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The Shift of Supply and Demand Functions
due to the Spiral of Planning

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by

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Abstract

The *evaluation disparities* of bids and expectations observed in many *market experiments* organized as double sealed bid auctions may be interpreted as a *status quo effect of thinking* (TIETZ 1992a). Usually, decisions are not a result of a simultaneous mathematical solution, but of a recursive process of thinking. Under the conditions of *bounded rationality* decision making in an interdependent situation does not follow an infinite regress of game theoretic reasoning but goes along the *spiral of planning* where thinking stops, when a possible decision is found which satisfies the actual *aspiration level*. The status quo influences the aspiration level.

The status quo of thinking is influenced not only by external conditions but also by considerations made during the pre-decision phase. The role position is by far the most important influence on the one-sided view of the decision situation. That induces a high aspiration level at the beginning of the spiral of planning. The neglect of the considerations made by the decision makers at the other side of the market leads to an incomplete and inconsistent *mental model* of the situation and to an early stop of the thinking process. The resulting evaluation disparity is connected with a high *reluctance to trade*.

Control experiments show that supply and demand functions are shifted to the right, if the market participants are asked by a questionnaire before the decision - accordingly to the *planning report method* - what they would offer in the opposite role (*potential bid*). The shift reduces the reluctance to trade and is more distinct on the supply side. A similar shift can be reached by a questionnaire in which the participants have to make decisions for both roles not knowing which role is *randomly* assigned to them later on.

The results show that the intensity of thinking and the resulting decisions are tremendously influenced by the experimental procedure. The results of inquiries and one-shot experiments produce interesting information on the first impression about a problem, but they may differ distinctly from the well-planned behavior of earnest and prepared decision makers with an improved degree of, still bounded, rationality.

Evaluation Disparities and the Spiral of Planning

The evaluation disparities in market experiments I reported on two years ago in Exeter (TIETZ 1992a) may be seen as a *status quo effect of thinking*. The disparity consists of high selling and low buying prices. Similar disparities were observed also for the corresponding expectations about the uniform market price. The evaluation disparities result in lower trade volumes on markets than one would expect on the assumption of equal distributed bids on both sides of the market. This phenomenon is interpreted by KAHNEMAN (1988) as *reluctance to trade*.

Usually, decisions are not a result of a simultaneous mathematical solution, but of a recursive process of thinking organized as cybernetic system (TIETZ 1982). In game theoretic reasoning decisions can be derived by an infinite regress of argumentation of the players. Under the conditions of *bounded rationality* in an interdependent situation decision making goes along the *planning spiral*. (*Figure 1*). In the planning spiral thinking is stopped, when a possible decision is found which satisfies the actual *aspiration level*. The aspiration levels are influenced by the status quo. I have discussed this concept at the last IAREP-Conference in Stockholm from the aspect of consistency of the mental model of the decision environment (TIETZ 1992b).

In the turns of the planning spiral the decision problem is considered from various points of view. The number of turns made in this spiral and thus the degree of convergence is influenced by the experimental framing. I postulated as an important task of Experimental Economics to lead subjects during the predcision phase in such a planning spiral, in order to induce inconsistencies between the mental models established at different states of planning. Such inconsistencies lead to *cognitive dissonance* under which the decision maker feels uncomfortable and tends to reduce such cognitive imbalances (FESTINGER 1957, FREY 1978, and esp., SAMUELSON and ZECKHAUSER 1988, p. 39)¹). That improves the consistency of the mental model and the rationality of decisions. The *planning report method*, used since the early seventies in Frankfurt, is a method for preparing a decision in a reasonable, boundedly rational way (TIETZ 1972).

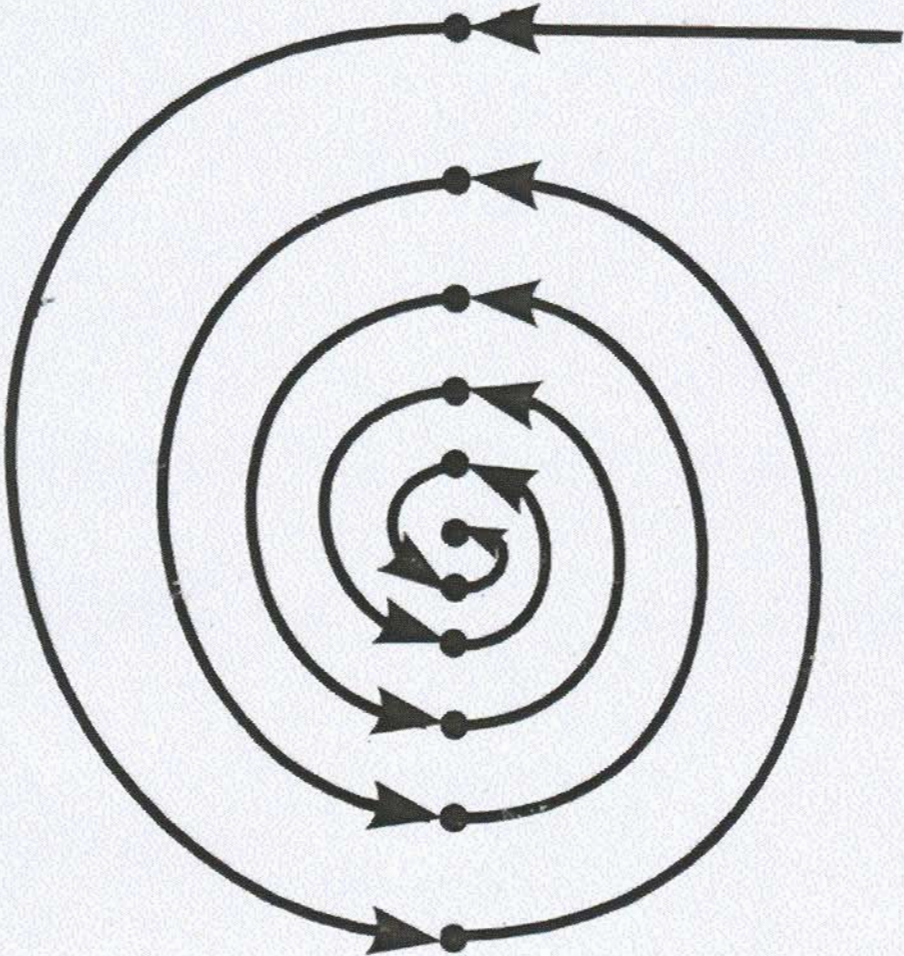
The status quo of thinking is influenced not only by external conditions or by the initial endowment (THALER 1980, KNETSCH and SINDEN 1984, 1987, KAHNEMAN, KNETSCH, and THALER 1991, ORTONA and SCACCIATI 1992). It are the considerations, that are made or not made during the pre-decision phase, which influence the status quo of thinking and the resulting evaluation disparities. The intensity of planning depends on the relative

1) That the term "cognitive dissonance" - also by FESTINGER -is not restricted to postdecision periods, cf. JECKER 1968.

The Planning Spiral



role B



role S



importance of the decision problem and the planning procedure used. Where - under the financial restrictions of research - the relative importance cannot be increased by high monetary incentives, the planning behavior may be influenced by the *planning report method* using questionnaires on expectations and on potential aspiration levels and decisions.

The perceived role position is by far the most important influence on the one-sided view of the decision situation. That induces a high aspiration level at the beginning of the spiral of planning. Neglecting the possible considerations made by the decision makers at the other side of the market delivers an incomplete and inconsistent *mental model* of the situation. An early stop of the thinking process leads to a high *evaluation disparity*, which results in a remarkable *reluctance to trade*.

Experimental Procedure

The experiment used to control for such effects is the market experiment BÖMA (BörsenMarkt). It is a double sealed bid auction for a homogeneous good, organized like a real commodity exchange. The commodities traded usually are apples, oranges, or tangerines. The classroom experiment can be performed with any number of participants.²⁾ In the standard version of BÖMA about half of the participants take the role of sellers and the other half of buyers. As a gift from the experimenter, each seller receives the ownership of one unit of the fruit, but not yet the possession, and that unit can be offered for sale. A buyer can purchase at most one unit. In some versions of the experiment the buyers get initial monetary transfers

The participants have to write down in a contract form their expectation about the resulting uniform market price and their bidding price for one unit. The bidding price is a limit order for one unit. The seller's bid, the offer, is the lowest price for which he is willing to sell the one unit of the good (minimum selling price); the buyer's bid is the highest price for which he is willing to buy one unit of the good (maximum buying price).

The experimenter, acting as a stock broker, sorts the collected contracts according to the bids. The resulting demand and supply functions are written on the blackboard in table form. The broker determines the uniform market price (p^*) at the point of intersection of both functions. In case of ambiguity as a consequence of the discrete step functions a bid of a seller is selected as the market price. Other special rules concern repartition or the obligation of the broker to balance, up to a certain amount, excess demand or supply from his own resources (self-dealing for a settlement of balance). In such cases we use in the

2) We have performed the experiment with 13 to 309 participants. cf. TIETZ 1992a.

following the mean between the volumes offered and demanded at the market price as volume traded (x^*).

After the determination of the market price, the broker executes the trades. Buyers with bids higher or equal to the market price get one unit of the good and have to pay the market price. Sellers with bids less or equal to the market price are paid the market price and sellers with higher bids get one unit of the good. The buyers in addition receive their transfer-payments, if any.

To test the influence of the *planning spiral* we repeated this experiment with apples this spring in my lectures on Microeconomics with 185 undergraduate students. The planning and decision form had more questions than before. The variety of questions lead to four conditions or groups. The questions are:

1. All subjects were at first asked:
"An apple has for me a value of ... Pfennig."
2. The buyers (and the potential buyers of group 4) are informed on their transfer payment (0 to 80 Pfennig).
3. Some subjects were asked for their potential bid (group 2). They were asked as sellers:
" Which amount would you offer, if you would be a buyer?"
The buyers are asked a corresponding question.
4. Some subjects were told, that they have to make their decisions before their roles will be assigned randomly with equal probability after the collection of the forms. Half of them got a planning and decision form, which had the question for the sellers on the first page (group 3) and the other half of them with the questions for the buyers on the first page (group 4).
5. All subjects were asked for their expectations on the uniform market price.
6. All subjects have than to fill in their bidding price.
7. All subjects had to give some reasons for their decision.
8. On the reverse of the form, groups 3 and 4 had than to answer the questions for the opposite role, without the value question (1). Group 3 was first informed about their potential transfer payments (2). They had than to follow again steps 5 to 7.

The four groups are:

Group 1: control group. (Only questions on value and expectations). (21 sellers, 24 buyers)

Group 2: potential bid condition. (22 sellers, 24 buyers)

Group 3: random roles, sellers side first. (46 sellers and buyers)

Group 4: random roles, buyers side first. (45 sellers and buyers)

Resulting shifts by experimental conditions

The effects of the planning spiral can be shown at the evaluation disparities, the differences between the means of bids on the supply and demand side, in *Table 1*. The disparity of the control group is with 36 Pfennig slightly higher than the (weighted) average of the 18 standard-experiments performed in the last two decades of 28 Pfennig, but within the 1- σ -range.³⁾ The question on the potential bid, condition 2, reduces this disparity to 13.64 Pfennig . The random assignment with the supply questions asked first, induces a smaller reduction to 21.74 (condition 3). If the demand form was filled in first (condition 4) the extremely low value of 8.38 Pfennig results.

The effects can be demonstrated in a better way, when we regard each of the 4 groups as a separate market. For both sides of the market of each group we normalized the quantity X by n , i.e. number of subjects. The relative quantity (RXC) was computed with a correction for continuity

$$(1) \text{ RXC} = \frac{X - .5}{n} .$$

Thus, the mean quantity is at $\text{RXC} = .50$. The bid prices were arranged in ascending order for sellers and in descending order for buyers. Linear regressions with the price as regressand and the *relative quantity* as regressor transforms partly the induced changes of the central tendency and the variance in shifts of supply and demand functions (*Table 2*).

Figure 2 shows the supply and demand functions for the four conditions. One can see, that the change from condition 1 to 4 double on the supply side the intersection with the ordinate (S_0) from 19 to 39. The slope (SS) is reduced tremendously from 133 to 50 and the intersection on the right border (S_1) is reduced from 152 to 89. On the demand side the influences of the changing preparation conditions are smaller. Here, conditions 2 and 4

3) cf. TIETZ 1992a: p. 102, Table 7.1, δp . col. 12, the three last lines.

Table 1: Means (μ), Standard Deviations (σ), and Evaluation Disparities (δ) of BÖMA 92-5

	S u p p l y		D e m a n d		Disparity
	μ	σ	μ	σ	δ
Condition					
Bids					
1. c.g.:	85.86	39.36	50.	23.89	35.86
2. p.b. :	70.64	27.31	57.	26.01	13.64
3. r.s.f.:	72.72	37.54	50.98	24.	21.74
4. r.d.f.:	64.22	14.79	55.84	20.42	8.38
Expectations					
1. c.g.:	77.81	25.63	54.79	17.59	23.02
2. p.b.:	69.32	25.05	55.92	14.	13.4
3. r.s.f.:	67.76	15.8	53.89	17.1	13.87
4. r.d.f.:	63.91	14.35	56.91	14.6	7.
Values					
1. c.g.:	60.	33.49	49.17	22.02	10.83
2. p.b:	56.14	20.39	48.75	14.09	7.39
3. r.s.f.:	56.8	20.42	56.80	20.42	(0.)
4. r.d.f.:	58.51	19.71	58.51	19.71	(0.)

c.g. = control group,
p.b. = potential bid,
r.s.f. = random supply side first,
r.d.f. = random demand side first

Table 2: Estimated and Derived Parameters of BÖMA 92-5

	S u p p l y				D e m a n d			
	R²	S0	SS	S1	R²	D0	DS	D1
Condition								
Bids								
1. c.g.:	.948	19.39	132.93	152.32	.839	87.93	-75.86	12.07
2. p.b.:	.942	24.67	91.93	116.6	.732	95.59	-77.18	18.41
3. r.s.f.:	.398	31.67	82.1	113.77	.959	91.7	-81.45	10.25
4. r.d.f.:	.938	39.40	49.64	89.04	.894	89.31	-66.92	22.38
Expectations								
1. c.g.:	.868	36.4	82.83	119.22	.862	83.1	-56.61	26.49
2. p.b.:	.938	27.24	84.16	111.4	.921	79.21	-46.56	32.65
3. r.s.f.:	.884	42.02	51.48	93.5	.914	82.22	-56.66	25.56
4. r.d.f.:	.922	40.05	47.73	87.77	.949	81.55	-49.28	32.27
Values								
1. c.g.:	.977	2.59	114.82	117.41	.761	82.45	-66.57	15.88
2. p.b.:	.963	21.45	69.38	90.83	.876	71.6	-45.70	25.9
3. r.s.f.:	.917	22.93	67.76	90.68	.917	90.68	-67.76	22.92
4. r d.f.:	.936	25.47	66.08	91.55	.936	91.55	-66.08	25.47

c.g. = control group,

p.b. = potential bid,

r.s.f. = random supply side first,

r.d.f. = random demand side first

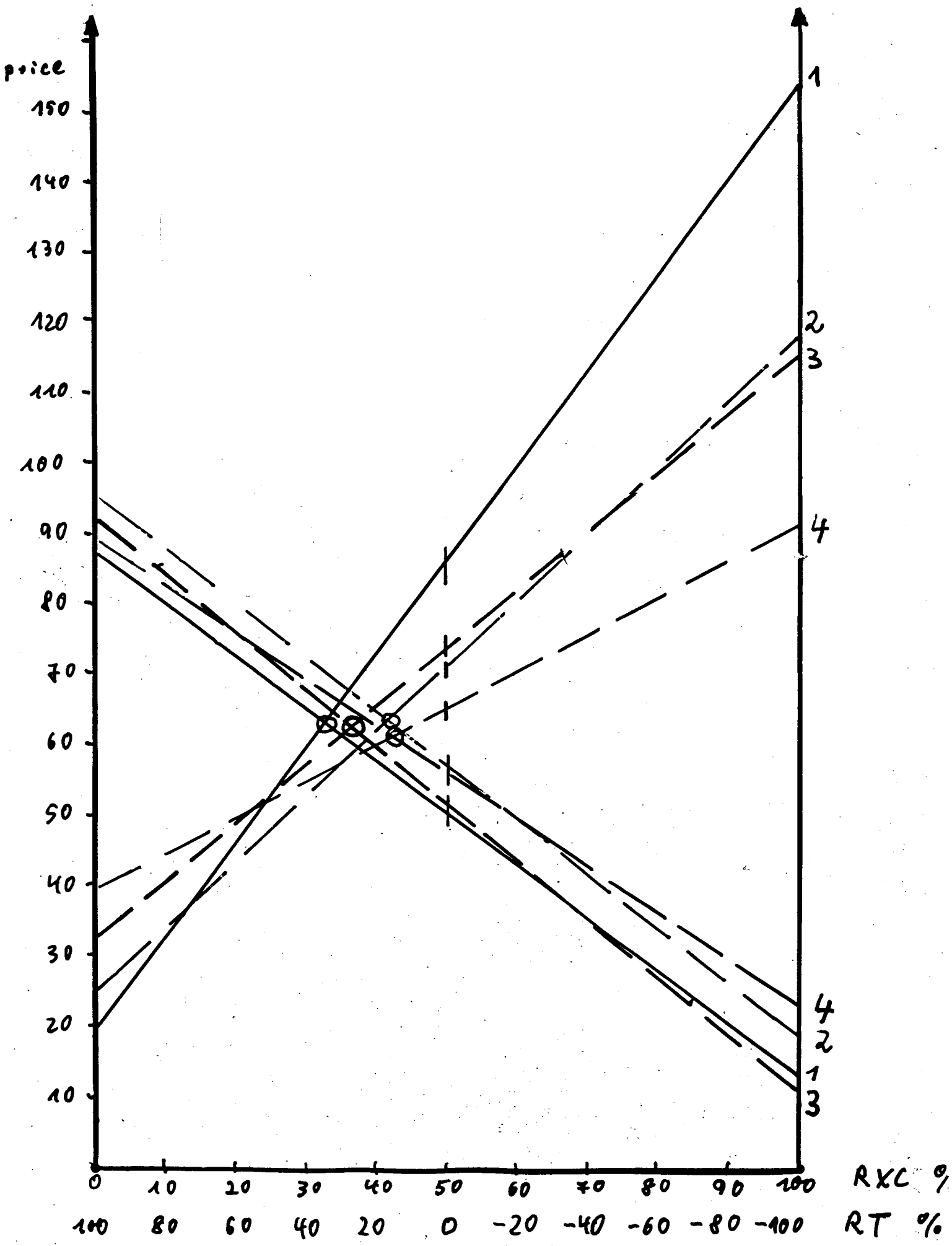


Figure 2: Bids

result in a small almost parallel shift, whereas condition 3 has no distinct influence. The means of the bids, shown at $RXC = .5$, reflect the evaluation disparities in a corresponding way.

The consequences of the shifts are changing transaction volumes at the markets. To make these changes more clearly, we define the *reluctance to trade* RT by

$$(2) \quad RT = 1 - \frac{RXC}{.5},$$

where RXC is the relative quantity traded. This measure is 1, when no transactions occur, 0 for $RXC = .5$ and -1 for $RXC = 1$, a complete willingness to trade. Computing RXC at the points of intersection of the estimated supply and demand functions delivers an estimation of the market transactions, since the number of market participants are almost equal. The estimated reluctance to trade is shown below RTE in *Table 3*. There, the reluctance to trade is reduced from 34 % to 27 % by condition 3 and halved to 16 and 14 by conditions 2 respectively 4. Using the individual data for the computation of the market equilibrium and of RT in a similar way, the reduction effect is even more distinct. $RTDS$ shows the reluctance to trade for this discrete method (using according to the rules a sellers bid as equilibrium price and the mean of present sellers and buyers as total market volume n). The reluctance to trade is halved from 38 % to 15 % by condition 3 and tremendously reduced to 8.7 by condition 2, the potential bid. For condition 4, the random assignment with the demand questions first, the reluctance to trade is turned even to a negative value of 8.9, i.e. a low willingness to trade. Conditions 2 and 4 lead to equilibrium quantities which are close to 50 %, the volume expected on the assumption of equally distributed offers and bids on both sides of the market.

That the distributions become more similar due to the planning spiral can be shown also in another way. Let us label the prices at the intersection with the left ordinate, where the relative quantity is 0, S_0 and D_0 and the right intersection, where the relative quantity is 1, S_1 and D_1 for the supply and demand functions respectively (*Table 2*). We can define an approximately measure of asymmetry AS by the area between the supply and the mirror image of the corresponding demand curve, which has reversed from left to right (*Figure 3* for one area and *Figure 4*, if two separate areas exist):

$$(3) \quad AS = \begin{cases} \frac{|S_0 - D_1| + |S_1 - D_0|}{2}, & \text{for } \text{sign}(S_0 - D_1) = \text{sign}(S_1 - D_0), \\ \frac{(|S_0 - D_1| - |S_1 - D_0|)(D_1 - S_0)}{2\{(S_1 - S_0) - (D_0 - D_1)\}} + \frac{|S_1 - D_0|}{2}, & \text{otherwise.} \end{cases}$$

Table 3: Reluctance to Trade and Asymmetry

	RTE %	RTDS %	AS	ASM %	PE
Condition					
Bids					
1. c.g.:	34.35	37.78	35.86	26.39	62.64
2. p.b.:	16.13	8.70	13.64	10.68	63.22
3. r.s.f.:	26.58	15.22	21.74	17.57	61.80
4. r.d.f.:	14.37	-8.89	8.38	6.98	60.57
Expectations					
1. c.g.:	33.02	33.33	23.02	17.36	64.14
2. p.b.:	20.49	8.70	14.17	11.31	60.7
3. r.s.f.:	25.65	13.04	13.87	11.40	61.44
4. r.d.f.:	14.43	-11.11	7.	5.79	60.47
Values					
1. c.g.:	11.94	11.11	14.49	13.28	53.14
2. p.b.:	12.84	-17.39	8.22	7.84	51.68
3. r.s.f.:	(0.)	(-19.56)	(0.)	(0.)	56.8
4. r.d.f.:	(0.)	(-15.56)	(0.)	(0.)	58.51

RTE = reluctance to trade estimated

RTDS = reluctance to trade, discrete, supply bid used

AS = asymmetry in absolute terms (prices)

ASM = asymmetry relative to the mean of 4 intersections

PE = equilibrium price estimated

c.g. = control group,

p.b. = potential bid,

r.s.f. = random supply side first,

r.d.f. = random demand side first

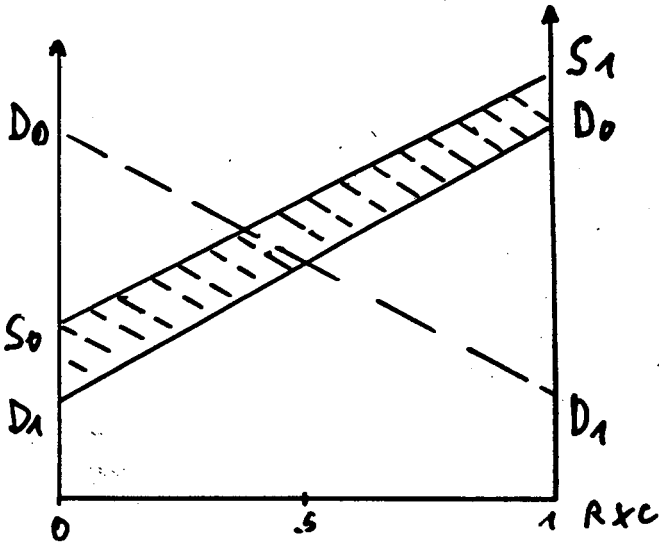


Figure 3: One area of asymmetry

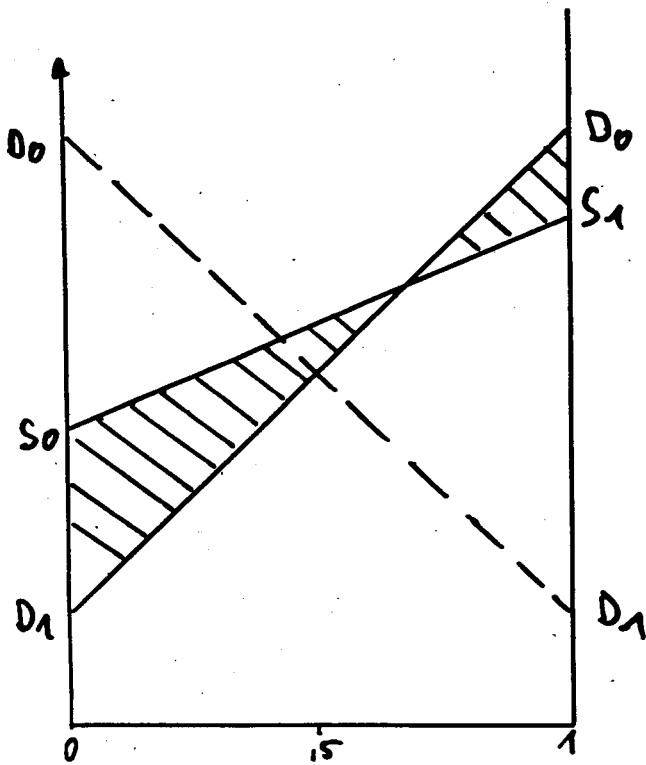


Figure 4: Two separate areas of asymmetry

On the condition of equal signs AS equals the disparity measure δ . If the signs are unequal, AS is greater than δ . We can normalize this measure between 0 and 1 for non-negative intersection values by the division through twice the mean of the four intersection values:

$$(4) \text{ ASM} = \frac{\text{AS} * 2}{(S_0 + S_1 + D_0 + D_1)}$$

As **Table 3** below AS and ASM shows, the reduction of asymmetry is distinct for conditions 2 and 4 and moderate for condition 3 in both measures.

Additional questions in the planning form bring the distributions of bids of both sides of the market closer together. This is true for those cases where the individuals on the supply and demand side belong to different samples, as for conditions 1 and 2, as well as for the random conditions 3 and 4, where the conditional bids of both sides of the market are from identical samples. The evaluation disparity presented in the asymmetry measure instead of means shows more clearly that it is a sign of an inconsistent, one-sided mental model. The argument, that higher supply-bids are a sign of meaningful rent seeking behavior, disregards, that the corresponding argument used at the demand side increases only the reluctance to trade

Regarding expectations about the uniform market price in the same way as the bids, we get a similar but more stable picture. **Figure 5** shows that the shifts occur still distinctly on the supply side. Not only the bids but also the expectations show the evaluation disparity which is sensitive to the planning spiral especially on the supply side. The findings on the effects of the 4 conditions on the reluctance to trade and on asymmetry (**Table 3**) are in a similar order as for the bids, but often showing lower values especially for the control group (condition 1). The expectations on the demand side are less influenced by the planning spiral than on the supply side.

Also the value-question shows a distinct reduction of the slopes of supply and demand functions for condition 2 (**Figure 6**). The small reluctance to trade is turned for RTDS in a negative one. The asymmetry seems to be more reduced than the disparity. Conditions 3 and 4, which contain identical values for both "sides of the market" are near together. That means, that the value-question, as the first question on the planning form, is not influenced by the fact which role was subsequently asked first.

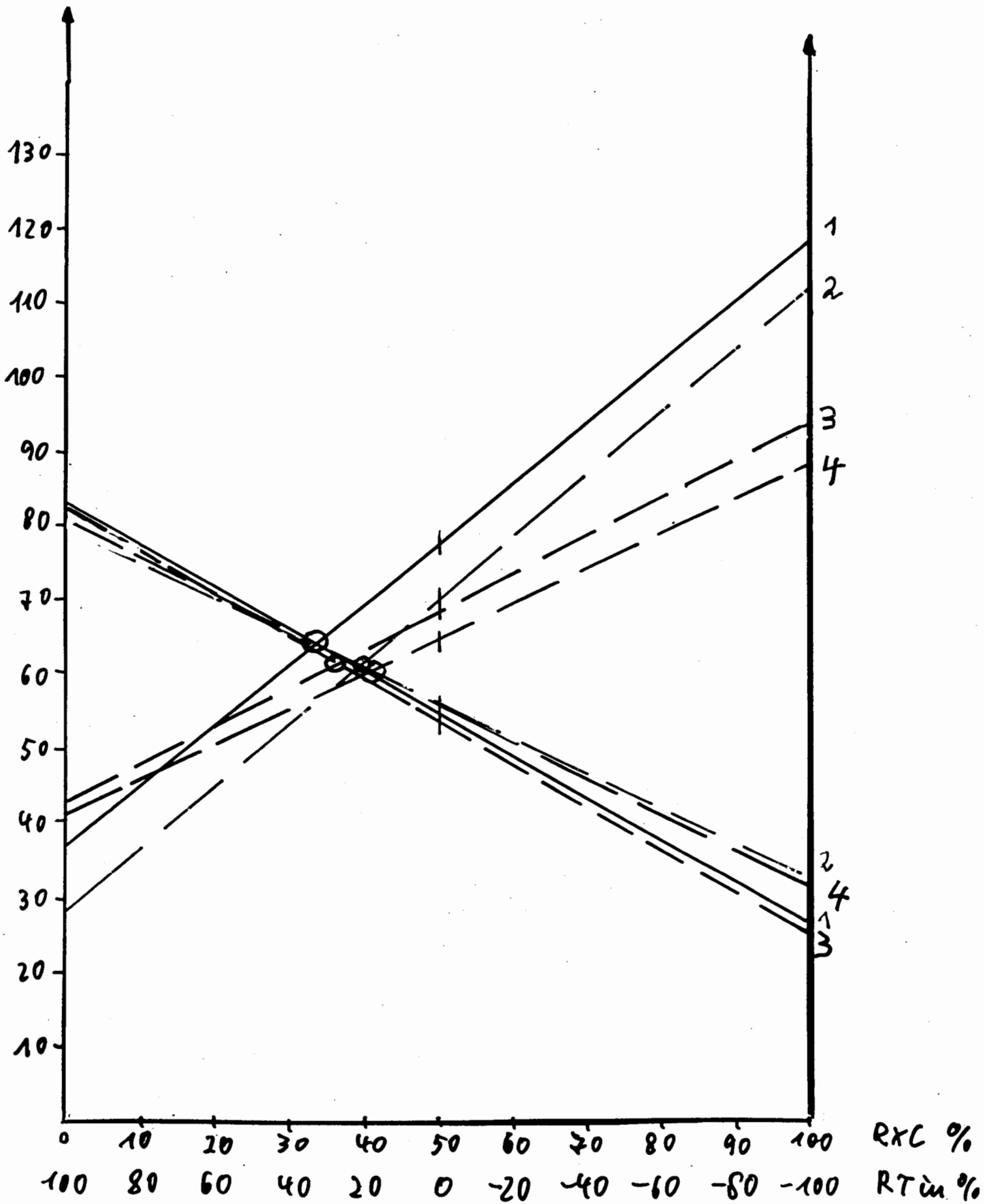


Figure 5: Expectations

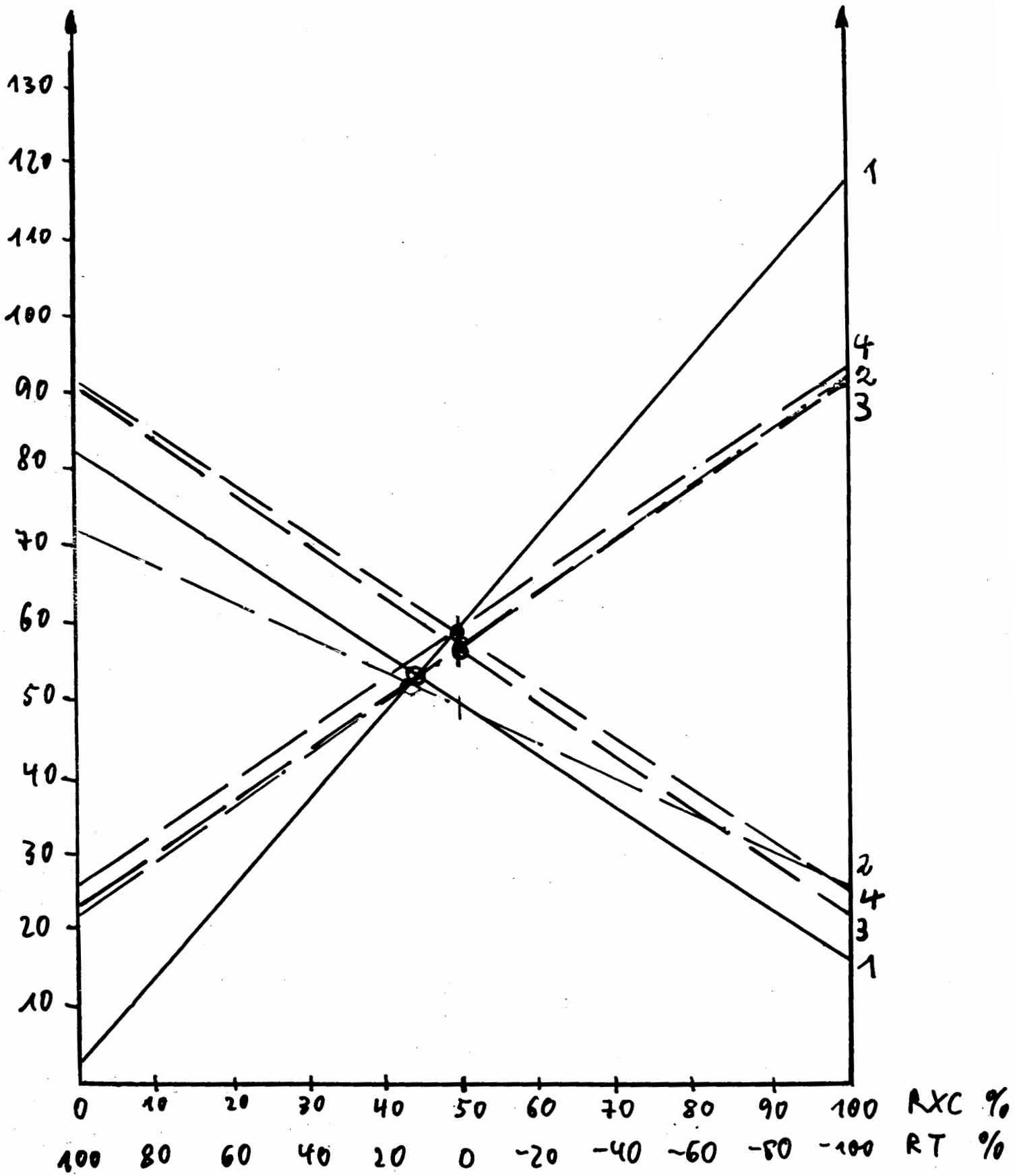


Figure 6: Values

Differences Between Supply and Demand Side

As we have seen, there are distinct differences between the reaction of both sides of the market on the planning spiral. The means of bids and expectations move more downwards for suppliers than upwards for demanders (*Table 1*). This is not true for values. The slopes of the supply functions, and also variances, are reduced from higher absolute values to a larger extent than that of demand functions (*Table 1 and 2*). Other clear distinct differences could not be seen. Also the coefficients of determination R^2 (*Table 2*), here a measure of linearity of the function, give no clear hints.

Discussion

Other experiments with similar experimental conditions show similar results, but additional experiments are needed to clarify the specific influence of individual questions. The consistency of the mental model of the decision maker is improved by the experimental planning phase. The intensity of thinking and the resulting decisions are tremendously influenced by the experimental procedure. The results of inquiries and one-shot experiments give interesting information on the first impression about a problem, but they may differ distinctly from the well-planned behavior of earnest and prepared decision makers with an improved degree of, still bounded, rationality.

The planning report method is a useful instrument to improve the rationality degree of decisions. The spiral of planning leads the decision maker into cognitive dissonances which can be reduced by improving the mental model and its consistency. The planning report method is a supplementary method to improve the rationality of decisions. Where the decisions are important for the decision maker, e.g. where remarkable financial incentives exist, the decision maker will also follow the spiral of planning in his reasoning, without special forms. Since we are not interested to give a description of all types of behavior, but only on that which may be characterized as boundedly rational, we need either high monetary rewards or an intensively preparation of decisions. Computerized experiments have to take care, that there is enough time for thinking. Thinking can not be substituted by velocity and mass.

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