Trading Goods versus Sharing Money - An Experiment Testing Whether Fairness and Efficiency are Frame Dependent

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Abstract

Systematic experiments with distribution games (for a survey, see Roth, 1995,) have shown that participants are strongly motivated by fairness and efficiency considerations. This evidence, however, results mainly from experimental designs asking directly for sharing monetary rewards. But even when not just one kind of monetary tokens is distributed efficiency and fairness are less influential. We investigate and confirm this frame dependency more systematically by comparing net-trade-proposals and payoff-proposals for the same exchange economy with two traders, two commodities and multi-period-negotiations.

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1 Introduction

Experimental results for social interaction often question the Game-theoretic benchmark solution (based on own material payoff maximization) whenever it predicts a very biased payoff distribution (see Roth, 1995, for a survey of results). Already the early and surprisingly clearcut results of Owen and Nydegger (1975) revealed a strong tendency

- to maximize total payoff and
- to share it rather equally if possible.[1]

Later findings revealed slightly more heterogeneity in behavior but confirmed that participants strive for efficiency and equal monetary payoffs.

These robust findings from many experiments by many scholars may, however, be due to an implicit framing or even demand effect: What participants can choose in most of those experiments[2] is either directly the distribution of monetary rewards, e.g. in the ultimatum experiment (Güth et al., 1982), or something sufficiently close to it, like chips, as in the Owen and Nydegger (1975)-study. Already two types of tokens, that are linearly related to monetary earnings, may, however, seriously question the efficiency and fairness of the results (Güth et al., 1982, and Güth and Gneezy, 1997), especially if one does not know the monetary token values of the other party (Kagel et al., 1992).

Our **main hypothesis** goes even further: Presenting an allocation problem as a monetary reward allocation task suggests or even calls for considering efficiency and fairness.[3] If, however, what parties earn in monetary terms has to be calculated rather than chosen directly there will be significantly less efficiency and fairness.

To test this experimentally we rely on a simple exchange economy with two traders and two commodities, where allocations can be identified by the consumption vector of one trader in the trade box, determined by total endowments (Edgeworth, 1881). In one treatment participants bargain over net trades by indicating an allocation in the trade box. In the other treatment they bargain in the corresponding payoff space like in usual bargaining games (e.g. Nash, 1950 and 1953). Thus, in one treatment they have to derive the monetary consequences of an allocation (in the trade box) whereas in the second treatment they only have to check whether a given payoff vector in payoff space is feasible.

In the following, section 2 we describe the set up of the exchange economy with its benchmark solutions, both in allocation space as well as in payoff space. Details of the experimental design are given in section 3. The experimental results are described and statistically analyzed in section 4. Section 5 concludes.

2 The exchange economy

We assume the simplest exchange economy (see Hildenbrand and Kirman, 1988) with households $h \in H = \{a, b\}$ and two commodities 1 and 2, i. e. with consumption vectors $x_h = (x_{h,1}, x_{h,2})$ in $\mathbb{R}^2_+$. Total endowments are

$$E_1 = e_{a,1} + e_{b,1} \text{ and } E_2 = e_{a,2} + e_{b,2} \text{ with } E_1,\ E_2 > 0,$$

[1] In public-good experiments with the best-shot technology (the maximal contribution determines how much of the public good is produced) this is not possible which results in low efficiency and unfair payoff distributions (Prasnikar and Roth, 1992).

[2] More generally, most experiments instead of material consequences, from which such earnings can be derived, directly assign monetary payoffs to strategy vectors or plays.

[3] What we mean here is not that the usual monetary payoff proposals should be framed as market decisions but that choices are not payoff proposals.

where $e_{h,i}$ denotes agent h's endowment of commodity i. We assume $e_{a,1} = E_1$ and $e_{b,2} = E_2$ and thus $e_{a,2} = 0 = e_{b,1}$.

Monetary payoff functions are assumed as

$$U_a(x_a) = x_{a,1}^{\alpha}\, x_{a,2}^{1-\alpha} \text{ and } U_b(x_b) = x_{b,1}^{\beta}\, x_{b,2}^{1-\beta} \text{ with } 0 < \alpha, \beta < 1.$$

Allocations

$$X = (x_a, x_b) \text{ with } x_a, x_b \in I\!R^2_+, \text{ and } x_a + x_b = (E_1, E_2)$$

can be identified with the consumption vector x_a in the trade box B (see Figure 1). All allocations x_a are individually rational[4] in the sense that $U_h(x_h) \geq 0 = U_h(e_h)$ since we assume $e_h \neq (0, 0)$ but $e_{h,1} \cdot e_{h,2} = 0$ for both $h \in H$.

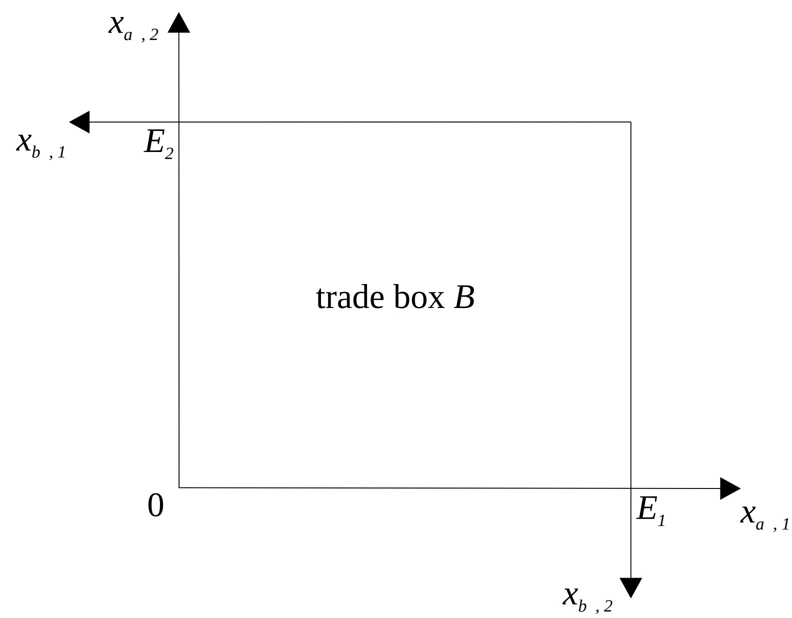

Figure 1: THE TRADE BOX

The interior efficient allocations x_a can be derived by maximizing

$$L(x_a, \lambda) = x_{a,1}^{\alpha}\, x_{a,2}^{1-\alpha} - \lambda \left[U_b - (E_1 - x_{a,1})^{\beta}\, (E_2 - x_{a,2})^{1-\beta}\right]$$

over $x_a \in B, \lambda \in I\!R$ for all constants U_b satisfying

$$0 < U_b < E_1^{\beta}\, E_2^{1-\beta}.$$

From $\frac{\partial L(\cdot)}{\partial x_{a,1}} = 0$, $\frac{\partial L(\cdot)}{\partial x_{a,2}} = 0$ and $\frac{\partial L(\cdot)}{\partial \lambda} = 0$ (the second order conditions follow from the convexity of preferences) one obtains the conditions

$$\frac{\alpha}{1-\alpha} \cdot \frac{x_{a,2}}{x_{a,1}} = \frac{\beta}{1-\beta} \cdot \frac{E_2 - x_{a,2}}{E_1 - x_{a,1}} \tag{1}$$

and

$$U_b = (E_1 - x_{a,1})^{\beta}\, (E_2 - x_{a,2})^{1-\beta}. \tag{2}$$

[4]Thus, both treatments, the one with the trade box and the one with the payoff space as action sets, identify individual rationality with natural non-negativity constraints.

Solving equation (1) for $x_{a,2}$ yields

$$x_{a,2} = \frac{\beta\,(1-\alpha)\,E_2\,x_{a,1}}{\alpha\,(1-\beta)\,(E_1 - x_{a,1}) + \beta\,(1-\alpha)\,x_{a,1}}. \tag{3}$$

Inserting this into (2) leads to

$$U_b = (E_1 - x_{a,1})^{\beta}\left(E_2 - \frac{\beta(1-\alpha)E_2 x_{a,1}}{\alpha(1-\beta)E_1 - [\alpha(1-\beta) - \beta(1-\alpha)]\,x_{a,1}}\right)^{1-\beta} \tag{4}$$

which can be solved numerically, yielding a function $x_{a,1}(U_b)$. Finally, one computes $x_{a,2}(U_b)$ via equation (3). Thus, we have derived how the (interior) efficient allocations $x_a(U_b) = (x_{a,1}(U_b), x_{a,2}(U_b))$ depend on household b's payoff U_b. Whereas in allocation space B, the set of efficient allocations is directly determined by the so-called contract curve (see Figure 2) $x_a(U_b)$, in payoff space (see Figure 3) it is given by the utility frontier $U_a^+(U_b) = U_a(x_a(U_b))$. Note that point N in Figures 3 and 2 represents the Nash (1950 and 1953)-bargaining solution in payoff space, resp. in the trade box.

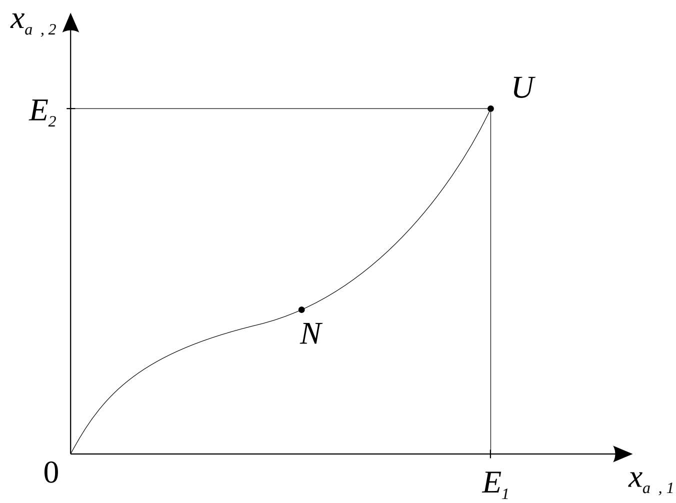

Figure 2: THE CONTRACT CURVE

3 Experimental design

The computerized experiment was performed in the experimental laboratory at the University of Karlsruhe. A session with 16 participants always relied on 2 matching groups with 8 participants each. In each matching group players were randomly assigned to play the role of player a or player b, which they kept throughout the whole experiment. We refer to the possible 5 rounds of simultaneous trade proposals with the same partner as one period of trade.

After one period of trade players were rematched within matching groups. Participants in total played 10 periods. To discourage repeated game effects as far as possible participants were not informed that rematching is restricted to smaller matching groups.[5]

[5]Statistically, due to repeated measurement only matching groups qualify as independent observations.

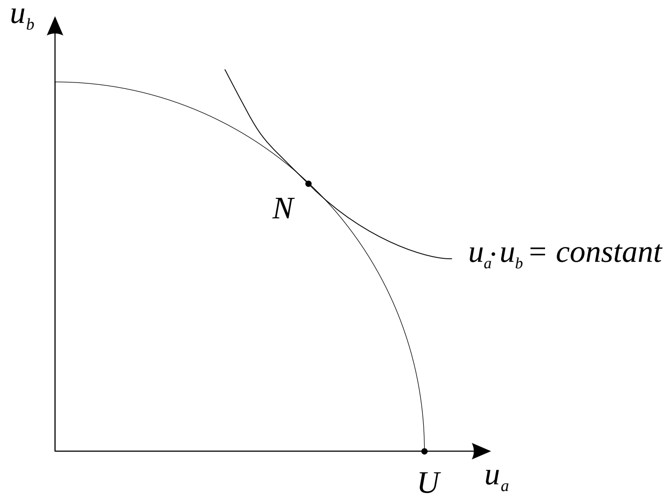

Figure 3: THE PARETO FRONTIER IN BARGAINING

In both treatments we ran five sessions, i.e. we collected data from 10 matching groups per treatment. To simplify notation we consider the decision problems faced by the participants from a neutral trader's perspective (either a or b) in Figures 2, resp. 3. Thus, in

- treatment B (trade box) a participant selects her own consumption vector x by clicking on a point in the visible trade box (Figure 1) on the computer screen with the mouse which automatically generates the residual consumption vector $\hat{x}$ via the relation $\hat{x} = (E_1, E_2) - x$.
- In treatment P (payoff space) a participant selects her own payoff demand u and the payoff level $\hat{u}$ which she concedes to her opponent by clicking on the desired point in the payoff space (Figure 3) visible on the computer screen.

In treatment B subjects are informed about the whole trade box and the utility (and the monetary payoff) of player a and b induced by each allocation x. Analogously, in treatment P subjects know the feasible payoff space U below the utility frontier (in Figure 3). The proposals of both players in each round are made simultaneously with no more than five rounds to reach an agreement. Each round lasted 1 minute at most. If at least one player did not deliver her proposal in time, this period was counted as "time out". After reaching an agreement or after five rounds of proposals participants were rematched.

In the B-treatment a proposal $\hat{x}$ of player a implies a commodity bundle for both players. Let us denote the other's proposal by y. Whenever the two proposals are mutually feasible in the B-treatment, i.e. when the sum of the chosen consumption vectors does not exceed total resources, i.e. if

$$x + y \leq (E_1, E_2),$$

an agreement is reached and both players get the payoff they proposed for themselves, that is, either $u_a(x)$ and player b earns $u_b(y)$, resp. $u_a(y)$ and $u_b(x)$. If the proposed commodity vectors x and y exceed total resources no agreement is reached yielding a new round of proposals (except for round 5) when this implies conflict with $u_a(e_a) = 0$ and $u_b(e_b) = 0$.

In the P-treatment we denote a payoff proposal by u and the other's payoff proposal by v. Since participants know the feasible utility both proposals are feasible by restriction. Agreement is reached if (u, v) is a feasible payoff vector, i.e. if (u, v) is contained in the utility space (Figure 3), as confined by the u_a-, the u_b-axes and the Pareto or utility frontier $U_b^+(\cdot)$. In case of an agreement, both parties obtain the utility (payoff) which they claimed for themselves in that round, i.e. u, resp. v, otherwise the payoffs are 0.

As the game has a large multiplicity of strict equilibria, an unambiguous benchmark solution has to rely on equilibrium selection. The Nash (1950 and 1953)-bargaining solution maximizing the dividend product $u_a u_b$ over the feasible payoff set, illustrated by the graph in Figure 3, will serve as a standard of comparison for both treatments (the reference point N in Figure 2 and 3).

The instructions for both treatments (Appendix) introduce the background of an exchange economy and are formulated as similarly as possible. When clicking on a point in the trade box the utility of player a and b for this allocation proposal appears on the screen. Analogously, through a mouse click on points in the feasible utility space U the payoffs $(u, \hat{u})$ are shown on the screen. Subjects can click on an arbitrary point in the trade box (treatment B) resp. in the feasible utility space (treatment P) on the screen. For the participants both sets seem to be "continuous" although the computer "approximates" by a small grid. As can be seen from the instructions (Appendix) the participants can also explore possible agreements without having to compute their monetary implications (B-treatment) themselves. The software has been designed in such a way that all attempts as well as their order are recorded which might indicate how participants reason what to choose. The conversion rate between the Euro and experimental currency units was EUR 0.75 for 1 experimental payoff unit.

Previous bargaining experiments often imposed symmetry. Their results could be questionable since subjects in symmetric designs tend to play fair.[6] In our design we therefore incorporated asymmetry by

$$\alpha = 1/3, \text{ and } \quad \beta = 2/3, \quad \text{and } (E_1, E_2) = (8, 3), \; e_a = (E_1, 0), \; e_b = (0, E_2).$$

This completes the description of our design by which we test the main **hypothesis** that presenting an allocation problem in payoff or in commodity space (trade box) induces significant efficiency and fairness effects.

4 Experimental results

An experimental session lasted no more than 50 minutes. The payoffs turned out to be different for a- and b-participants and for participants in treatment B and treatment P and are reported in table 1. It is notable that

treatment	mean u_a	mean u_b	max u_a	max u_b	min u_a	min u_b
B	1.96	2.08	2.73	3.27	0.5	0.61
P	2.43	2.49	3.72	4.62	1.82	1.77

Table 1: Overview of realized payoffs

- the subjects in treatment P earn more than in treatment B, regardless of their role and for all measures (mean, max, min) in Table 1, and

[6] One possible way of reasoning implying this would be as follows: "Since we are both equal, we will in all likelihood get the same. But then we should choose the best symmetric allocation!"

- (except for $\min\{u\}$ in treatment P) b-participants fare better.

Did the subjects always reach an agreement? Did they always submit their proposals in time? Tables 2 and 3 show how many agreements resp. disagreements or timeouts were observed. Results for all 10 matching groups are shown for both treatments separately. Note that in each period each matching group (with 4 pairs of bargaining partners) produced 4 final decisions after no more than 5 rounds which implies 40 decisions within 10 periods.

groups	# observations	timeout	no agreement	agreement
B1	40	1	3	36
B2	40	1	5	34
B3	40	0	8	32
B4	40	0	5	35
B5	40	0	10	30
B6	40	0	3	37
B7	40	0	10	30
B8	40	0	3	37
B9	40	0	4	36
B10	40	0	2	38
mean		0.2	5.3	34.5

Table 2: Bargaining agreements (treatment B)

groups	# observations	timeout	no agreement	agreement
P1	40	0	5	35
P2	40	0	3	37
P3	40	0	3	37
P4	40	0	2	38
P5	40	0	8	32
P6	40	0	3	37
P7	40	0	6	34
P8	40	0	2	38
P9	40	1	7	32
P10	40	0	3	37
mean		0.1	4.2	35.7

Table 3: Bargaining agreements (treatment P)

According to Tables 2 and 3 there are only very few cases of not reaching a decision in time ("timeout"). Also, disagreement cases did not occur very often. There is no big difference between treatments. Indeed, about 87% of all bargaining pairs reached an agreement irrespective of the treatment.

4.1 Focal points

In this section we analyze whether the subjects in our experiments have aimed at some selective outcome (like an equal commodity split, an equal payoff split, or the Nash-bargaining solution) and whether framing has an effect on which benchmark is more decisive.

a) According to our main hypothesis of frame dependency **fair divisions** play a major role, e.g. in treatment B **equal sharing of commodities**, that is, both demand the commodity vector $(4, 1.5)$. Tables 4 and 5 show the number of the nearly equal-split proposals realized [7] (out of 40 per group) in case of treatment B, separately for both types of players and for both commodities. Nearly equal splits can differ by no more than 0.1 from the respective component

groups	proposal a-player, equal split of commodity 1	commodity 2	both commodities $x_a = (4, 1.5)$
B1	19	2	1
B2	10	1	0
B3	12	5	0
B4	19	2	1
B5	16	1	0
B6	32	4	4
B7	9	1	0
B8	16	13	8
B9	1	5	1
B10	18	8	1
mean	15.2	4.2	1.6

Table 4: Number of equal commodity-split proposals of player a

groups	proposal b-player, equal split of commodity 1	commodity 2	both commodities $x_b = (4, 1.5)$
B1	26	0	0
B2	17	0	0
B3	20	1	0
B4	13	0	0
B5	19	0	0
B6	27	0	0
B7	18	0	0
B8	21	3	2
B9	11	0	0
B10	20	0	0
mean	19.2	0.4	0.2

Table 5: Number of equal commodity-split proposals of player b

of the equal split $(4, 1.5)$. From the experimental results in Tables 4 and 5 we conclude that

- there is a remarkable asymmetry in dividing commodity 1 and 2. There are more equal-split proposals of commodity 1 than of commodity 2 regardless of who makes the proposal. We see almost no (exact) equal-split proposal for both commodities.

[7] We only count realized proposals. Note that if one trader realizes an equal split, the other ,due to a more moderate own demand, may not.

- In most groups the number of equal-split proposals in at least one commodity does not exceed 50%. Equal split in commodity space does **not** seem to be focal in commodity division (treatment B).

b) Whereas in the B-treatment the participants can generate proposals based on commodity quantities or the payoffs, in treatment P the subjects can focus only on payoffs. The payoff division, generated by equal commodities and denoted by[8] $u_{es} = (u_a, u_b) = (2.1, 2.9)$ should therefore be more frequent in the B- rather than in the P-treatment. Again, we allow for some

	proposal treatment B		
groups	u_a	u_b	$u_{es} = (2.1, 2.9)$
B1	1	1	0
B2	8	2	1
B3	6	3	2
B4	6	0	0
B5	2	0	0
B6	6	1	1
B7	3	1	0
B8	14	2	0
B9	9	9	4
B10	10	0	0
mean	6.5	1.9	0.8

Table 6: Number of commodity-split proposals leading to $u_{es} = (2.1, 2.9)$ (treatment B)

	proposal treatment P, reference point u_{es}		
groups	u_a	u_b	$u_{es} = (2.1, 2.9)$
P1	0	8	0
P2	1	0	0
P3	0	0	0
P4	0	0	0
P5	3	0	0
P6	3	1	1
P7	1	2	0
P8	12	4	3
P9	5	8	1
P10	1	1	0
mean	2.6	2.4	0.5

Table 7: Number of payoff proposals relying on $u_{es} = (2.1, 2.9)$ (treatment P)

noise in aiming at $(2.1, 2.9)$. We count proposals as aiming at the target when u_a is contained in the interval $(2.1 - 0.1, 2.1 + 0.1)$ and u_b in $(2.9 - 0.1, 2.9 + 0.1)$. Of the 40 decisions (per group) only very few proposals aim at equal payoffs regardless of the treatment (see tables 6 and 7). In treatment B, 21% of the decisions rely on u_{es}, while in treatment P, this happens only in

[8]Note that $u_a(4, 1.5) = 2.08008$ and $u_b(4, 1.5) = 2.8845$. Because of grid approximation we have to round up to $(2.1, 2.9)$.

12.5% of all decisions. Thus, in the box treatment the tendency to propose payoff distributions, induced by equal split of commodities, is stronger.

c) One central question is, which treatment inspires more attempts to **divide payoffs equally**. The equal and efficient payoff split is determined by the intersection point $u_{eps} := (2.54, 2.54)$ of the 45 line and the Pareto frontier in the u_a/u_b space. Its experimental success is reported in Tables 8 and 9.

	proposal treatment B, equal payoff split of		
groups	u_a	u_b	$u_{eps} = (2.54, 2.54)$
B1	16	25	14
B2	10	16	8
B3	10	19	7
B4	16	10	3
B5	17	16	9
B6	24	27	20
B7	9	21	8
B8	7	19	5
B9	0	14	0
B10	13	22	8
mean	12.2	18.9	8.2

Table 8: Number of equal payoff proposals (treatment B)

	proposal treatment P, equal payoff split of		
groups	u_a	u_b	$u_{eps} = (2.54, 2.54)$
P1	10	9	8
P2	28	17	14
P3	22	30	19
P4	14	32	11
P5	21	16	10
P6	27	18	12
P7	25	16	15
P8	20	14	8
P9	7	14	7
P10	17	12	10
mean	19.1	17.8	11.4

Table 9: Number of equal payoff-split proposals (treatment P)

As before, we count proposals u_a resp. u_b "near" the equal payoff split, i.e. contained in the interval $(2.54 - 0.1, 2.54 + 0.1)$ around $(2.54, 2.54)$ as equal. Comparing Tables 8 and 9 with Tables 6 and 7 shows that efficient and equal payoff splits seem to be more attractive than equal commodity sharing. More importantly, in treatment P we find more equal payoff proposals than in treatment B which supports our conjecture that the framing matters.

d) The **Nash-bargaining solution** yields the payoff vector $u_{Nash} = (2.2, 3.1)$. From Tables 10 and 11 we conclude that it was proposed only in very few cases. Neither in treatment B nor in treatment P the exact Nash solution was proposed. If we count proposals u_a resp. u_b

groups	proposal treatment B, Nash payoff u_a	u_b	$u_{Nash} = (2.2, 3.1)$
B1	11	0	0
B2	5	0	0
B3	2	0	0
B4	2	0	0
B5	9	0	0
B6	3	0	0
B7	13	0	0
B8	6	0	0
B9	16	0	0
B10	4	0	0
mean	7.1	0	0

Table 10: Number of Nash proposals (treatment B)

groups	proposal treatment P, Nash payoff u_a	u_b	$u_{Nash} = (2.2, 3.1)$
P1	14	0	0
P2	0	0	0
P3	4	0	0
P4	2	0	0
P5	6	0	0
P6	0	0	0
P7	5	0	0
P8	0	1	0
P9	14	0	0
P10	1	0	0
mean	4.6	0.1	0

Table 11: Number of Nash proposals (treatment P)

as Nash proposals if they are contained in the interval $(2.15, 2.30)$ resp. $(3.0, 3.2)$, according to Tables 10 and 11 both treatments have inspired more such u_a proposals than u_b proposals.

4.2 Test results

Let us now test the hypothesis that "framing matters" through appropriate statistical tests.

a) We, first, compare some selected overall features in both treatments, namely

(1) the number of "timeout" cases

(2) the number of disagreement cases

(3) the number of agreement cases

(4) the frequency of proposals based on equal splits of commodities

(5) the frequency of proposals based on equal split and efficient payoffs

(6) the frequency of inefficient proposals $u_a = u_b$

(7) the frequency of inefficient proposals $u_a < u_b$

(8) the frequency of inefficient proposals $u_a > u_b$.

treatment	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
trade box (B)	2	53	345	8	82	10	176	69
payoff space (P)	1	42	357	5	114	46	128	64

Table 12: Difference between treatment B and P (selected aggregate data)

The χ^2 test results show that "overall behavior", as captured by these criteria and reported in Table 12, in treatment B and P is significantly different.[9]

b) We split the "overall" performance tests into three parts to better understand what accounts for the framing effect. **First**, we consider the proposals for an equal split of both commodities where we, of course, take payoff proposals in line with such equal commodity splits. The χ^2-test

treatments	equal split of commodity 1	commodity 2	both commodities	row total
trade box	65	19	8	92
payoff space	26	24	5	55
column total	91	43	13	147

Table 13: Equal commodity splits

reveals a significant difference of equal commodity split proposals which are more frequent in treatment B than in treatment P.[10]

Second, we compare the frequency of equal payoff splits in both treatments, where we do not differentiate between payoff splits of Pareto efficient and inefficient allocations. In Table 14 all payoff proposals are counted. The χ^2-test shows a significant difference between treatment

treatments	payoff proposals equal payoff	unequal payoff	row total
trade box	92	245	337
payoff space	160	192	352
column total	252	437	689

Table 14: Equal payoff splits

B and treatment P.[11] When the action space is the payoff space as in treatment P we observe many more equal payoff-split proposals than in trade-box treatment B.

Third, we analyze whether framing has an impact on the efficiency of the proposals. In Table 15 all proposals are classified regardless of their efficiency. Again the χ^2-test reveals a

[9] $\chi^2 = 38.545$, $p = 0.001$.
[10] χ^2-variable: 9.262, $p - value = 0.0097$.
[11] χ^2-variable: 24.462, $p - value = 0.0000008$.

treatments	payoff proposals Pareto efficient	not Pareto efficient	row total
trade box	82	255	337
payoff space	114	238	352
column total	196	493	689

Table 15: Equal payoff splits

significant difference between treatments.[12] In the payoff space treatment P we observe more efficient division proposals than in treatment B.

c) To compare the payoff proposals by type a- and b-participants, we employ the Mann-Whitney U test to the data in Table 16. Columns 2 and 3 (resp. 5 and 6) in Table 16 are group means

groups	proposal treatment B u_a	u_b	groups	proposal treatment P u_a	u_b
B1	2.32	2.44	P1	2.34	2.62
B2	2.19	2.45	P2	2.47	2.55
B3	2.21	2.50	P3	2.52	2.41
B4	2.34	2.13	P4	2.52	2.53
B5	2.35	2.44	P5	2.42	2.51
B6	2.41	2.47	P6	2.39	2.49
B7	2.27	2.52	P7	2.46	2.53
B8	2.13	2.45	P8	2.29	2.38
B9	2.13	2.52	P9	2.26	2.59
B10	2.28	2.27	P10	2.54	2.31
mean	2.26	2.42		2.42	2.49
variance	0.01	0.02		0.01	0.01
median	2.28	2.45		2.44	2.52

Table 16: Payoff proposals in treatments B and P

(over all proposals of group members over 10 periods). The Mann-Whitney U test yields the following answers on how role asymmetry and frame, resp. treatment are interrelated:

1. Is there a difference in the payoff proposals by type a and type b in treatments B and P?
    - u_a is significantly smaller (at the 5% level) in treatment B than in treatment P.[13]
    - u_b-proposals do not differ significantly in treatments B and P.[14]
2. Is there a difference between u_a- and u_b-proposals in treatment B, resp. treatment P ?
    - In treatment B there is a significant difference between u_a- and u_b-proposals[15]. The latter are more demanding.
    - In treatment P the u_a- and u_b-proposals do not differ significantly.[16]

[12] χ^2-variable: 5.487, $p - value = 0.019$.
[13] Mann Whitney U statistic: 13.50, $p - value = 0.006$.
[14] Mann Whitney U statistic: 29.00, $p - value = 0.112$.
[15] Mann Whitney U statistic: 14.50, $p - value = 0.007$.
[16] Mann Whitney U statistic: 29.00, $p - value = 0.112$.

5 Concluding remarks

Demand effects of experimental designs are unavoidable. What has worried us, however, is that robust findings of payoff distribution experiments have been unquestionably translated to economic or social decision environments where the behavior is not to choose payoffs but rather some market or other type of social activity of which the payoff implications are derivable but not at all obvious. Our framing hypothesis does not claim that there is no efficiency or equity when action space and payoff space differ but only that the tendency to strive for efficiency and equity is significantly weaker. Our data confirms our intuition, i.e. we consciously or unconsciously improve efficiency and fairness when we let the participants decide on payoffs directly rather than on behavior like market decision making which implies such payoffs.

The situation for which we have analyzed the framing hypothesis has been a simple exchange economy with two commodities and two trading agents. Regardless of whether bargaining relied on trade or payoff proposals (treatment B, resp. P) we always allowed for five rounds of simultaneous proposals at most in order to allow for coordination among negotiators. Our treatment B can be viewed as an attempt to study the evolution of trade experimentally without imposing market institutions like price vectors applying to all traders (see also Osborne and Rubinstein, 1990, who explain trade by bilateral trade arrangements as in treatment B). In this sense, our study may deserve some interest of its own, despite our main interest in testing the framing hypothesis.

Compared to this, the P-treatment is a typical payoff distribution experiment, albeit one relying on non-transferable utilities (see Mayberry, Nash, and Shubik, 1953, for an early study of a so-called NTU-bargaining game) and the asymmetry of the bargaining parties. The two latter aspects suggest a worst-case scenario for testing the basic framing hypothesis, since both, non-transferable utilities as well as the structural asymmetry of the player roles, in all likelihood discourage efficiency and fairness concerns. For the B-treatment the effect of utility transfers and the symmetry of the feasible set in payoff space would have been less obvious. Here, those aspects would have to be derived by the participants themselves which questions their relevance. It was, therefore, important to confront the participants with a more complex bargaining game avoiding the constant pie assumption and symmetry of the player roles.

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Appendix

A Translation of the instructions for the experiment

To simplify the exposition we present the instructions only for a-players. It is easy to see how these must be adapted for b-players.

A.1 Treatment trade box

Experimental instructions

You are participating in an economic experiment. The participants take their decisions independently of each other while sitting at a computer terminal. Any other form of communication between the participants is not allowed.

This experiment lasts **10 periods**. Each period consists of a maximum of **5 rounds**. There are 2 types of players, players of **type A** and players of **type B**. The roles of the players are assigned to the participants randomly and are are not changed during the experiment. In this room, there are only players of type A, in a second room there are only players of type B. One player of type A and one player of type B are randomly rematched at the beginning of each period in order to form a new group of two. Therefore, a pair of players is not changed during the current period. Afterwards, each player is matched with another player just by chance. You will not know who your partner is. Even after the experiment is finished you will not know any of your previous partners.

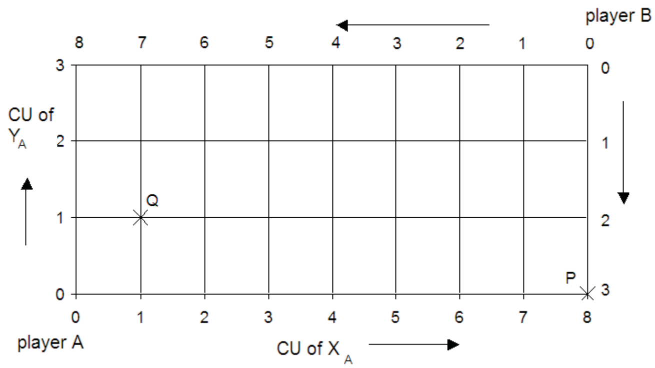
In each period you and your partner can dispose of **8 commodity units (CUs) of commodity X** and **3 commodity units of commodity Y**. The amounts of the commodities X and Y are denoted by x resp. y. You and your partner can agree on a particular allocation of these commodity amounts. The amounts of both commodities which are allocated to player A are denoted by x_A resp. y_A. The commodity amounts allocated to player B are denoted by x_B resp. y_B.

Player A evaluates the commodity amounts allocated to him in monetary units (MUs) according to the function $a(x_A, y_A)$. Function $b(x_B, y_B)$ is the evaluation function of player B.

Both evaluation functions are explicitly given by:

$$a(x_A, y_A) = x_A^{1/3} \cdot y_A^{2/3} \quad \text{and} \quad b(x_B, y_B) = x_B^{2/3} y_B^{1/3}$$

You can divide 8 CUs of commodity X and 3 CUs of commodity Y. Look at the following image which will appear on your screen:



Your CUs of X ...... CUs of X for your partner ......

Your CUs of Y ...... CUs of Y for your partner ......

Your MUs ...... MUs of your partner ......

The box above contains all possible allocations of both commodities between player A and B.

> *Example:*
>
> *Suppose both players would agree on allocation P; then A would possess 8 CUs of X and B would possess 3 CUs of Y.*
>
> *In Q, player A would possess 1 CU of X and 1 CU of Y, while B possesses 7 CUs of X and 2 CUs of Y.*

Both players make an allocation proposal **simultaneously**, i.e. they enter their proposal into the computer without knowing the partner's proposal. You propose an allocation by moving the mouse pointer over the above picture shown on the screen and clicking on the desired commodity allocation with the left mouse button. The proposals are exact up to two decimals. Below the figure on the screen each player is shown the CUs of X and Y and the respective monetary values induced by his/her allocation proposal. Furthermore, you see the CUs on the screen and their monetary value resulting from your proposal to player B. You can alter your proposal at any time. However, once you have made your final decision on your proposal and sent it to the server by clicking on the OK-button, it cannot be changed anymore.

By clicking on the F1-button you can obtain information about previous periods at any time.

In short, the experiment works as follows:

You have one **period** to come to an agreement on the allocation of the total amounts of the commodities X and Y. A period consists of a maximum of **5 rounds** . **In each round** you and your partner can submit an allocation proposal. The duration of a round is limited to one minute, i.e. you can submit your proposal within one minute.

If both players agree on their allocation proposals within one minute each player is notified to collect the payoffs induced by the allocation and the next period starts. Agreement occurs when the simultaneous commodity-allocation proposals are feasible. Two allocation proposals are regarded to be feasible when:

> First, the sum of CUs of X which both players proposed for themselves is less or equal to 8.
>
> And second, the sum of CUs of Y which both players proposed for themselves is less or equal to 3.

In this case both players get **the amount of each commodity they have proposed for themselves**. The players are credited these amounts in MUs. If the players' proposals imply that not all resources of commodity X or Y are consumed completely the remainder is wasted.

If a round has to be closed (after one minute) without having reached an agreement (i.e. the proposed allocations are not feasible or both proposals do not arrive in time) the next round starts. If there is no agreement within 5 rounds each player obtains zero MUs as period payoff of the current period and the next period starts.

A period lasts no more than five rounds and it ends either by reaching an agreement within five rounds or by reaching no agreement resp. by not sending a proposal at all. Once a round is finished a player is informed only whether an agreement has been reached or not. That is, each player only knows her own proposal and does **not know the partner's proposal in any case**. After the experiment is finished each player gets the sum of all period payoffs in cash. The conversion rate of MUs to the Euro is equal to 0,75.

> *Example:*
>
> *Player A proposes 7 CUs of X and and 2.9 CUs of Y for herself. Player B proposes 6.7 CUs of X and 2 CUs of Y for herself. These allocation proposals are not feasible since player A and player B together want to get 13.7 CUs of X and 4.9 CUs of Y, while there are only 8 and 3 CUs of both commodities available.*
>
> *Now suppose that player A proposes 2 CUs of X and 0,5 CUs of Y for herself. Player B proposes 1 CU of X and 1 CU of Y for herself. These proposals are in fact feasible since the total commodity demand is equal to 3 CUs of X and 1.5 CUs of Y. Therefore, both players get what they proposed for themselves. 5 CUs of X and 1.5 CUs of Y are wasted. The period is finished.*

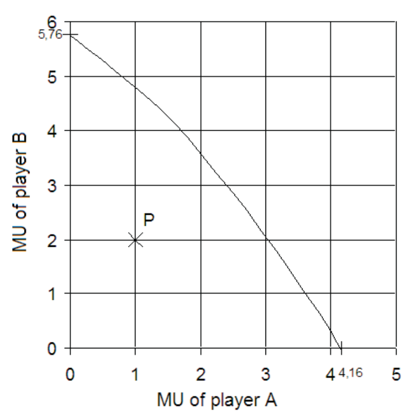
A.2 Treatment payoff space

Experimental instructions

You are participating in an economic experiment. The participants make their decisions independently of each other while sitting at a computer terminal. Oral communication between the participants is not allowed.

This experiment lasts 10 periods. Each period consists of a maximum of 5 rounds. There are 2 types of players, players of **type A** and players of **type B**. The roles of the players are assigned to the participants randomly and are not changed during the experiment. In this room there are only players of type A, in a second room there are only players of type B. One player of type A and one player of type B are randomly rematched **at the beginning of each period** in order to form a new group of two players. Therefore, a pair of bargaining partners is not changed during the current period. Afterwards, each player is matched with another player just by chance. You will not know who your partner is. Even after the experiment is finished you will not know any of your previous partners.

In each period there is the **same number of monetary units** (MUs) available to a group of two players. You can come to an agreement on how to divide this sum. In order to do this look at the following drawing which will appear on your screen (The MUs for A are depicted on the x-axis, The MUs for B are depicted on the y-axis):



Your MUs: ...... MUs of your partner: ......

The area below the curve and the curve itself represent all possible divisions of the total amount given in MUs.

> *Example: In P player A gets 1 MU and player B gets 2 MUs.*

Both players make their division proposal simultaneously, i.e. they type their proposal into the computer without knowing the partner's proposal. You propose a particular division allocation by moving the mouse pointer over the above picture shown on the screen and clicking on the desired money-division proposal with the left mouse button. The proposals are exact up to two decimals. Below the figure on the screen each player is shown the MUs of X and Y. You can alter your proposal at any time. However, once you have made your final decision on your proposal and sent it to the server by clicking on the OK-button, it cannot be changed anymore.

By clicking on the F1-button you can obtain information about previous periods at any time.

In short, the experiment works as follows:

You have **one period** to reach an agreement on the division of the total monetary amount. A period consists of a maximum of **5 rounds**. In each round you and your partner can submit a division proposal. The duration of a **round** is limited to **one minute**, i.e. you can submit your proposal within one minute.

If both players agree on their division proposals within one minute each player is credited the respective amount of MUs and collects the payoffs according to the proposals and the next period starts. Both players reach an **agreement** when both **division proposals** are feasible. Two proposals are **feasible** when each player does not propose to get more money than her partner would want to give to her. In this case both, players A and B are credited the amount they require for themselves. If the players reach an agreement such as that the total sum of MUs available is not exhausted the remaining money is wasted.

In case you did not reach an agreement (i.e. the proposed divisions are not feasible or 1 minute elapsed without any party making a proposal) the next round starts. If you do not reach an agreement even after 5 rounds have elapsed you will get 0 MUs in the current period and the next period starts.

Therefore, a period consists of a maximum of 5 rounds. A period ends within 5 rounds either by making a feasible division proposal or by reaching the time limit without making a proposal or by not reaching an agreement. After a round is finished each player is informed whether an agreement has been reached or not. Each player knows only her own proposal and is **not informed about her partner's previous proposals**. After 10 periods each player obtains the sum of all her period payoffs in cash. The conversion rate is as follows: 1 MU is equivalent to 0,75 Euro.

> *Example:*
>
> *Player A proposes 3.5 MUs for herself and 0.5 MUs for player B. Player B proposes 4.8 MUs for herself and 0.5 MUs for player A. That is, player B wants to give 0.5 MUs to player A, while player A wants to have 3.5 MUs, therefore, these proposals are not compatible. Furthermore, player B wants to have 4.8 MUs for herself, while player A would only propose to give 0.5 MUs to her. If both players are in round 1 to 4 a new round starts otherwise a new period starts.*
>
> *Now, suppose that player A proposes 0.8 MUs for herself and 4.3 MUs for player B, while player B proposes 0.6 MUs for herself and 3.9 MUs for player A. Since A proposes 4.3 MUs for B, however, B only requires 0.6 MUs and B proposes 3.9 MUs for A, while A proposes 0.8 MUs this division is feasible and each player gets the amount she requires. That is, A gets 0.8 MUs, B gets 0.6 MUs. The remaining amount of money is wasted and the period is finished. If both players are in a period < 10, a new period starts. If you are already in period 10 the experiment is finished.*