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Working Paper — Digitized Version

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Manuskripte aus den Instituten für Betriebswirtschaftslehre der Universität Kiel, No. 276

Provided in Cooperation with:
Christian-Albrechts-University of Kiel, Institute of Business Administration

Nr. 276

THE DISPOSITION EFFECT IN SECURITIES TRADING: AN EXPERIMENTAL ANALYSIS

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September 1991

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Abstract

The "disposition effect" is the tendency to sell assets that have gained value ("winners") and keep assets that have lost value ("losers"). Disposition effects can be explained by two elements of prospect theory: The idea that people value gains and losses relative to the initial purchase price (a reference point), and the tendency to seek risks when faced with losses and avoid risks when faced with gains. In our experiments, subjects buy and sell shares in six risky assets. Asset prices fluctuate each period. As the disposition effect predicts, subjects sell winners and keep losers. When shares are automatically sold at the end of each period, the disposition effect is greatly reduced.

Acknowledgement

We like to thank Hans-Jürgen Keppe for insightful comments and his help with the experiments. Subject money was provided by the State of Schleswig-Holstein. Shyam Sunder provided helpful comments on an earlier draft of the paper.

An earlier version of this paper was presented at the IAREP/SASE Conference, Stockholm, June 1991 and at the Bonn Workshop in Mathematical Economics, July 1991.

1 Introduction

Prospect theory (Kahneman and Tversky 1979) predicts that outcomes are coded as gains or losses relative to a reference point, and decision makers are risk-averse in the gain domain and risk-seeking in the loss domain. The use of a reference point to determine gains and losses will henceforth be called a "reference point effect". The difference in risk attitudes for gains and losses is called a "reflection effect".

Reference point effects have been studied in a variety of economic settings (e.g. Thaler 1985 for applications to marketing). In a financial setting the reference point effect explains the disposition to sell winning stocks too early and ride losing stocks too long, which Shefrin and Statman (1985) call the "disposition effect". The studies mentioned in section 2 show that this disposition effect seems to be reflected in market data.

A conclusive test of the dispostion effect using real market data is difficult because investors' expectations, as well as individual decisions, can not be controlled or easily observed in markets like the New York Stock Exchange. If an effect is found at the aggregate level it can often be explained by different hypotheses. In this paper we will therefore present an experimental investigation of the disposition effect. In our laboratory environment subjects could buy and sell shares which were defined as risky prospects.

Experimental data have been used before to test hypotheses in financial settings. Copeland and Friedman (1987, 1991) tested different market efficiency assumptions. Camerer and Weigelt (1991a,b) tried to explain the existence of bubbles. Sarin and Weber (1991) investigated ambiguity effects in different market settings.

In our paper we will proceed as follows. In section 2 we will briefly describe previous work on the disposition effect and present some theoretical considerations on how the effect should influence market prices and volume. The hypotheses and experimental design are presented in section 3. The results will be described in section 4.

2 Related Work and Theoretical Considerations

2.1 Related Work

The reflection and reference point effects can be best demonstrated using an example. Suppose, a decision maker has to choose between a sure 5 DM and a 50-50 lottery yielding either 0 DM or 10 DM. According to prospect theory most decision makers will be risk averse, i.e. prefer the sure 5 DM (assuming the reference point is a gain of 0 DM). If a decision maker has to choose between a 50-50 lottery of receiving 0 DM or having to pay 10 DM and a sure payment of

5 DM he will in general pick the (risky) lottery.

Kahneman, Tversky (1979) provided empirical evidence for the fact that a decision maker's risk attitude depends on the reference point. Risk-aversion for gains and risk-seeking for losses was also found in the studies of Hershey and Schoemaker (1980), Cohen, Jaffray and Said (1987), Hogarth and Einhorn (1990), Thaler and Johnson (1990), Tversky and Kahneman (1991), and van der Pligt and van Schie (1990).

In most decision situations there are several possible reference points. In a financial setting, the purchase price of a stock is one natural reference point for evaluating the stock. Shefrin, Statman (1985) found evidence that "investors tend to sell winners too early and ride losers too long" (p.778). This disposition effect can be explained by investors judging gains and losses relative to their initial purchase price, and being risk-averse toward gains and risk-seeking toward losses. (We demonstrate this more formally below.) Ferris, Haugen, Makhija (1988) used price and volume data for thirty stocks listed on the American Stock Exchange and the New York Stock Exchange. Using a regression approach they compared current trading volume with historic trading volume. As predicted by the disposition effect, current volume was negatively (positively) correlated with the volume on those previous days in which the stock price was higher (lower) than the current price. However, beside some statistical problems in their analysis, their results can be explained by competing hypotheses (see the discussion of their paper, pp.698) and offer no special insight into the investor's decision making process.

Our main experimental study will put the investor in a portfolio decision situation. We therefore briefly want to mention some experimental work dealing with similar questions although those studies do not investigate reference point effects.

Kroll, Levy, Rapoport (1988a,b) did several experiments to test various aspects of portfolio theory. In one type of experiment they created a simple decision situation where the decision maker could invest in a sure investment and in one of two risky investments. In each period the prices of the risky assets where determined by a probability distribution known to the subjects. The second type of experiment the investor was allowed to invest in <u>three</u> different risky assets. In both experiments subjects were paid according to their performance in the experiment. The main finding of their experiments is that subjects' behavior is quite different from the behavior predicted by portfolio theory or by the capital asset pricing model. Subjects do not diversify properly, the data do not imply individual separation, i.e. subjects do not choose their portfolios as a combination of the risk free asset and one risky asset (as required by CAPM), and subjects wanted to know past price movements (even though they were told that prices were determined in each period by an independent probability distribution). Related empirical studies can be found in Gerke (1990), Maital, Filer, Simon (1986) and Rapoport, Zwick, Funk (1988-a,b).

Since the disposition effect deal with volume, we want to mention research which has found a relation between price changes and trading volume (see Karpoff 1987 for an overview). Andreassen (1988) showed experimentally that people trade more if the variance of a stock is higher than if it is lower. In a second experiment subjects saw prices or price changes. The results provide strong evidence that the price-volume relationsship is due to trading on prices movements.

2.2 Theoretical Considerations

We illustrate with a simple example how reflection effects and reference point effects combine to cause disposition effects. Suppose an investor bought a share of stock for the price P. Then the stock falls in value by the amount L, to a price of P-L. (We call this a "loser" stock). The investor can sell the stock or hold it. If she holds the stock, it is equally likely to return to its purchase price P or to fall by L again, to a price of P-L-L=P-2L. In the corresponding "winner" stock situation, the stock rose by the amount G, to a price of P+G. If the investor holds the stock it is equally likely to fall back to P or to rise by G again, to a price of P+2G.

Figure 1a shows the situation when the investor's reference point is the original purchase price P. We assume, as in prospect theory, that people value gains and losses from the reference point. Then a loser stock is worth P-L if it is sold, and either P or P-2L if it is held. If the reference point is P, the investor "frames" the investment decision as a choice between a certain loss, with negative value v(-L), or keeping the stock, accepting a gamble with value v(0) ("breaking even") or v(-2L). If she is risk-seeking in the domain of losses (and the chances of breaking even or losing another L are equal), she will keep the stock. Intuitively, investors will keep losers because the pain of an additional loss L is less than the pleasure of recovering the purchase price.

[Insert Figures 1a-b around here]

A winner stock is worth P+G if it is sold, and either P or P+2G if it is held. If investors are risk-averse toward gains gambles, they will sell the stock to "lock in" the certain gain G (creating a gain with value v(G)) rather than gambling on earning v(2G) or v(0). Investors will sell winners.

The argument so far only considers two periods. For a larger number of periods each former price of the stock could serve as a reference point. It is straightforward to extend the disposition effect to any of these reference points, i.e. derive risk-seeking behavior for losses and risk-averse behavior for gains with respect to the specific reference point.

Now suppose that investors adjust their reference points as the prices of stocks change. Figure 1b shows what happens. Suppose the current price is the reference point from which gains and losses are valued, rather than the purchase price. Then the loser stock with a current price of P-L will either gain +L (if it returns to the purchase price P) or lose an additional -L (if it falls to P-2L). Investors will keep these stocks if a gamble over v(L) and v(-L) is better than v(0), and sell them otherwise. The winner stock (which is not shown in Figure 1b) will either gain G or lose -G; investors will keep them if the gamble over v(G) and v(-G) is better than v(0). The form of the value function would predict that for equal chance gambles the investor will always sell the (winning or losing) lottery.

In our experiments, G and L are equal because winner and loser stocks go up or down in increments of equal size. When the reference point is the current price, winner and loser stocks are treated identically. Thus, disposition effects only arise when the original purchase price or another price of a previous period is the reference point (as in Figure 1a), and when reflection effects cause investors to seek risk by holding losers and avoid risk by selling winners.

3 Hypothesis and Experimental Design

3.1 Hypothesis

We will derive hypotheses for the type of market in which the price is independent of the action of each investor. The main hypothesis to be tested is that the number of shares sold will be smaller for losing assets than for winning assets. Of course, it only makes sense to talk about winning and losing stocks if a reference point has been previously definied. We consider two possible reference points. Hypothesis 1 will consider the purchase price as a reference point. Hypothesis 2 will consider the effect of the price of the previous period. We are now able to define the hypotheses:

H1: Subjects sell more shares when the sale price is above the purchase price than when the sale price is below the purchase price.

H2: Subjects sell more shares when the sale price is above the last period price than when the sale price is below the last period price.

When people are buying and selling stocks over a couple of periods the holding at the end of one period is usually equal to the holding at the beginning of the next period. Selling a stock requires a deliberate action. This condition can be contrasted with a condition where all stocks are automatically sold at the beginning of a period and subjects have to rebuy the stocks (for the same price they were automatically sold). Without transaction costs, a rational decision maker should behave identically in both types of experiments. As we think that the disposition effects are caused by a reluctance to deliberately incur losses, and an eagerness to guarantee gains, subjects who must sell assets deliberately will exhibit greater disposition effects than Type II subjects who automatically sell them.[1]

H3: The disposition effects get smaller when assets are automatically sold than when selling requires a deliberate action.

We will also investigate if the amount of price change is related to volume. A higher change in price will increase the salience of a stock thus will increase the trading volume. Also according to the results reported in capital market research we formulate hypothesis 4.

H4: The amount of volume traded is positively correlated with the amount of price change.

[1] The difference is similar to "endowment effects" studied by Kahneman, Knetsch & Thater (1990) and others.

3.2 Experimental Design

In our experiment subjects could make portfolio decisions for 14 periods. Each period they could buy and sell six risky assets at prices which were announced publicly before each period. The prices of the risky assets were generated by a random process described in more detail below (thus prices were not determined by trading).

Our design differs from other portfolio experiments, e.g., Kroll, Levy, Rapoport (1988a,b) because we did not tell subjects the probability distribution underlying each share's price movements. In each period new information on the distributions of share prices arrived (via new prices). As subjects were allowed to invest in six different stocks their optimal portfolio could change from period to period. Adjusting the optimal portfolio could be a rational reason to trade.

In the beginning of the experiment each subject was endowed with 10.000,-- DM. At the end they received a percentage of the sum of their cash at hand and the final value of their portfolio. (The percentages were .1% and .2% in Type I and II experiments.) Subjects could not borrow money or sell assets short.

To test hypothesis 3 we ran two types of experiments. In Type I the holdings of shares at the beginning of each period were equal to the holdings at the end of the previous period. In Type II all shares which were held at the end of a period were automatically sold in the beginning of the next period (after the new share prices were announced) but subjects could buy the shares back.

In the experiment we used six different shares, labelled A-F. We described the shares using the neutral German word "Anteile" ("parts, or "shares") rather than calling them "stocks". The amount not invested in shares was held in cash which paid no interest.

The process by which prices of risky shares were determined was explained in detail. In each period, it was first determined if the price of each asset would rise or fall. The six assets had different chances of rising and falling in price. The chance that the price of an asset would rise was 65% for one asset (labelled ++), 55% for one asset (labelled +), 50% for each of two assets (labelled 0), 45% for one asset (labelled -) and 35% for one asset (labelled --). Since prices never stayed the same, the chance that a price would fall was always one minus the chance that it would rise. Subjects knew the chances of all six assets rising and falling, but they did not know which share (labelled A-F) had which probability of rising.

After the rise or fall was determined for each asset, it was determined randomly if the prices would rise or fall by 1, 3 or 5 DM. All three possibilities were equally likely. Notice that the expected value of price change for a potential portfolio was zero.

Using a random number table the price sequences were determined by the experimenter before the experiment. The table was shown in the beginning of each experiment. The predetermination of the prices allowed us to have identical sequences of share prices in all experiments. Students did not know the trend of shares from previous experiments because one experiment took place in Aachen and the two experiments in Kiel took place months apart.

[Insert Figure 2 around here]

Fig. 2: Price of shares

Figure 2 shows the price of shares for periods -3 to 14. Subjects had to infer the trends of the price movements from past prices. The prices of periods -3 to 1 were given (but not shown in a graph like Figure 2) to give subjects an idea of the trend of a share at the beginning of the experiment. We chose to have different share prices in period 1 (except for D and F).

The experiment was run using a questionnaire. In the beginning the subjects were told that they could buy and sell "Anteile" (shares) and were told how prices were determined. The questionnaire contained a record sheet where subjects recorded prices of shares and their trades. After periods 1, 7 and 14 in Type II experiments (but only after period 14 in one Type I experiment) subjects were asked to guess which of the six shares A-F exhibited which of the six possible trends (++,+,0,0,-,--).

Experiment I was conducted in two groups, Ia and Ib. Group Ia consisted of 29 engineering students from Aachen University, who earned from 7.65 DM to 12.93 DM with an average of 10.08 DM (with at that time around 1.50 DM for US-$ 1.00). In experiments Ib and II subjects were 35 and 39 business and economic graduate students from University of Kiel. They earned between 8.85 DM and 12.58 DM (average 10.04 DM) in experiment Ib and between 17.75 DM and 23.66 DM (average 20.03 DM) in experiment II. The experiments took about 1.5 hours (2.5 hours for experiment II). All parts of the written instructions were collected after the experiments.

4 Results

The goal of the present paper is to test the disposition effect hypothesis. Therefore, we will concentrate on testing H1-H4. In a separate paper (Weber and Camerer, 1991), we compared portfolio holdings with normative predictions of portfolio theory.

We will first perform a direct test of the hypotheses (section 4.1). Then we will investigate if alternative explanations stemming from portfolio considerations are able to explain the results in section 4.1 (section 4.2). Finally (section 4.3) we will check if the ability to assign correct trends to shares can explain the the behavior documented in section 4.1.

4.1 Testing the Hypotheses H1-H4

Hypothesis 1 stated that subjects sell more of those shares where the price is above the purchase price than where the price is below the purchase price. As subjects were forced to sell at the beginning of each period in experiment II we only used data from experiment Ia+b to test this hypothesis.

To test H1 we faced the problem that there is no unique purchase price for a position of shares. We calculated the results for two accounting principles. The "first-in, first-out" (fifo) principle assumes that the shares which are bought first are sold first. The "last-in, first-out" (lifo) principle assumes that the shares which are bought last are sold first.

	A %	B %	C %	D %
Gain	1392-51	3103-70	420-46	542-23
=	276-10	31- 1	5- 1	75- 3
Loss	1068-39	1271-29	492-53	1739-74

	E %	F %	Sum	%
Gain	678-78	1658-86	7793	59
=	25- 3	200-11	612	5
Loss	161-19	64- 3	4795	36

Tab. 1: Number of sales depending on purchase price (lifo)

Table 1 shows the number of shares sold making a gain (winners), breaking even (=), or making a loss (losers.). As the results do not differ much for the two accounting principles Table 1 only shows the lifo results. Averaging across all six shares, i.e. all five trends, 59% of the shares sold were winners; only 36% were losers. This is clear evidence of a disposition effect. The effect is present for four of the six shares (shares C and D are exceptions).

Recall from Figure 2 that the prices of shares A and F were higher at the end than in period 1, that the price of share E (and to some extent share C) was higher during most of the experiment than in period 1 and lower at the end, and that B and D (and to some extend C) were getting cheaper during most of the experiment.

	A	B	C	D	E	F	ALL
LIFO							
Sold	1.4	.9	-.1	-4.1	1.0	7.7	1.0
Kept	-.2	-6.4	-12.9	-8.1	-1.8	12.4	.4
FIFO							
Sold	1.8	.6	0	-4.3	1.1	7.9	1.0
Kept	-.1	-5.9	-10.6	-6.7	-1.5	13.3	.7

Tab. 2: Average profit for each share (experiment I)

A second test of H1 can be found in table 2. This table shows the average profit on shares that were sold or kept to the end of the experiment. According to H1, subjects will sell shares which gain and keep shares which lose. Therefore, shares kept until the end should yield a lower average profit (or a loss) than shares that were sold during the experiment. Table 2 clearly supports this hypothesis, using either accounting principle. Subjects realized an average profit of 1.0 DM (lifo and fifo) per share sold, while shares kept at the end gained less money on average (.4 DM under lifo and .7 DM under fifo). As shown in more detail in section 4.3, subjects had a good idea of which stocks had upward and downward trends. Nonetheless, the disposition effect is present for every share except F (which exhibited the most dramatic upward trend). Even A (upward trend) as well D and E (constant trend) show the effect.

Overall, we can say that hypothesis 1 can not be rejected.

Next we want to consider H2. It states that the price of the last period is adopted as reference point. Therefore, more shares should be sold if the price of a share has gone up in the last period than if the price has gone down. In this context we also want to investigate H3 stating that the disposition effect gets weaker if share are automatically sold in the beginning of each period.

Table 3 shows the number of sales together with the absolute number of pieces sold and the percentages of units sold (relative to all units sold) after prices gained twice (G G), lost then gained (L G), gained then lost (G L), or lost twice (L L). Remember that in experiment II subjects were forced to sell at the beginng of each period. Therefore, the data for Experiment II show the number of net sales, i.e. the number of shares which were sold that were not rebought immediately. Overall we had 22 "G G" pairs, 15 "L G" pairs, 19 "G L" pairs and 20 "L L" pairs.

	Experiment I			Experiment II		
price trend t-2 t-1	sales	units sold	%	sales	net units sold	%
G G	184	3815	29	236	5480	24
L G	155	5265	40	199	6570	29
both	339	9080	69	435	12050	54
G L	93	2067	16	182	6470	29
L L	83	2002	15	143	3850	17
both	176	4069	31	325	10320	46

Tab. 3: Number of sales in period t depending on previous prices

Table 3 shows that in experiment I, twice as many units were sold when the price rose in the last period (G G and L G) as were sold when the price fell (G L and L L). The effect almost disappears in experiment II.

To further analyze the selling behavior depending on share price movement we investigated individual data. Let S_+ be the number of sales if the price has gone up in the last period[2] and let S_- be defined analogously. We define a disposition coefficient $\alpha_{I or II} = (S_+ - S_-) / (S_+ + S_-)$ for each subject in experiments I or II. The disposition coefficient α is zero or less if no disposition effect can be observed and greater

[2] We also checked if the price of periods further back than two periods can explain the selling behavior. We could not find an effect.

than zero if there is a disposition effect. It is one (minus one) if a subject only sells after a gain (loss).

The cumulative distribution of individual α's is shown in figure 3. About a third of the subjects have positive values of α. On average we have $\alpha_I = .30$ and $\alpha_{II} = .155$. A t-test shows that both means were significantly greater than zero ($p < .01$), i.e., a disposition effect is present for the average subject in both experiments. The disposition effects appear weaker in experiment II, with automatic selling. A t-test rejects the hypothesis of the mean of experiment II being larger or equal to the one of experiment I ($p < .05$). Both hypothesis 2 and 3 can not be rejected.

[Figure 3 around here]

Fig. 3: The cumulative distribution of individual disposition coefficients α

Table 4 presents the data of table 3 divided in three different groups: the number of sales are combined for the winning stocks A and F (++ and + trends), the constant stocks D and E (0 trends) and the losing stocks B and C (-- and - trends). For each experiment we present two types of percentage data. The left columns represent the percentages of sales in the relevant periods similar to the data reported in Table 3. However, for different stocks the number of "G G" etc. periods is quite different. The percentages in the corresponding right columns are therefore based on the number of sales divided by the number of periods.

t-2 t-1	Shares A and F (++ and + trends) Exp. I		Exp.II	
G G	41.1	24.9	44.0	24.6
L G	27.7	39.2	30.5	46.8
both	68.6	64.1	74.6	71.4
G L	15.8	18.3	17.6	19.8
L L	15.3	17.7	7.9	8.8
both	31.2	35.9	25.4	28.6
t-2 t-1	Shares B and C (-- and - trends) Exp.I		Exp.II	
G G	16.1	26.6	9.2	15.2
L G	57.3	49.3	30.1	26.7
both	73.4	75.9	39.3	41.8
G L	13.2	15.7	39.6	44.3
L L	13.4	8.4	21.2	13.9
both	26.6	24.1	60.7	58.2
t-2 t-1	Shares D and E (0 trends) Exp.I		Exp.II	
G G	33.2	34.9	20.6	22.2
L G	28.7	30.2	26.1	28.1
both	61.7	65.1	46.7	50.2
G L	19.9	15.7	27.8	22.4
L L	18.3	19.2	25.4	27.3
both	38.1	34.9	53.3	49.8

Tab. 4: Number of sales in period t depending on previous prices (per group of stock)

Table 4 shows a strong disposition effect in experiment I for <u>all</u> group of stocks (as in Table 3), but there is no disposition effect for 0-trend stocks (D and E) and losing stocks (B and C) in experiment II.

Summarizing, we can say that H2 can also not be rejected.

Before addressing hypothesis 4 we want to present some additional data which will help to clarify some points in the discussion section.

The disposition effect only deals with the numbers of shares sold. Our data also allow us to investigate the effect of stock price movement on buying behavior. Table 5 gives the percentages of stocks bought after the stock gained (G) or lossed (L) in the previous period.

	Exp. I	Exp. II
A and F		
G	57	58
L	43	42
B and C		
G	25	41
L	75	59
D and E		
G	26	40
L	74	60
All shares		
G	38	46
L	62	54

Tab. 5: Number of buys in period t depending on prices in period t-1

The results seem to indicate an inverse "disposition effect". For experiment I the "disposition effect" is smaller for shares bought (Table 5) than for shares sold (Table 3). The reduction from experiment I to experiment II mainly is reflected in the non-winning shares for the buying and selling conditions.

Table 2 already gave some insight in the overall profit per type of share for experiment I. The results for both experiments show that people gain on the winning shares, A and F, and lose considerably on the other stocks. Subjects trade on losing stocks (or refuse to sell them even after their downward trend is apparent) instead of staying away. Interestingly enough the results for both experiments do not differ significantly. We will follow up on this point in the discussion.

Hypothesis 4 states that the amount of price change is positively correlated with the volume traded. We define as the volume traded the number of shares bought and sold for a specific absolute price change. The following data are from experiment I, periods 2-14:

Volume for +/- 1: 9596 (per case: 299.9)
Volume for +/- 3: 7386 (per case: 369.3)
Volume for +/- 5: 14105 (per case: 440.8)

The data seems to indicate that H4 can not be rejected. A t-test comparing the volume for a change of +/- 5 and +/- 1 shows that the average volume with a previous change of 5 is significantly larger than the average volume with a previous change of 1 ($p < .05$).

4.2 Portfolio Selection

It is conceivable that the results in section 4.1 could be generated by rational investors following portfolio theory (Markowitz 1959). In this section we will show that this explanation is not true.

As shown in Weber, Camerer (1991), under some simplifying assumptions a risk-averse subject should hold the following optimal risky portfolios:

Period 2-6: (A-68%, B-0%, C-0%, D-1%, E-3%, F-28%), or a higher percentage of A.

Period 7-14: (A-19%, B-0%, C-0%, D-2%, E-4%, F-75%), or a higher percentage of F.

Of course, we do not expect subjects to hold precisely these portfolios. In the first few periods they might hold larger positions in B-E. But they should invest primarily in A and F and switch from A to F in the middle of the experiment.

Table 6 shows the average trading pattern per subject in experiment I. The table lists the average number of shares bought (+), the average number of shares sold (-) and the average holding (=) at the end of each period.

	Share A			Share B			Share C		
	number of shares			number of shares			number of shares		
Period	bought	sold	held	bought	sold	held	bought	sold	held
1	13.8	0	13.8	10	0	10	5.7	0	5.7
2	3.0	1.3	15.6	8.3	3.9	14.3	5.6	1.5	6.8
3	3.3	4.4	14.4	7.8	5.8	16.3	2.9	2.1	7.6
4	6.8	1.6	19.6	11.5	1.3	26.6	0.9	2.0	6.5
5	6.3	1.3	24.6	5.6	13.4	21.8	0.6	2.6	4.5
6	7.8	1.8	30.6	1.6	7.9	15.5	0.9	0.4	5.1
7	4.4	5.4	29.5	1.4	2.0	14.9	0.9	0.9	5.1
8	4.2	5.1	28.6	0.6	2.3	13.2	3.9	0.0	9.0
9	1.7	3.3	27.0	1.0	1.0	13.2	0.8	0.3	9.4
10	1.6	0.4	28.3	0.1	1.3	12.0	0.5	0.8	9.1
11	1.1	5.1	24.3	6.8	0.5	18.3	0.8	2.5	7.4
12	0.6	9.1	15.8	11.7	3.1	26.9	0.8	0.2	0.8
13	0.9	3.5	13.2	24.1	0.0	50.9	0.3	1.0	7.3
14	10.4	0.8	22.8	3.1	26.8	27.1	0.9	0.6	7.6

	Share D			Share E			Share F		
	number of shares			number of shares			number of shares		
Period	bought	sold	held	bought	sold	held	bought	sold	held
1	19.1	0.0	19.1	3.0	0.0	3.0	15.8	0.0	15.8
2	3.7	2.7	20.1	1.3	1.0	3.3	4.1	3.2	16.7
3	3.7	2.0	21.8	0.9	1.1	3.1	4.7	1.3	20.1
4	2.3	4.5	19.6	0.7	0.7	3.1	1.8	7.3	14.5
5	1.4	4.3	16.7	3.8	0.3	6.6	1.9	2.9	13.5
6	4.8	1.9	19.7	0.4	2.5	4.5	1.0	2.2	12.3
7	5.5	2.7	22.4	0.[illegible]	2.7	2.8	4.4	1.3	15.4
8	2.7	2.8	22.3	1.0	0.3	3.5	4.5	1.9	18.0
9	0.6	2.6	20.3	0.2	0.3	3.4	4.8	0.8	22.0
10	0.5	0.4	20.4	0.0	0.3	3.1	1.7	0.7	23.1
11	0.4	1.4	19.3	0.8	0.6	3.2	4.3	0.1	27.3
12	0.0	5.6	13.8	2.3	0.3	5.2	4.4	1.4	30.4
13	0.5	3.7	10.6	0.8	2.0	4.1	2.7	3.9	29.1
14	0.1	5.8	4.9	0.4	0.6	4.0	3.1	3.1	29.1

Total Amount of Trade for Shares A-F

1	2	3	4	5	6	7
67.4	36.3	39.9	41.4	41.3	33.1	32.6

8	9	10	11	12	13	14
29.2	17.3	8.1	26.9	39.5	40.6	55.7

Tab. 6: Average trading in Experiment I

Table 6 shows that the average trading pattern is different from the pattern portfolio theory predicts. Subject trade far too much (see Kroll, Levy, Rapoport 1988a for similar results) and hold a wider variety of shares than they - should. Portfolio theory can not explain why subjects sell A and F during the last periods and buy the losing share B.

4.3 Trend of Shares

As in section 4.2 one might argue that a misperception of trends of the shares can explain some of our results. The best estimate of which of the six shares has each of the six trends comes from counting the number of times a share went up in price. The share with the most price increase is the most likely to have the trend ++; the share with the second highest number of price increases is most likely to have the trend +, etc. A rational investor would infer the trends F:++; A:+; D and E:0; C:-; B:-- before period 8 and F:++; A:+; D and E:0; B:-; C:-- at the end.

To calculate a measure of fit between the best estimate and a subject's actual guess we code ++=2, +=1, 0=0, -=-1, --=-2 and sum over the absolute differences between the rational estimate the student's estimates. This number "δ" ("δ'") is the sum of all absolute differences before period 8 (at the end). It ranges from 0 (perfect estimates) to 12. Table 7 gives the means and standard devations of δ and δ' for experiment Ia,b and II.

	Exp. Ia	Exp. Ib	Exp. II
Period 8			
Mean δ	-	2.11	4.18
Standard. δ	-	2.40	2.80
Period 14			
Mean δ'	3.93	2.43	4.82
Standard. δ'	2.34	1.44	2.73

Tab. 7: Quality of Trend Estimation

Table 7 shows that the quality of trend estimation did not improve over time, but it was fairly accurate to begin with in period 8. A switch of only one rank would lead to $\delta = 2$. Subjects must have known that B and C were the losers and A and F were the winners. Another look at the quality of trend estimation is given in Table 8. The table states the average estimate if the trends are coded as explained above. Subjects only differ substantially from a rational estimate in the evaluation of B and F.

	A	B	C	D	E	F
Exp. Ia						
Period 14	.41	-1.52	-.76	.11	-.17	1.79
Exp. Ib						
Period 7	.97	-1.51	-.46	-.23	.14	1.86
Period 14	.69	-1.6	-1.17	-.11	-.06	1.94
Exp. II						
Period 7	.90	-1.13	-.26	-.10	.43	1.51
Period 14	.08	-.85	-.95	.10	-.51	1.21

Tab. 8: Quality of Trend Estimation

We did not find a difference in earning across subjects depending on the quality of trend estimation (see Weber, Camerer 1991).

5 Discussion

Our data suggest that people exhibit a disposition effect: They tend to sell fewer shares when the price falls than when it rises. They also sell less when the price is below the purchase price than when it is above. Disposition effects are especially harmful in our design because falling prices imply, in a statistical sense, that a stock is likely to have a downward trend and shares <u>should</u> be sold. Rising prices imply a stock has an upward trend and should <u>not</u> be sold. But subjects do exactly the opposite of what they should do: they sell "winners" and keep "losers". Our findings clearly support the results in Shefrin, Statman (1985) and Ferris, Haugen, Makhija (1988). The results are inconsistent with portfolio theory.

The tendency to sell winners too early and ride losers too long can be explained in two ways. First, in prospect theory disposition effects occur because subjects use their purchase price as a reference point and gamble in the domain losses (by keeping stocks that have lost value) and avoid risk in the domain of gains (by selling stocks that have gained value). A second possibility is that subjects misperceive probabilities of future price change: For example, they might think losing stocks will bounce back and winning stocks will fall.

Since the probabilities of price changes were given and subjects were well statistically trained, we lean toward the first explanation. However, the data shed some doubts on our initial opinion. Subjects were losing the same amounts of money in experiment I and II. But according to table 3, forcing subjects to sell their shares at the start of each period (in experiment II) reduces the disposition effect. However, subjects still lose money while buying the losing shares. After the share B has fallen considerably a rational subject know that B has a negative trend. Asked about the trend, subjects seem to know that B is at least not a winning stock. Nevertheless, as table 6 states there was a large amount of B shares bought in the last periods of the experiment. A rational investor should not try to outguess the market. So taken together a mistake belief in mean-reversion seems also to be represented in our data. This mean-reversion could also explain the buying behavior (Table 5). Similar behavior is found in casinos where people often do not believe that after a sequence of red there is still a 50-50 chance that red will occur (neglecting the zero). Similiar behavior was also found in Kroll, Levy, Rapoport (1988b) where subjects wanted to see the past behavior of a normal distribution known to them before making decisions. The idea of outguessing the market could also be an explanation for people trading much more than they should according to theory.

In future research it will be interesting to separate the two explanations. As an explanation of why people do not adjust their reference point a more careful study of the sunk cost fallacy (Thaler 1980) seems worthwhile. As we found a disposition effect for the purchase price and for the previous price there is a need to develop an understanding how reference points adapt over time. The relations of our results to real world phenomena, as e.g. the overreaction research (De Bondt, Thaler 1989) should be investigated. Within the disposition effect research we are curious whether self-control rules and taxes to make people behave more rationally.

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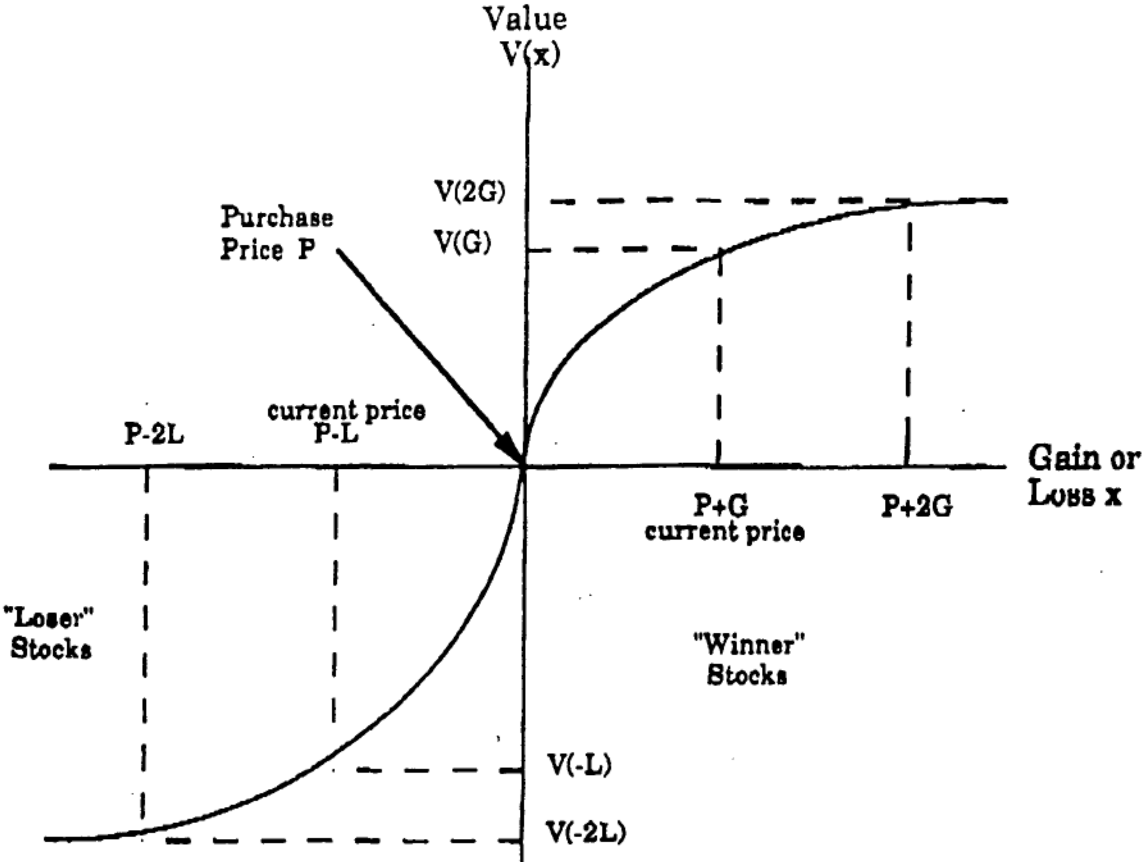

Figure 1a: Disposition Effects when the Purchase Price is the Reference Point

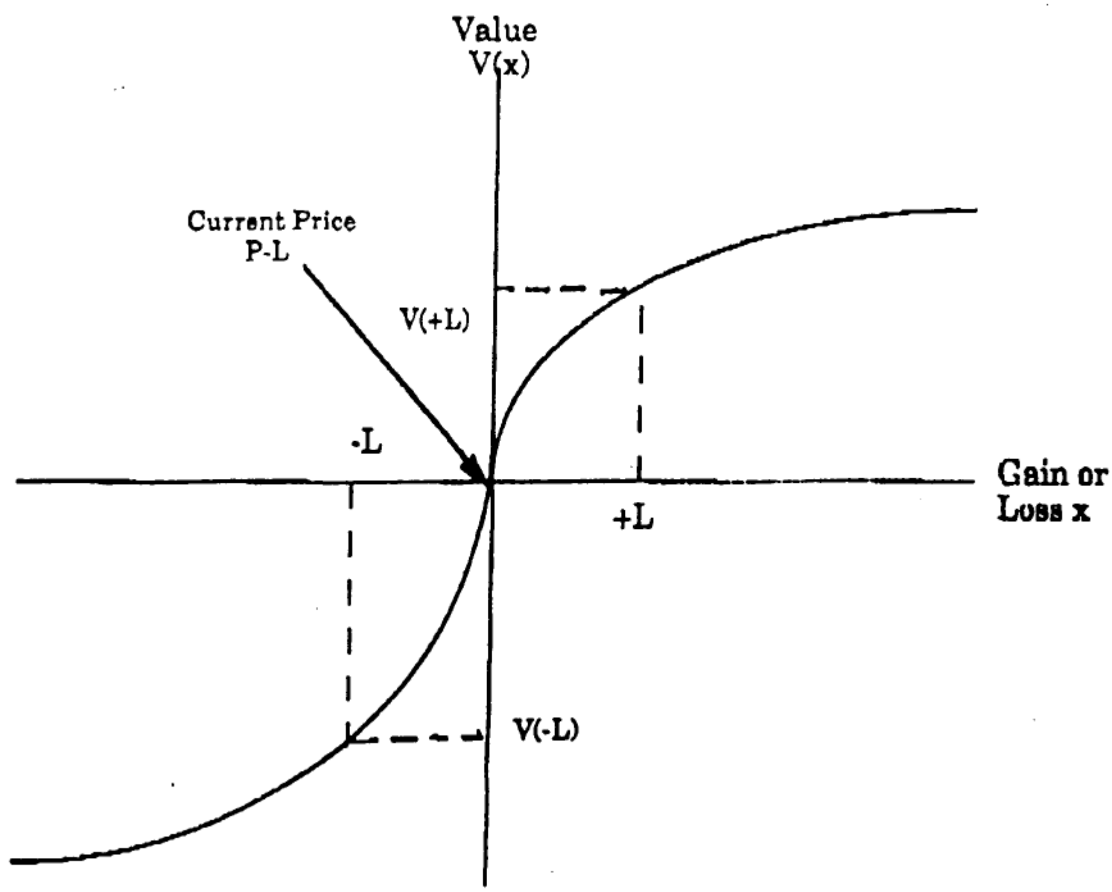

Figure 1b: Absence of Disposition Effect when the Current Price is the Reference Point (Loser Stock Only)

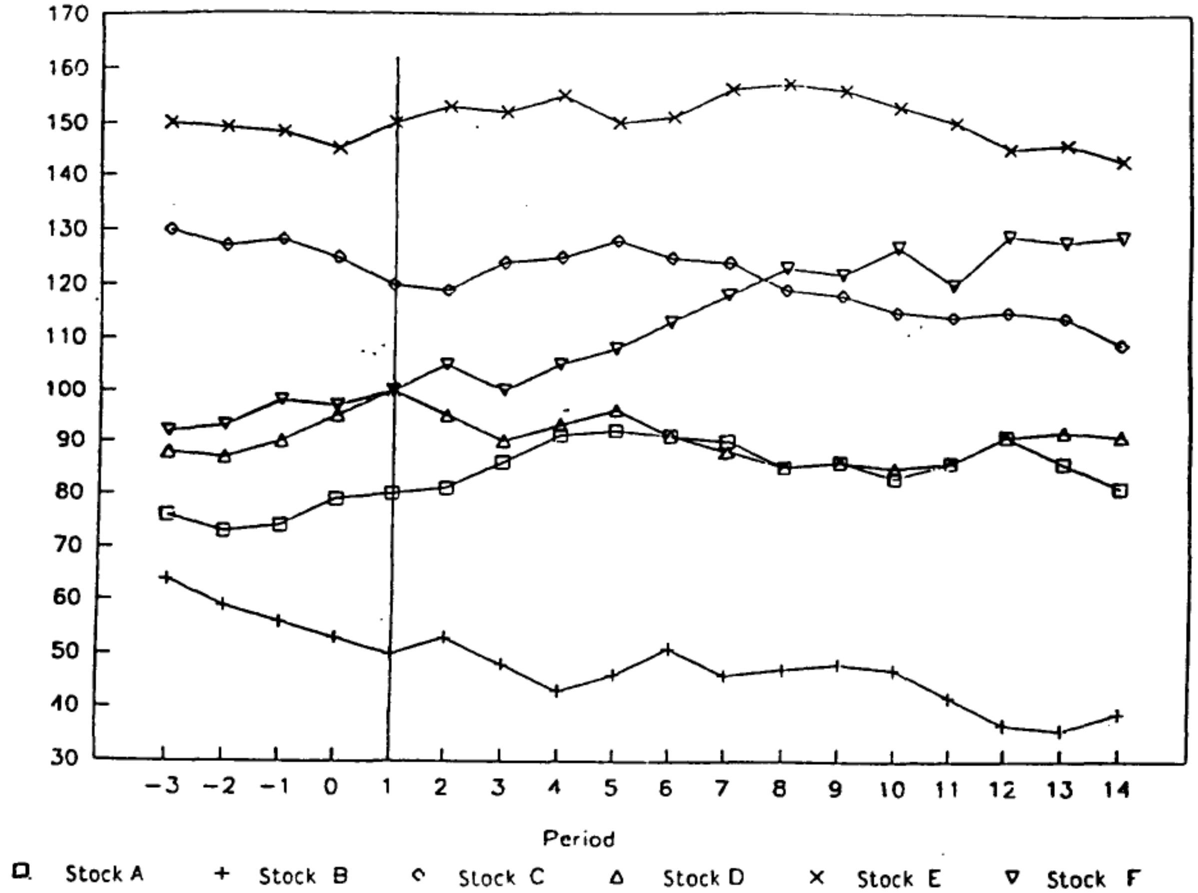

Figure 2

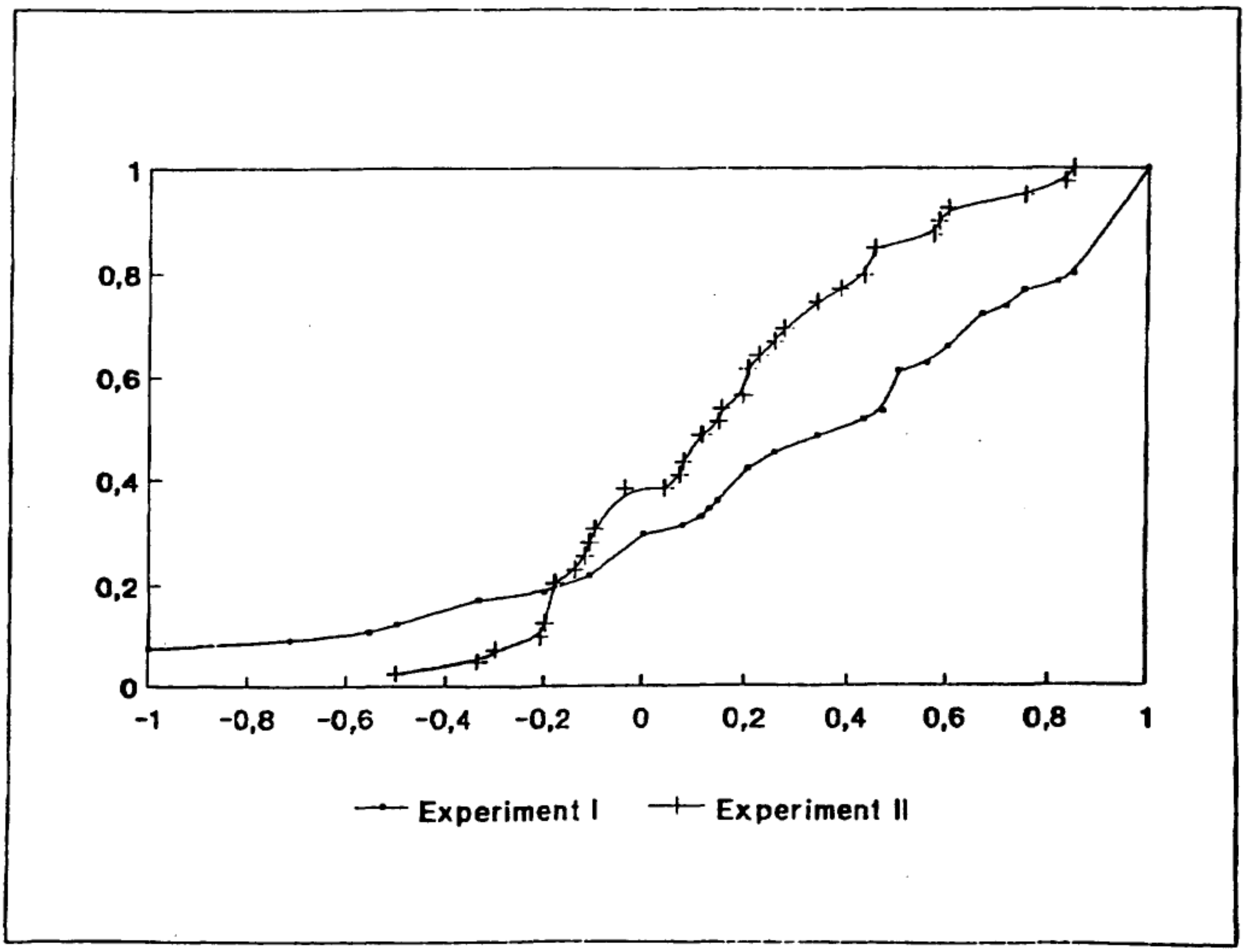

Figure 3