Project Module in Management and Applied Economics

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Economic Preferences

Risk, Time, and Social Preferences

Risk Preferences

Risk Preferences

- Many theories of human behavior, in economics and neighboring disciplines, assume that a set of preferences drives individual decision-making.
- This includes preferences about risk, the timing of rewards, and in the social domain, reciprocity, altruism, and trust.
- Given the importance of preferences in economists' conceptual framework, a substantial empirical literature has focused on understanding the potential determinants and consequences of preference variation.
- Today: Focus on Risk Attitudes

Concepts

- shared preconception that, for the most part, people dislike risk.
- typical assumptions:
  - when offered a choice between a risky lottery versus a safe payment equal to the expected value of the lottery: choose safe payment
  - when offered a choice between two lotteries with the same expected value: choose the lottery with lower variance (less risk)
  - when offered a choice between two lotteries where one has a higher expected value but also more risk: choice will depend on the extent of risk aversion

Concepts: Importance

- risk-aversion intuition is a key driver in many situations
  - creates a demand for insurance (health insurance, unemployment insurance, property insurance, flood insurance, and so forth) plays a central role in financial investment
  - is relevant in principal-agent models (incentive-insurance trade-off; sorting)
  - is important in life-cycle models as people face risk concerning employment, income, asset returns, health, and so forth.

Concepts: Modelling Risk Aversion

- Expected Utility Framework
  - concavity of utility function
  - evaluation at life-time wealth
  - advantage: quantification (once parameter of utility function known we can make predictions)
  - disadvantage: empirically questionable (calibration problem – Rabin, 2000)

Risk Preferences in Standard Economic Theory

- Lottery: A lottery *L* is described by a vector of outcomes (x_i) and probabilities (p_i), ($p_i \geq 0$) and $\sum p_i = 1$.
  $L = (x_1 p_1; x_2 p_2; \ldots; x_i p_i; \ldots; x_n p_n)$

Theoretical Framework: Expected Utility Model

Axiom 1 (Continuity) *The preference relation* $\succeq$ *on the space of simple lotteries* $\mathcal{L}$ *is such that for all* $L^a, L^b, L^c \in \mathcal{L}$ *such that* $L^a \succeq L^b \succeq L^c$, *there exists a scalar* $\alpha \in [0, 1]$ *such that*

$$L^b \sim \alpha L^a + (1 - \alpha) L^c.$$

Axiom 2 (Independence) *The preference relation* $\succeq$ *on the space of simple lotteries* $\mathcal{L}$ *is such that for all* $L^a, L^b, L^c \in \mathcal{L}$ *and for all* $\alpha \in [0, 1]$:

$$L^a \succeq L^b \Leftrightarrow \alpha L^a + (1 - \alpha) L^c \succeq \alpha L^b + (1 - \alpha) L^c.$$

Theoretical Framework: Expected Utility Model

Theorem 1 (Expected Utility) *Suppose that the rationale preference relation $\succeq$ on the space of simple lotteries $\mathcal{L}$ satisfies the continuity and independence axioms. Then, $\succeq$ can be represented by a preference functional that is linear. That is, there exists a scalar u_s associated to each outcome x_s, $s = 1, ..., S$, in such a manner that for any two lotteries $L^a = (p_1^a, ..., p_S^a)$ and $L^b = (p_1^b, ..., p_S^b)$, we have*

$$L^a \succeq L^b \Leftrightarrow \sum_{s=1}^{S} p_s^a u_s \geq \sum_{s=1}^{S} p_s^b u_s.$$

Expected Utility – Independence Axiom

The independence axiom is not without difficulties. The oldest and most famous challenge to it has been proposed by Allais (1953). Allais proposes the following experiment. An urn contains 100 balls that are numbered from 0 to 99. They are four lotteries whose monetary outcomes depend in different ways on the number of the ball that is taken out of the urn. The outcome, expressed say in thousands of dollars, are described in Table 1.1.

Lottery	0	1-10	11-99
L^a	50	50	50
L^b	0	250	50
M^a	50	50	0
M^b	0	250	0

Table 1.1: Outcome as a function of the number of the ball

Source: Gollier (2004). *The Economics of Risk and Time*, MIT Press

Theoretical Framework: Expected Utility Model

- Risk premium:
  Amount one is willing to pay to escape a pure risk.

- Certainty equivalent
  Amount one is willing to pay/accept to escape a lottery.
  - The certainty equivalent equals the expected value of the lottery minus the risk premium.

Concepts: Modelling Risk Aversion

- Prospect Theory
  - value function;
  - reference point
  - probability weighting

- Salience
  - context-dependence leads to probability weighting
  - salient outcomes receive more attention ⇒ probability is over-weighted

Preference Measures and Preference Parameters

Measurement and Parameters of Risk Aversion

- preference parameters cannot be observed directly
  - preference parameters have to be revealed by measures problem:
  - confounding factors and measurement error
- to illustrate, consider that a risk measure R is a function of preference parameter r and confounding factors x; suppose that measurement is subject to additive random error E, such that

$$R = f(r, x) + E \qquad (1)$$

- implications for the correlation between two risk measures Ri and Ri if

$$R_i = f(r, x) + E_i \qquad (2)$$

$$R_j = g(r, x) + E_j \qquad (3)$$

Risk Preferences – Measurement

Measures Based on Lottery Choices

Measuring Risk Aversion: Incentivized Lottery Choices

Holt and Laury (2002, AER)

- Choices between two lotteries

TABLE 1—THE TEN PAIRED LOTTERY-CHOICE DECISIONS WITH LOW PAYOFFS

Option A	Option B	Expected payoff difference
1/10 of \$2.00, 9/10 of \$1.60	1/10 of \$3.85, 9/10 of \$0.10	\$1.17
2/10 of \$2.00, 8/10 of \$1.60	2/10 of \$3.85, 8/10 of \$0.10	\$0.83
3/10 of \$2.00, 7/10 of \$1.60	3/10 of \$3.85, 7/10 of \$0.10	\$0.50
4/10 of \$2.00, 6/10 of \$1.60	4/10 of \$3.85, 6/10 of \$0.10	\$0.16
5/10 of \$2.00, 5/10 of \$1.60	5/10 of \$3.85, 5/10 of \$0.10	−\$0.18
6/10 of \$2.00, 4/10 of \$1.60	6/10 of \$3.85, 4/10 of \$0.10	−\$0.51
7/10 of \$2.00, 3/10 of \$1.60	7/10 of \$3.85, 3/10 of \$0.10	−\$0.85
8/10 of \$2.00, 2/10 of \$1.60	8/10 of \$3.85, 2/10 of \$0.10	−\$1.18
9/10 of \$2.00, 1/10 of \$1.60	9/10 of \$3.85, 1/10 of \$0.10	−\$1.52
10/10 of \$2.00, 0/10 of \$1.60	10/10 of \$3.85, 0/10 of \$0.10	−\$1.85

- Small vs. large stakes (20, 50, 90 times low stakes)
- Hypothetical vs. real payments

Measuring Risk Aversion: Incentivized Lottery Choices

Holt and Laury (2002, AER): Findings

TABLE 3—RISK-AVERSION CLASSIFICATIONS BASED ON LOTTERY CHOICES

Number of safe choices	Range of relative risk aversion for $U(x) = x^{1-r}/(1-r)$	Risk preference classification	Proportion of choices		
			Low real[a]	20x hypothetical	20x real
0–1	$r < -0.95$	highly risk loving	0.01	0.03	0.01
2	$-0.95 < r < -0.49$	very risk loving	0.01	0.04	0.01
3	$-0.49 < r < -0.15$	risk loving	0.06	0.08	0.04
4	$-0.15 < r < 0.15$	risk neutral	0.26	0.29	0.13
5	$0.15 < r < 0.41$	slightly risk averse	0.26	0.16	0.19
6	$0.41 < r < 0.68$	risk averse	0.23	0.25	0.23
7	$0.68 < r < 0.97$	very risk averse	0.13	0.09	0.22
8	$0.97 < r < 1.37$	highly risk averse	0.03	0.03	0.11
9–10	$1.37 < r$	stay in bed	0.01	0.03	0.06

[a] Average over first and second decisions.

Measuring Risk Aversion: Incentivized Lottery Choices

- Advantages
  - stakes and probabilities known
  - incentivized choice
  - reveals preference parameter (under strong assumptions)

- Disadvantages
  - often small stakes (calibration problem)
  - potentially cognitively demanding
  - costly to measure

Measuring Risk Aversion: Hypothetical Lottery Choices

Risk Measure in Barsky et al. (1997)

- Suppose that you are the only income earner in the family, and you have a good job guaranteed to give you your current (family) income every year for life. You are given the opportunity to take a new and equally good job, with a 50–50 chance it will double your (family) income and a 50–50 chance that it will cut your (family) income by a third.
  - Would you take the new job?

Measuring Risk Aversion: Hypothetical Lottery Choices

Risk Measure in Barsky et al. (1997)

- If the answer to the first question is “yes,” the interviewer continues:
  - Suppose the chances were 50–50 that it would double your (family) income, and 50–50 that it would cut it in half. Would you still take the new job?

- If the answer to the first question is “no,” the interviewer continues:
  - Suppose the chances were 50–50 that it would double your (family)income and 50–50 that it would cut it by 20 percent. Would you then take the new job?

Measuring Risk Aversion: Hypothetical Lottery Choices

Risk Measure in Barsky et al. (1997)

TABLE I

RISK PREFERENCE SURVEY DESIGN

	Gamble[a]	Relative risk aversion (1/θ)			Relative risk tolerance (θ)			Expectation conditional on survey response[c]	
		Upper bound	Lower bound	Mean[b]	Lower bound	Upper bound	Mean[b]	1/θ	θ
I.	Reject both one-third and one-fifth	∞	3.76	15.8	0	0.27	0.11	15.7	0.15
II.	Reject one-third but accept one-fifth	3.76	2	2.9	0.27	0.5	0.36	7.2	0.28
III.	Accept one-third but reject one-half	2	1	1.5	0.5	1	0.68	5.7	0.35
IV.	Accept both one-third and one-half	1	0	0.7	1	∞	1.61	3.8	0.57

a. Gambles all have a 50 percent probability of doubling lifetime income and a 50 percent probability of losing half, one-third, or one-fifth of lifetime income.

b. These columns report the mean if the *true* value is between the lower and upper bounds.

c. These columns give the expected value of relative risk tolerance and relative risk aversion conditional on *observing* response I, II, III, or IV. This conditional expectation takes into account measurement error in the survey response. This baseline case assumes lognormality, no status quo bias, and no persistent measurement error. (See text for details and Table XIV for other cases.)

Measuring Risk Aversion: Hypothetical Lottery Choices

Risk Measure in Barsky et al. (1997)

TABLE IIA
RISK TOLERANCE BY PRIMARY AND SECONDARY RESPONDENTS

Respondent	Percent choosing response				Number of responses	Mean risk tolerance[a]
	I	II	III	IV		
All respondents	64.6	11.6	10.9	12.8	11707	0.2412
Primary respondent	64.8	11.4	10.7	13.0	7278	0.2413
Secondary respondent	64.3	11.8	11.2	12.5	4429	0.2410

The p-value for the hypothesis that the mean risk tolerance is equal across primary and secondary respondents is 0.92.

a. The mean risk tolerance is computed using the baseline parametric model.

Measuring Risk Aversion: Hypothetical Lottery Choices

- Advantages
  - stakes and probabilities known
  - large stakes can be implemented (squares with expected utility framework)
  - not costly in terms of money
- Disadvantages
  - potentially cognitively demanding
  - not clear whether choice reveals preference

Measuring Risk Aversion: Risky Behavior

- Wearing seat-belts
- Becoming self-employed
- Gambling

- Buying insurance

Measuring Risk Aversion: Risky Behavior

- Advantages
  - stakes can be large
  - No direct cost

- Disadvantages
  - potentially many confounding factors
  - stakes and probabilities not necessarily known

Measuring Risk Aversion: Self-Assessments

- General risk question:
  - *How do you see yourself: Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please tick a box on the scale, where the value 0 means: 'unwilling to take risks' and the value 10 means: 'fully prepared to take risks*'
  - 11-point scale
- Questions about willingness to take risks in specific contexts:
  - Health, car driving, financial matters, sports and leisure, career

Measuring Risk Aversion: Self-Assessments

- Advantages
  - easy to ask
  - no direct costs
- Disadvantages
  - potentially many confounding factors
  - stakes and probabilities not known
  - no objective metric (scale use, etc.)

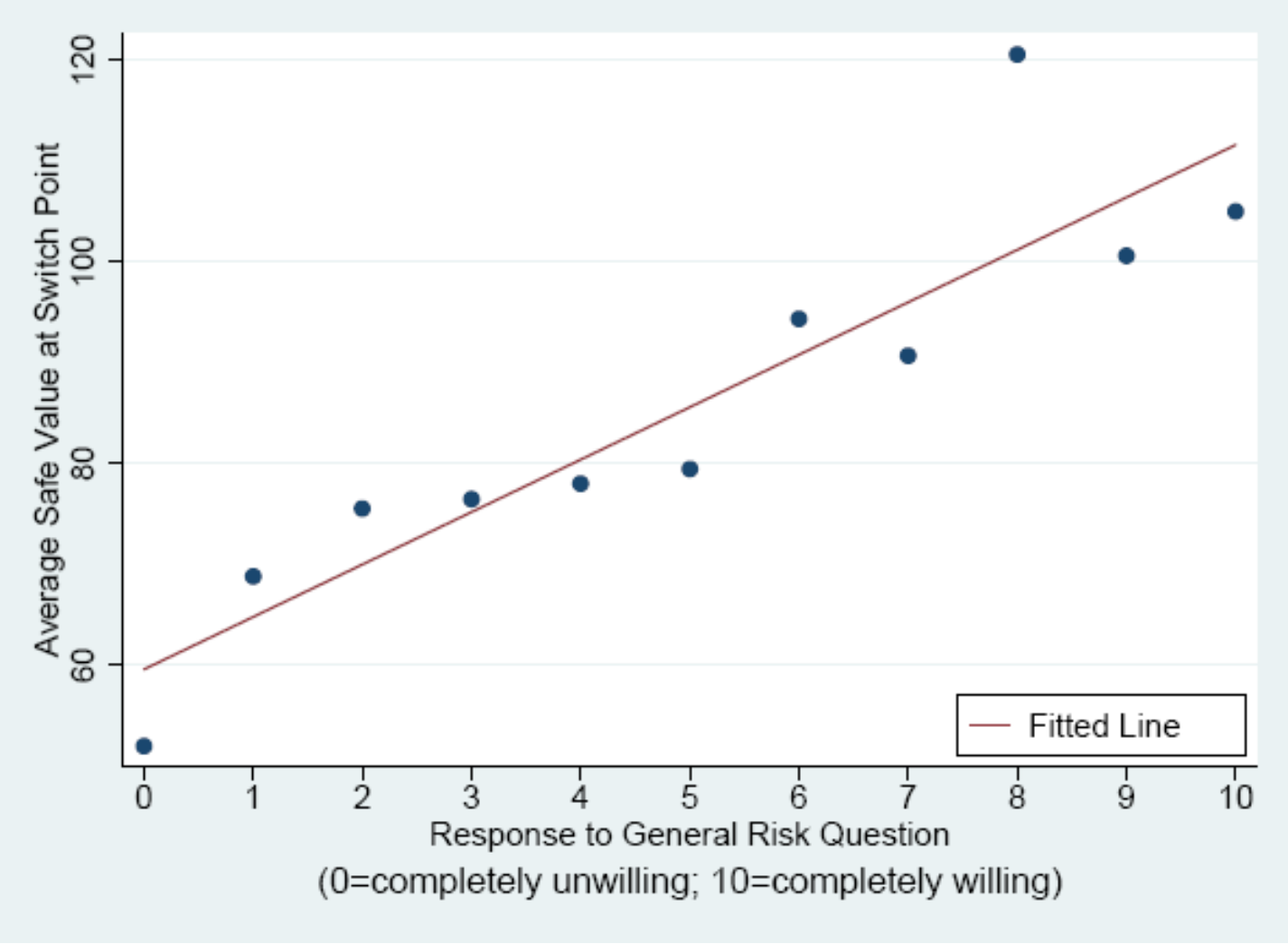
Validation of Self-Assessments

See Dohmen, Falk, Huffman, and Sunde (2011). "Individual Risk Attitudes: Measurement, Determinants and Behavioral Consequences." *Journal of the European Economic Association* 9(3): 522-550.

- 450 subjects, representative sample of adult population
  - Subjects answer the general risk question
  - Subjects also take part in paid lottery experiment
    - Lottery: 300 or 0 Euros, with equal probability
    - Safe option: X Euros, where X varies across 20 choices
    - One choice is randomly selected and implemented
    - Incentive compatible measure of risk preference: switching point from the lottery to the safe option
  - Lottery measure standardizes for incentives and context.

- Risk question predicts switching point
  - Ordered Probit, Interval regressions, OLS regressions (n=450)
  - Extensive socio-economic controls

General Risk Question and Risk Taking Behavior



Additional Evidence on Validity

- General/context specific risk questions predict:
  - Holding stock:
    - a one standard deviation increase in willingness to take risks (in financial matters) is associated with a 35 percent increase in the probability of holding stocks
  - Self-employment:
    - a one standard deviation increase in willingness to take risks (general risk question) is associated with a 30 percent increase in the probability of being self-employed
  - Sorting into incentive schemes:
    - Dohmen and Falk (2006)
  - Sorting into occupations based on earnings variance
    - (Bonin et al., 2007)
    - Risk premium in wages: Mincer wage regression: for each point on 11-point scale, 2 percent higher log monthly wages.
  - Geographical mobility:
    - Impact on the probability of moving residence between geographical regions (Jaeger et al., 2007).
  - Educational choice, investment in health, traffic offenses, etc.

Time Preferences: Concepts and Measurement

Discounting

- Discounting: trade-off between earlier/lower and later/higher consumption
- Standard economic theory assumes exponential discounting, i.e., a constant discount factor δ
  Intertemporal trade-offs are made the same way, irrespective of when they occur.
  - People are rational, no preference reversal, no regret, no self-control problems

The Discounted Utility Model

- “Despite Samuelson’s manifest reservations about the normative and descriptive validity of the formulation he had proposed, the DU model was accepted almost instantly, not only as a valid normative standard for public policies (e.g., in cost-benefit analyses), but as a descriptively accurate representation of actual behavior. A central assumption of the DU model is that all of the disparate motives underlying intertemporal choice can be condensed into a single parameter—the discount rate.” (cited from Frederick et al., 2002, JEL, p. 351)

Problematic Assumptions

- Ability to recalculate the utility from new optimal consumption path
- Utility independence
- Consumption independence
- Stationary instantaneous utility

Exponential Discounting

- Standard assumption in almost all applications

$$U = u(c_t) + \delta u(c_{t+1}) + \delta^2 u(c_{t+2}) + \ldots \delta^T u(c_{t+T})$$

  - u(·): Concave period utility function.
  - ct: Consumption in period t.
  - $\delta < 1$: Discount factor.

- Discounting is exponential: Consumption c = 1 yields utility $\delta^k u(1)$ *k* periods from now.

Exponential Discounting

- Exponential discounting implies time consistency.
- If an individual prefers sequence x_t, x_{t+1}, ... to sequence y_t, y_{t+1}, ... viewed from period 0, then she has the same preference viewed from period t, i.e., she does not want to reverse her decision in period t.
- Follows from exponential discount:

$$\sum_{s=0}^{T} \delta^{t+s} u(x_{t+s}) \geq \sum_{s=0}^{T} \delta^{t+s} u(y_{t+s})$$

$$\Rightarrow \sum_{s=0}^{T} \delta^{s} u(x_{t+s}) \geq \sum_{s=0}^{T} \delta^{s} u(y_{t+s})$$

- Produces elegant mathematical results.

Measuring Time Discounting

- Typical approach
  - Infer from inter-temporal choices

Problems with Standard Model/Exponential Discounting

"Virtually every assumption underlying the DU model has been tested and found to be descriptively invalid in at least some situations." (Frederick et al., 2002, JEL, p.352)

Violations of DU Model with Constant Discounting

- Absurd discount rates
  - negative discount rates
    (e.g., tax refunds)
  - extremely high discount rates
    (e.g., little insulation)
- Gains are discounted more than losses
- Small outcomes are discounted more than large outcomes

Violation: Utility not stationary and independent over Time

- Violation of consumption independence
  - Cases in which U(xi) is not independent of U(xj)
- Preference for improving sequences
  - “irrational” wage profiles
  - Sequence of restaurant visits
  - Sequence of pleasurable events
    - Many individuals do not prefer a sequence in which the most pleasurable event in a series of events comes first
    - We tend to experience/remember the end of a sequence more intensively
- Instantaneous utility might depend on context/circumstances

Violation: Mental Accounting

- According to the life-cycle theory of savings & consumption:
  - calculate NPV of financial wealth
- In practice, people tend to:
  - Add small windfall gains to “income account” (high MPC)
  - Add larger gains to “assets account” (low MPC)
  - Avoid consuming future earnings.

Violation: Memory and Anticipation

- We don’t merely consume experiences, we consume the past & future.
  - Memory: we often derive utility or disutility from past experiences (e.g., weddings, regrets).
  - Anticipation: we savor future positive experiences and dread future negative experiences.

Violations of DU model with Constant Discounting

- Empirically, non-constant discounting is often found
  - Time-inconsistency
- Subadditive discounting (e.g. Read, 2001)

Violation: Impatience/Impulsivness

- Evidence suggests that individuals discount near future more strongly (i.e., different discount factors).
  - "Tomorrow" compared to "Today" is different than "Tomorrow plus a year" compared to "A year":
  - Example:
    - Choice between 100 now or 110 in a month.
    - Choice between 100 in 12 months or 110 in 13 months
    - Many people are more patient in the future.
    - Preference reversal
    - Can lead to self-control problems: E.g. procrastination of a diet, stop smoking, learning for test, etc.

Violation: Impatience/Impulsivness

- Produces time-inconsistency – incompatible with exponential discounting.
  - Strotz (1950s), Herrnstein (1960s) were the first to describe this phenomenon.
  - Many papers have measured effects like this (see especially papers by Thaler, Loewenstein, Kirby, Read, and review by Frederick, Loewenstein, and O'Donoghue)

Consumption Choices over Time

- The person in our example likes to save in the long-run.
  - But how much will the person save?

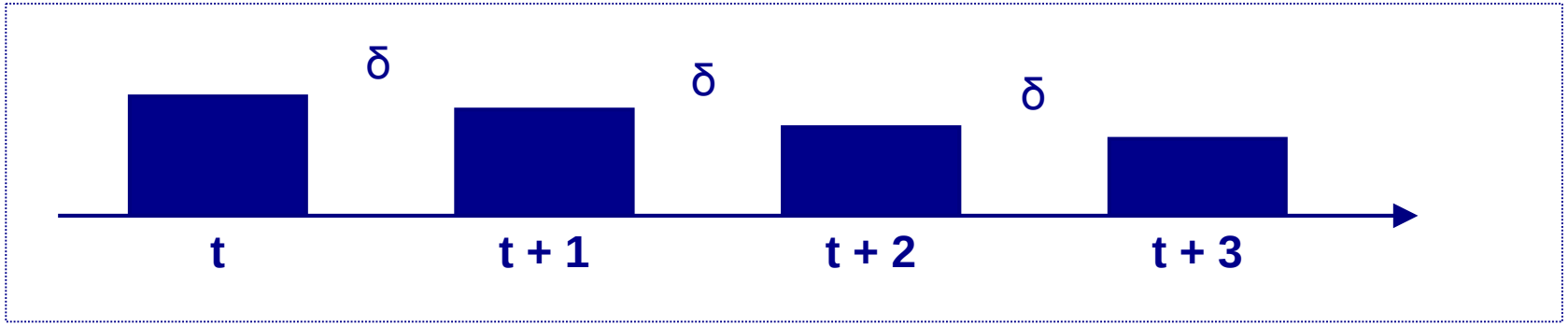
1st year: nothing
2nd year: nothing
3rd year: nothing
4th year: nothing
5th year: nothing
….

Self-Control Problem

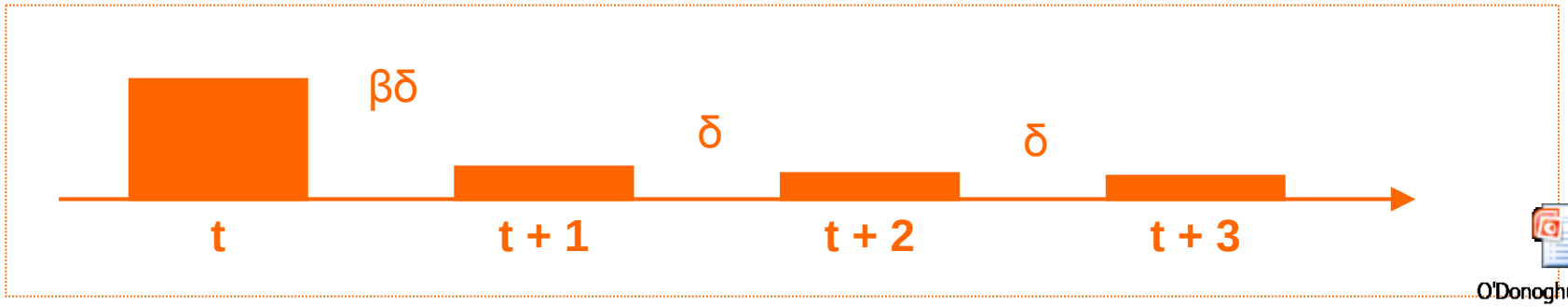
- Person always consumes too much and never saves, although the person wants to save in the long-run

Standard vs. βδ-Model

- Standard model: exponential discounitng



- Quasi-hyperbolic discounting (βδ-Model)



O'DonoghueRabin Model

→ Produces time-inconsistency (and self-control problems).

Alternative Models

- Models that enrich instantaneous utility function
  - Habit formation models
  - Reference-point models
  - Utility from anticipation
  - State-dependent utility (visceral influences)

- Projection bias
- Mental-Accounting
- Choice Bracketing
- Multiple-Self Models
- Temptation Utility


Dual-Self Model


Neuro evidence

Measuring Time Discounting

- Typical approach
  - Infer from intertemporal choices

Workhorse Experimental Design: “Price List Format”

- Example:
  - Subjects make 20 choices listed in a choice table.
  - The choice is always between a payment available at date *t*, and a larger payment available at a future date, *s* > *t*.
  - We obtain an incentive compatible measure of the annual internal rate of retur (**IRR**) needed to induce waiting.

  - *Problems: mulitple switching points*

Subadditivity – Implications for Measuring Discounting

Evidence from Dohmen, Falk, Huffman, Sunde (2011), "Interperting Time Horizon Effects in Intertemporal Choice", IZA DP 6385

Three different Approaches to Measurement

- Three types of comparison:
  - Overlapping Design (OD)
    - Comparison of intervals of different length
  - Shifted Design (SD)
    - Comparison of intervals of the same length shifted in time
  - Overlapping Shifted Design (OSD)
    - Comparison of intervals of the same length that cover a common time period

Three different Approaches

- Most common: compare overlapping horizons T and T'>T, starting on the same date.
  - E.g., today to 6 months, and today to 12 months.
  - We call this the **overlapping design (OD).**
  - This design has usually found declining discounting (see Frederick et al., 2002).

Three different Approaches

- Less common: same length T, but non-overlapping.
  - E.g., today to 6, and 6 to 12 months.
  - We call this the **shifted design (SD).**
  - Sometimes declining (e.g., Kirby and Herrnstein, 1995), but other times increasing or constant (Sutter et al., 2010).

Three different Approaches

- Least used: overlapping horizons of different lengths T and T', starting on different dates.
  - E.g., today to 12, and 6 to 12 months.
  - We call this the **overlapping-shifted design (OSD)**
  - The few times it was tried (e.g., Barron, 2000; Read, 2001), more consistent with constant or increasing.

Price List Format

- Subjects made 20 choices.
- The choice was always between a payment available at date *t*, and a larger payment available at a future date, *s* > *t*.
- Subjects knew that at the end one choice would be randomly selected and implemented.
  - The payment would arrive in the mail within 2 days of the experiment, as a certificate redeemable either at *t* or at *s*.
  - Very high credibility: Subjects part of SOEP panel, interviews by well-known polling company, etc.
- We obtain an incentive compatible measure of the annual internal rate of return (**IRR**) needed to induce waiting.

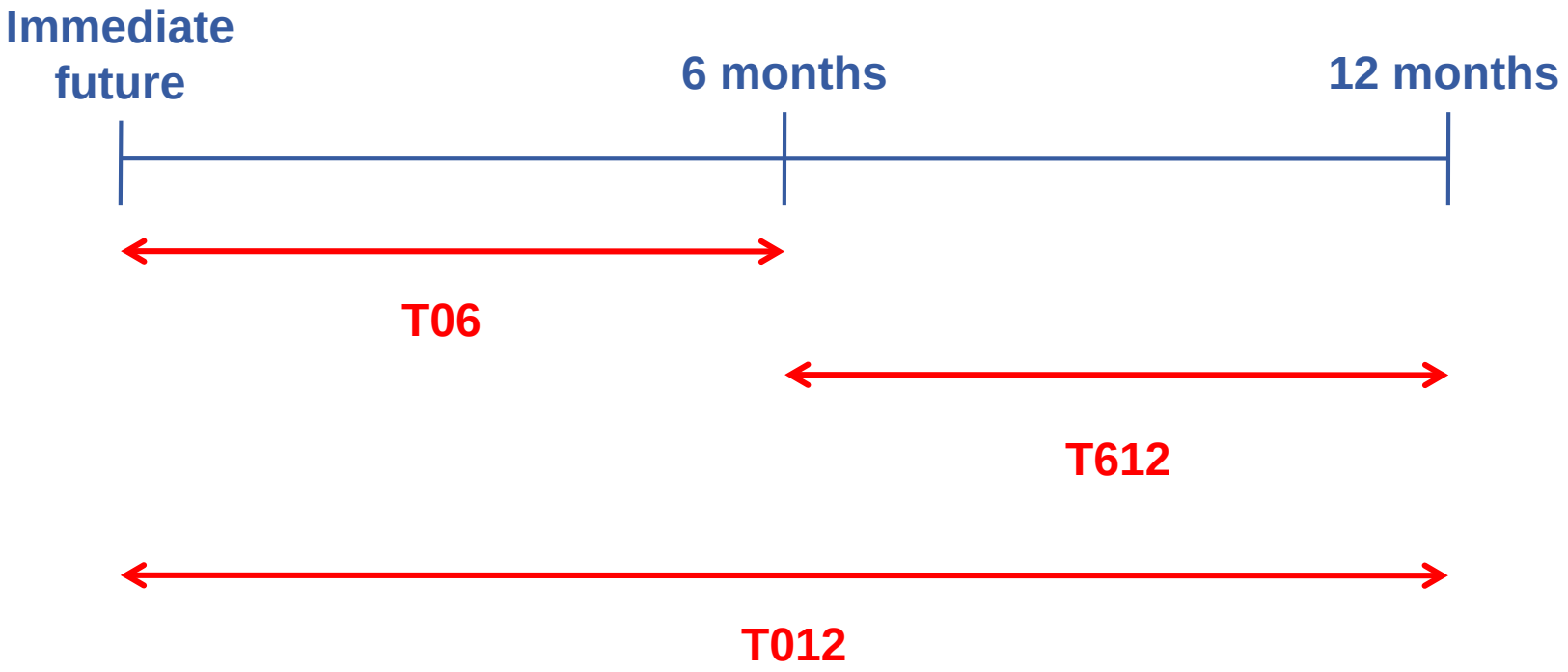
Two Data Sets

- 1. Pretest data
  - 500 subjects
  - Constructed to be representative of adult population living in Germany
  - Three discounting intervals for each subject:
    - T012
    - T06
    - T612
  - Randomized order of discounting experiments
  - Early payment always 100 Euro
  - Chance of being paid: 1/7

Two Data Sets

- 2. SOEP data (subsample of 2006 wave)
  - Experiment integrated into long existing data set
  - Extremely rich information (life course, important life events, socio-economics, preferences, attitudes, personality
  - 1503 subjects
  - Representative of adult population living in Germany
  - Different discounting intervals for different sub-samples:
    - Sub-sample 1 (N=490): T012 and T06
    - Sub-sample 2 (N=487): T012 and T01
    - Sub-sample 3 (N=526): T01 and T1213
  - Order not randomized
  - Early payment always 200 Euro
  - Chance of being paid: 1/9

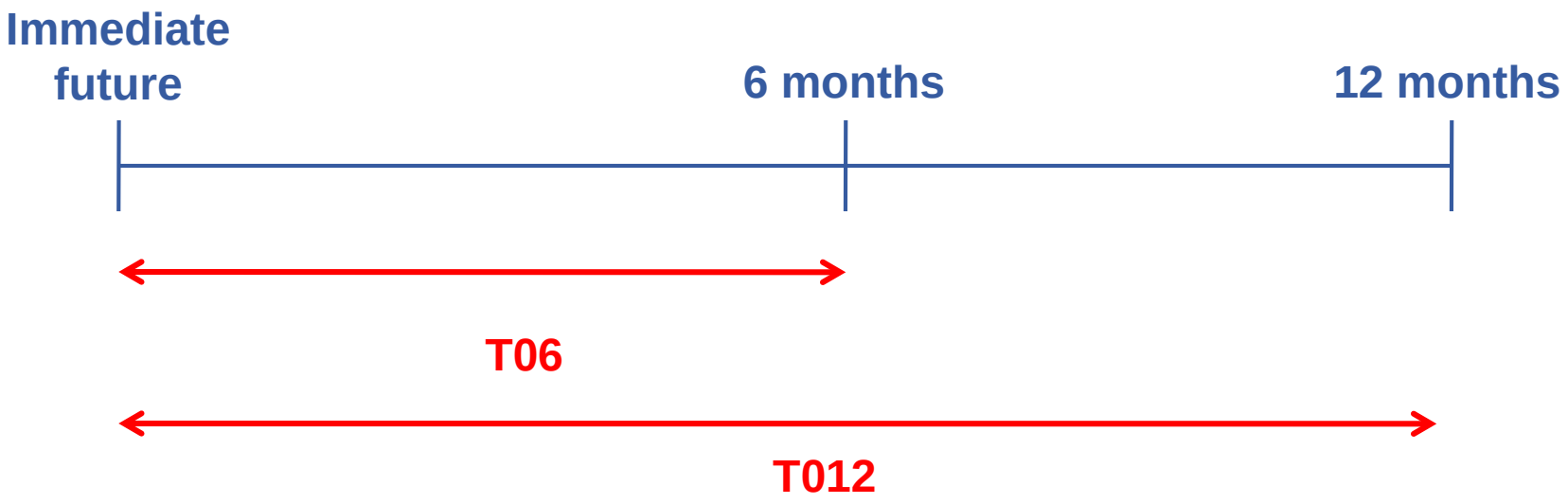
Pretest Data: Three Measures for each Individual (N=500)



Note: Order was randomized across individuals.

SOEP Data: Two Measures for each Individual, three Sub-samples (N=490, N=487, N=526)

- Sub-sample 1: Immediate to 12 months, immediate to 6



SOEP Data:

- Sub-sample 2: Immediate to 12 months, immediate to 1

SOEP Data:

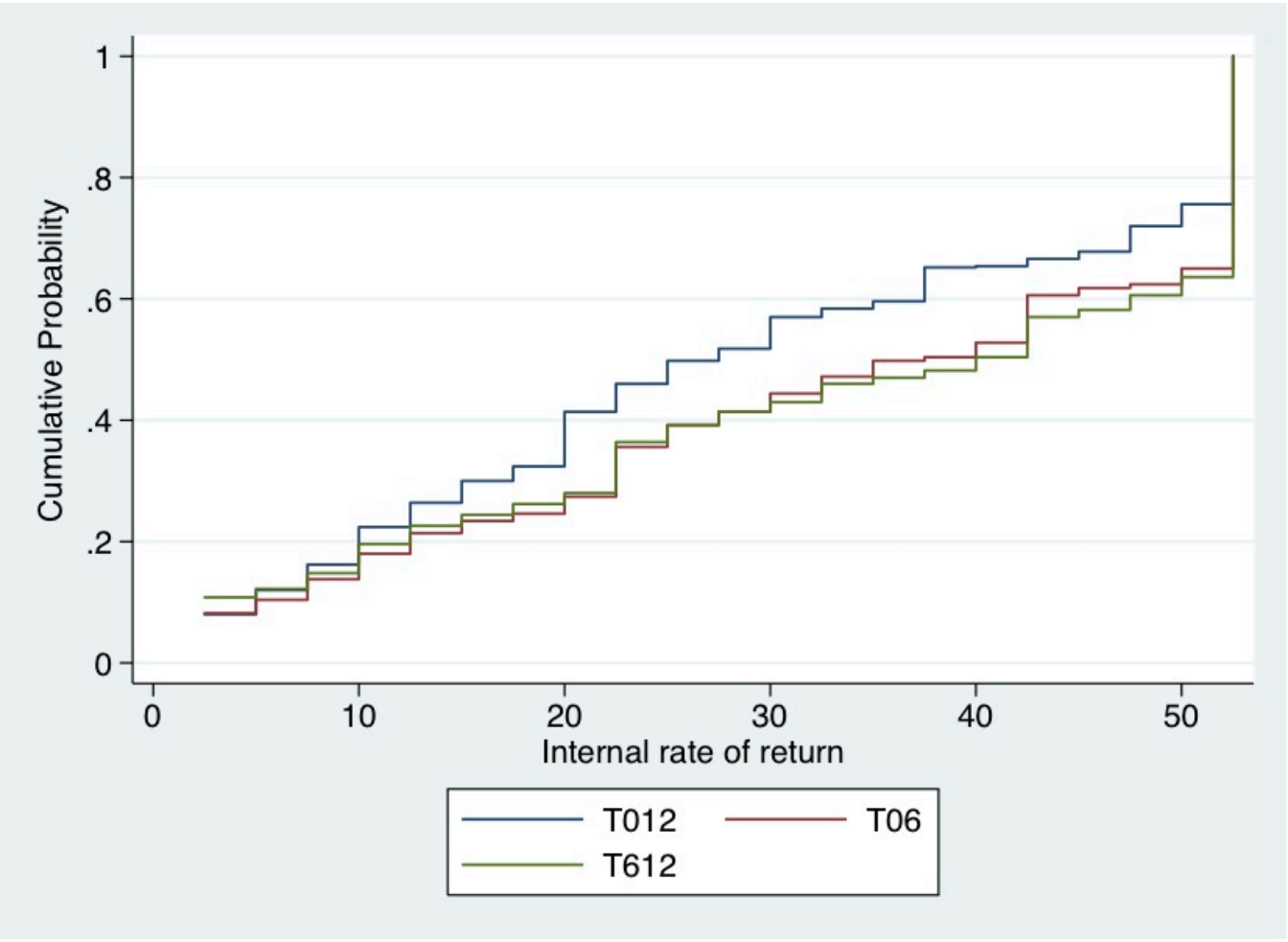
- Sub-sample 3: Immediate to 1 month, 12 months to 13

Note: Choice tables have 100% upper bound, rather than 50% as in Samples 1, 2, and Pretest.

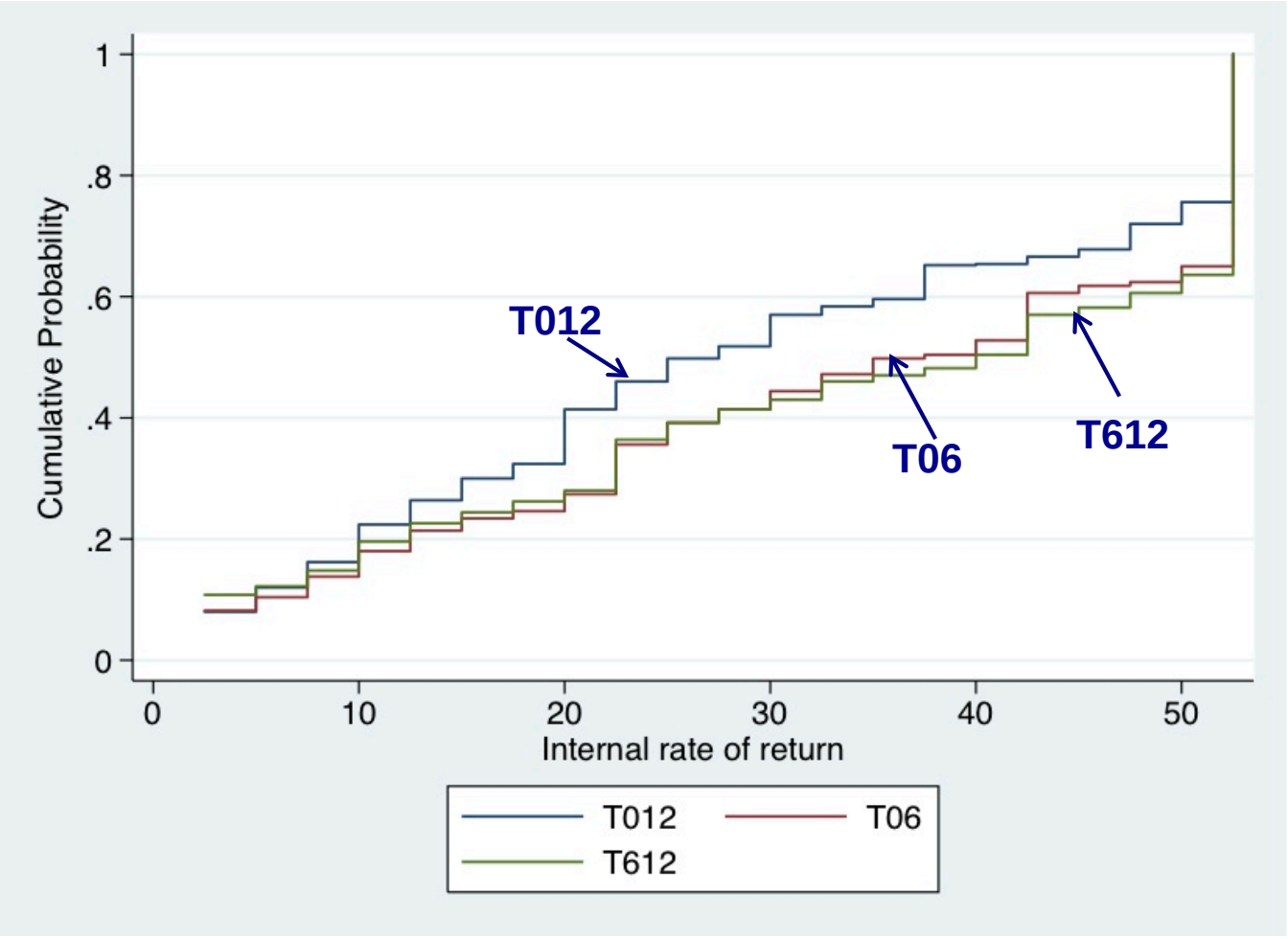
Behavioral Predictions

- Constant: Same IRR for all time horizons.
- Declining:
  - Greater IRR for short than long, in OD comparisons
  - Greater IRR for earlier horizon, in SD comparisons.
  - Greater IRR for longer horizon, starting earlier, in OSD.
- Increasing: reverse of declining.
- Quasi-hyperbolic: declining or same as constant (front-end-delay).
- Arbitrage: same as constant.

CDFs of IRR by Time Horizon, Pretest Data



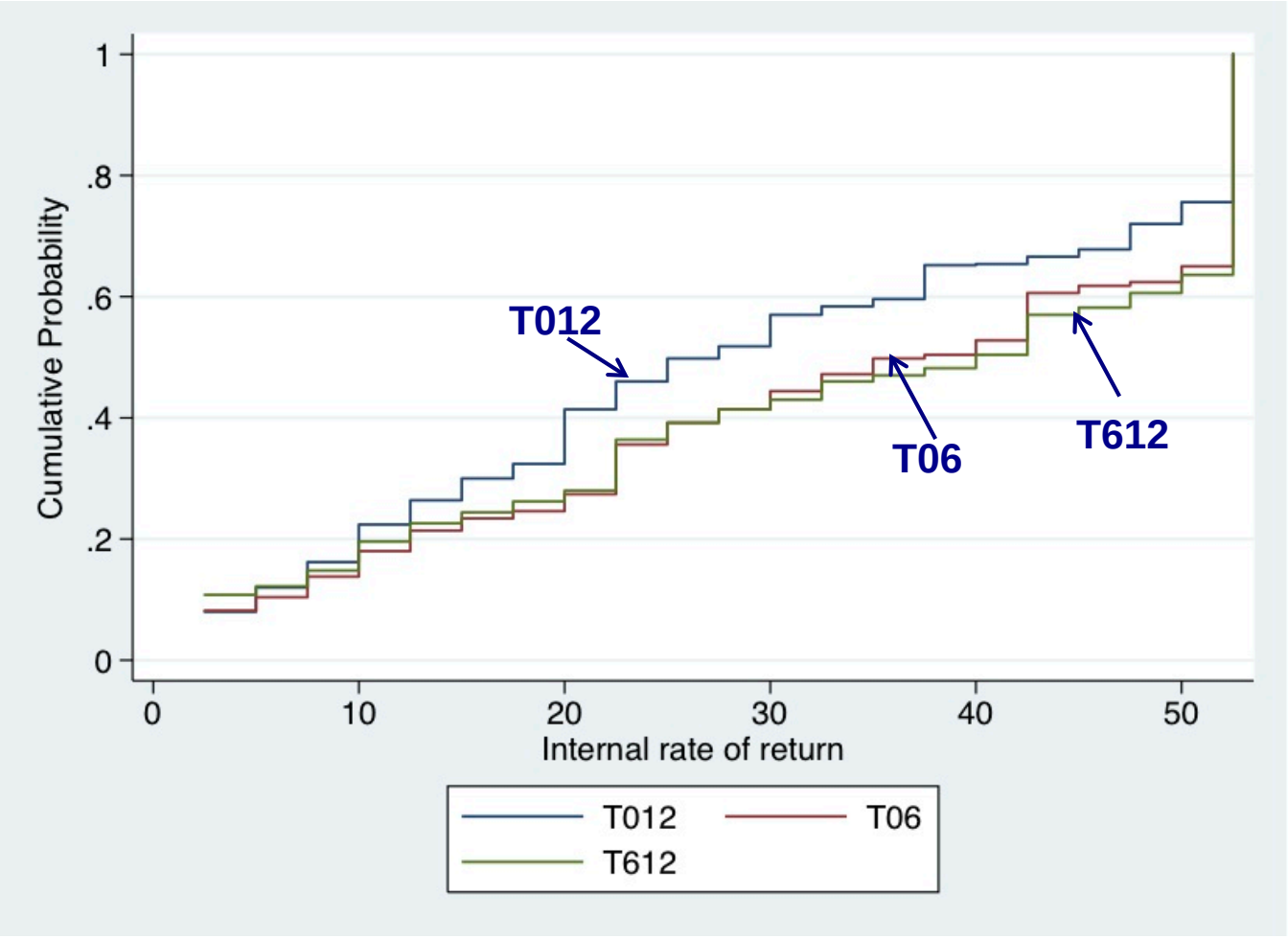
CDFs of IRR by Time Horizon, Pretest Data



Subjects are on average more impatient over short horizons (T06 and T612) than over long horizon (T012) :

$IRR_{T06} > IRR_{T012}$
$IRR_{T612} > IRR_{T012}$

CDFs of IRR by Time Horizon, Pretest Data



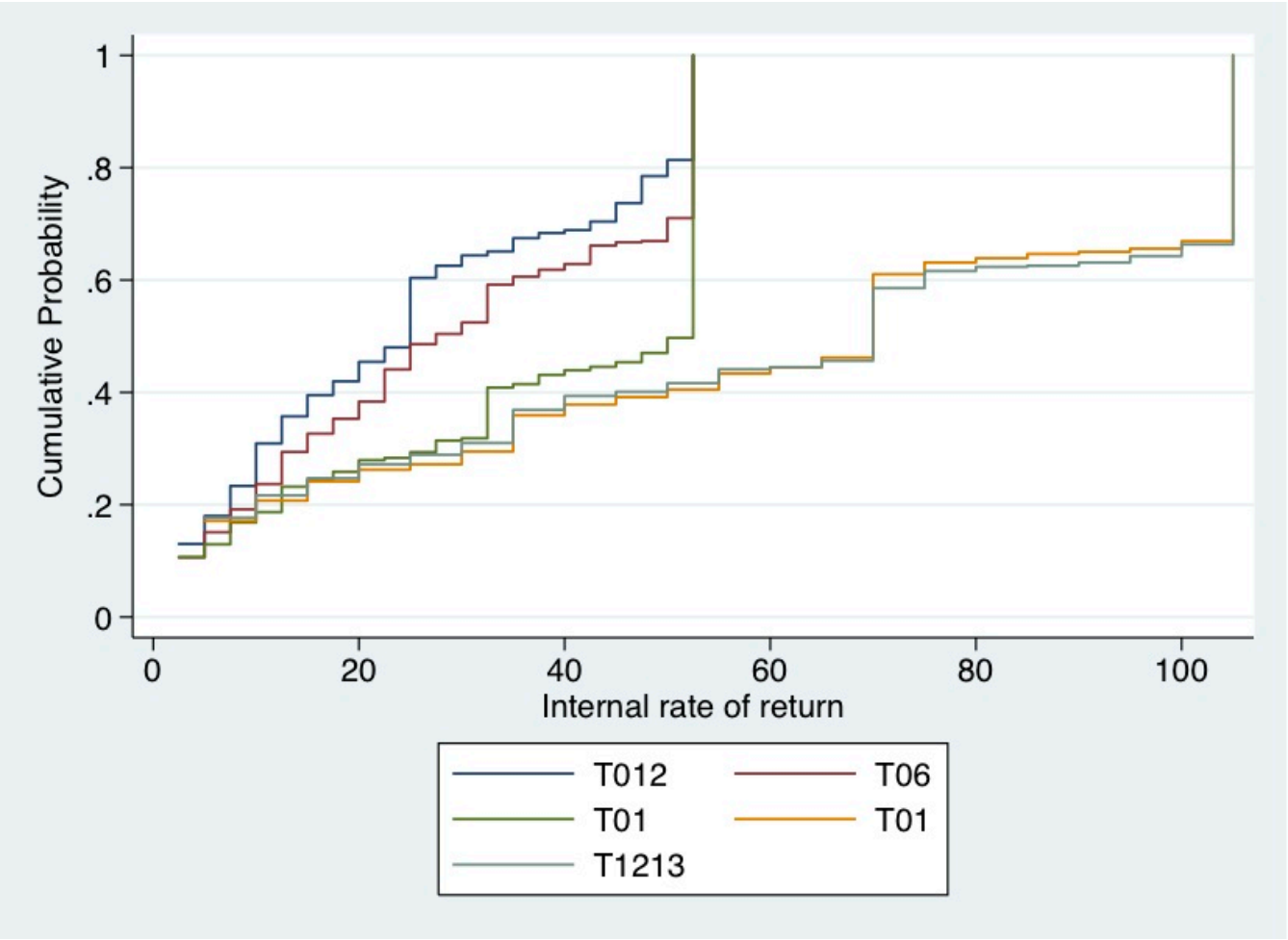
Subjects are on average more impatient over short horizons (T06 and T612) than over long horizon (T012) :

$IRR_{T06} > IRR_{T012}$
$IRR_{T612} > IRR_{T012}$

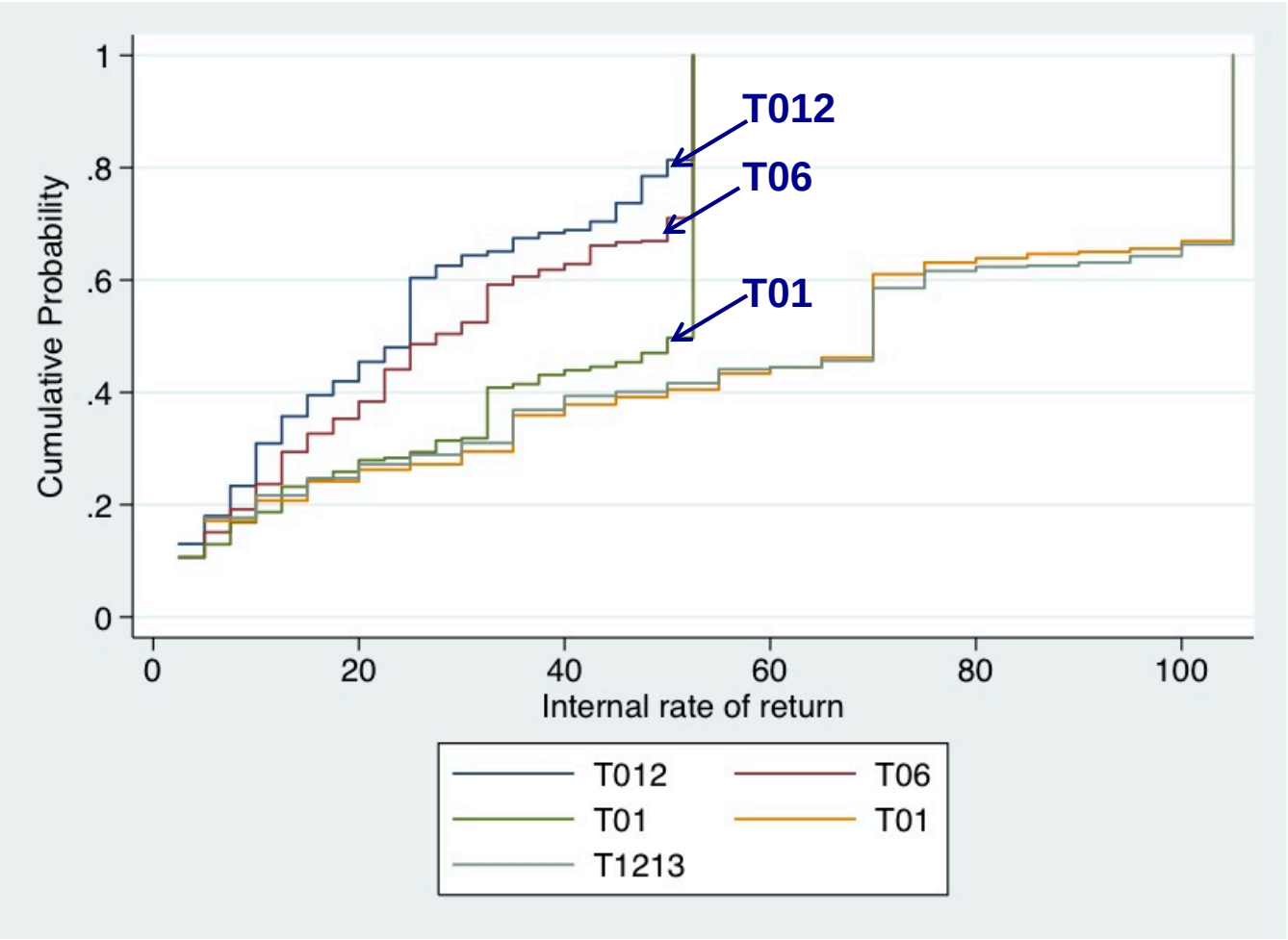
Impatience is the same over 6-month horizons, regardless of when they occur:

$IRR_{T06} = IRR_{T612}$

CDFs of IRR by Time Horizon, SOEP Data



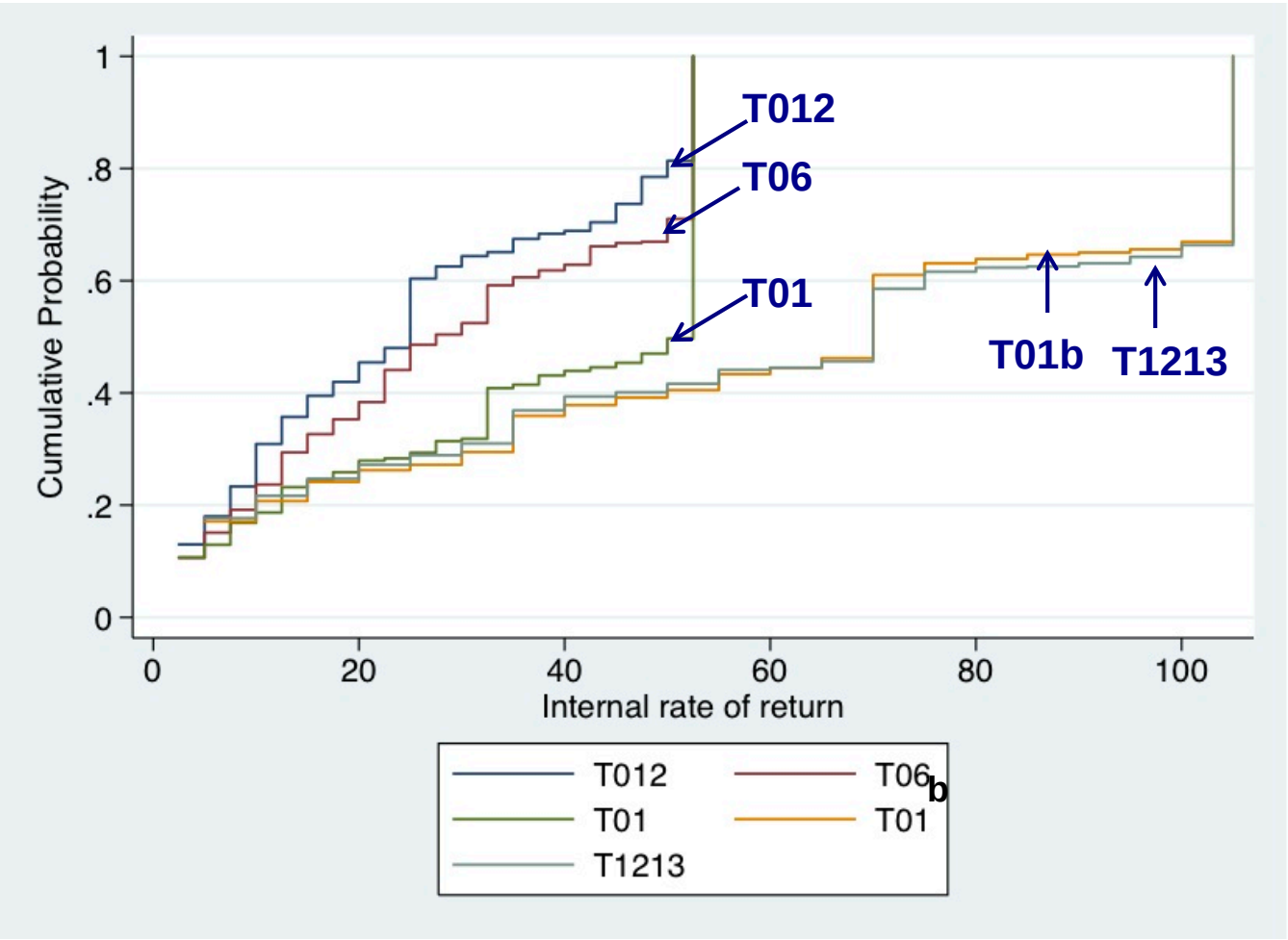
CDFs of IRR by Time Horizon, SOEP Data



Again, impatience decreases (monotonically) as length of horizon increases:

$IRR_{T01} > IRR_{T06} > IRR_{T012}$

CDFs of IRR by Time Horizon, SOEP Data



Again, impatience decreases (monotonically) as length of horizon increases:

$IRR_{T01} > IRR_{T06} > IRR_{T012}$

But horizons of equal length have equal impatience, independent of start date:

$IRR_{T01b} = IRR_{T1212}$

Table 4: Stylized Facts on IRR and Time Horizon, and Possible Explanation

	Constant discounting	Declining discounting discounting	Increasing discounting	$\beta - \delta$ or two-system, present $>$ 1 day	$\beta - \delta$ or two-system, present$\leq$ 1 day	Any discounting with arbitrage
Pretest data						
Finding 1						
T06>T012		Yes		Yes		
Finding 2						
T06=T612	Yes				Yes	Yes
Finding 3						
T612>T012			Yes			
SOEP data						
Finding 4						
T06>T012		Yes		Yes		
Finding 5						
T01>T012		Yes		Yes		
Finding 6						
T01>T06		Yes		Yes		
Finding 7						
T01b=T1213	Yes				Yes	Yes

Notes: Findings compare mean (median) IRRs for different time horizons. Table entries of "Yes" indicate stylized facts that a given model can explain.

Summary

- More impatient for short than long horizons, but insensitive to when short horizon starts.
- Time horizon length matters, contrary to constant discounting.
- Little sensitivity to starting date of horizon, contrary to non-constant discounting.
- Quasi-hyperbolic, arbitrage cannot explain results either (if anything make same predictions as constant discounting)

Summary

- Time horizon effects appear to exist, but are not easily explainable by shape of an underlying discount function
- Looking at just one type of measure can be misleading

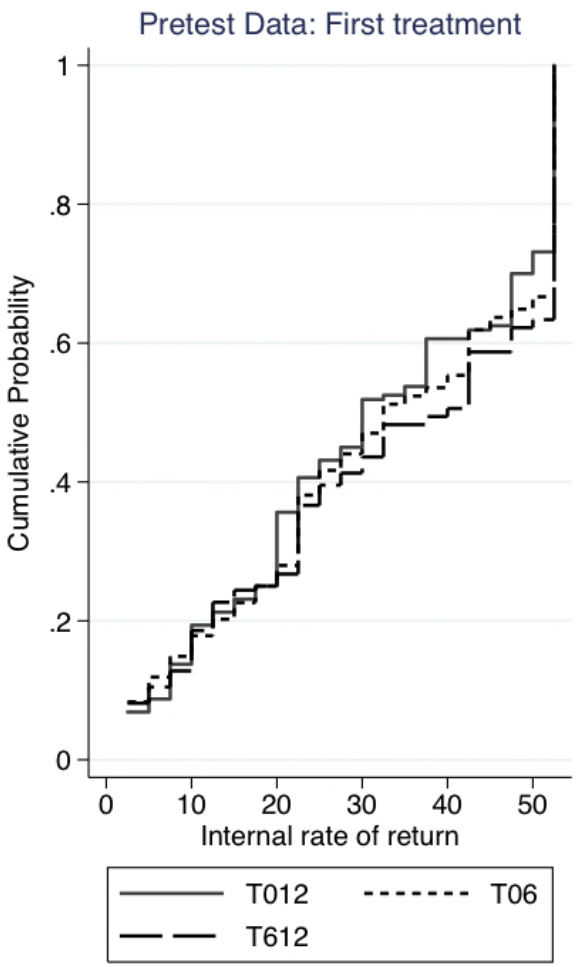
- Puzzling evidence for existing models of discounting and intertemporal choice

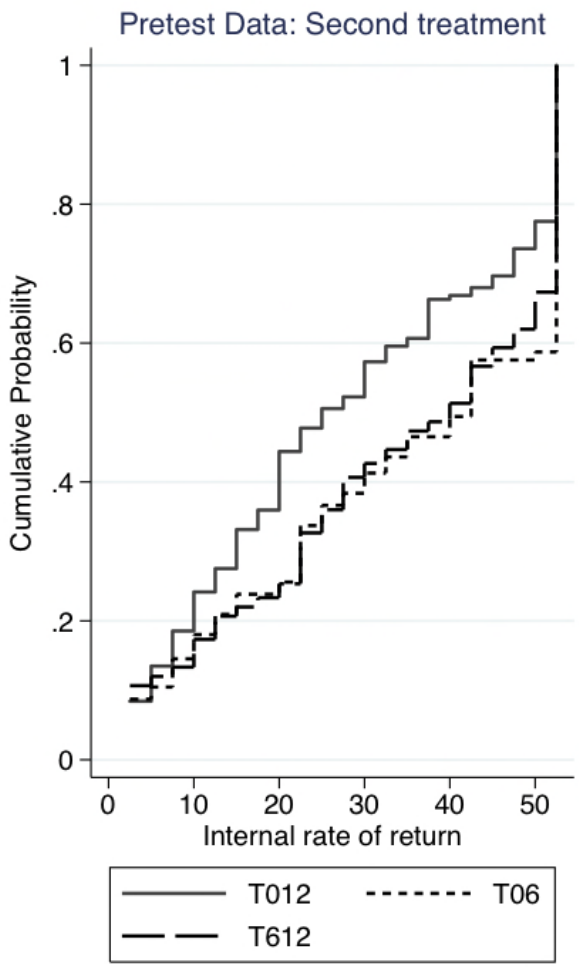
Alternative Explanation: Subjective Perceptions

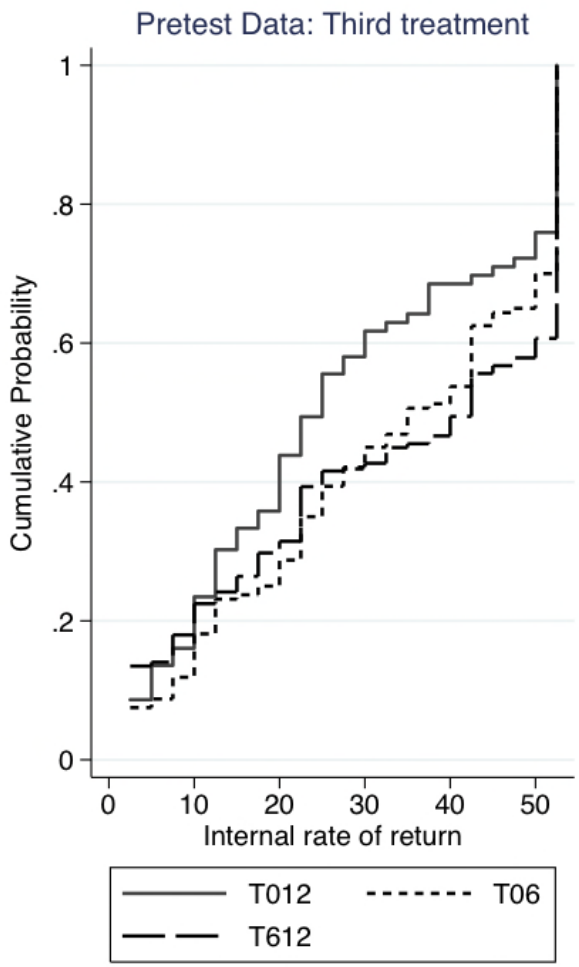
- Perceptions of time duration, money magnitude, might not correspond perfectly to objective.
  - E.g., doubling objective duration less than doubles subjective, then get greater patience for long horizon.

- Testable prediction: Framing effects, or reference points, well-known to influence perception.

- Exploit randomized order in Pretest:
  - First treatment, no salient reference.
  - Later treatments, salient reference.

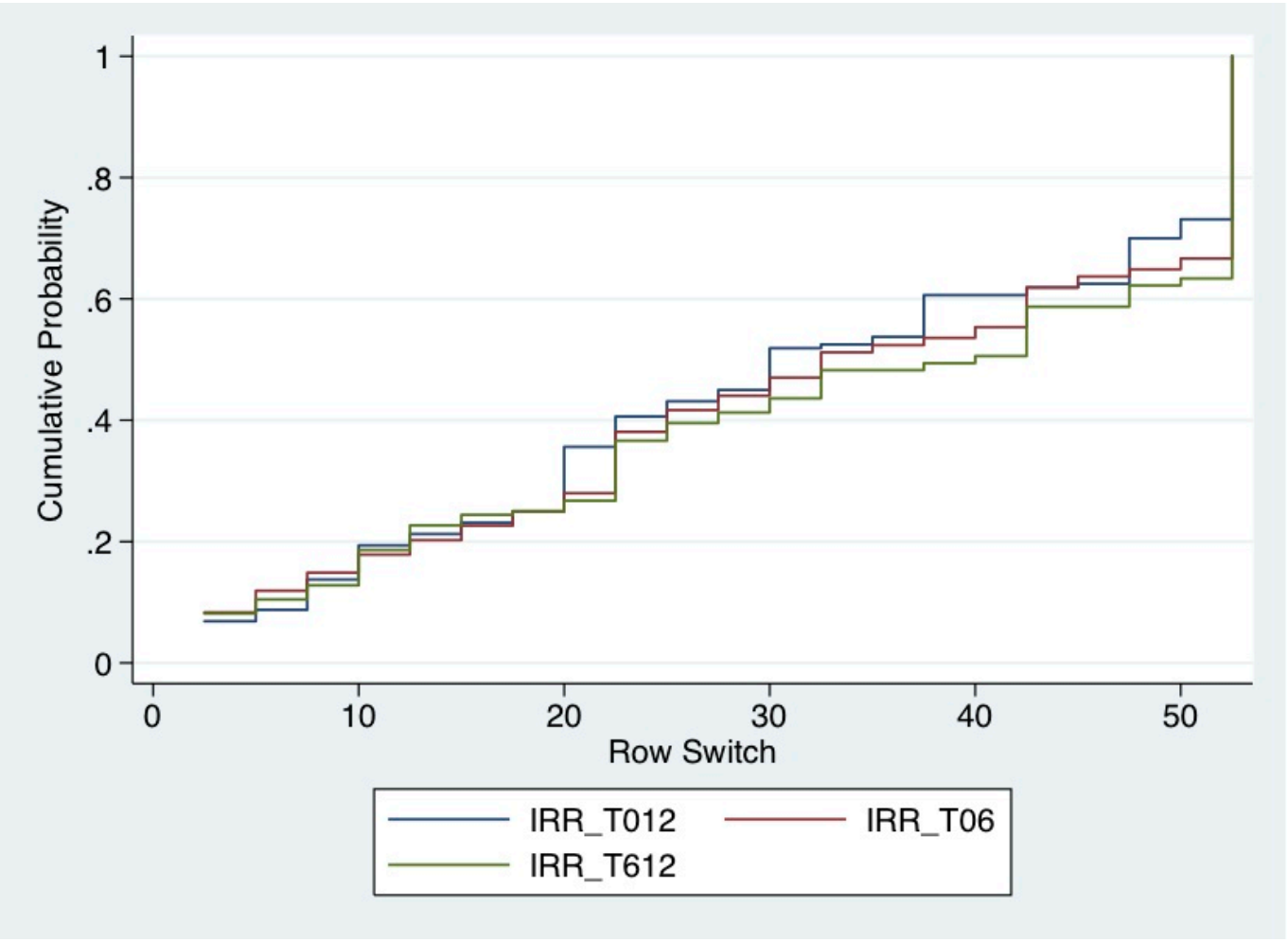






- No significant effect of time horizon across first treatments.
- Differences are significant for second and third treatments.

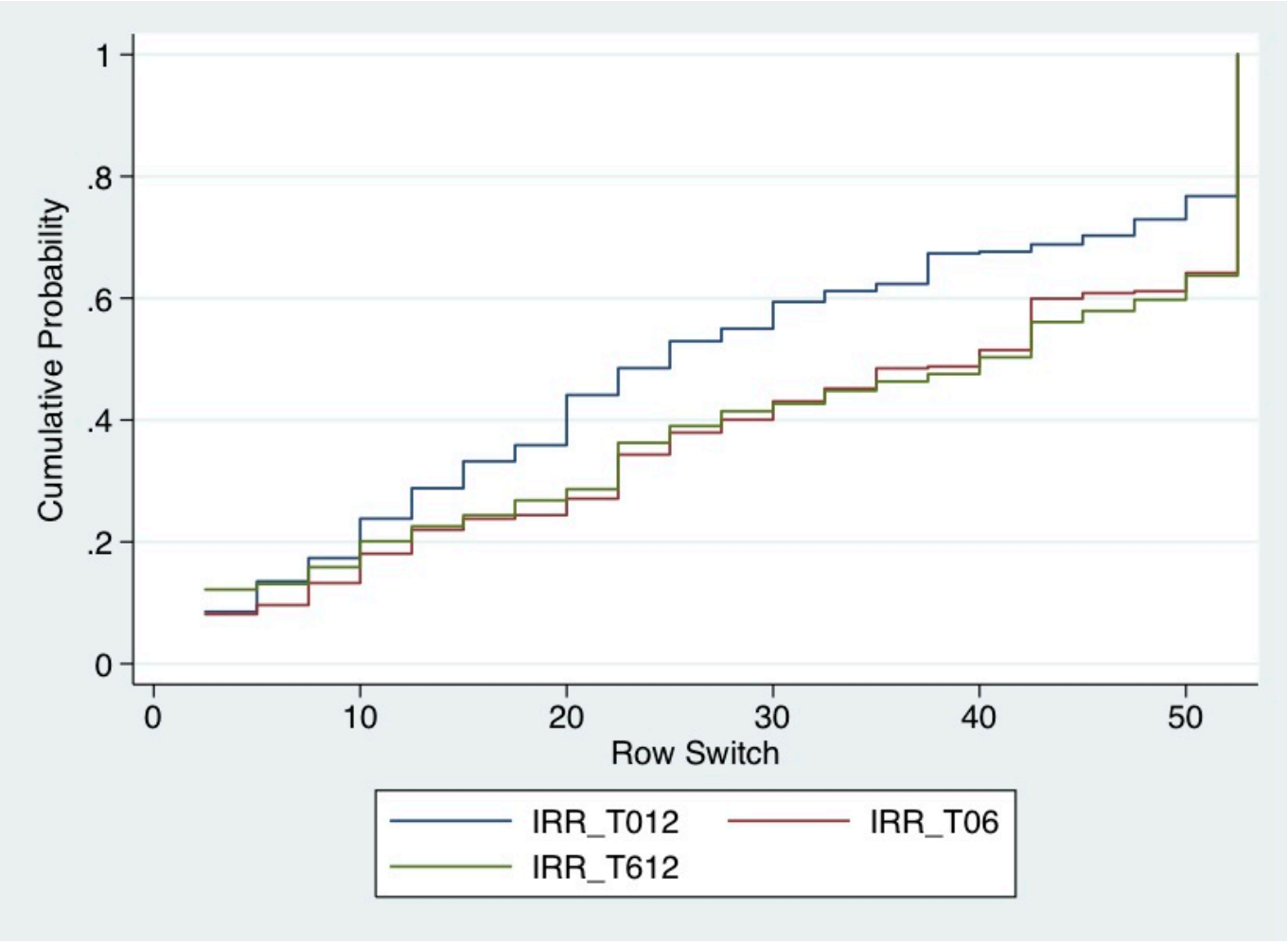
Little Impact of Time Horizon, in first Choice Table (between subjects)….



Between-subject comparison of first choice-table.

No significant difference across time horizons.

… Impact amplified for later Choices



Choices in second and third choice tables.

Difference between IRR_{T012} and other horizons is highly significant.

Conclusions

- Results may help organize previous mixed evidence.
  - A particular type of comparison, most commonly used, tends to generate declining discounting
  - Others reliably generate constant or increasing.
  - Looking at only one type of measure can be misleading.

- Declining, constant, increasing discounting do not explain time horizon effects in experiments.
  - little support for one or the other assumption from choice experiments.
  - models of constant and non-constant discounting still very useful, but limited in explaining all results at once

Conclusions

- Different interpretation of studies relating experimental measures to economic outcomes.
  - To the extent that there is a relationship (evidence is mixed), different mechanism besides discounting?
- Time horizon effects more about relative comparisons than previously realized.
- Menu effects on inter-temporal choice.

Social Preferences: Concepts and Measurement

Social Preferences

- Social preferences (or other-regarding preferences) require some kind of social comparison
  - Other persons matter (i.e. one has to evaluate the well-being of others)
- Not all actions that benefit others are motivated by social preferences
  - Strategic motives
  - Selfish actions
    - Example:
      - being kind to others because it is good for reputation

Social Preferences

- Different motivational sources, preferences are subsumed under the term social preferences:
  - Altruism
  - Inequity and inequality aversion
  - Positive reciprocity
    - Rewarding kind behavior
  - Negative reciprocity
    - Punish unkind behavior (even at a cost)
  - Trust,
  - Envy,
  - Guilt,
  - Shame,
  - Etc.

Experimental Evidence for Social Preferences

- Experimental evidence that shows that selfishness cannot be sole driver of behavior
  - **Bargaining**
    - Equal offers in bargaining games
    - Disadvantageous counter offers
    - Ultimatum game: rejections of positive offers
    - Dictator game: positive transfers
  - **Trust game, moonlighting game and gift exchange game (market)**
    - Positive and negative reciprocity
  - **Public Goods Games**
    - Cooperation higher than predicted by standard theory
    - Conditional cooperation
  - **Punishment (in public goods games)**
    - Punishment of defectors

Field Evidence for Fairness and Reciprocity

- Observed behavior in the field
  - Collective action (strikes, consumer protest, voting)
  - Tax compliance (people pay more than is optimal given they are rational and selfish)
  - Donations

Falk (2006)

- Questionnaire studies in labor market
  - Bewley (1995, 1997)
  - Agell and Lundborg (1995)
  - Campbell and Kamlani (1997)
  - SOEP data, see Dohmen, Falk, Huffman and Sunde (2009)

Measuring Social Preferences

Experimental Measure

- Experimental approaches can be used to quantify behavior in a controlled, standardized environment
  - Dictator game behavior
  - First-mover behavior in ultimatum games
  - Trust game
  - Gift-exchange games

- Lab measures have advantage that we can control strategic motive (one-shot anonymous interaction)

Ultimatum Game

- 2 players bargain over division of a fixed amount (say 10 euro).
- Sequential game: player 1 proposes a division, player 2 accepts or rejects. If the offer is rejected, both players end up with zero payoff.
- Standard prediction?
- Observed outcome: 50/50 split.
- Evidence for reciprocity: fairness matters!

Dictator Game

- Similar set-up as ultimatum game
- Difference with ultimatum game: player 2 cannot reject the offer.
- Standard prediction?
- Observed outcome: 50/50 split.
- Evidence for altruism: fairness matters!

Public Goods Game

- n players, players decide simultaneously about contribution in a public good.
- Contributions are multiplied by a factor x.
- Each player receives a share 1/n of the public good.
- Contribution is socially optimal, but privately suboptimal (as x<n by construction)
- Typical findings:
  - substantial share of conditional cooperators.
  - declining contributions in repeated game.
  - Possibility to punish free riders substantially increases contributions.

Trust Game/Investment Game

Berg, Dickhaut, McCabe (1995)

- 2 player sequential game
- Both players are endowed with 10 points
- Player 1 can give 0 up to 10 points to player 2, i.e. invest points.
- Each invested point is tripled
- Player 2 gets to know the investment and can give points back to 1 (but does not have to)
  - Payoff player 1: 10-x+y
  - Payoff player 2: 10+3x-y
    (x is investment, y is returned amount)
- Standard prediction.....

Trust Game: Results

Berg, Dickhaut, McCabe (GEB, 1995)

- Standard prediction.....
  - Player 2 gives nothing to 1 (independent of investment)
  - Player 1 invests nothing
- Typical findings:
  - Players 1 do invest
  - Players 2 give back points
  - Investments of 5 and 10 benefit player 1
  - On average players 1 are just compensated
- Evidence against the standard prediction

An Experimentally Validated Preference Module

Armin Falk (University of Bonn)
Anke Becker (Harvard University)
Thomas Dohmen (University of Bonn and Maastricht University)
David Huffman (Oxford University)
Uwe Sunde (LMU Munich)

Motivation

Develop a Preference Module that can be administered at low cost (to large samples)

- **Experiments:**
  - incentivized decision-making, controlled laboratory environment
  - reliable measure
  - **but:** often infeasible (e.g. prohibitively costly)

- **Surveys:**
  - easy to administer, relatively low costs and many observations applicable to almost every sample
  - **but:** decision-making not incentivized

➔ combine the virtues of surveys and incentivized experiments

Validation Study – Approach

Preference Module

- covers six key economic preferences
  - Risk taking
  - Time discounting
  - Social preferences: altruism, trust, positive and negative reciprocity

- consists of (survey) items that have predictive power with respect to behavior in incentivized experiments
- obtained measures are behaviorally valid
- low costs and easy administration

Design of Study – Details

- All 409 subjects take part in incentivized experiments.
- All 409 subjects answer a large set of survey questions.
- Two sessions, scheduled one week apart

	Session 1	*Session 2*
Group 1	Experiment: Risk and Time Preferences Survey: Social Preferences	Experiment: Social Preferences Survey: Risk and Time Preferences
Group 2	Experiment: Social Preferences Survey: Risk and Time Preferences	Experiment: Risk and Time Preferences Survey: Social Preferences

Design of Study – Experimental Measures

Table 2: Overview: Behavioral measures

Preference	Experiment	Measure
Time Discounting	Two lists of choices between an amount of money "today" and an amount of money "in 12 months".	Average switching point over both lists of choices from the early to the delayed amount.
Risk Taking	Two lists of choices between a lottery and varying safe options.	Average switching point over both lists of choices from the lottery to the safe option.
Positive Reciprocity	Second mover behavior in two versions of the trust game (strategy method).	Average amount sent back in both trust games.
Negative Reciprocity	Investment into punishment after unilateral defection of the opponent in a prisoner's dilemma (strategy method) and minimum acceptable offer in an ultimatum game.	Average score: amount invested into punishment and minimum acceptable offer in an ultimatum game.
Trust	First mover behavior in two versions of the trust game.	Average amount sent as a first mover in both trust games.
Altruism	First mover behavior in a dictator game with a charitable organization as recipient.	Size of donation.

Design of Study

- Careful elicitation of experimental preference measures:
- Inexperienced Subjects
- Multiple Behavioral Measures
- Perfect Stranger Matching Protocol
- Relatively High Stakes

Design of Study – Survey Measures

- For each preference the survey included:
  - a set of “general” questions (adapted from the GSOEP)
  - a set of other subjective items
  - a set of quantitative items
  - a hypothetical version of the respective incentivized experiment

Item Selection Process

- Best subset selection
  - For given number of regressors (survey item) find best linear model according to R2
  - For set of candidate models: find best model in terms of number of items using
    - BIC
    - predictive power (out-of-sample)
    - cross-validation
- Additional ex-ante considerations:
  - Specificity of items

Preference Module

Risk taking:

1. List of 31 hypothetical choices between a lottery (300 Euro with a 50-percent chance and 0 Euro with a 50-percent chance) and varying safe options (starting at 0 Euro and increasing to 300 Euro in increments of 10 Euro)
2. How do you see yourself: are you a person who is generally willing to take risks, or do you try to avoid taking risks? Please use a scale from 0 to 10, where a 0 means you are “completely unwilling to take risks” and a 10 means you are “very willing to take risks”. You can also use the values in-between to indicate where you fall on the scale.

Preference Module – continued

Time preference:

1. List of 25 hypothetical choices between an early payment “today” (100 Euro) and a varying delayed payment “in 12 months” (100.0/103.0/106.1/109.2/112.4/115.6/118.8/122.1/125.4/128.8/132.3/135.7/139.2/142.8/146.4/150.1/153.8/157.5/161.3/165.1/169.0/172.9/176.9/180.9/185 Euro).
2. How do you see yourself: in comparison to others, are you a person who is willing to give up something today so as to benefit from that in the future, or are you not willing to do that? Please use a scale from 0 to 10, where a 0 means you are “completely unwilling to give up something today” and a 10 means you are “very willing to give up something today”. You can also use the values in-between to indicate where you fall on the scale.

Preference Module – continued

Altruism:

1. Imagine the following situation: Today you unexpectedly received 1000 Euro. How much of this amount would you donate to charity? *(Values between 0 and 1000 are allowed)*
2. How would you assess your willingness to share with others without expecting anything in return, for example your willingness to give to charity? Please use a scale from 0 to 10, where 0 means you are "completely unwilling to share" and a 10 means you are "very willing to share". You can also use the values in-between to indicate where you fall on the scale.

Preference Module – continued

Trust:

1. *(after reading the instructions for the Trust Game, see paragraph on Positive Reciprocity)* Suppose you were assigned the role of the other person. Which amount would you choose
2. to transfer?

   How well does the following statement describe you as a person? As long as I am not convinced otherwise, I assume that people have only the best intentions. Please use a scale from 0 to 10, where 0 means "does not describe me at all" and a 10 means "describes me perfectly". You can also use the values in-between to indicate where you fall on the scale.

Preference Module – continued

Positive Reciprocity:

- Please consider the following situation: You and another person, whom you do not know, both participate in a study where you can decide on how to assign a certain amount of money and thereby determine the outcome. The rules are as follows. Both participants get an account with 20 Euros. At the beginning, both participants thus own 20 Euros. The other person decides first. She can transfer money to your account. She can transfer any amount: 0, 1, 2 Euro, etc. up to 20 Euro. Each Euro that she transfers to you is tripled by the conductors of the study and booked to your account. After this first stage the other person therefore has 20 Euro minus the amount she transferred to you in her account. You have 20 Euro plus the tripled amount of the transfer of the other person on your account. Now you get to decide: you have the opportunity to transfer money back to the other person. You can transfer any amount up to 80 Euro, depending on how much you have in your account. This will be the end of the study and the account balances will be final. The other person has in her account 20 Euros minus the amount she transferred to you plus the amount you transferred back. You have 20 Euro plus the tripled amount of what the other person transferred to you minus the amount you transferred back to her. We would like to know how much you would choose to transfer back to the other person, for a given transfer of her to you.

  Suppose the other person transfers 5/10/15/20 Euro to your account. After the first stage you then own 20+3*5/10/15/20=35/50/65/80 Euro, the other person owns 20-5/10/15/20=15/10/5/0 Euro. What amount do you choose to transfer back?

- Which bottle of wine do you give to the stranger who has helped you?

Preference Module – continued

Negative Reciprocity:

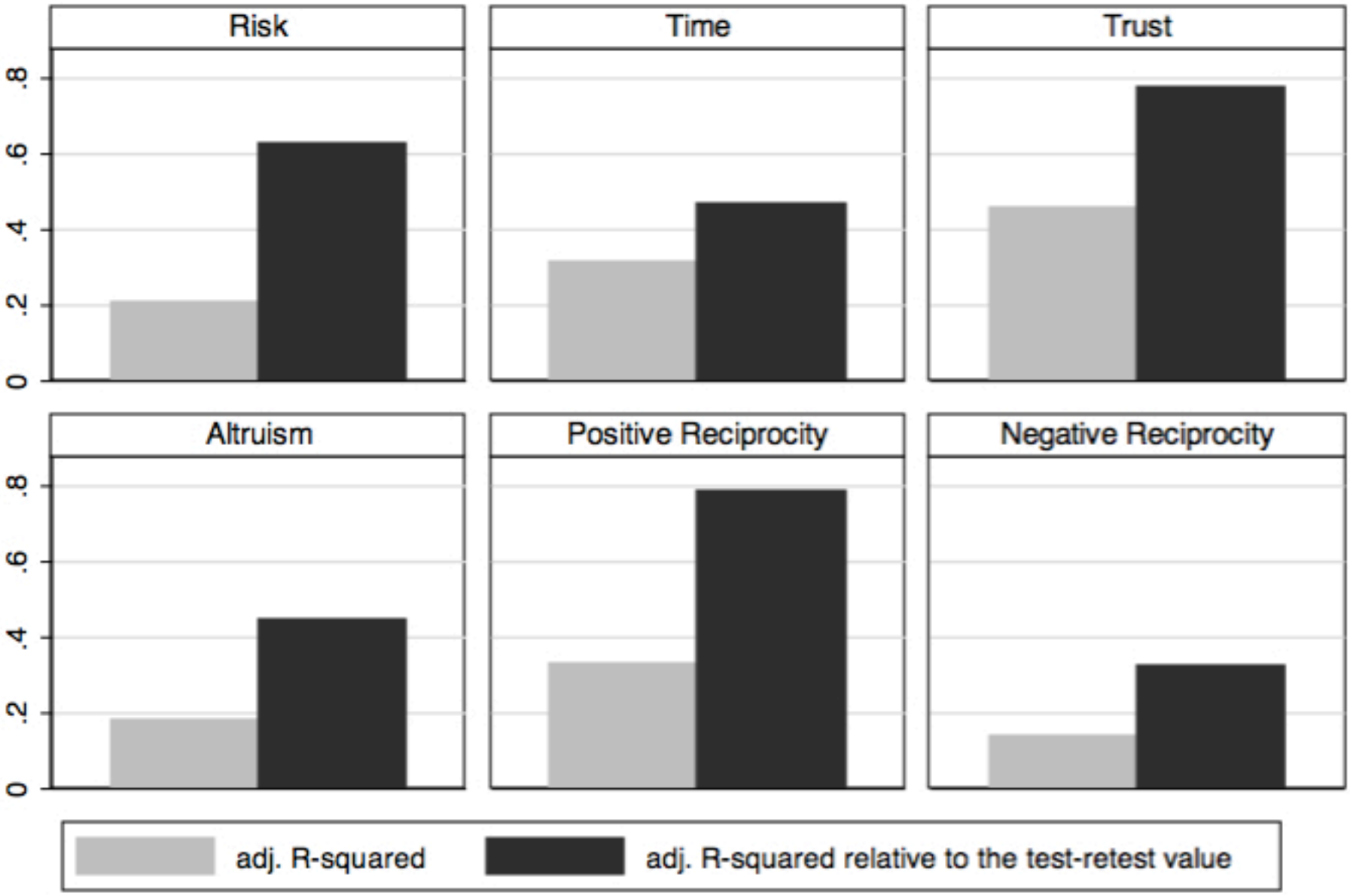
1. Consider the following: Together with a person you do not know you have won 100 Euro in a contest. The rules are as follows. One of the two of you has to make a proposal on how to divide the money between the two of you. The other one is informed about the proposal and has two options. Either he can accept the proposal or he can reject it. If he accepts the proposal, the proposed division of the money is implemented. If he rejects the proposal both get nothing. Suppose the other person makes the proposal about the division of the money. You then have to decide whether to accept or to reject the proposal. Which minimum amount does the other person have to offer you for you to accept the proposal?
2. How do you see yourself: Are you a person who is generally willing to punish unfair behavior even if this is costly? Please use a scale from 0 to 10, where 0 means you are "not willing at all to incur costs to punish unfair behavior" and a 10 means you are "very willing to incur costs to punish unfair behavior". You can also use the values in-between to indicate where you fall on the scale.

Benchmark Criterion: Test-Retest Correlation

What is the adequate benchmark level of Adjusted R^2 when evaluating the predictive power of our preference module?

- A value close to 1? No:
  - measurement error
  - differences between the measures
- More adequate:
  R^2 resulting from regressing the experimental measure on the same experimental measure
  - 44 subjects participated in all experiments twice
  - two sessions, again one week apart

The preference module: explained variance



Streamlined Module

- We constructed **Streamlined Version for International (Telephone) Survey**:
- Select from restricted pool of items
  - Discard “complicated” items
  - Discard choice tables (staircase procedure available)
- Conduct pretest in 22 countries of various heritage in local language (translated back and forth by professionals)
- Adjust wording where necessary
- shorter version can be applied in telephone studies and cross-cultural contexts
  - Takes 7 to 9 minutes of survey time

Survey questions in World Poll Preference Module

Questionnaire can be downloaded in several languages from https://www.briq-institute.org/global-preferences/downloads

1. **Please tell me, in general, how willing or unwilling you are to take risks.**

Please use a scale from 0 to 10, where **0** means you are **"completely unwilling to take risks"** and a **10** means you are **"very willing to take risks"**. You can also use any numbers between 0 and 10 to indicate where you fall on the scale, like 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

completely unwilling to take risks										very willing to take risks
0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

2. We now ask for your willingness to act in a certain way in four different areas.

Please again indicate your answer on a scale from 0 to 10, where **0** means you are **"completely unwilling to do so"** and a **10** means you are **"very willing to do so"**. You can also use any numbers between 0 and 10 to indicate where you fall on the scale, like 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

	completely unwilling to do so										very willing to do so
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
How willing are you to punish someone who treats **you** unfairly, even if there may be costs for you?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
How willing are you to punish someone who treats **others** unfairly, even if there may be costs for you?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
How willing are you to give to good causes without expecting anything in return?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3. How well do the following statements describe you as a person?

Please indicate your answer on a scale from 0 to 10. A **0** means **"does not describe me at all"** and a **10** means **"describes me perfectly"**. You can also use any numbers between 0 and 10 to indicate where you fall on the scale, like 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

	does not describe me at all										describes me perfectly
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
When someone does me a favor I am willing to return it.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
If I am treated very unjustly, I will take revenge at the first occasion, even if there is a cost to do so.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
I assume that people have only the best intentions.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
I am good at math.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
I tend to postpone tasks even if I know it would be better to do them right away.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

4. Please imagine the following situation: You can choose between a sure payment of a particular amount of money, or a draw, where you would have an equal chance of getting 300 Euro or getting nothing. We will present to you five different situations.

4.1 What would you prefer: a draw with a 50 percent chance of receiving 300 Euro, and the same 50 percent chance of receiving nothing, or the amount of 160 Euro as a sure payment?

□ 1 = 50/50 chance => ***Go to question* 4.17**

□ 2 = Sure payment => ***Go to question* 4.2**

4.2 Would you prefer the 50/50 chance or the amount of 80 Euro as a sure payment?

□ 1 = 50/50 chance => ***Go to question* 4.10**

□ 2 = Sure payment => ***Go to question* 4.3**

4.3 Would you prefer the 50/50 chance or the amount of 40 Euro as a sure payment?

Conclusion

- Our preference module combines the virtues of experimental and survey measures of preferences.
- Obtained measures are behaviorally valid.
- Administration is easy and comes at low costs.
- It can serve a variety of purposes, e.g.
  - to obtain additional preference measures in lab experiments
  - to assess preferences of large representative samples
  - ...

Additional Material

Neurobiological Foundations of Social Preferences

Fließbach, Weber, Trautner, Dohmen, Sunde, Elger, Falk:
"Relative comparison affects reward-related brain activity" (*Science*, 2007)

Social Comparison: Absolute vs. Relative Income

- Traditional economic models: absolute level of income most important determinant of individual well-being and economic decision-making
- Since long challenged by social psychologists and anthropologists (Festinger, 1954)
  - More recently also by economists

Importance of relative Comparison

- If relative comparison affects individuals' subjective well-being, and thus behavior: far reaching implications for the positive and normative predictions of economic theories
  - Patterns of consumption and savings (Carroll, 2000) (Keeping up with the Joneses)
  - Labor supply (Boskin and Sheshinski, 1978; Neumark and Postlewaite, 1998)
  - Importance and modeling of fairness considerations
  - Subjective well being (Clark and Oswald, 1996)
  - Design of optimal taxation and redistribution schemes
  - Provision of incentives in firms (Bewley, 1998)
    - Wage policies should take the wage structure within firms into account: Fair wages and motivation

"O.K., if you can't see your way to giving me a pay raise, how about giving Parkerson a pay cut?"

6

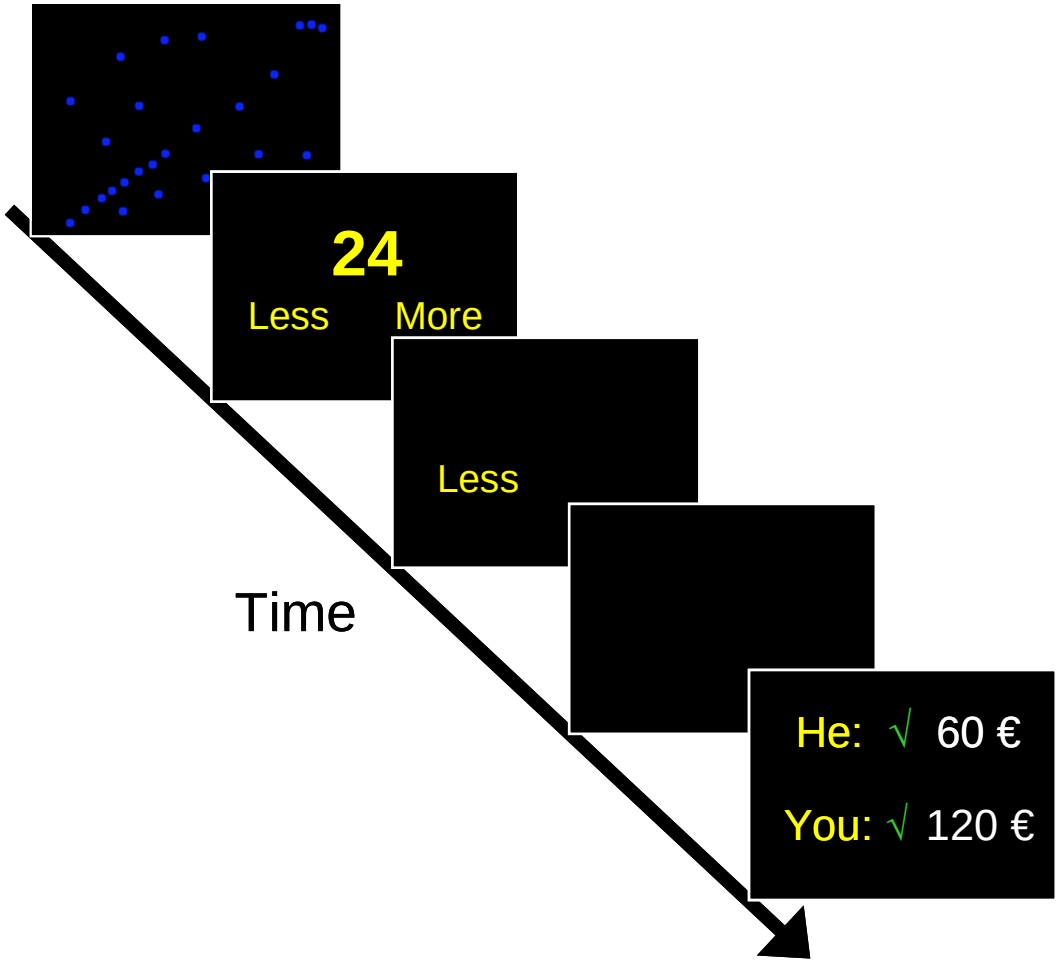
Despite Importance, Empirical Knowledge quite limited

- Relative comparison for subjective well-being has mainly been investigated using survey data
  - Methodological problems plague research in this area
    - measurement of relevant incomes, reference groups, and subjective well-being
    - endogeneity of income
    - self-reported, indirect evidence
- Nothing is known about the neurophysiological processing of social comparison
- We combine (fMRI) and behavioral experiments
  - Circumvent the problems faced by previous contributions
  - Direct evidence
- Measure brain responses to absolute and relative incomes and identify their relative importance for activation of reward processing brain areas in humans

Design-Overview

- Two subjects simultaneously and repeatedly perform a simple work task in two adjacent MRI scanners
  - 1.5 Tesla (T) Avanto Scanner and a 3 T Trio Scanner
- 33 (38) male subjects, average age 27.4 (SD 4.8)
- 2x3 factorial design varying the relative payment (factor 1) and the absolute level of payment (factor 2)
- 300 trials, one was randomly selected and paid in cash plus show-up fee

Design



Dots (1.5s)

Question

Probe (max. 1.5s)

Response Feedback (250ms)

Delay (0.2-1.7s)

Reward Feedback (4s)

Payoff Conditions

Task Performance (Accuracy)	Relative reward level (A:B) (Factor 1)	Absolute reward level (Factor 2)	Payoffs (subject A – subject B)	Condition
Both subject incorrect			0 – 0	C1
Only Subject A correct		High	60 – 0	C2
		Low	30 – 0	C3
Only Subject B correct		High	0 – 60	C4
		Low	0 – 30	C5
Both subjects correct	1 : 2	High	60 – 120	C6
		Low	30 – 60	C7
	1: 1	High	60 – 60	C8
		Low	30 – 30	C9
	2: 1	High	120 – 60	C10
		Low	60 – 30	C11

Design Details

- Payoffs were +/- 10 percent
- Pay conditions were evenly and randomly chosen
- Task was exactly the same for two Ss, and they knew that
- Ss knew in advance that payoffs could vary and that this depends only on correct or incorrect estimates

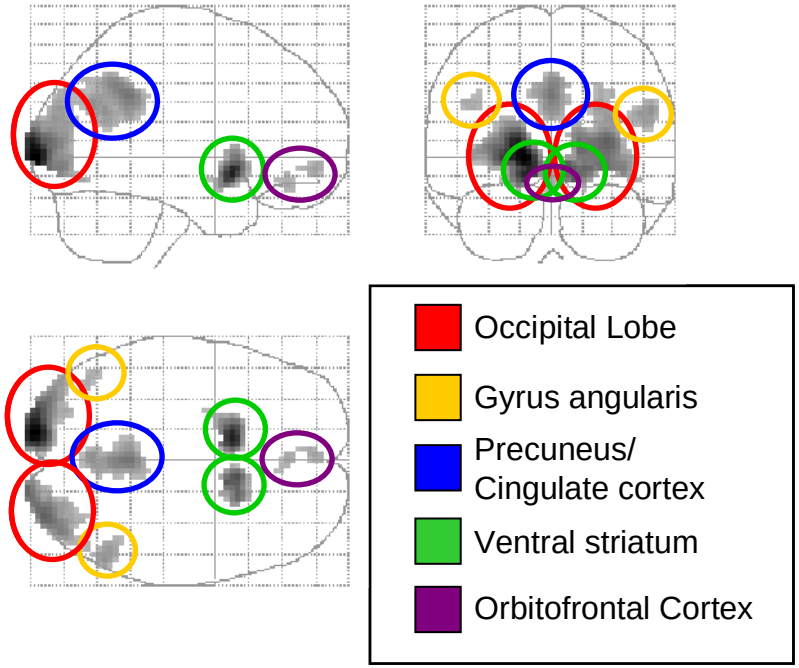
Hypotheses

- Brain regions that are engaged in the prediction and registration of rewards include ventral striatum
  - (O'Doherty JP, 2004; O'Doherty JP, Deichmann R, Critchley HD, Dolan RJ, 2002; Breiter HC, Aharon I, Kahneman D, Dale A, Shizgal P, 2001)

- Standard economic model: no differential activation in response to different relative payments
- Social comparison model: activation increases in increasing relative payments

Results

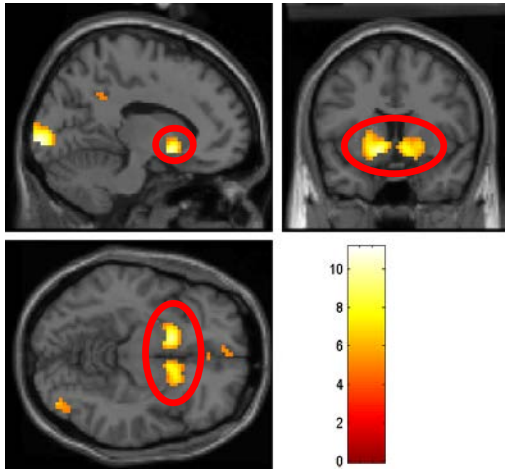
- Mean accuracy for the estimation task was 0.81 (SD 0.07)
- Conditions C1-C5 were used to identify brain regions putatively involved in reward processing independently of the conditions of interest (C6-C11)
- Conditions (C2, C3) with payment were contrasted with no payment (C1, C4, C5).
- Significant activations in three bilateral and three medial regions
  - Left and right occipital cortex, left and right angular gyrus, left and right ventral striatum, precuneus and medial orbitofrontal cortex
    - (Repeated measurements ANOVA ; $P < 0.05$, FWE-corrected for multiple comparisons, extent threshold 10 voxels)



Glassbrain projection of brain regions showing stronger BOLD responses in conditions where a subject solely received a reward (C2, C3) compared to conditions where he did not receive a reward at all (C1, C4, C5) ($p < 0.05$, FWE-corrected, extend threshold 10 voxels).

Main Results

- 3x2 repeated measurements ANOVA with the relative and absolute amount of payment as factors (and in case of bilateral activations side as an additional cofactor)
- In the ventral striatum, the activation (BOLD response) strongly depended on the relative amount of money earned
  - Main effect of this factor: $F_{2,31} = 8.0$, $P < 0.001$
- Thus: Activation increases in relative payment



ROI-defining conditions

A correct, B not

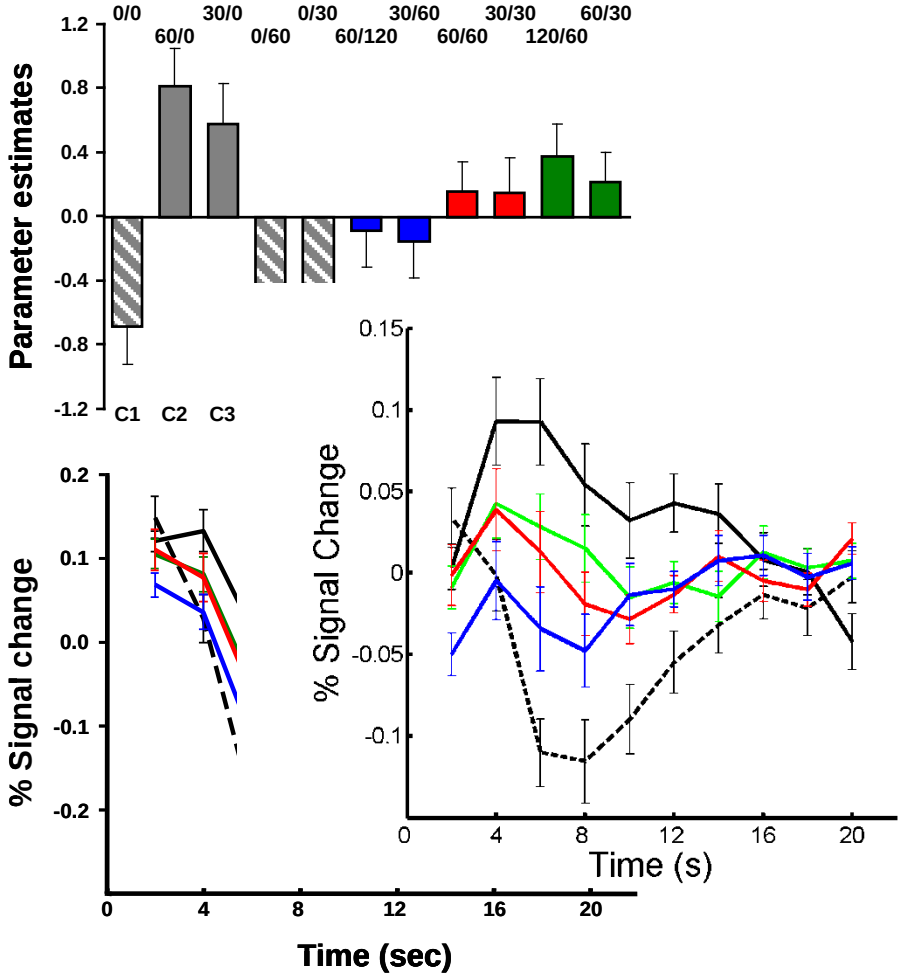
A not correct

Conditions of interest (both correct)
A's income : B's income

1:2

1:1

2:1



Results

- No main effect of the absolute amount ($F_{1,32} = 0.98$, n.s.), nor an interaction between absolute and relative payment ($F_{2,31} = 0.29$, n.s.)
- No significant influence of the side of the activation or scanner type (main effects and all interactions with these factors not significant)

Neurophysiological Importance of Social Comparison and Reciprocity

- Reciprocity is a particular important type of social preference and is based on the comparison of outcomes relative to those of relevant others
- Social comparison prerequisite of reciprocal behavior
  - People who care only about their own level of outcomes should not indicate a willingness to reciprocate.
  - Activation levels in the ventral striatum, correlated with answers concerning the willingness to reciprocate?
- Sensitivity of ventral striatal response: abs(C6 – mean) + abs(C8 – mean)+ abs(C11 – mean).
- If only the absolute amount of money matters for reward-related brain activity, this sum should be small
- Survey measures for reciprocity, locus of control, Big 5, SWB

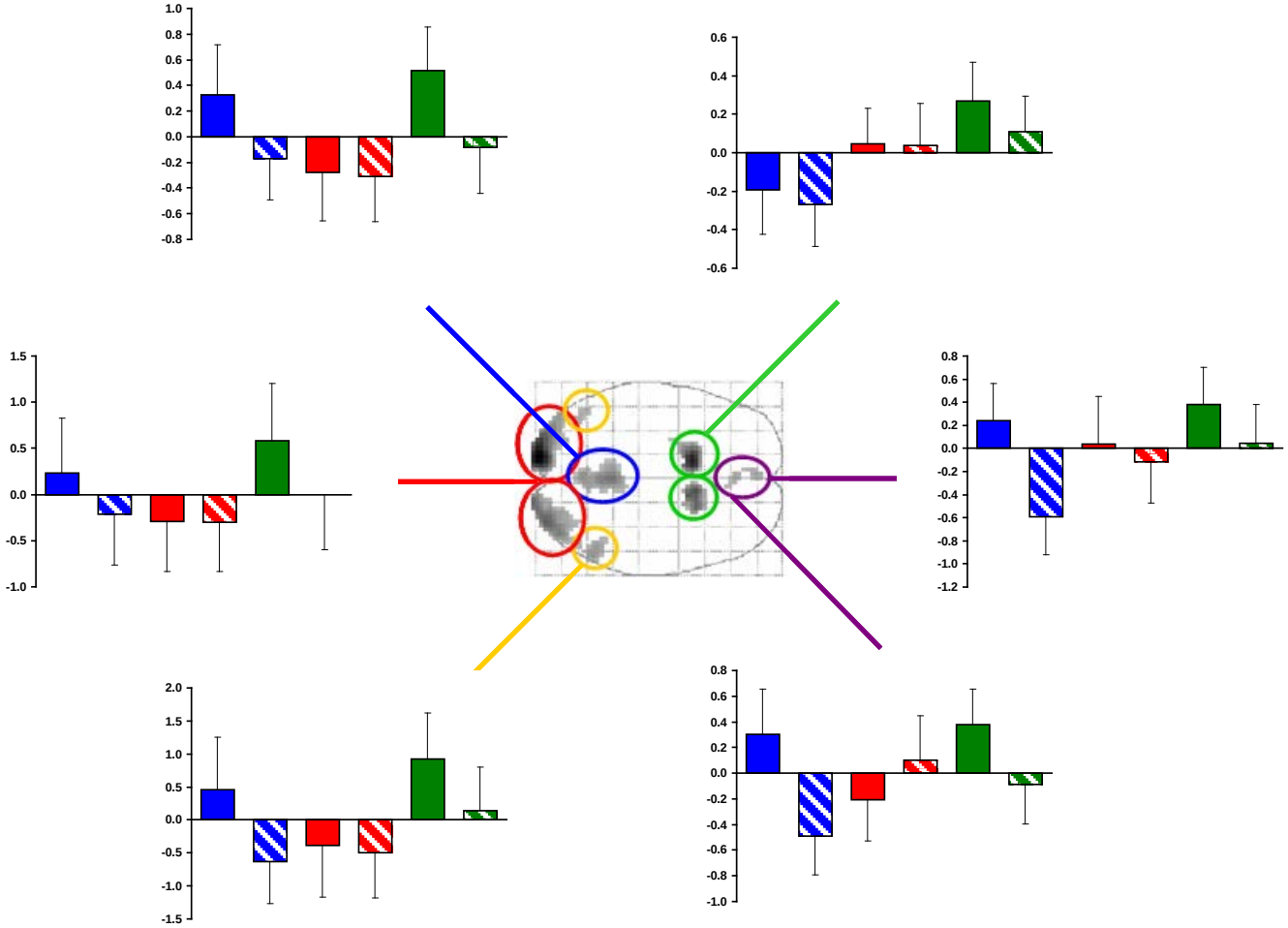
Table: Sensitivity and reciprocal inclination

Explanatory variables	Beta-values	Standard error
Reciprocity	0.822**	0.392
Std. Conscientiousness	0.245	0.325
Std. Extraversion	0.475*	0.275
Std. Agreeableness	0.462	0.319
Std. Openness to experience	0.012	0.27
Std. Neuroticism	-0.175	0.268
Locus_internal	0.064	0.127
Locus_external	0.092	0.08
Subjective well-being	0.148	0.156
Constant	-2.326	2.039
Observations	31	
R-squared	0.32	

Note: OLS regression with standard errors. * indicates significance at 10 %, ** indicates significance at 5%, *** at 1%. Observations of two subjects could not be used due to item non-response in the survey. Dependent variable is sensitivity of ventral striatal response and measured as follows: we first determined the mean activation level for each subject for conditions that involved payments of 60 Euro (conditions C6, C8 and C11). Then we added up all absolute differences of mean activation of these conditions and the mean for each subject, i.e., *abs* (C6 – mean) + *abs* (C8 – mean) + *abs* (C11 – mean).

Results

- All posterior regions (occipital lobe, angular gyrus, precuneus/cingulated cortex) showed a different pattern with response strength significantly varying with both absolute *and* relative payment.
- In these regions, responses were the highest for the high payment condition in the 1:2 *and* the 2:1 condition, i.e., in situations when high amounts of money were unequally paid regardless of the fact which of the subjects received more.
  - A similar pattern was found in the two orbitofrontal regions



Parameter estimates for the conditions of interest for all ROI. Colours indicate relative reward level (blue = 1:2, red = 1:1, green = 1:2), filling indicates absolute reward level (solid = high, striped = low).

Discussion

- Contextual information is immediately integrated into reward dependent brain responses in the ventral striatum
- Strong and immediate impact of relative comparison on the processing of rewards in the human brain
  - Support for the importance of relative comparison and relative income in addition to absolute consumption value of income as sole determinant of utility
  - Ss did not know each other, underestimate the effect?
- Results also suggests that brain reaction is more in line with a status model than with an equality model