ETH
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CHAIRS OF SOCIOLOGY

Signaling Models and Experiments
A Research Perspective

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Signaling Theory

Signal your type: Method to achieve cooperation in a social dilemma situation if information is incomplete

Explaining seemingly irrational behaviour: Large investments in “distinctions” (Bourdieu), conspicous consumption (Veblen), dress codes, “inefficient” social norms (Posner), wasting resources (advertisement campaigns), donations and gift-giving (Camerer).

Signaling your type!

Faculty meeting, University of Bern, June 20th, 2002, temperature 30° C

	Economists & Social. Science	Business & Administration
No tie	**9***	**1**
Wearing a tie	**1**	**5**

φ-coefficient = 0.73

*including observer

Trust game under incomplete information with Signaling

(Model based on Posner „Law and Social Norms“)

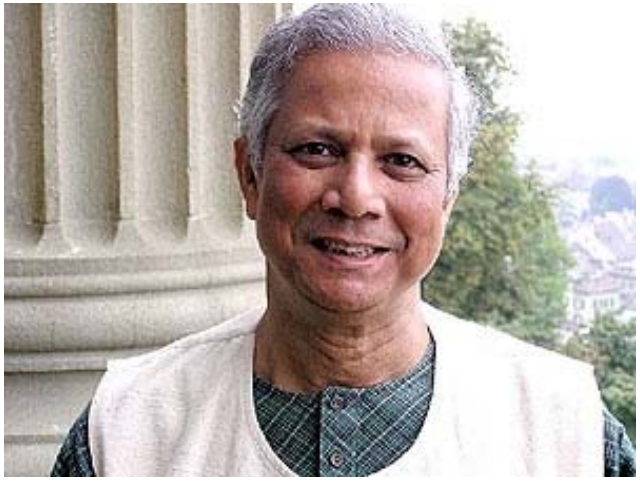
We assume a trust situation with two types of actors. Actors have the same preferences but act under different structural conditions. Type A plays a repeated game while type B is in a one-shot situation. („Stayer“ versus „Mover“.) Hence, types can be distinguished by discount parameters. However, there is incomplete information. The trustor does not know the type of the trustee.

Note: We do not assume „honest“ or „dishonest“ preferences.

With a high proportion of „mover“ no cooperation will emerge.

Signaling the type may help to promote cooperation. (Signaling theory of social norms.)

Example: Microcredits



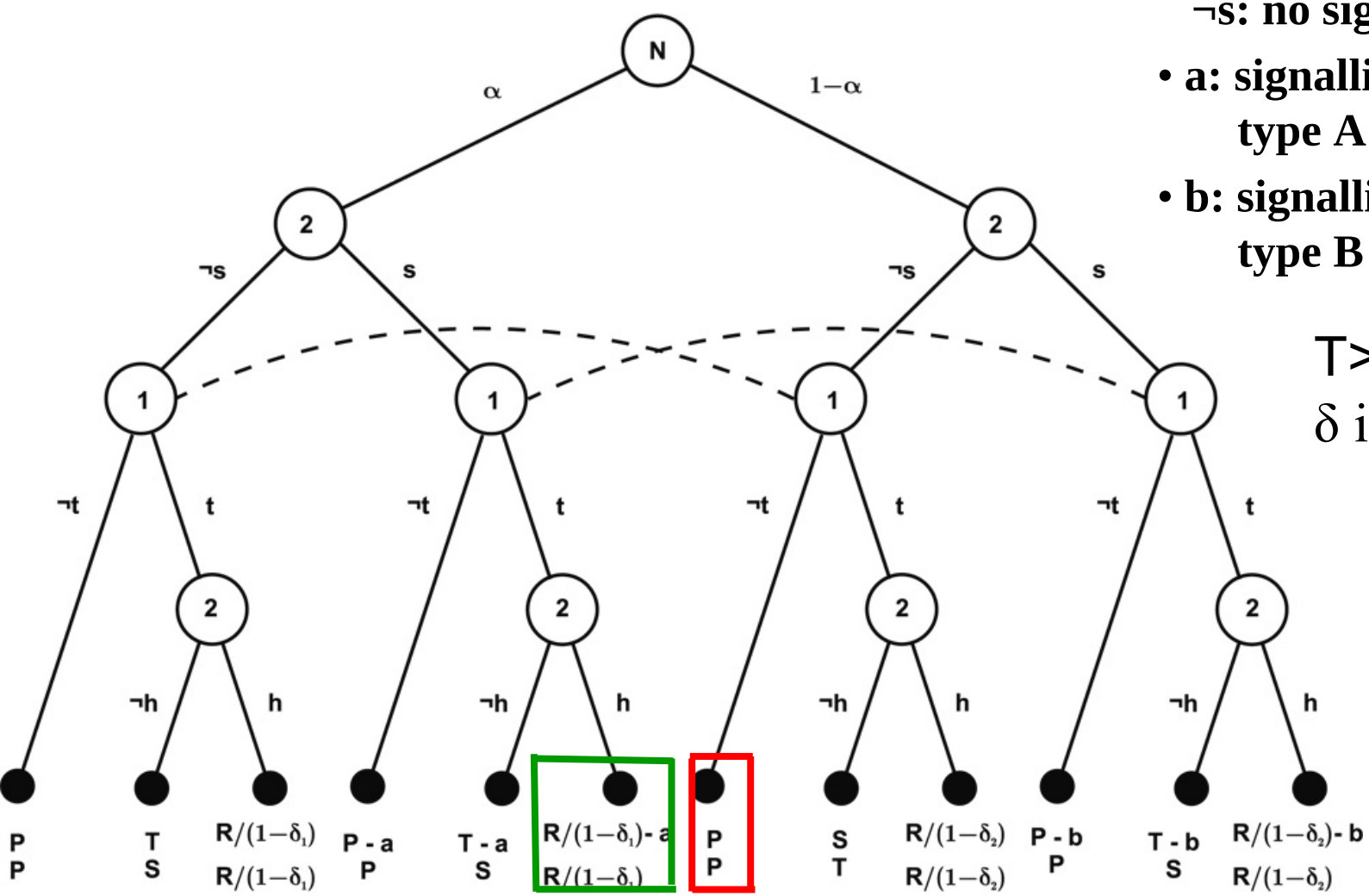
Muhammad Yunus, Gr¨under der Grameen Bank und Gewinner des Friedens-Nobelpreises 2006.

The Grameen Bank preferably lends money to women.
Women take care of children and are less probable to be fly-by-nights.

Example: Engagement rings

In the US, men are expected to spend up to 3 monthly wages on an engagement ring.

Trust game with signals of trustworthiness



- **s: send signal;**
  ¬s: no signal
- **a: signalling cost type A**
- **b: signalling cost type B**

T>R>P>S

δ is discount rate

Conditions for a separating signaling equilibrium

(1) Type A: $R/(1-\delta_1) - P > a$

(2) Type B: $T - P < b$

Equilibrium strategies („Perfect Bayesian equilibrium“)

- **Type A signals (s), type B does not signal (¬s).**
- **Trustor chooses trust (t) if s, otherwise no trust (¬t).**
- **Type A honors trust.**

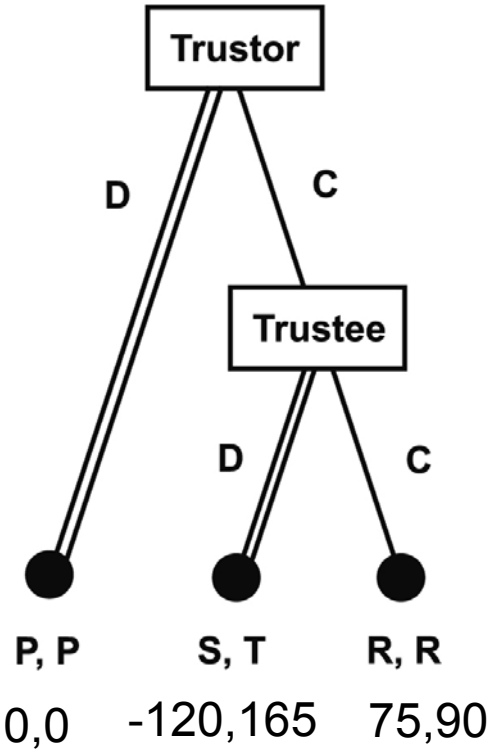
Extension: Equilibrium strategy if s is the amount of an investment. A invests $s^* = T - P + \varepsilon$, B invests 0. Trustor cooperates if $s = s^*$ and defects otherwise.

Hypotheses

1. Trustees of type A have a higher likelihood to signal than type B trustees.
2. Trustors respond to signals by an increased likelihood of cooperation.
3. Trustees of type A reciprocate trust while type B trustees are expected to exploit trustor.

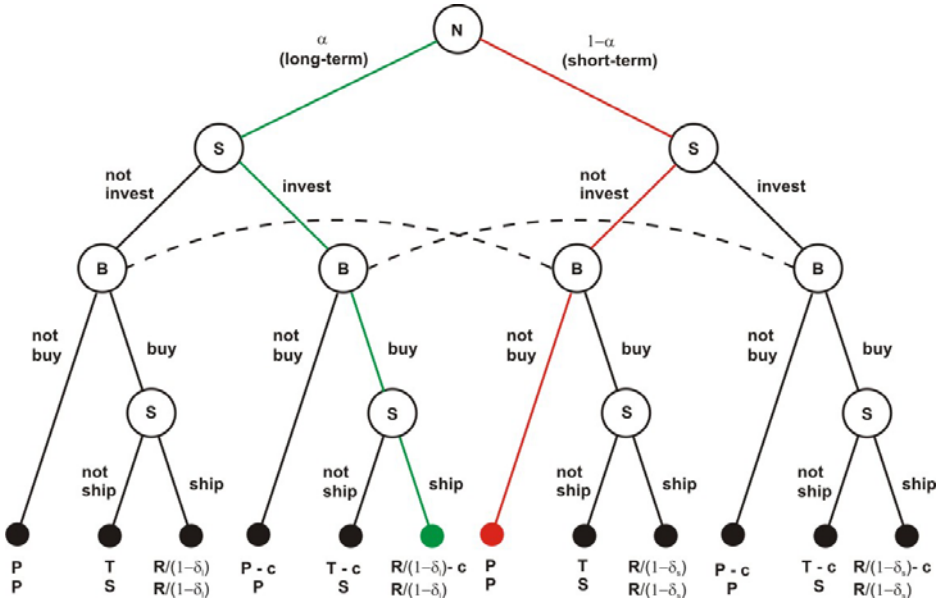
Experimental Design

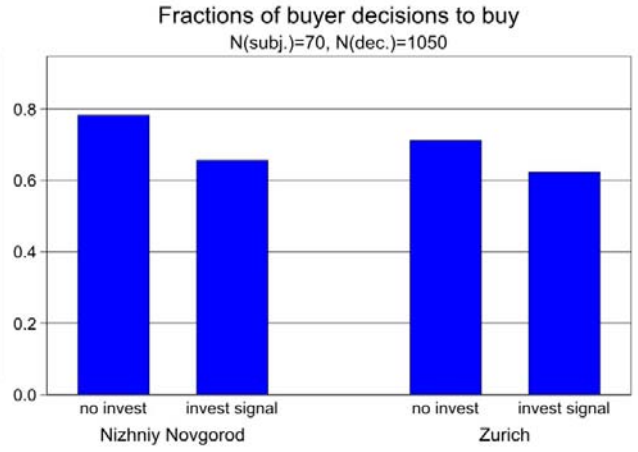
- **5 buyers (trustors) and 5 sellers (trustees) play 15 trust games**
- **with seller‘s payoffs P=0, R=90, T=165 and buyer‘s payoff P=0, R=75, S= -120.**
- **5 interactions repeated (type A), 10 interactions one-shot trust game (type B) (α=1/3 is common knowledge)**
- **Treatment: Control (no signal possible) versus signalling condition. Sellers can spend up to 175 points for signal.**
- **80 subjects in Russia, 90 subjects in Switzerland**

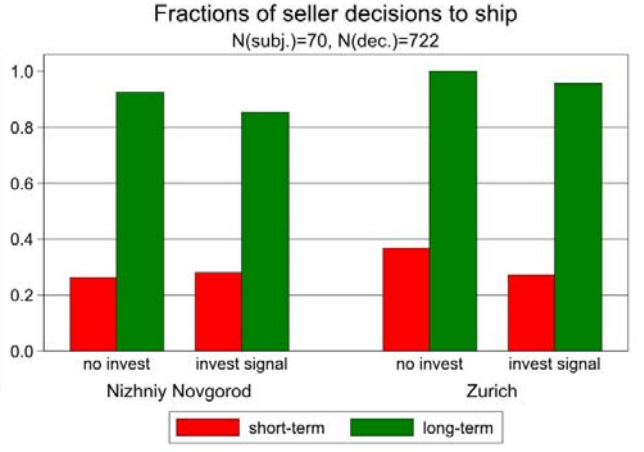


Signaling experiment 1

	Treatment			
	Nizhniy Novgorod		Zurich	
Seller type	no invest (3 sessions)	invest signal (5 sessions)	no invest (3 sessions)	invest signal (3 sessions)
short-term (10/15 rounds)	150	250	150	150
long-term (5/15 rounds)	75	125	75	75
	225	375	225	225







N.N.: Δc = 13.4, t = 2.95, p = 0.007
Zurich: Δc = 24.4, t = 5.48, p < 0.001

N.N.: OR = 0.53, z = -1.87, p = 0.06
Zurich: OR = 0.67, z = -1.08, p = 0.28

N.N.: OR = 20.1, z = 7.38, p < 0.001
Zurich: OR = 109.8, z = 5.84, p < 0.001

(OLS and logit regressions, two-sided tests with robust standard errors accounting for within subject clustering)

Learning: Evolution of Response to Signal

Trustee simulated by computer (subject informed!)

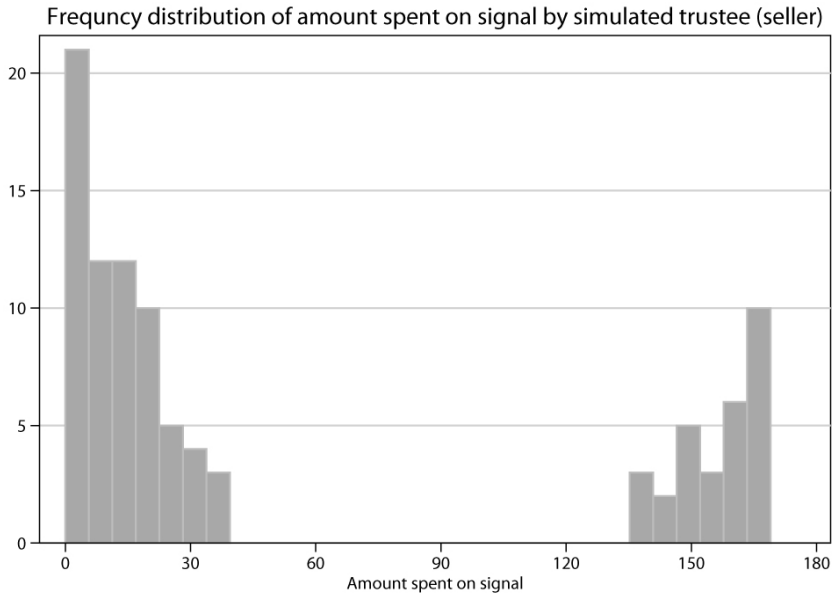
Random signal plus noise over ca. 100 rounds

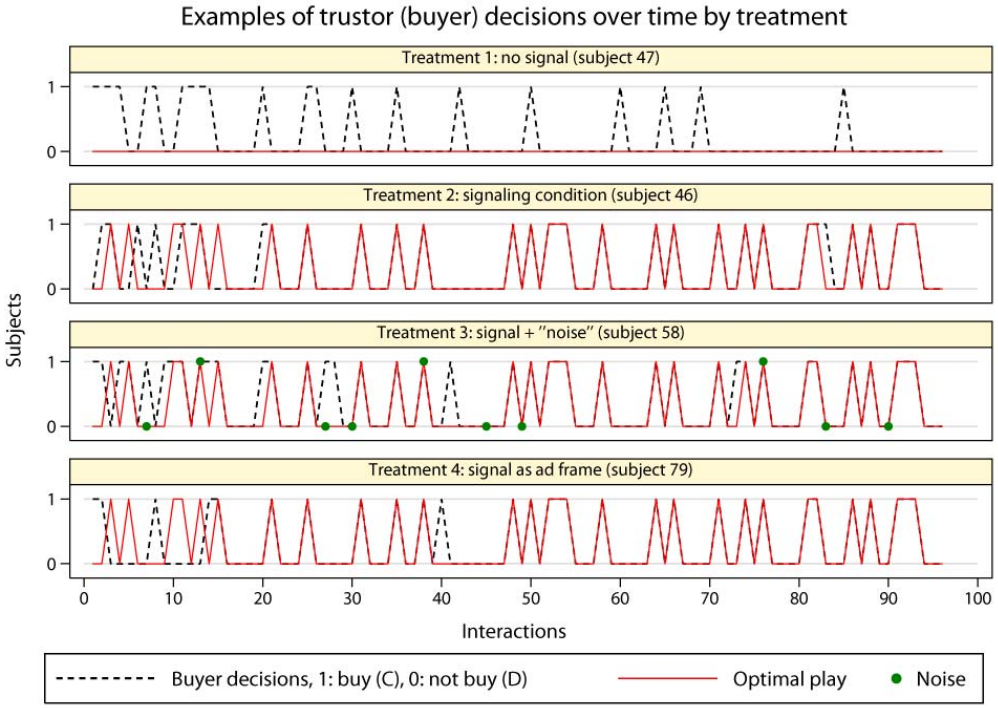
Treatments:

1. **no signal (control)**
2. **signal (low versus high plus error component)**
3. **signal (plus small probability of trustor's error)**
4. **signal as ad frame**

Signaling experiment 2 (design)

Seller type	Treatments: no invest (13 subj.)	invest signal (13 subj.)	invest signal noise (13 subj.)
short-term (67/96 rounds)	871	871	871
long-term (29/96 rounds)	377	377	377
	1248	1248	1248



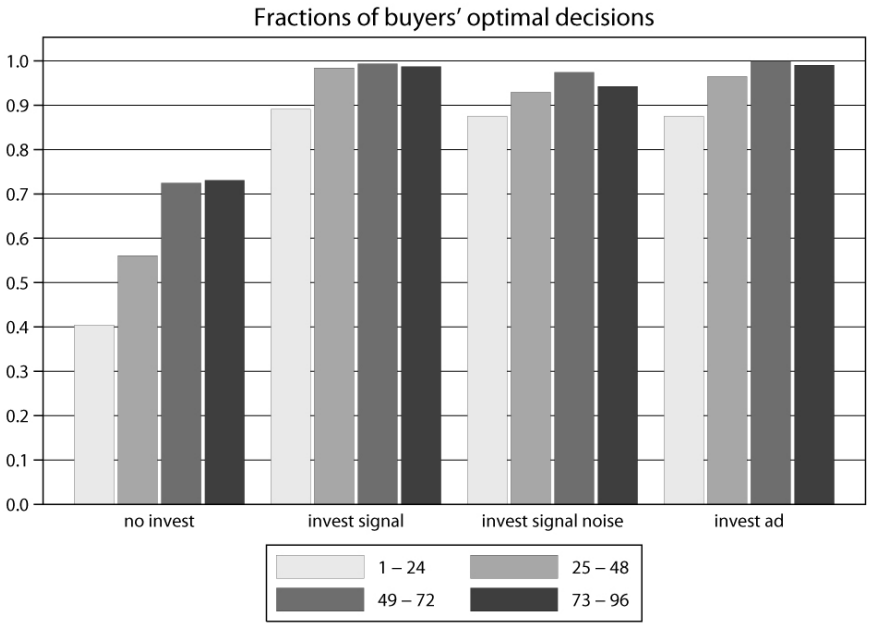


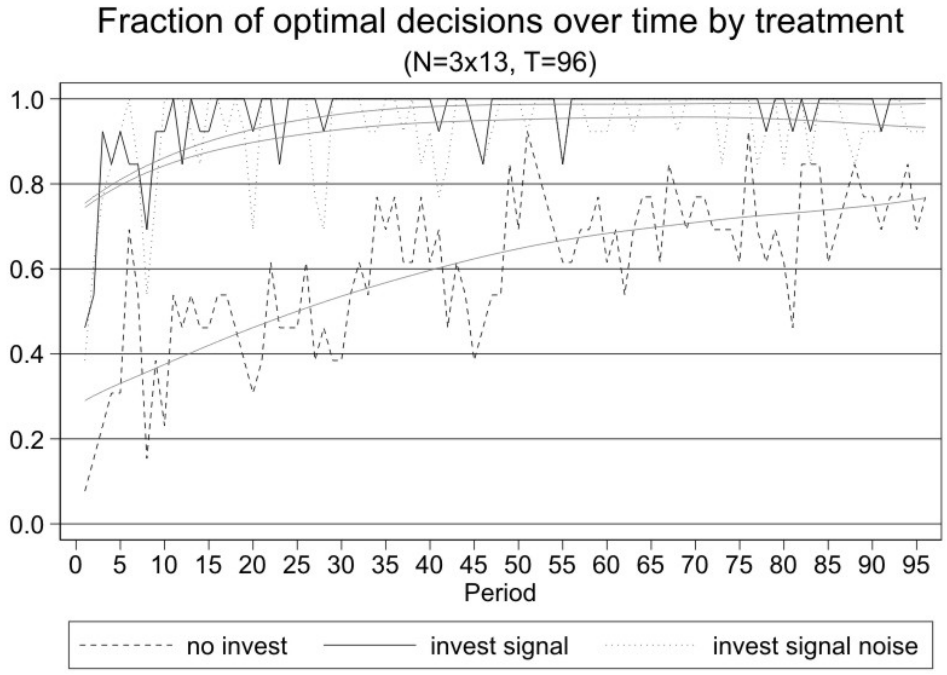
Signaling experiment 2 (results)

Logit: Probability of optimal decision

	Linear		Quadratic	
	Coef	SE	Coef	SE
signal	3.684*	0.477	4.298*	0.544
signal noise	2.250*	0.453	2.635*	0.562
time	0.021*	0.006	0.020*	0.005
t*signal	0.033*	0.010	0.009	0.006
t*signal noise	-0.001	0.008	-0.006	0.007
$time^2$			-0.000	0.000
t^2*signal			-0.001*	0.000
t^2*signal noise			-0.000	0.000
Constant	0.460	0.341	0.640	0.384
N (dec.)	3744		3744	
N (subj.)	39		39	
Wald-Test	144.3*		219.3*	

* $p < 0.05$





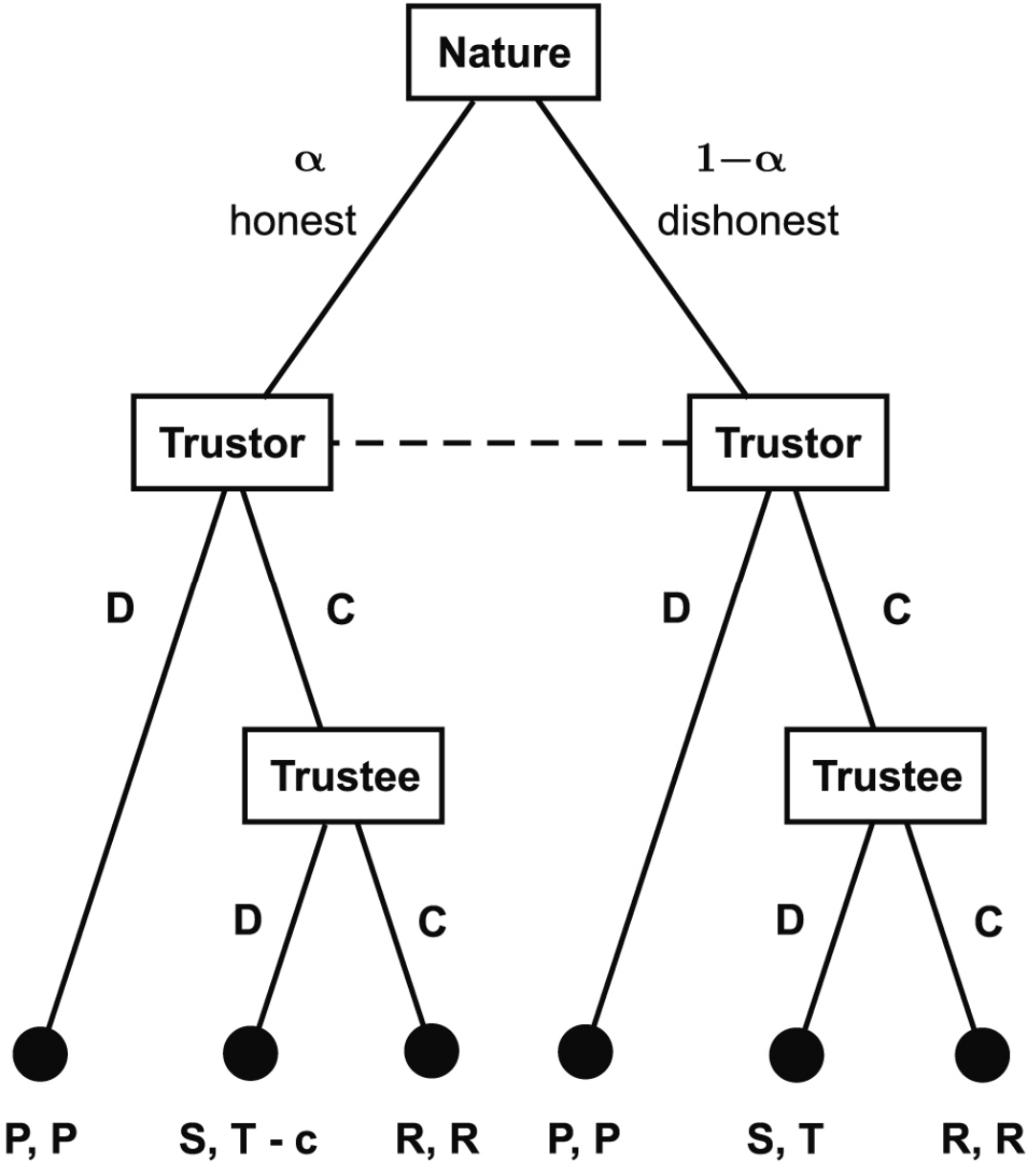
Research Perspective and Challenges

- **Experiments with one-shot or short sequence signaling games are misleading. Evolution of response to signal: Learning by trial and error**
- **Biology: Many applications of signaling theory**
- **Economics: Investment in education as costly signals (Spence)**
- **Sociology: Much essayistic writing about ”symbols”, “distinctions” etc. Why not using more precise models of game theory?**
- **Signaling theory may account for “puzzling” phenomena not easily explainable by other approaches (inefficient norms, “voting paradox”, readiness to engage in discrimination …)**
- **Policy issue: Signaling furthers cooperation but institutions may be more efficient and fair.**
- **Many interesting propositions follow from signaling theory. However, there is mainly anecdotic evidence and there are few examples of controlled experiments or field experiments.**

Experimental Methods

Rare exceptions in sociology!

	Articles 05-07	Experimental Work
British J. of Soc.	**75**	**0**
ASR	**126**	**1**
AJS	**111**	**3**
AER	**270**	**33**



Rational solution

Trust if

$\alpha > \alpha^* = (P - S)/(R - S)$

otherwise distrust

"Coleman's threshold"

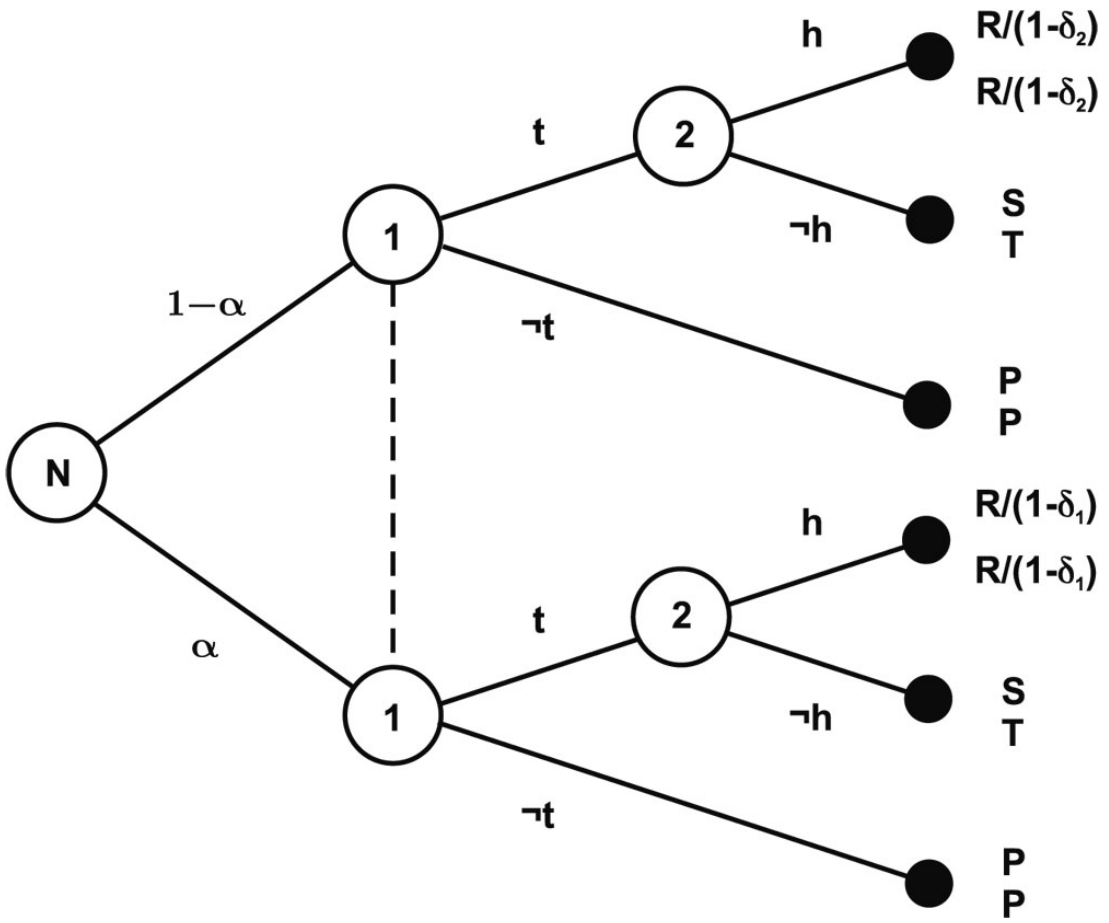
Efficiency problem if

$\alpha < \alpha^*$

$T > R > P > S$

$R > T - c$

Trust game with incomplete information



- **Trustor (Player 1), Trustee (Player 2)**
- **t: trust, ¬t: do not trust**
- **h: honor trust, ¬h: do not honor**
- **α: Probability that trustee is patient**
- **δ_1: discount factor patient type A, $R/(1-\delta_1) > T > P$**
- **δ_2: discount factor impatient type B, $T > R/(1-\delta_2) > P$**

Reminder: If α is less than the threshold, zero cooperation will emerge. ($P > \alpha R/(1-\delta_1) + (1 - \alpha)S$)

Solution: Efficiency gains by signalling if a separating equilibrium exists.

Trust game with signals of trustworthiness

- **Two types of trustees: patient (A) and impatient (B)**
- **Discount factor patient type: δ_1; discount factor impatient type: δ_2, such that $\delta_1 > \delta_2$.**
- **Patient trustee interested in repeated games: $R/(1-\delta_1) > T$**
- **Impatient trustee abuses trust in first game: $R/(1-\delta_2) < T$**
- **An interaction ends, if trustor does not trust ($\neg$t) or trustee abuses trust ($\neg$h).**

Experimental design

- **17 sessions à 10 subjects conducted in Nizhniy and Zurich**
- **3 conditions: no signal, signal invest, signal advertise**
- **5 buyers and 5 sellers play in 15 independent interactions**
- **with seller‘s payoffs P=0, R=90, T=165 and buyer‘s payoff P=0, R=75, S= -120.**
- **5 interactions repeated, 10 interactions one-shot trust game (α=1/3 is common knowledge)**
- **Only sellers know whether repeated or one-shot**
- **Sellers don‘t know exact number of games if repeated (discount factor: patient type: δ=2/3)**
- **Seller can spend between 0 and 175 points on signal**
- **Buyer gets informed about points seller has spent on signal**
- **Interaction ends if buyer doesn’t buy or seller doesn’t ship**
- **Instruction, Quiz, test run, experiment, questionnaire, money**

Experimental design

	Treatment				
	Nizhniy		Zurich		
	no signal	signal invest	no signal	signal invest	signal ad[3]
Interaction	(3 sessions)	(5 sessions)	(3 sessions)	(3 sessions)	(3 sessions)
one-shot (10/15 rounds)	150	250	150	150	132
repeated (5/15 rounds)	75	125	75	75	66
	225	375	225	225	198

Table 1: Number of interactions by treatment and interaction type. In each session 10 subjects played either in the role of a buyer or seller. Subjects played 15 rounds with alternating partners. One third of the interactions consisted of repeated games.

Experimental design

Interaktion

Testrunde 2 von 2

Sie sind ein **Verkäufer** und werden mit demselben Käufer

etwa 3 mal

ein Geschäft machen können.

Bevor sich der Käufer entscheidet, ob er mit Ihnen ein Geschäft machen will, haben Sie die Möglichkeit, in ein **Signal an den Käufer** zu investieren.

Sie können einen Betrag **zwischen 0 und 175 Punkten** in das Signal investieren und das Signal an den Käufer senden. Die investierte Punktzahl wird Ihnen von Ihrem Guthaben abgezogen.

Ihre Investition: 60

Signal senden

Ihr Guthaben in dieser Interaktion beträgt:

175 Punkte

Interaktion

Testrunde 2 von 2

Sie sind ein **Käufer**.

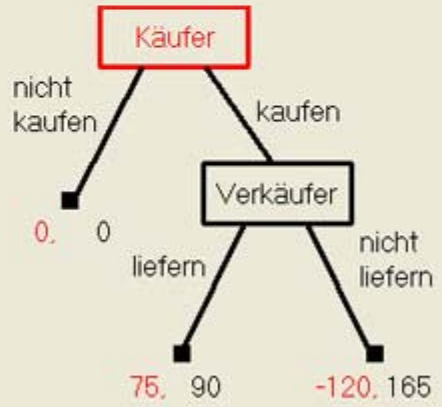
Der Verkäufer hat **60 von 175 Punkten** in ein Signal an Sie investiert.

Sie können sich jetzt entscheiden, ob Sie mit diesem Verkäufer ein Geschäft machen möchten oder nicht.

nicht kaufen | kaufen

Ihr Guthaben in dieser Interaktion beträgt:

175 Punkte

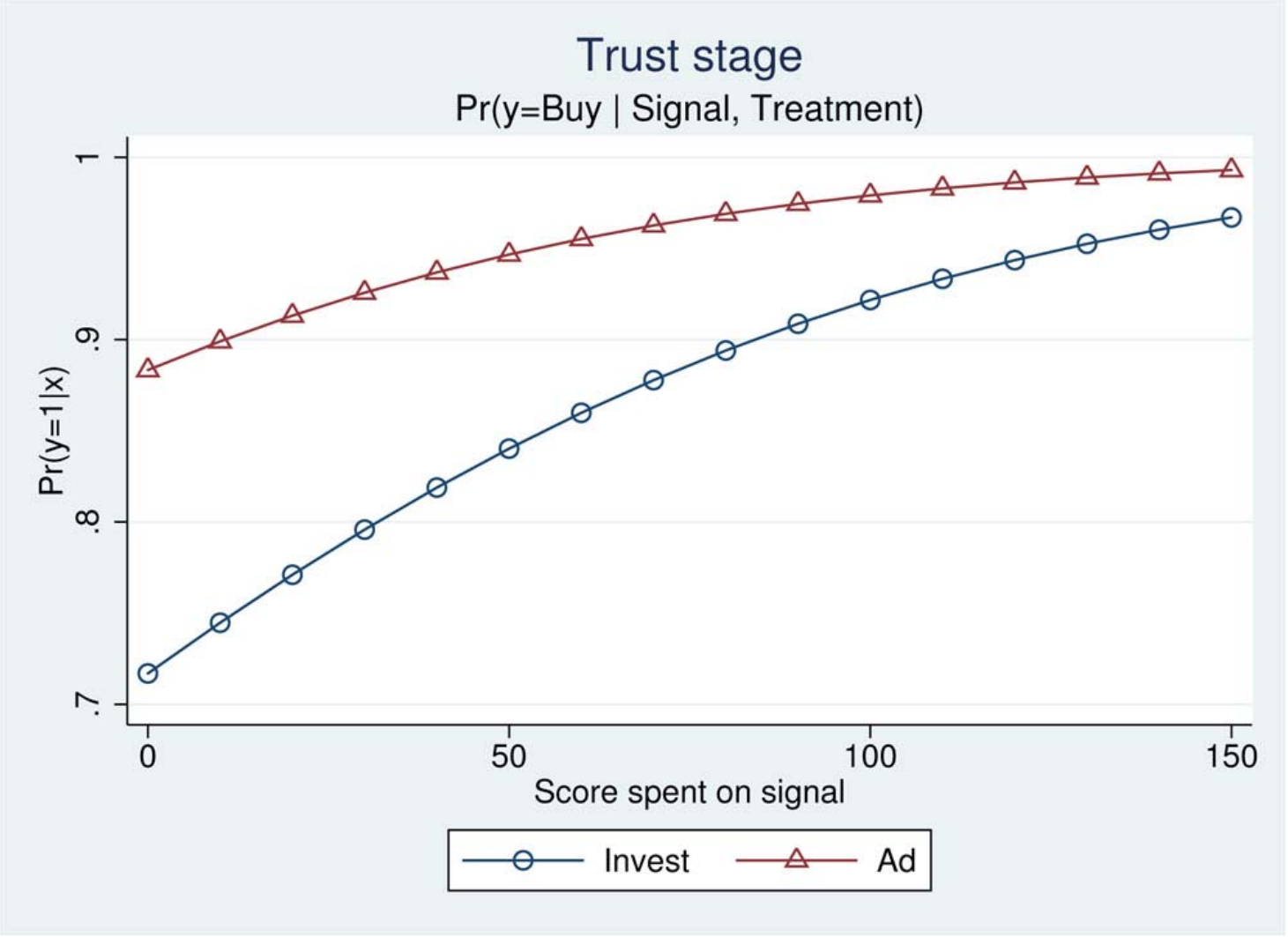


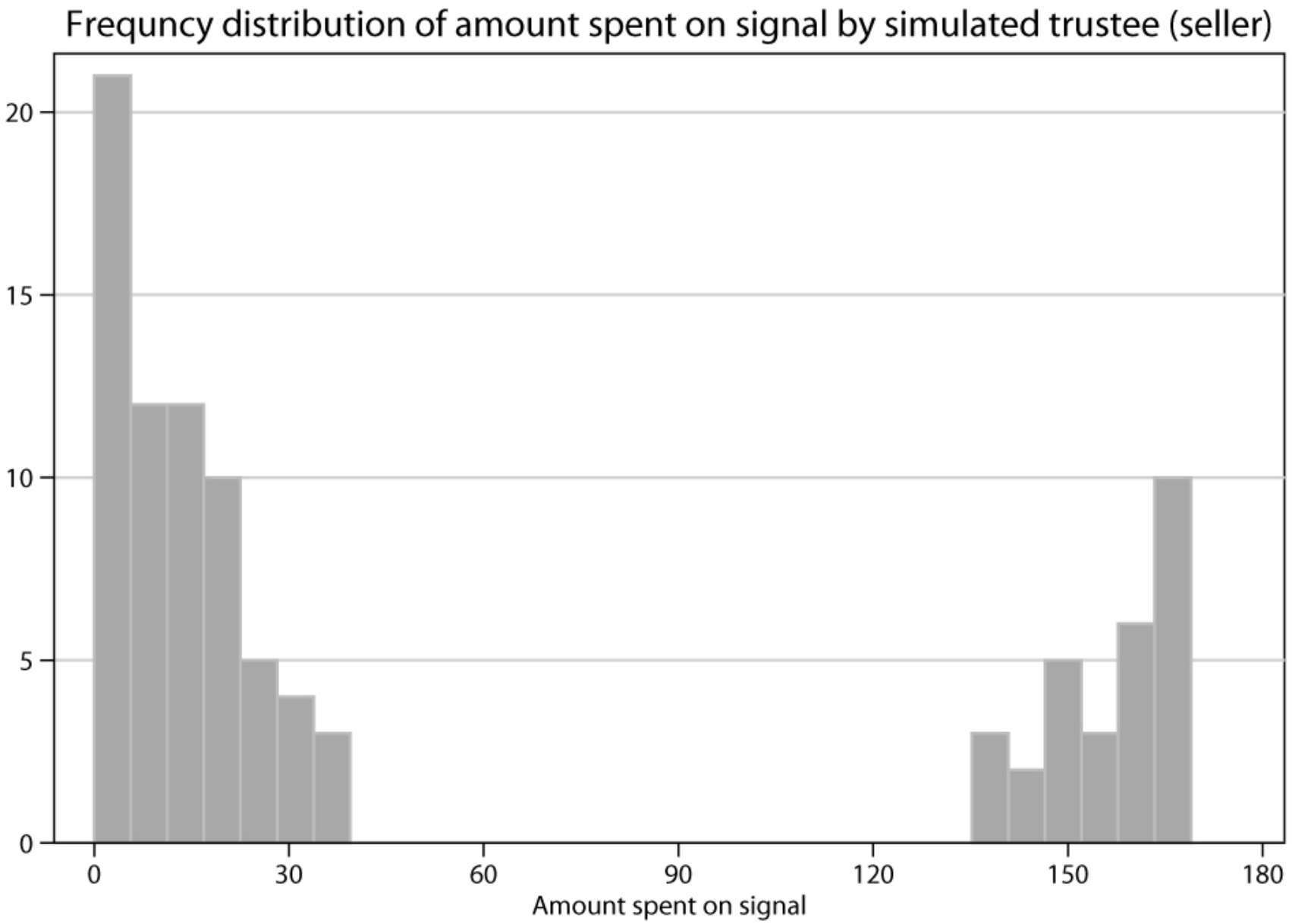
Results: signalling stage

	Nizhniy		Zurich	
	M1	M2	M1	M2
Repeated	13.408**	14.021**	22.717***	21.984***
	(4.551)	(4.457)	(3.765)	(3.792)
Ad			-26.557**	-26.428**
			(8.878)	(8.857)
Round		-0.292		0.353
		(0.298)		(0.357)
Constant	38.192***	40.322***	43.054***	40.473***
	(4.107)	(5.259)	(6.363)	(5.706)
R^2	0.049	0.049	0.261	0.262
N	375	375	423	423

Table 2: OLS-regression with points spent on signal as dependent variable. Coefficient estimates and adjusted standard errors in parentheses. Two-sided t-test, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Results: trust stage




Frequncy distribution of amount spent on signal by simulated trustee (seller)
20
15
10
5
0
0
30
60
90
120
150
180
Amount spent on signal