

Investors' Decision to Trade Stocks – An Experimental Study

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This paper experimentally examines the behavior of investors when buying and selling stocks. This behavior was tested under different conditions, among them restrictions on asset holdings or different information conditions. Basic financial theory suggests that subjects buy and sell according to expectations regarding the future prices of assets. On the other hand, behavioral biases, such as the disposition effect, suggest that subjects are affected by past performance of assets. In a series of experiments, subjects were asked to allocate a given endowment among six assets. All the assets had the same normal distribution with positive mean. The results show no disposition effect in the simple case with no restrictions. A reverse disposition effect was found in case 2, where subjects were required to hold only three assets and change one asset on each round. However, when subjects received information on the market return each period, they showed disposition effect when gain and losses are measured relatively to the market. We explain these results by the disappointment effect and momentum trading behavior. The main contribution of the current research is to demonstrate that the disposition effect or momentum behavior can be a product of trading conditions.

Keywords: Behavioral finance, Disposition effect, Experimental economics, Momentum, Trading

INTRODUCTION

The pioneering work of Shefrin and Statman [1985] shows that investors in markets tend to sell profitable assets too soon and hold losing assets too long. They named this phenomenon the disposition effect.

The goal of the current paper is to experimentally examine the effect of an asset's past performance on trading decisions made by subjects, under different conditions. The experiment procedure extends the experimental studies of Weber and Camerer [1998] and Chui [2001]. The subjects were asked to invest at least 50% of their portfolio in six different assets with the same normal distribution over a period of 20 rounds. Subjects were divided into three groups. Subjects in Group 1 could buy and sell assets without any

restrictions on trading. Subjects in Group 2 had to hold three assets in each round and were required to sell and buy at least one asset in each round. As a result of this restriction, subjects were more active in the experiment. Subjects in Group 3 were unrestricted (as in Group 1) with one distinction: they were provided information on the average return of all the assets (market performance).

In most studies in this field, the reference point is the asset purchase price or the asset price in the last period, while in the current study market performance was also used as a reference point. In the paper, we compare the behavior of subjects under the three conditions and analyze the effect of restrictions and different information on investors' trading decisions. The rest of the paper is organized as follows. The second section provides a review of the relevant literature. The next defines the assumptions and hypotheses of the study. The next describes the experimental procedure, followed by the presentation the results. The final section summarizes and concludes.

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LITERATURE REVIEW

In an efficient capital market, the tendency to buy or sell an asset should be affected by expectations regarding the future prices of assets rather than by their past performance. Shefrin and Statman [1985] analyzed data that included information on private accounts in commercial banks in the United States and on buying and selling of mutual funds in the period 1961–1981. They found that investors tend to sell profitable (in relation to the purchase price) transactions too soon and hold losing transactions too long; they named this phenomenon the disposition effect.

The disposition effect has been considered from three different perspectives in the research literature: by using market data, by using investor data and through empirical studies. Odean [1998] examined 10,000 private accounts in investment banking in the United States. He found that private investors sell a profitable stock 1.68 times more than a losing stock. Investors kept profitable stocks 104 days on average and losing stocks 124 days on average. The results also showed that investors' strategies were not optimal. The return on the stocks they sold was higher than the return on the stocks they kept. Odean concluded that private investors are influenced by the disposition effect.¹ Additional studies that used data on private and professional investors also showed the existence of the disposition effect.

Other empirical works have found that professional investors are less affected by the disposition effect than are private investors (Shapira and Venezia [2000]), Dhar and Zhu [2002]). Locke and Mann [2000] observed that professional investors with lower performance are more affected by the disposition effect. Heisler [1994] found that professional investors on the Chicago Stock Exchange are affected by the disposition. Brown et al. [2002] noted that investing over a longer period of time and with higher amounts reduces the disposition effect. Grinblatt and Keloharju [2001] discovered that investors tend to sell stock with minor losses rather than stock with high losses.

Weber and Camerer [1998] conducted a laboratory experiment to test the disposition effect in a controlled environment. They presented subjects with six assets and information on the chances of profitable and losing. The subjects were allowed 14 trading rounds. The results support the disposition effect hypothesis, since 60% of the selling orders were for profitable stocks and only 40% were for losing stocks. The reference point was the asset's purchase price and its price in the previous round. The return on the stocks sold by the subjects was higher than the return on the stocks they kept.

Chui [2001] conducted an experiment similar to that of Weber and Camerer, which involved punishing investors with low trading performance, and also found the existence of the disposition effect. Oehler et al. [2002] conducted a market experiment with 12–18 subjects and 16 trading periods. The market price was fixed by participants' trading behavior, and the stock's economic price was fixed by a binomial function

with known parameters. The findings support the disposition effect.

Boebel and Taylor [2000] tested the disposition effect using the average purchase price and the price in the previous round as reference points. They found no effect when the average purchase price was the reference point and a minor effect when the price in the previous round was the reference point.

One explanation for the disposition effect is based on prospect theory (Kahneman and Tversky [1979]), which claims that subjects act as risk averse investors with respect to gains and risk seekers with respect to losses. When the asset price increases, investors face two alternatives: to sell the asset and gain a sure amount or to keep the asset and face risk. A risk averse investor prefers the sure amount and therefore will sell the asset. When the asset price decreases, investors face two alternatives: to sell the asset and face sure loss or to keep the asset and face risk. In this case, the investor acts as a risk seeker, preferring the risk and therefore keeping the asset.

The second explanation is based on mean reversion (Andreassen [1988]). According to this approach, the price of assets converges to the mean. Investors tend to keep losing assets and sell profitable assets since they believe in tendencies toward change, meaning that today's losing assets will show a profit in the future and today's profitable assets will show losses in the future.

HYPOTHESES

The first hypothesis of this study deals with the amount of time subjects decide to hold losing and profitable assets. The holding period was calculated from the purchase point until the selling point of the asset (the point at which the investor has no holdings of the asset). When purchasing and selling occur a few times, the holding time is calculated as the weighted average of the times from the purchase points to the selling points.²

The first test of the past performance effect is whether a subject holds losing assets longer than profitable assets. Next, we defined realized profit (loss) if the market price is higher (lower) than the purchase price and the asset was sold. We defined total profit (loss) as the realized and unrealized profit (loss). In a second test³ we calculated the proportion of times gains were realized (PGR) and proportion of time losses were realized (PLR) for each subject.

The following two equations present the calculations of PGR and PLR:

$$PGR = \frac{\text{realized_profit}}{\text{realized_profit} + \text{unrealized_profit}} \quad (1)$$

$$PLR = \frac{\text{realized_loss}}{\text{realized_loss} + \text{unrealized_loss}} \quad (2)$$

The third test examined the effect of last round performance on subjects' investment decisions. For each subject

we calculated the probability of buying and selling an asset, with profit or loss in the last round. With no past performance effect, we expect to find random selection, meaning no difference between the probabilities.

Using the three tests above, our base hypothesis assumes that there is no difference between trading profitable and losing assets in all conditions.

Hypothesis 1: The disposition effect.

H0: Subjects are not affected by the disposition effect.

- Subjects hold losing and winning assets for the same amount of time.
- Subjects show the same trend in selling profitable and losing assets, and so, $PLR = PGR$.
- The probability of buying profitable (losing) assets in recent round is no different from the probability of selling profitable (losing) assets in recent round.

We are also interested to test whether the information on market index influence the subject's investments strategy. It is possible that subjects use the market index as a reference point and compare the return from their asset to the market index return when they decide to buy or sell the asset. However, our base hypothesis assumes that there is no difference between trading profitable and losing assets with market index as a reference point.

Hypothesis 2: The effect of information on market index.

H0: When subjects are exposed to information on market return there is no effect of gain and losses relatively to the market on their trading behavior.

- Subjects hold losing and winning assets for the same amount of time when market index is the reference point.
- Subjects show the same trend in selling profitable and losing assets, and so, $PLR = PGR$ when market index is the reference point.

THE EXPERIMENT

The experiment was divided into three cases (see translated instruction in the Appendix). Fifty subjects were divided into three groups, and each subject⁴ participated in only one of the three cases. The subjects "played" 20 rounds and were given feedback following each allocation round, as well as historical information from all the preceding rounds.

Subjects did not receive information on the distributions of the assets; however, they were given information on historical prices (and returns) during five periods (see Appendix) prior to the beginning of the experiment (from period -5 to -1).

At the beginning of the experiment, each subject was allocated an initial endowment of 1000 N.I.S (New Israeli Shekels). Subjects were instructed to allocate their funds to any of the assets in any proportion.

In all the cases, six assets (A, B, C, D, E and F) were presented to subjects. At each point, the buying order was

denoted by a number that was added to the name of the asset (for example, A1 for the first purchase of A, A2 for the second purchase of A, and so on). The return for each asset was randomly selected from the normal distribution, with expected value of 3% and standard deviation of 10%. The returns were drawn independently for each asset and each subject. No short selling was allowed.

The study comprised three experimental cases. In all cases subjects had to invest at least 50% of their portfolio value in the assets.

Case 1: No Restrictions on Trading (19 subjects)

No addition restriction.

Case 2: Trading Requirement (14 subjects)

On each round, subjects were restricted to hold only three assets, sell one of the assets they hold and buy another asset they do not hold. Each asset in the portfolio had to be a minimum of 10% of the subject's budget.

Case 3: Additional Information (17 subjects)

Subjects were given information on market return (the average of the six assets) and no addition restriction.

The experiment was computerized and lasted approximately one hour. Each round was followed by an on-screen report of the portfolio value (see Appendix). Specifically, for each asset, information provided included unit purchase price, unit market price, total market value in the portfolio, weight in the portfolio, daily return and accumulated return.

Each subject was also informed of the value of his or her holdings, which included market value of the assets plus cash. In Case 3 subjects were told the daily and accumulated return of the market (the average of the six assets).

Subjects were told that in round 19 (one round before the end), they would be given the option to sell their holdings at prices higher by 3% of the market value (26%, 57% and 59% of the subjects in cases 1, 2 and 3, respectively, chose to sell their holdings in round 19). Rounds 19 and 20 were not included in the data analysis. At the end of the experiment, the subjects' holdings were sold at the market price. Payment for the experiment was 1.5% of final value of the subject's portfolio.⁵

RESULTS

Table 1 summarizes the average holding time for profitable and losing assets in all the rounds and for all the subjects. The reference point is the asset's purchase price.

The average proportion of gains realized (PGR) and the proportion of losses realized (PLR) were calculated for all cases (see equations 1 and 2). Table 2 presents the results:

Table 1 shows that in Cases 1 and 3 the average number of days subjects held profitable and losing assets is not significantly different, meaning that subjects held losing and winning

TABLE 1
Average Holding Time for all Rounds.

	Performance	Rounds	Average Holding days
Case 1	Profit	241	3.17
	Loss	125	3.16
	T-test (p-value)		$t = 0.008$ ($p = 0.497$)
Case 2	Profit	225	2.71
	Loss	168	2.06
	T-test (p-value)		$t = 3.34$ ($p < 0.01$)
Case 3	Profit	250	3.31
	Loss	78	3.28
	T-test (p-value)		$t = 0.08$ ($p = 0.467$)

asset for the same amount of time. This result indicates that there was no disposition effect in these two cases (Hypothesis 1a cannot be rejected), consistent with Boebel and Taylor [2000]. Case 2 exhibits a reverse disposition effect, meaning that the number of days losing assets were held was lower than the number of days profitable assets were held.

Table 2 shows that PGR does not differ from PLR for Cases 1 and 3, indicating that there is no disposition effect (Hypothesis 1b cannot be rejected). In Case 2, PLR is higher than PGR, indicating a reverse disposition effect. The results are consistent with the results in Table 1.

Table 3 presents the percent of rounds in which subjects sell and buy profitable and losing assets in recent round.

Table 3 shows that in Case 1, subjects sold and bought losing and profitable assets at the same percentage, indicating that there is no effect (Hypothesis 1c cannot be rejected). In Case 2, where subjects were forced to change one of the three assets they hold on each round, they tend to buy recent profitable assets and sell recent losing assets. These findings are consistent with the momentum trading behavior (Grinblatt et al. [1995]) and tendency to rely on recent outcomes (Barron and Erev [2003]). Under momentum investment strategies, investors buy recent profitable stocks and sell recent losing stocks. This behavior is inverted to the disposition effect.

Another explanation to the reverse disposition effect in Case 2 (or momentum trading) is the disappointment effect (Allais [1979], Bell [1985], Loomes and Sugden [1986]), which is a result of comparison between states of world (Mellers et al. [1997]). This effect may influence subjects' investment strategies (Fielding and Stracca [2007], Chang and Sullivan [2007]) and future economics decision making (Antonelli et al. [2001]).

TABLE 2
Average PGR and PLR.

	PGR	PLR	T-test (p-value)
Case 1	0.287	0.273	$t = 0.19$ ($p = 0.42$)
Case 2	0.376	0.56	$t = 1.73$ ($p = 0.053$)
Case 3	0.321	0.231	$t = 1.19$ ($p = 0.13$)

TABLE 3
Percent of Rounds for Buying and Selling Losing and Profitable Assets.

	Action	Losing asset	Profitable asset
Case 1	Sell	53.8%	49.3%
	Buy	46.2%	50.7%
	T-test (p-value)	$t = 0.526$ ($p = 0.30$)	$t = 0.125$ ($p = 0.45$)
Case 2	Sell	61.5%	40%
	Buy	38.5%	60%
	T-test (p-value)	$t = 1.56$ ($p = 0.07$)	$t = 2.167$ ($p = 0.025$)
Case 3	Sell	27.6%	50.8%
	Buy	72.4%	49.2%
	T-test (p-value)	$t = 3.99$ ($p < 0.01$)	$t = 0.27$ ($p = 0.39$)

In our experiment, subjects may feel disappointed from assets that lose and sell them when they can. The strong effect of disappointing in Case 2 could be a result of the restriction on trading. Since subjects were not able to hold as much assets as they want compared with Cases 1 and 3, they chose to sell a disappointing asset and buy a profitable asset since they believe in momentum and hope to minimize their disappointing in the next trading round because of "disappointment aversion" (Ang et al. [2005]).

In Case 3 subjects tended to buy losing assets more than profitable assets. This is opposite to the findings in Case 1. One possible explanation to the difference is that the reference in Case 3 is the market return and gain or losses should be measured relatively to the market.

An analysis using relative gain and losses is presented in Table 4. The table presents the average holding time for losing and profitable assets and the PGR and PLR for Case 3. The reference point for each asset is the accumulated market return for the same holding period. If an asset's accumulated return is above (below) the accumulated market return, the asset is a profitable (losing) asset.

Table 4 shows that when we used the market return as the reference point, the number of days losing assets were held was higher than the number of days profitable assets were held, and the PGR was higher than PLR, indicating the existence of the disposition effect. The profit or loss relative to the alternatives (market return in this case) affected

TABLE 4
Average Holding Time, PGR and PLR for Case 3 –
with Market Return as Reference Point.

	Performance	Average
Case 3 holding time	Holding time Profitable	3.15
	Holding time Losing	4.53
	T-test (p-value)	$t = 5.1$ ($p < 0.01$)
Case 3 PGR and PLR	PGR	0.39
	PLR	0.25
	T-test (p-value)	$t = 1.63$ ($p < 0.06$)

the number of holding days per subject in the direction of disposition effect (Hypothesis 2a and 2b can be rejected).

The results shown in Table 4 can explain the results for Case 3 in Table 3. We found a disposition effect relative to the market, indicating that subjects tend to sell profitable assets more than losing asset. Table 3 shows that subjects tend to sell last period profitable assets more than last period losing assets (50.8% and 27.6%, respectively, T-test = 3.67, $p < 0.01$). In 74.8% of the cases in which an asset loses in the last period, its return was below the market in the last period, and in 79.1% of the cases in which an asset is profitable in the last period, its return was above the market in the last period. These results fit with the finding that subjects tended to hold losing assets (relative to the market) longer than winning assets (relative to the market), as shown in Table 4. The results show that when given market information people seem to consider gain and losses relative to the market. In this case they use residual analysis relative to the market to measure gain and losses. This approach is consistent with classical CAPM analysis.

We can explain this result by using the "central tendency bias" (Hollingworth [1910], Helson [1964], Crawford et al. [2000]) or mean reversion (Andreassen [1988]). It is possible that when subjects exposed to the market return they are "market mean reversion," meaning that they believe that the price of an asset converges to the market mean, which is the average of all assets. Actually, subjects use the market index as a reference point (Kahneman and Tversky [1979]). The subjects believe in tendencies toward mean, meaning that today's losing assets (relatively to the market) will show profit in the future (relatively to the market), and today's profitable assets (relatively to the market) will show loss in the future (relatively to the market), and so tend to keep losing assets and sell profitable assets (relatively to the market).

CONCLUSIONS

This paper has experimentally examined the effect of an asset's past performance on subjects' current decisions under different conditions. When subjects were given no restrictions on the number of assets they can hold, no effect was found. However, when subjects were forced to hold three assets at a time and replace one asset with another on each round, they tended to sell losing assets too soon and hold profitable assets too long. Moreover, subjects tended to buy recent profitable assets and sell recent losing assets. These results indicate that, under restrictions, subjects trading behavior is consistent with momentum effect and not with the disposition effect.

Most of the studies on the disposition effect used the asset's purchase price as the reference point. However, in real life situations, subjects are exposed to market information. When subjects were given information on market return, the results indicate that the profit or loss relative to the alterna-

tives (market return, in this case) affects the number of days subjects hold assets in the direction of the disposition effect. This is consistent with relative disposition effect.

An interesting implication of this research is the effect of market conditions on subject behavior. While no effects were found for any restriction except minimum investment, when subjects were forced to buy and sell assets they were biased by momentum behavior, and when they had complete information (including market return) they were biased by the relative disposition effect.

It is important to emphasize that the current research does not prove the existence of the disposition effect or momentum behavior in general. The main contribution of the current research is to demonstrate that the disposition effect or momentum behavior can be a product of trading conditions and information.

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NOTES

1. For further support see also Lakonishok and Smidt [1986] and Bremer and Kato [1996].
2. See also Schlarbaum [1978a, 1978b] and Shapira and Venezia [2000].
3. This test is based on Odean [1998], Odean [1999] and Dhar and Ning [2001].
4. The participants were students from Ben-Gurion University and the Open University of Israel. Their average age was 24.
5. The average payment was 26 N.I.S. (approximately \$6).

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APPENDIX

Experiment Translated Instructions – Treatment 1

- Welcome to an experiment in decision making.
- In the experiment you will be asked to invest an amount of 1000 N.I.S you will get from the experiment organizers in number of assets.
- You are asked to invest at least 50% of your money at the assets.
{This sentence was presented in treatments 1 and 3. In treatment 2 subject were told that they have to hold in each round 3 assets and that the minimum weight if each asset should be 10% of the portfolio}
- At the time of the experiment you will participate in 20 investment rounds. In each round you will be asked to buy and sell six assets (A, B, C, D, E and F).
- In the end of the experiment you will be paid according to your portfolio's value. The payment would be 1.5% of your portfolio's final value.
- Before the experiment we will get the chance to practice the buying and selling with no payment.

The Experiment

- In the upper left side of the screen you will find a window of your "portfolio's state." In this window you can find the values of your holdings (the assets) and the amount of cash you have.
- In the lower screen you will find the "trade data." You can find a table, which presents data of the last five trade days for the six assets. For each asset you will find the: market price, daily return and the accumulated return from the beginning of the experiment (time zero).
- In order to start the trade you should press the "next day" button. After pressing the button the "trade data" window will open with the start point (time 0) data. In the right side of the screen you will see a "buying window." You are asked to enter your buying orders in this window. Please mark the assets you are interesting to buy and write the amount you are interesting to invest buy using the amounts up and down arrows. In the end press the OK button.
- After pressing the OK button you will get in the upper left side of the screen the state of your investments. In this window you will see for each asset in your portfolio the following data: unit purchasing price, market price, the weight of each asset in the portfolio (the asset total value in the portfolio divided by the portfolio value), the assets' daily return and the accumulated return from the time of

buying. You will also see the amount of cash you still have, the portfolio market value (the value of all of your assets accordingly to the market prices), and the value of your holdings (assets value + cash).

{In treatment 3 subjects were also told that they will see the daily return of the market portfolio (the average of the six assets) and for each asset also the market portfolio accumulated return (from the asset's buying sound)}

- Now you are asked to press again the “next day” button. After pressing the button the “trade data” window will open with the first day (time 1) data.
- In the upper right side you will see a “selling” window. If you are interesting to sell one or more of the assets, you are asked to mark the assets and the amount of selling and then press OK. If you are not interested to sell please press OK.
- After pressing OK in the right side of the screen you will see a “buying window.” You are asked to enter your buying orders in this window. Please mark the assets you are interesting to buy and write the amount you are interesting to invest buy using the amounts up and down arrows. You can buy new assets or asset you are all ready have. If you are buying assets you are already have, a number would be attached to the asset's name in order to separate between different buying transactions of the same assets (for example A1 for the first purchase of A, A2 for the second purchase of A and so on). Now press the OK button.
- After pressing the OK button, the you will be able to see in the window of your “portfolio's state” the state of each investment.
- Now you are asked to press again the “next day” button and get to the next round. You will be asked to trade for 20 rounds.
- One round before the last round will ask you to decide if you want to sell all of your asset and get 3% more of their market value. Of you like to sell all your assets please press YES in the window at the upper right side of the screen. If you want to go on to the last round press “NO.”
- In the last round (round 20) we will sell all of your assets in their market price at the last round. We will add the amount of your cash to the value of the assets.
- At the end of the experiment you will see the following information:
 - The value of your assets.
 - The amount of cash.
 - Total value of assets and cash.
 - The payment for the experiment (1.5% of the total value of assets and cash).
- Immediately after you will get the summary of your experiment we will pay money.

HISTORY SCREEN.

נתוני ההיסטוריה																				
יום	נכס A			נכס B			נכס C			נכס D			נכס E			נכס F				
	מחיר	שיעור תשואה יומי %	שיעור תשואה לתקופה %	מחיר	שיעור תשואה יומי %	שיעור תשואה לתקופה %	מחיר	שיעור תשואה יומי %	שיעור תשואה לתקופה %	מחיר	שיעור תשואה יומי %	שיעור תשואה לתקופה %	מחיר	שיעור תשואה יומי %	שיעור תשואה לתקופה %	מחיר	שיעור תשואה יומי %	שיעור תשואה לתקופה %		
-4	106	0	0	107	2	2	120	7	7	98	4	4	123	13	13	145	16	16		
-3	111	5	5	105	-2	0	127	6	13	103	5	10	127	3	17	153	6	22		
-2	104	-6	-2	100	-5	-5	111	-13	-1	113	10	20	108	-15	-1	176	15	41		
-1	104	0	-2	109	9	4	101	-9	-10	96	-15	2	116	7	6	174	-1	39		
0	113	9	7	105	-4	0	108	7	-4	100	4	6	129	11	18	170	-2	36		
1	128	13	13	114	9	9	109	1	1	114	14	14	122	-5	-5	153	-10	-10		
2	127	-1	12	121	6	15	109	0	1	101	-11	1	119	-2	-8	159	4	-6		
3	115	-9	2	136	12	30	108	-1	0	101	0	1	125	5	-3	164	3	-4		
4	109	-5	-4	148	9	41	120	11	11	97	-4	-3	133	6	3	162	-1	-5		
5	104	-5	-8	152	3	45	127	6	18	109	12	9	121	-9	-6	180	11	6		
6	103	-1	-9	149	-2	42	133	5	23	104	-5	4	113	-7	-12	183	2	8		

ליום ההיסטוריה הבא

ליום ההיסטוריה הבא

Asset A

Day	Price	Daily return	Accumulated return
-4	106	0	0
-3	111	5	5
-2	104	-6	-2
-1	104	0	-2
0	113	9	7
1	128	13	13
2	127	-1	12
3	115	-9	2
4	109	-5	-4
5	104	-5	-8
6	103	-1	-9

APPENDIX— PORTFOLIO'S STATE SCREEN

מצב השקעותיך

מניה	A1	B1	C1	D1
מחיר רכישה ליחידה	93	114	103	103
מחיר בשוק ליחידה	95	124	78	113
שווי שוק כולל	204	218	151	219
משקל בתיק	0.21	0.22	0.15	0.22
שיעור תשואה יומי	6	9	-12	33
שיעור תשואה לתקופה	2	9	-24	10

שווי המניות: 792 יתרת מזומנים: 200

סה"כ שווי התיק: 992

Asset	A1	B1	C1	D1
Purchasing price	93	114	103	103
Market price	95	124	78	113
Total market value	204	218	151	219
Weigh in portfolio	0.21	0.22	0.15	0.22
Daily return	6	9	-12	33
Accumulated return	2	9	-24	10

Assets value: 792

Cash amount: 200

Total portfolio value: 992

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