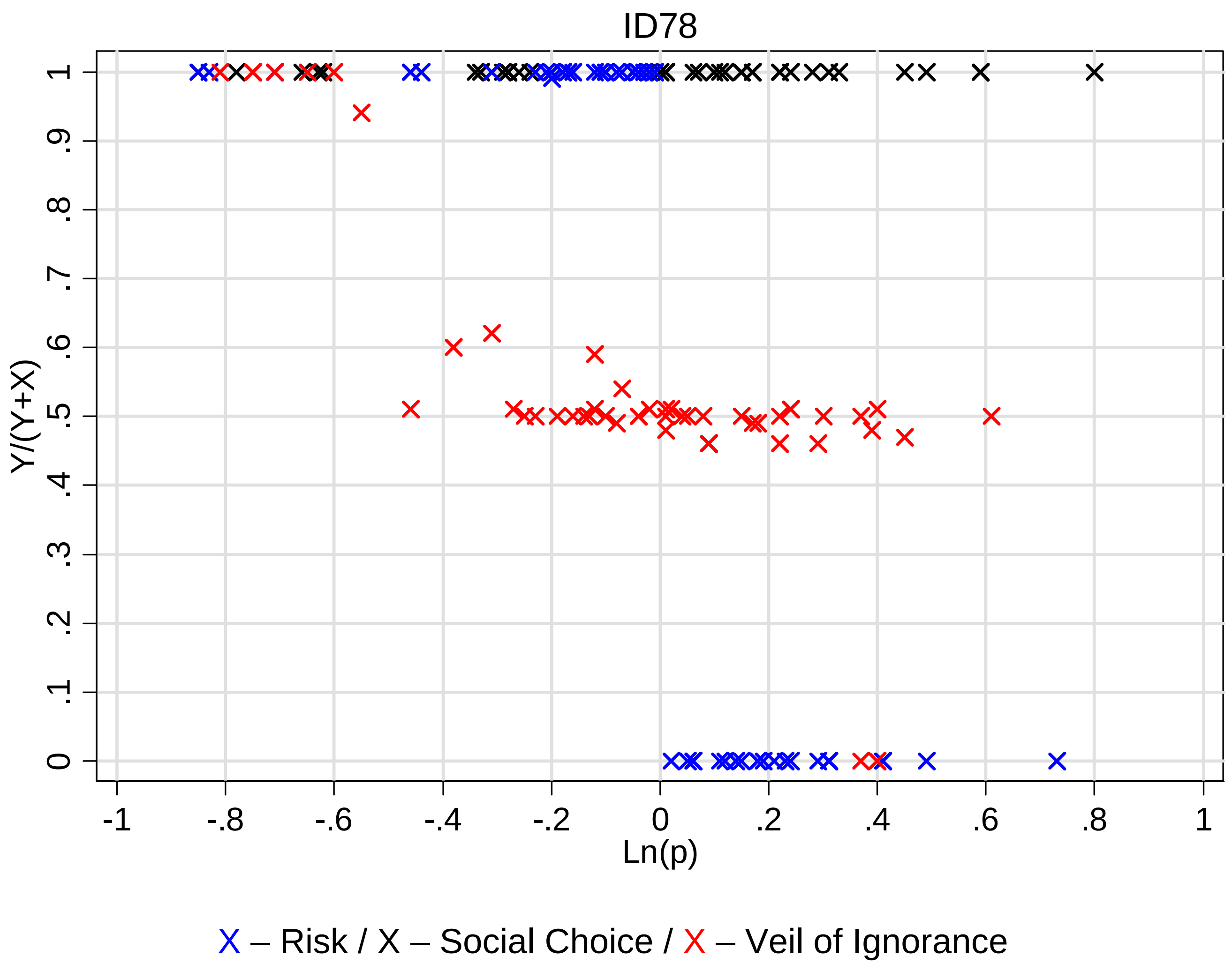
X – Risk / X – Social Choice / X – Veil of Ignorance

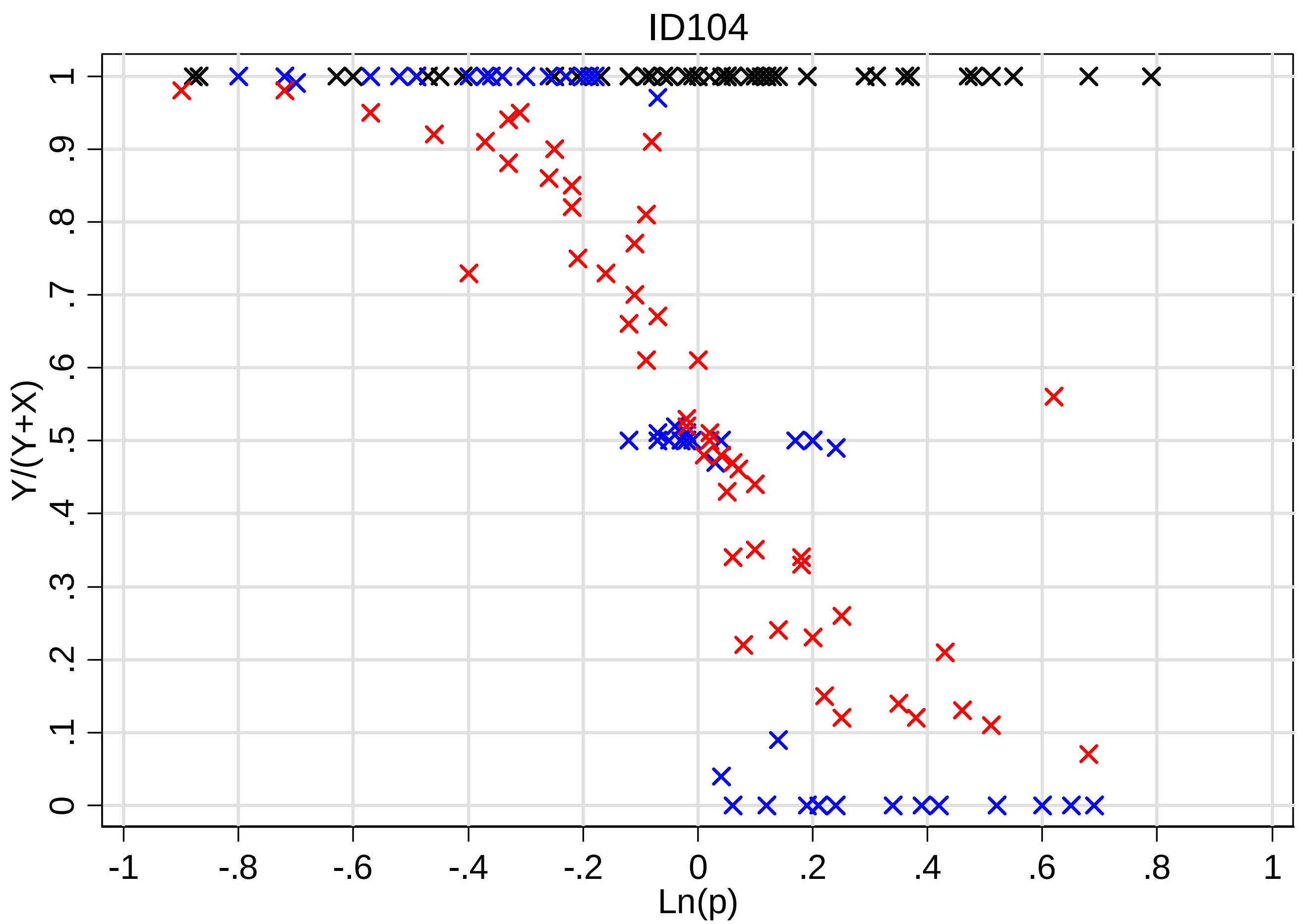


ID116
Y/(Y+X)
Ln(p)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
-1
-.8
-.6
-.4
-.2
0
.2
.4
.6
.8
1
X – Risk / X – Social Choice / X – Veil of Ignorance

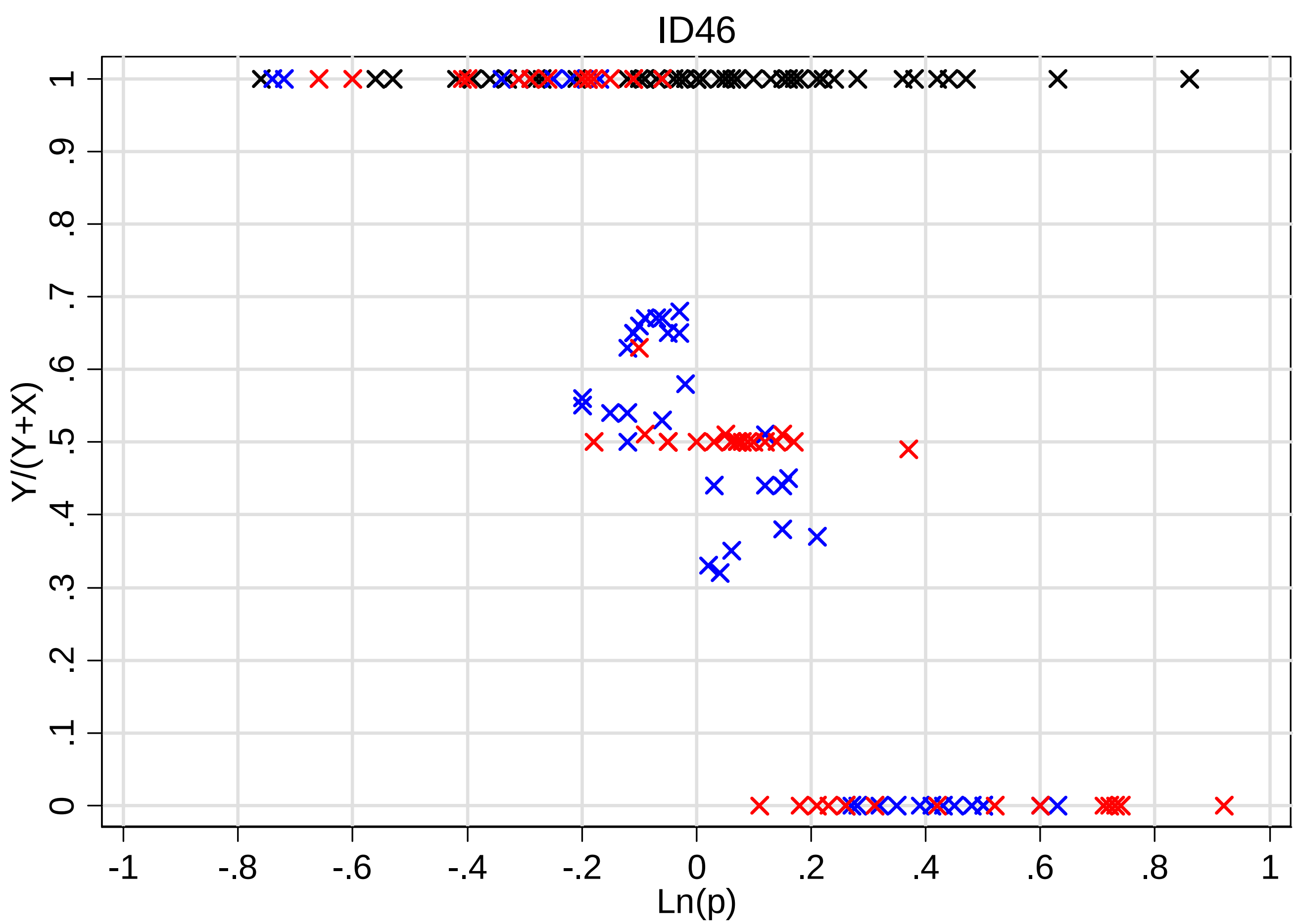


X – Risk / X – Social Choice / X – Veil of Ignorance

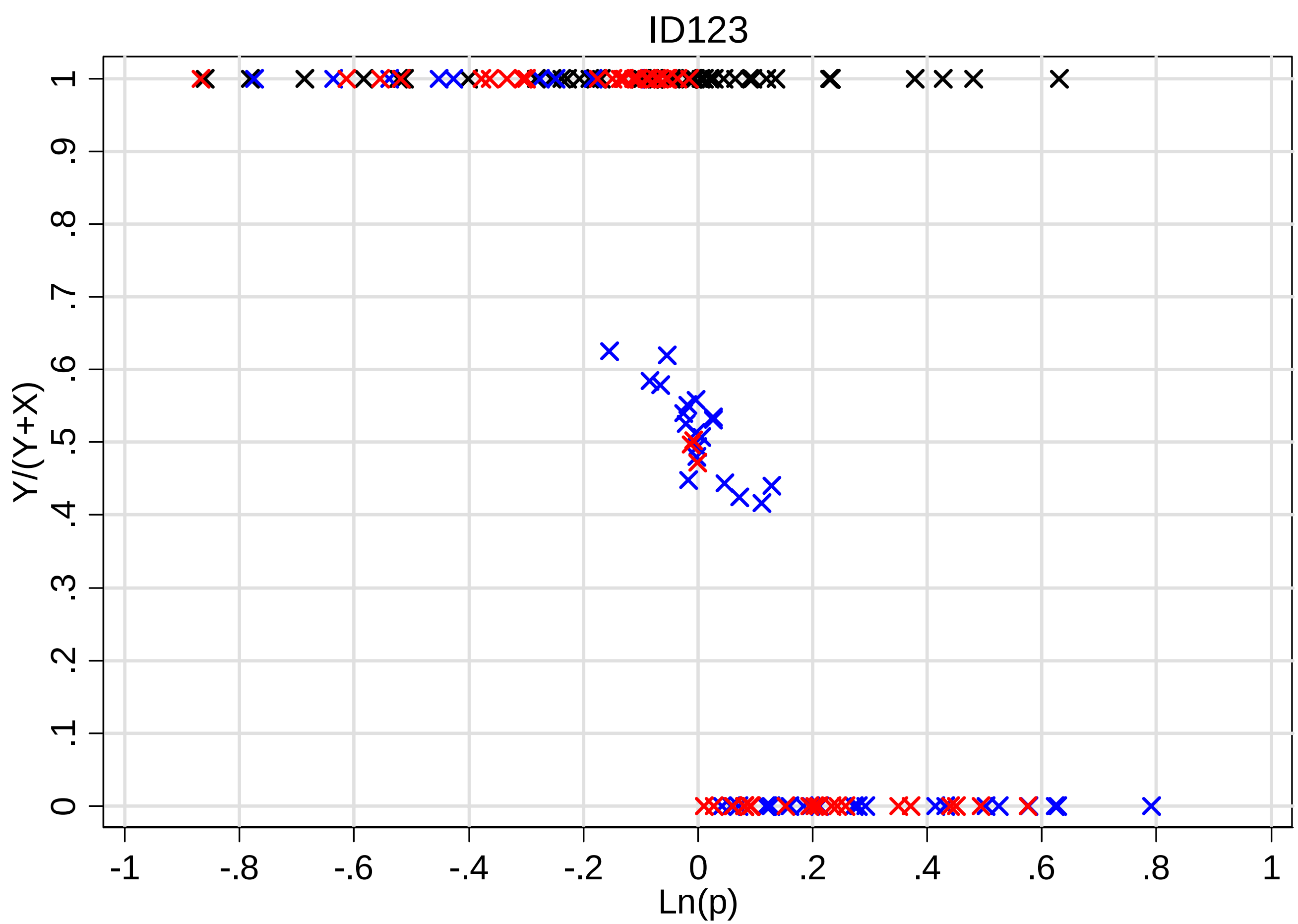

ID78
Y/(Y+X)
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1
-1
-.8
-.6
-.4
-.2
0
.2
.4
.6
.8
1
Ln(p)
X – Risk / X – Social Choice / X – Veil of Ignorance



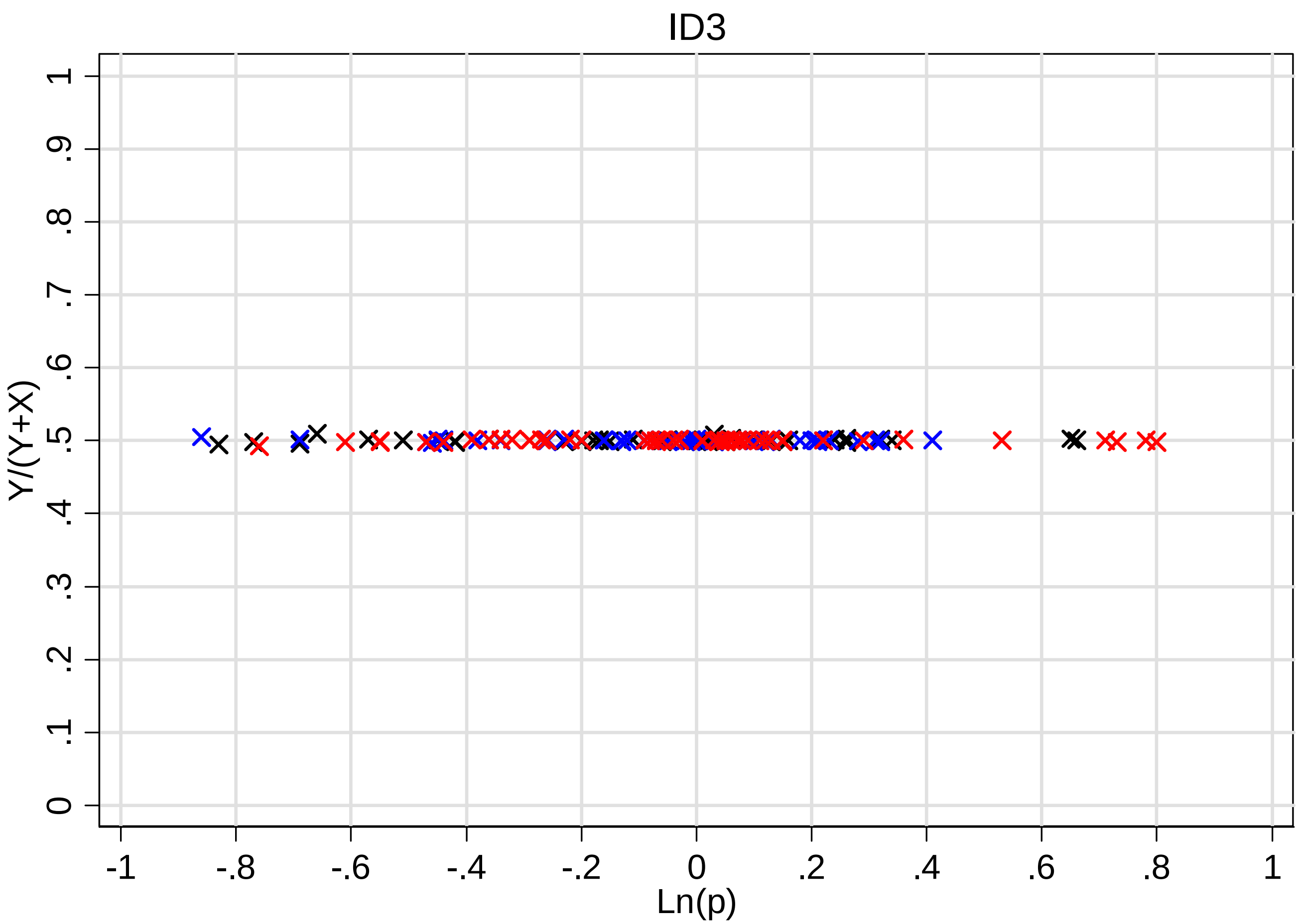
X – Risk / X – Social Choice / X – Veil of Ignorance



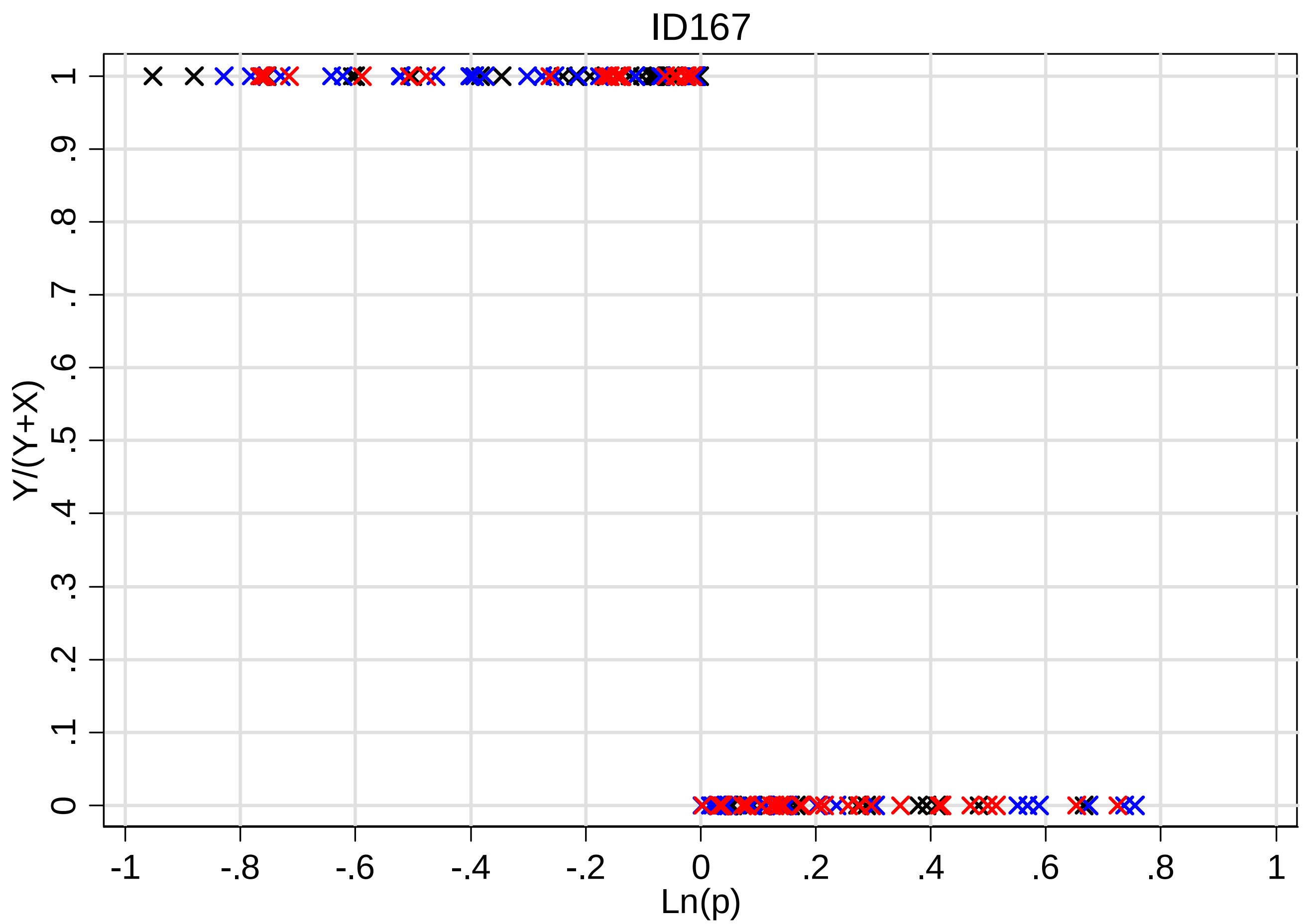
X – Risk / X – Social Choice / X – Veil of Ignorance



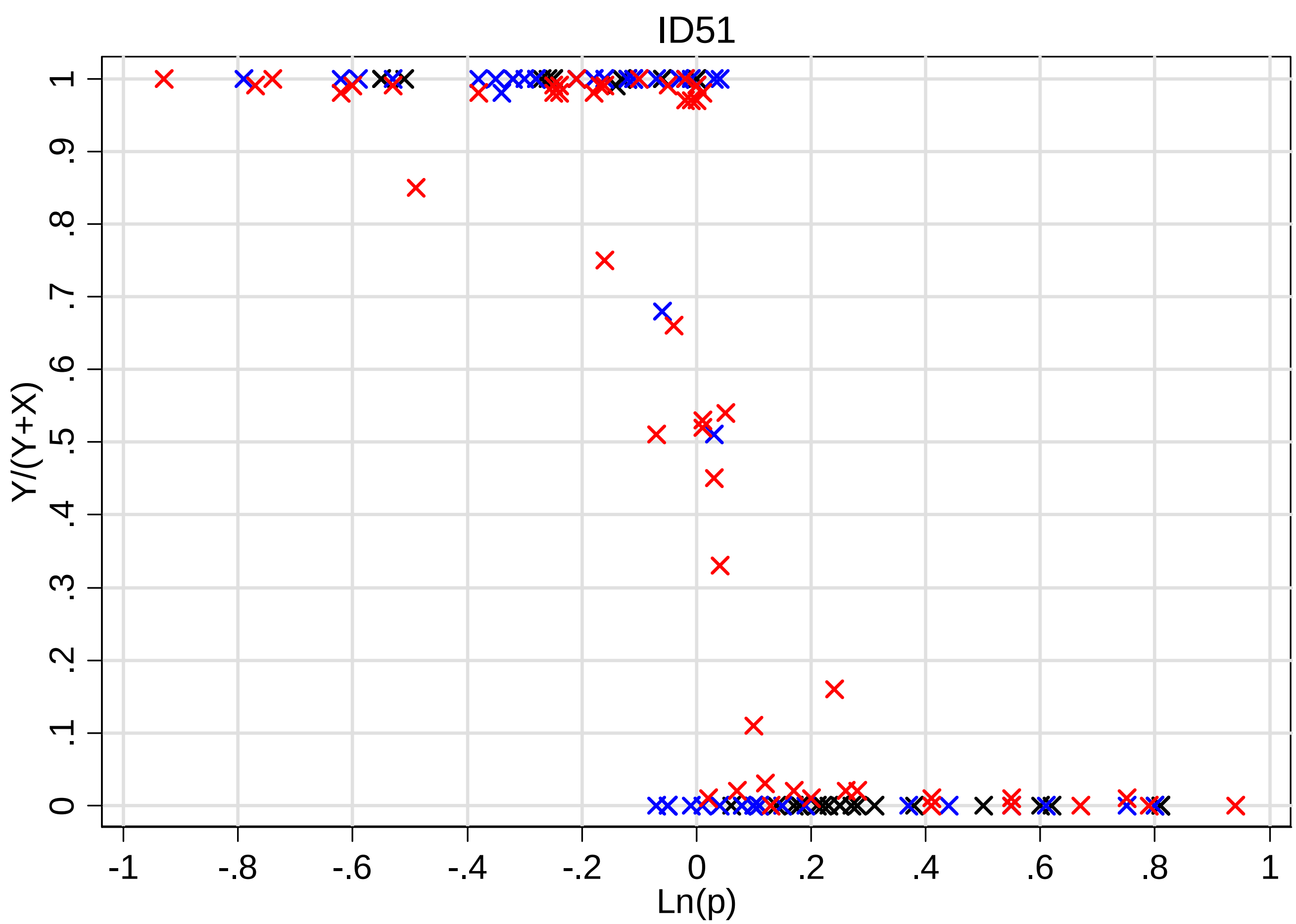
X – Risk / X – Social Choice / X – Veil of Ignorance



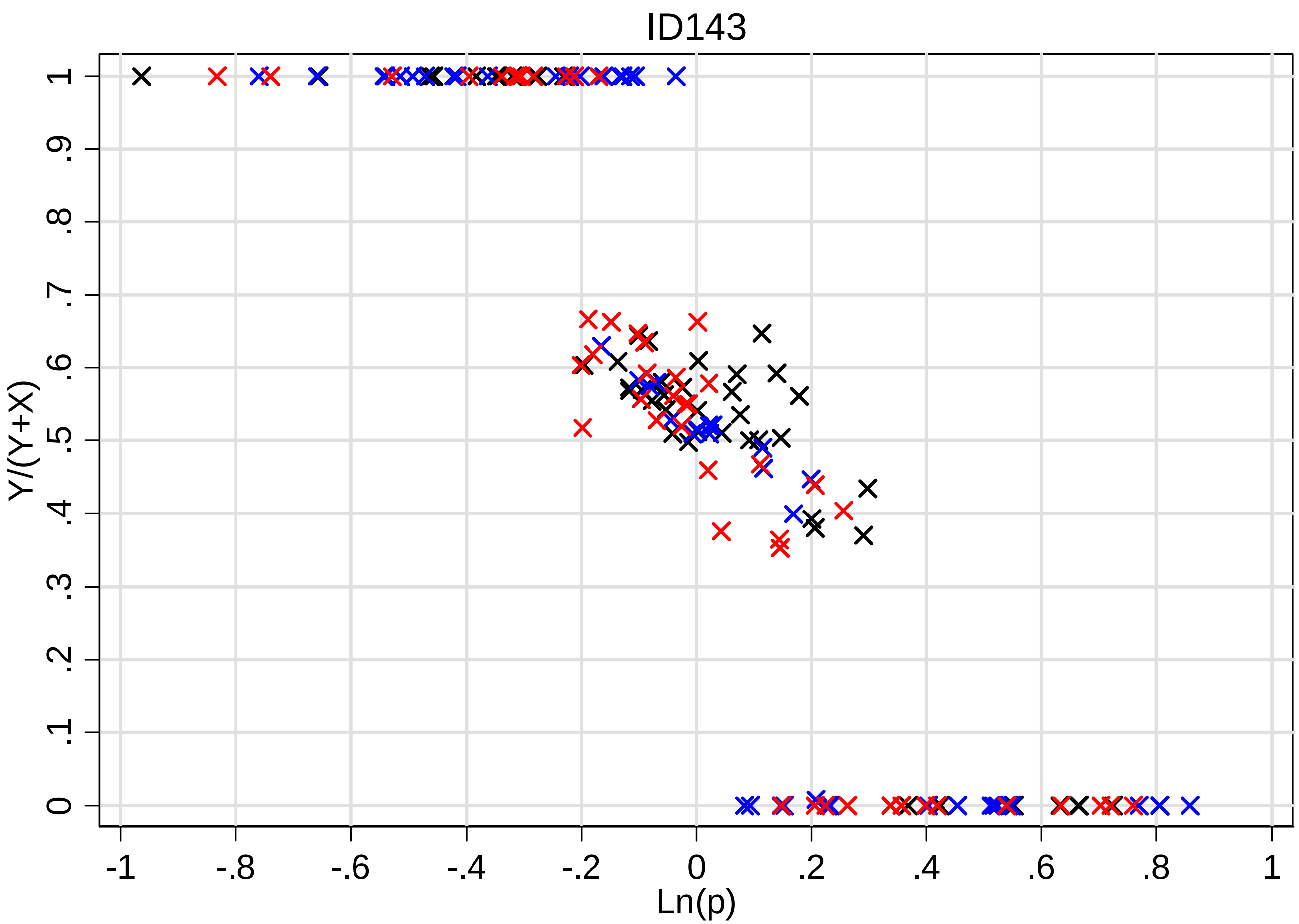
X – Risk / X – Social Choice / X – Veil of Ignorance



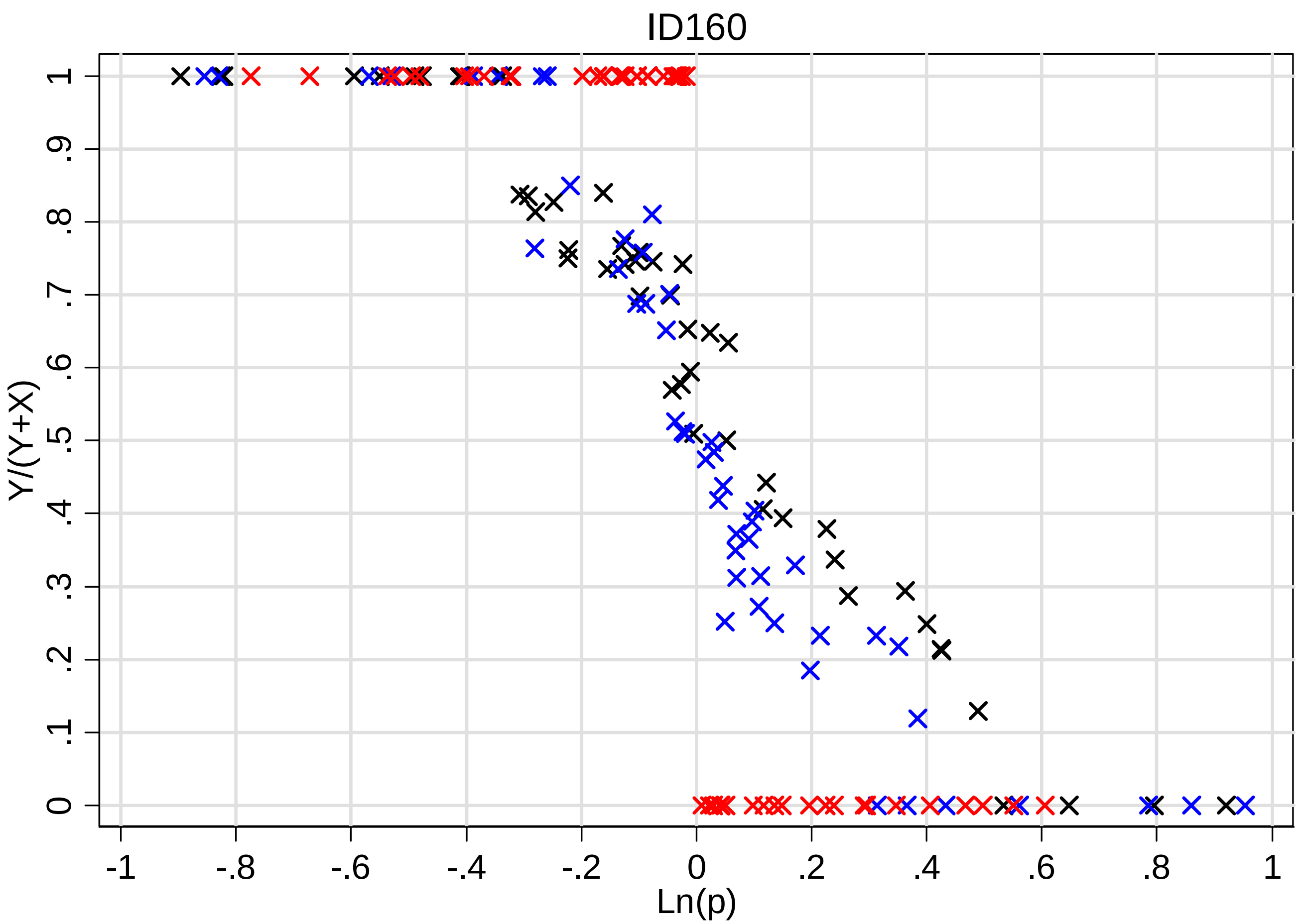
X – Risk / X – Social Choice / X – Veil of Ignorance



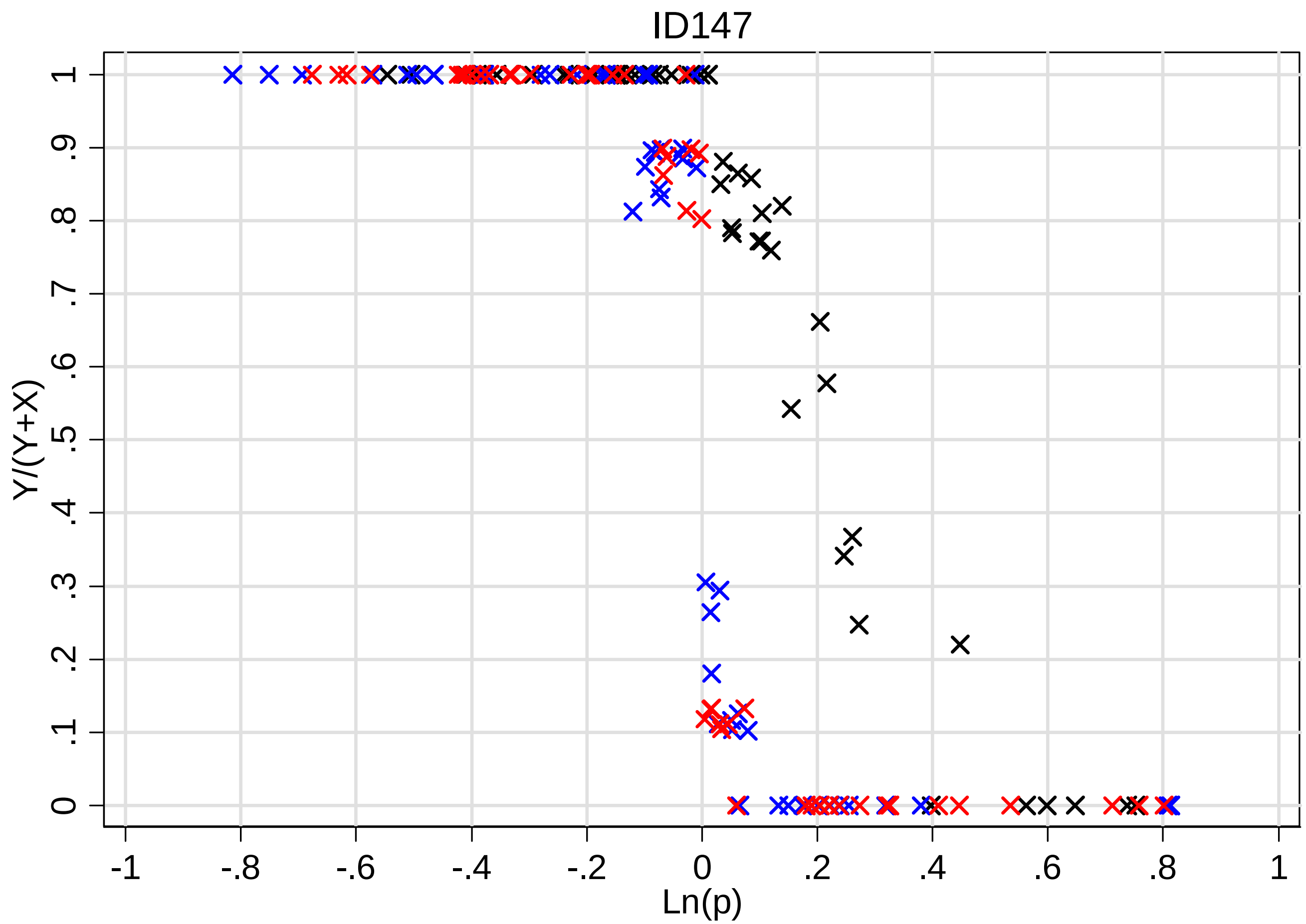
X – Risk / X – Social Choice / X – Veil of Ignorance



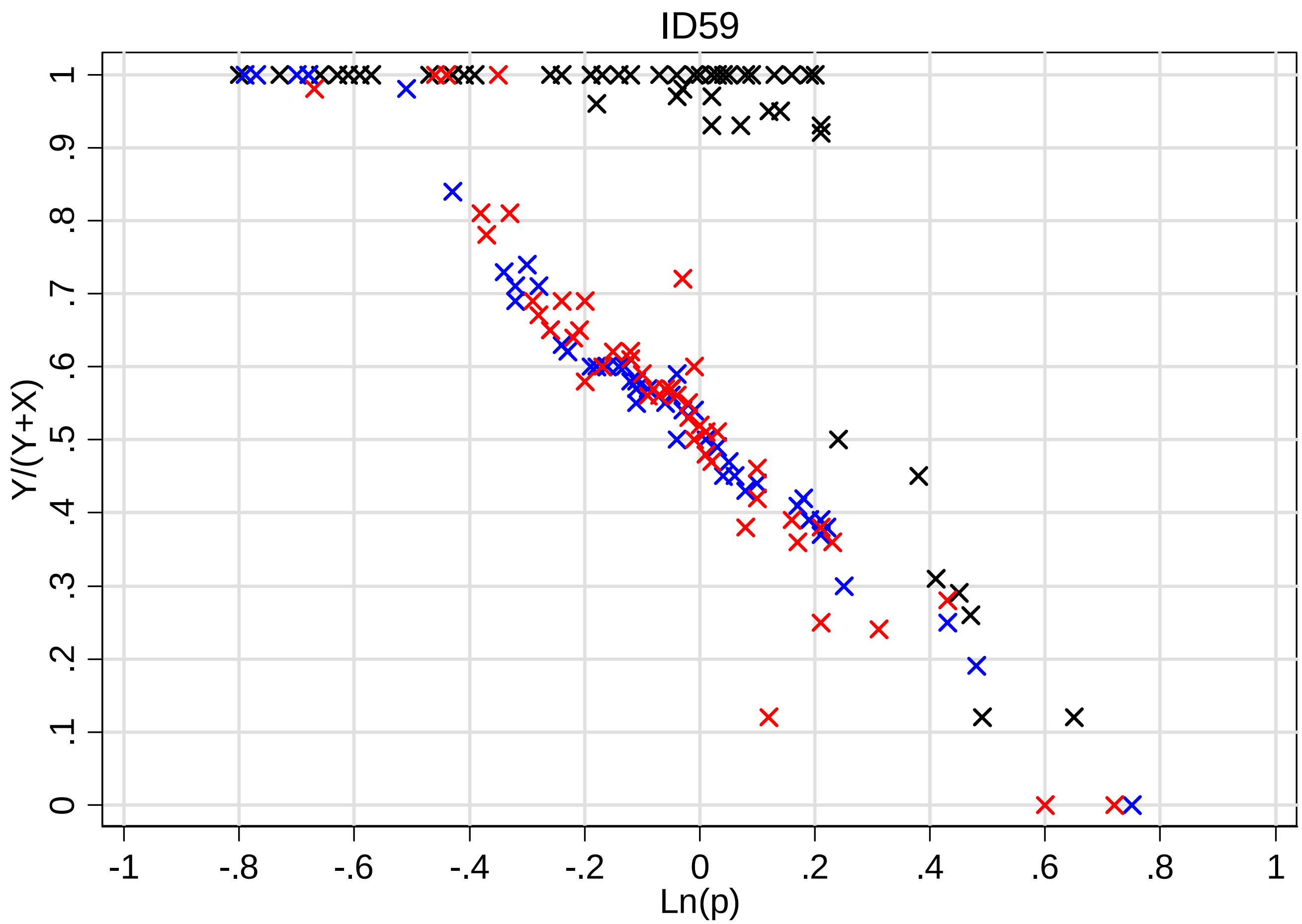
X – Risk / X – Social Choice / X – Veil of Ignorance



X – Risk / X – Social Choice / X – Veil of Ignorance



X – Risk / X – Social Choice / X – Veil of Ignorance



X – Risk / X – Social Choice / X – Veil of Ignorance

Testing the theory

- Because of the nature of the data, “flexible” functional forms do not provide a plausible fit for the data.

- No satisfactory formulation to explain the “switching” between stylized behavior patterns exhibited by many subjects.

- Parametric approaches may be possible – keeping in mind that individual behaviors are extremely heterogeneous.

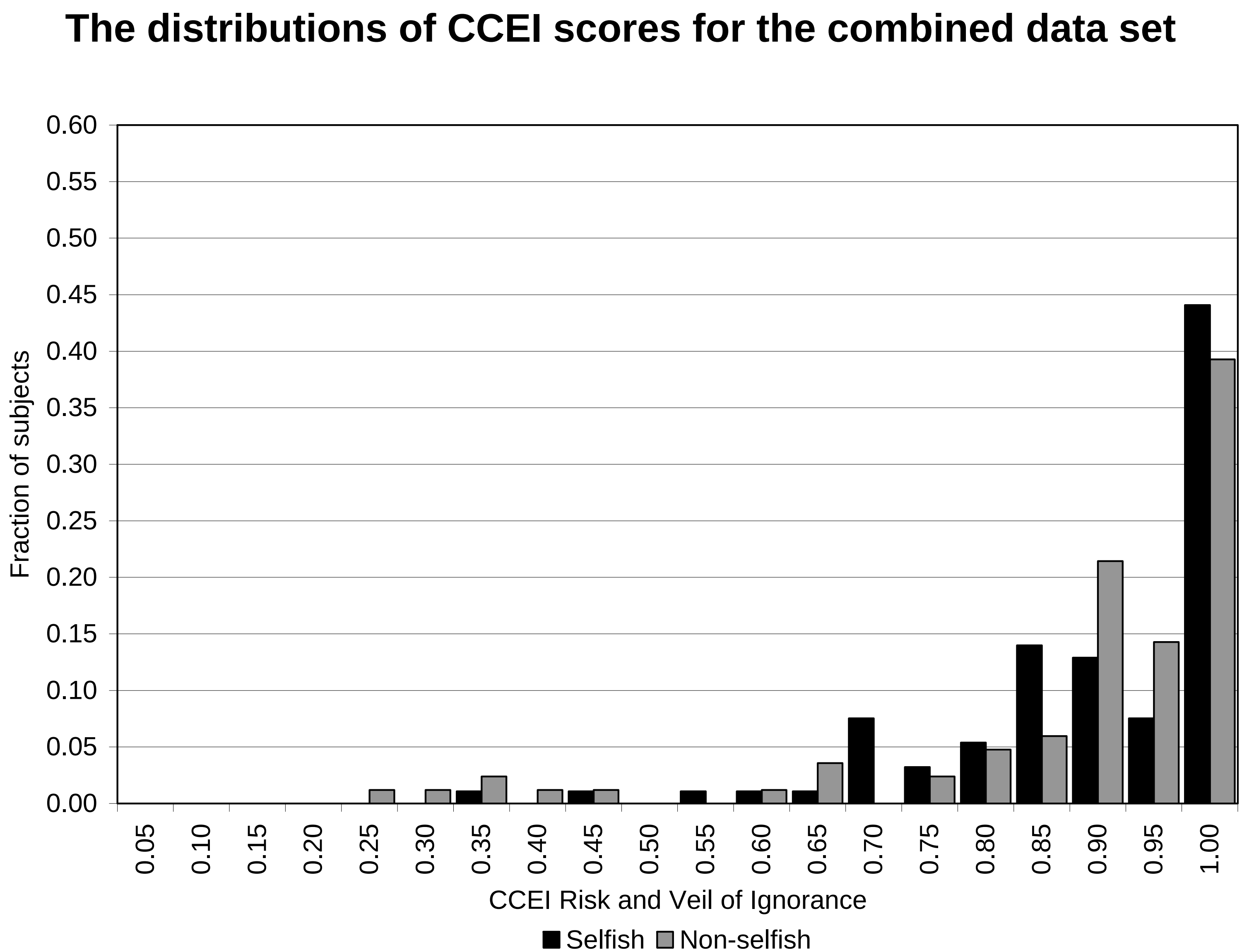
Non-parametric econometric approaches

Revealed preference

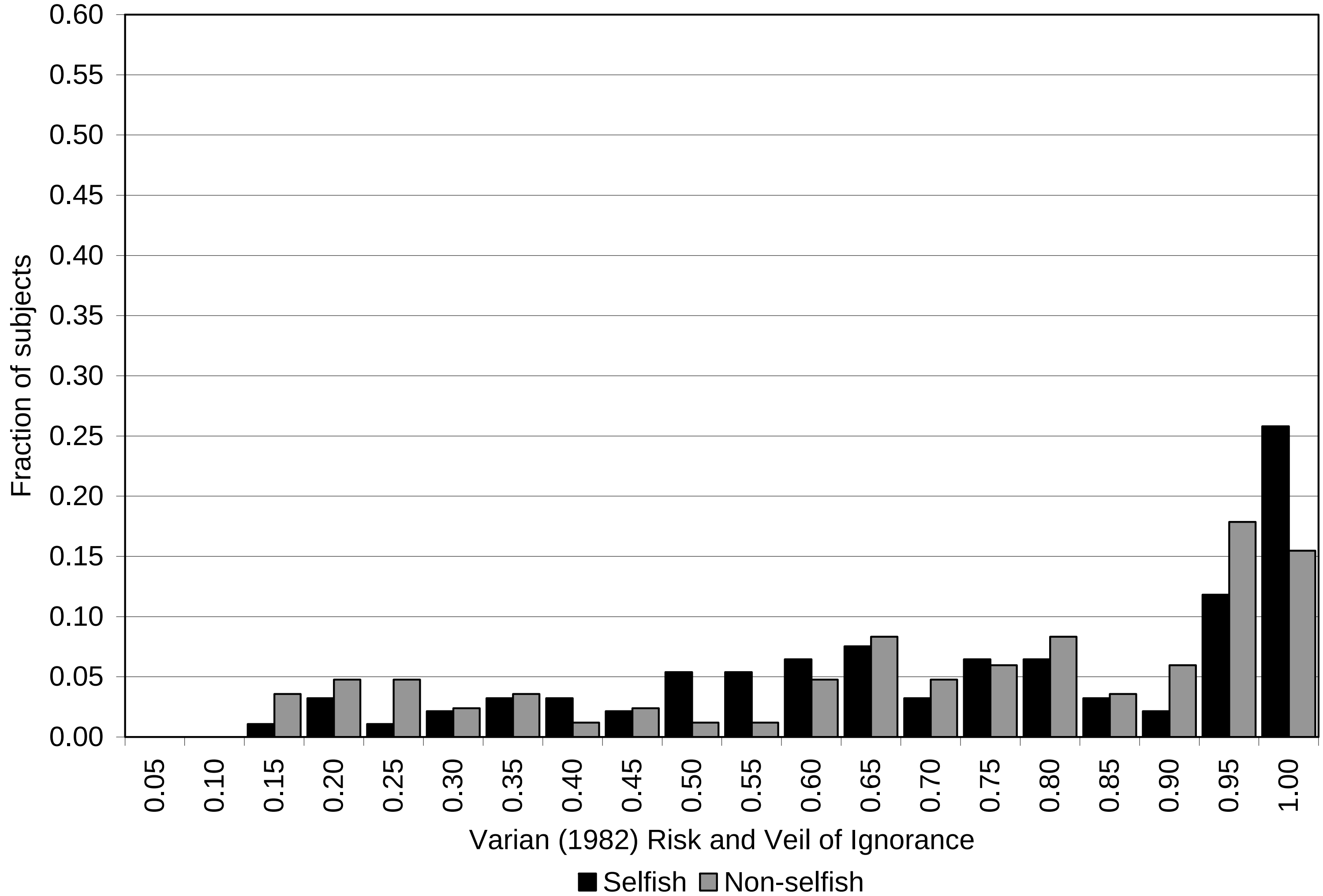
- The ratio of the CCEI score for the combined data set to the *minimum* of the CCEI scores for the separate data sets.

- A measure of the extent to which choice behaviors in any two environments coincide.

- Unfortunately, this test is weak – cannot discriminate between Risk and Veil of Ignorance behavior of selfish and non-selfish subjects.


The distributions of CCEI scores for the combined data set
Fraction of subjects
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
0.85
0.90
0.95
1.00
CCEI Risk and Veil of Ignorance
Selfish
Non-selfish

The distributions of Varian's (1982) scores for the combined data set



Kolmogorov-Smirnov type tests

- A two-sample Kolmogorov-Smirnov tests of the equality of distributions of token and budget shares.

- The test is sensitive to differences in both location and shape of the empirical cumulative distribution functions of the two samples.

- Generalize the univariate Kolmogorov-Smirnov statistics for bivariate samples (Adler and Brown, 1986).

Takeaways

- A positive account of preferences for both personal and social consumption in rich choice environments.

- Two methodological contributions:

  - The establishment of theoretical links between preferences in various environments.

  - An experimental technique that allows for the collection of richer data about preferences.

- The experimental platform and analytical techniques are applicable to many other types of individual choice problems.