DISPOSITION EFFECT AND INVESTOR UNDERREACTION TO INFORMATION

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Abstract

The purpose of this paper is to explain the underreaction of investors to information. In order to study the adjustment of prices to a fundamental value, we implement experimental markets with fluctuating fundamental values. The experimental design employed involves two treatments differentiated according to the information disclosed to the participants. The results show an underreaction to a change in the fundamental value. This underreaction is greatest when most of the subjects are facing a paper loss. This suggests that the disposition effect has a strong impact on price formation. Once most of the subjects are in a paper gain situation, the underreaction is at its lowest level when they receive good news. Thus, underreaction to information is influenced by paper gains and losses.

Keywords: Underreaction to information, Disposition effect, Experiment
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1. INTRODUCTION

The informational efficiency market hypothesis requires that prices fully reflect all available information at any time. Thus, the price of a stock is a good estimate of its fundamental value. The use of relevant information by rational investors is likely to create equality between the fundamental value of a stock and its price (Fama, 1970). In the presence of investors who are not perfectly rational any mispricing would be corrected by the arbitration mechanism and prices would gradually converge to the fundamental value. For stocks, the fundamental value is equal to the present value of future dividends. Of course, the flow of dividends is unknown and investors should anticipate this according to the information they have. Thus, to determine the fundamental value of a stock, the investor is expected to use the available information optimally, i.e., to anticipate future dividends rationally. However, in financial markets, investors tend to underestimate the significance of the financial information. This underestimation could lead to an underreaction to information.

Previous event studies have empirically examined the underreaction of investors to information. They demonstrate the existence of abnormal returns over several months, and consequently invalidate the efficient market hypothesis (EMH). These abnormal returns are a proxy of the underreaction of investors at the time of information disclosure (Vega, 2006; Chordia et al., 2009). The gradual price adjustment to the arrival of new information has been found in these following events: earning announcements (Bernard and Thomas, 1989; Truong, 2011; Zhang et al., 2013), stock repurchases (Ikenberry et al., 1995), dividend and omission announcements (Michaely et al., 1995; Liu et al., 2008), stock splits (Desai and Jain, 1997; Ikenberry and Ramnath, 2002) and analysts' forecasts (Hou et al., 2014).

Another stream of theoretical and empirical research seeks to explain this underreaction to information through a behavioral paradigm[32]. To this end, underreaction to information has been explained as the result of cognitive biases among investors. Behavioral finance offers explanations that are essentially based on the concept of bounded rationality and investigates price formation in the presence of investors who are not perfectly rational. Grinblatt and Han (2005) suggest that the explanation for the underreaction to information is related to investor preferences and offer a model that is based on the disposition effect.[33] According to Shefrin and Statman (1985), the disposition effect is the tendency of investors to sell winning stocks too quickly and hold losing stocks too long. The tendency of investors to hold losing stocks creates an imbalance between supply and demand for securities, which alters the price formation. The existence of investors prone to the disposition effect implies an underreaction to information (Grinblatt and Han, 2005; Hur et al., 2010). Frazzini (2006) shows that underreaction to information exists only when the news and the paper gain or loss at the aggregate level have the same sign. Hur et al. (2010) show that the disposition effect has a significant impact on prices when stocks are held by individual investors.

This paper aims to study the reaction of investors to the disclosure of new information. Its main objectives are i) to test the existence of underreaction to information, and ii) to check if this

[32] Rational explanations also exist to explain underreaction to information. These explanations are related to microstructure issues, such as the illiquidity of securities (Bossaert and Plott, 2000; Chordia et al., 2009) and the impact of transaction costs on trading fluidity (Lesmond et al., 2004; Ng et al., 2008 to name a few).

[33] The disposition effect is not the only behavioral explanation for underreaction to information. We direct the reader to the models of Barberis et al. (1998) and Daniel et al. (1998), which refer, respectively, to anchoring and self-attribution biases.

underreaction is related to the disposition effect, i.e. selling winning stocks too quickly and holding losing stocks too long implies. Thus, our research question is to investigate whether the presence of investors displaying the disposition effect generates stock price underreaction to information. To circumvent the problems related to the calculation of abnormal returns, we follow an experimental method. In this method, the phenomenon of underreaction is more easily detectable. In addition, experimentation allows us to measure variables that are difficult to quantify using real market data, as is the case, for example, for the fundamental value of a stock (Kirchler, 2009) and paper gains and losses.

This research shows the existence of underreaction to information. It is more pronounced when most participants hold stock with a paper loss. In contrast, when subjects are facing a paper gain, the prices adjust more strongly to the fundamental value. Thus, the reluctance of subjects to sell losing stocks prevents the price adjustment to the fundamental value and creates an underreaction to information. The findings discussed and presented in this article should provide useful insights for investors as well as asset managers. This research is one of the first experimental studies bringing together the disposition effect and underreaction to information. Research that has independently studied the disposition effect and underreaction to information is, however, more common. Thus, the methodological approach and the empirical results of this research enrich the existing literature regarding the impact of the disposition effect on price formation in financial markets.

The remainder of this paper is organized as follows. Section 2 presents the literature review and the hypotheses to be considered. Section 3 describes the experimental design. Section 4 reports and discusses the main empirical findings. Section 5 provides the conclusion.

2. LITERATURE REVIEW AND HYPOTHESES

If investors underreact to information, the correction of this initial assessment error takes place during the months following the event. Thus, abnormal returns are positive after announcements of good news and negative following bad news (Michaely et al., 1995; Ikenberry and Ramnath, 2002). In the months following earning announcements, stocks with positive surprises (compared with the analysts' expectations) have abnormal returns higher than those of stocks for which the surprises are negative (Bernard and Thomas, 1989). Thus, the prices do not immediately incorporate good or bad news. More recently, Truong (2011) analyses abnormal returns over different event windows and shows post-earnings announcement drift. A hedge strategy of going long on the top quintile of earnings for surprise stocks and short on the bottom quintile of earnings for surprise stocks generates a positive excess return in the year following earnings announcements. Generally speaking, the event study methodology is used due to the impossibility of calculating the exact fundamental value of stock. This kind of methodology is mainly based on theoretical models to assess expected returns. Therefore, price adjustment is not directly testable since the use of a computational model of expected returns is required. According to Fama (1970, 1991), results are conditioned by the choice of the estimation model of theoretical returns (known as the joint hypothesis problem).

Experimental studies have compared price changes with that of the fundamental value. According to Weber and Welfens (2007), the initial underreaction to announcements of good or bad news is followed by a tendency after the event for prices to converge slowly to a new fundamental value. Kirchler (2009) was interested in subjects' reaction to fundamental information in experimental markets with symmetric and asymmetric information. When information is symmetric, all subjects have the same information and changes in the fundamental value from one period to another are highly visible in the prices. However, in markets with asymmetric information, the dissemination process is much slower and the price adjustment to the fundamental value is weak. In experimental studies, subjects are continuously informed of the fundamental value of a stock, so a direct comparison of the established price and fundamental value is possible. Thus, an underreaction is detected when the price adjustment to the fundamental value is small. Therefore, we formed the first following hypothesis:

Hypothesis 1 (H1): The underreaction of investors to information exists if prices adjust weakly to the fundamental value.

Behavioral finance explains that the underreaction to new information can be attributed to cognitive biases. While the expected utility theory provides that decisions are made based on final wealth, prospect theory suggests that these decisions are taken on the basis of gains and losses in respect to a reference point (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). Individuals are risk averse with regard to gains and risk takers in relation to losses. In a situation of paper gains, investors prefer to secure their gain. In the case of paper losses, investors prefer to keep their stock and wait until prices rebound.

Investors prone to the disposition effect use one or more reference points when assessing their paper gains and losses. The benchmarks used are the purchase price, the average price over the previous period and the maximum price reached (Oehler et al., 2003; Baucells et al., 2011). Grinblatt and Han (2005), Frazzini (2006), Hur et al. (2010) and Zhao et al. (2011) assume that investors use the purchase price of a stock to assess their paper gains and losses. However, this variable is solely a proxy of the true variable because it is calculated based on previous transaction prices and volumes.

Grinblatt and Han (2005) show that the disposition effect alters price formation and generates an underreaction to information. This underreaction depends on the proportion of investors prone to the disposition effect. Indeed, the reluctance of some investors to sell losing stocks creates an imbalance between supply and demand, which implies an underreaction to information. Their model shows that the equilibrium price is the weighted average of the fundamental value of the stock and the reference price. When most investors trade the stock with a paper gain, the information is quickly reflected in stock prices. At the opposite, when investors negotiate stock with a paper loss, reluctance to sell losing stocks prevents the incorporation of information into prices. More precisely, two situations arise depending on the paper gain or loss. In the paper gain position, the adjustment of prices to new information is faster than in the paper loss position. Hence, we can formulate our second hypothesis as follows:

Hypothesis 2 (H2): The underreaction to information is more pronounced when most subjects are in a paper loss position.

Frazzini (2006) and Lin and Rassenti (2012) have studied the reaction of investors depending on both the quality of news (good or bad) and paper gains and losses. Frazzini (2006) uses trading volumes and daily returns to analyse the effect of paper gains and losses on investor reaction to earnings announcements. The author finds results that confirm that trading between disposition-prone investors influences prices and generates a post-earnings announcement drift. According to Frazzini (2006), when investors are in a paper gain (or loss) position at the aggregate level, prices underreact to the announcement of good (or bad) news. The author states that prices underreact to negative news when most of the current holders are facing a paper loss; whereas, when most investors are facing a paper gain, stock prices underreact to positive news. Therefore, we can form the following hypothesis:

Hypothesis 3 (H3): When most of investors are facing a paper gain, stock prices underreact to positive news, and when most of investors are facing a paper loss, stock prices underreact to negative news.

3. EXPERIMENTAL DESIGN

3.1. Market model

We consider two treatments - T1 and T2 - that differ according to the information disclosed to the subjects. Each treatment consists of six experimental sessions, each of which has 24 periods. Every period lasts 100 seconds. This periodicity is used by Kirchler (2009), Kirchler and Huber (2009) and Hanke et al. (2010). At the beginning of each session, the subjects were briefed using written instructions[34] which were followed by four trial periods.[35] The experiments were programmed and conducted with z-Tree (Fischbacher, 2007).

In the first treatment (T1), each subject was informed of the dividend for the current period and those of the next three periods (Kirchler and Huber, 2009). This assumed that the participants were well informed and knew the exact values of future dividends (Kirchler and Huber, 2007). Dividends followed a random walk without drift and were determined as follows:

$$D_t = D_{t-1} + \varepsilon_t \tag{1}$$

Where D_t is the dividend for the current period t; ε_t is a normally distributed random variable with a mean of zero and a variance equal to 0.16. The dividend for the first period was set at 2 EU per stock. The fundamental value of the stock was calculated by applying the dividend discount model (DDM) and assuming the last dividend to be perpetual:

$$FV_t = \sum_{i=t}^{t+2} \frac{D_i}{(1+r_e)^{i-t}} + \frac{D_{t+3}/r_e}{(1+r_e)^3} \tag{2}$$

FV_t is the fundamental value of the stock in period t and r_e is the discount rate of the DDM that corresponds to the risk-adjusted interest rate of 10% with a 3% risk-free rate[36].

In treatment T2, the subjects were only informed of the dividend for the current period and the fundamental value of the stock. To allow comparison between treatments, we used the same sets of fundamental values as calculated in treatment T1. The series of dividends D_t was calculated by multiplying the FV_t series of the first treatment by 0.1. During this second treatment, the dividend for the first period was not equal to 2 EU. We informed subjects that the dividend for the first period was around 2 EU and would changes randomly. Typically, the fundamental value is calculated using the following formula:

$$FV_t = \frac{D_t}{r_e} \tag{3}$$

In the second treatment, the dividend D_t for the current period was assumed to be constant and perpetual, and r_e is the risk-adjusted interest rate of 10%.

The major difference between the two treatments (T1 and T2) was the quality of the information disclosed to the subjects.[37] This choice of two treatments allowed us to test the robustness of our results in two different controlled environments.

3.2. Trading mechanism

In both treatments, the subjects traded in a continuous double auction market with an open order book, which is representative of most real stock markets. The interaction between the participants took place through a computer network. They could trade stocks with the other participants by proposing limit orders or by accepting offers in the market price. Market orders have priority over limit orders as market orders are executed instantaneously. All limit orders were recorded in the order book based on the prices offered. Partial execution was possible and an exchange was then concluded at the price offered for the desired quantity. Trading was done without transaction costs. Going short on money or stocks was not allowed. To ensure liquidity, the prices offered had a maximum of 1 decimal place. Holdings of money and stocks were carried over from one period to the next.

The trading screen provided traders in real-time with current information in their stocks, money holdings and their wealth. The screen served as an interface for the participants and allowed them to

[34] See experimental instructions in Appendix A.

[35] At the beginning of each experimental session subjects were briefed with written instructions. Afterwards we ran four trial periods to allow subjects to become familiar with the market.

[36] In a vast majority of experimental studies, the authors select the risk-free interest rate and the risk-adjusted interest rates respectively far from 2% and 8.5% per year (see e.g Kirchler and Huber, 2007). These interest rates were choose in function of the real financial market conditions at the time of the realization of the experimental study.

[37] Successive definitions of the informational efficiency hypothesis are always based on the concept of fundamental information (Fama, 1970, 1991). Here, we proposed two treatments that differed in the quality of information disclosed to the subjects. If the experimental markets were efficient, prices should have incorporated all available information in both the T1 and T2 treatments.

receive information about dividends and the fundamental value of stocks, observe the offers in the order book, trade with other participants and visualize the evolution of the prices during the current period.

After each period a history screen provided a common information on the dividend, the fundamental value and the closing price and individual information on average purchase price and the profit in EU. (See section 3.4 below for details on calculus of the profit).

3.3. Experimental implementation

We conducted our experimental sessions in the computer laboratory at La Rochelle Business School during the year 2011. The subjects were business students volunteered for the experimental study. All these students took finance classes and are familiar with financial concepts presented in the instructions. When asked, participants confirmed that they understood the experimental design. Sixty-nine subjects participated in the first treatment and 72 in the second, for a total of 141. Each student participated in only one session of the 12 experimental sessions (6 sessions by treatment). From 10 to 14 students participated in each session. Although the number of periods in each session was fixed at 24, we informed the subjects in the instructions that the experiment would be randomly terminated between periods 20 and 30, with equal probability for each period. The objective was to control the end of the experiment and to avoid some participants engaging in strategic behavior in the final periods (Kirchler and Huber, 2009; Hanke et al., 2010).

At the beginning of each experiment, all subjects were assigned 1,000 experimental units (EU) and 50 stocks. The wealth of each subject depended on the number of stocks in its possession and on the interest earned on the money held at the end of each period. Wealth was also a function of the market price and evolved during each transaction. It changed systematically even if the subject did not intervene at the time of the previous transaction. At the end of each period, subjects receive the current dividend for each stock they own. When a subject sold a part of its stocks, its retention of money increased in real time. For holding cash, the participants received a risk-free interest rate of 3% at the end of each period. The risk-adjusted interest rate (10%) serves as the discount rate in the DDM formulas. This rate kept constant until the end of the experiment. Within the framework of our experiments, we focused solely on the purchase price of the stock as the reference price. This choice was motivated by two reasons. First, referring to the experimental study by Oehler et al. (2003), the purchase price is the reference point most used by subjects to assess their paper gains and losses. Second, if we had studied several reference points, it would have been difficult to know which point had been used by each subject. During the experiments, the subjects were thus informed only of their average purchase price. This price was displayed in real time on each subject's trading screen and changed after each purchase transaction.

3.4. Incentive Structure

To motivate the students and encourage them to make good decisions, an incentive structure was set up in the form of purchase vouchers. The pay-off for each subject at the end of each session was calculated in EU and is equal to the sum of the profits over all the 24 trading periods of the session. For a given period, the profit is equal to the change in the wealth. At the end of each trading period, the wealth is calculated on the basis of the closing price. The final profit (expressed in EU) allows determining a rank for each participant. The value of the purchase voucher, between 0 and 30 euros, is depending on the rank (see Table A1 in Appendix A). The purchase vouchers were awarded to subjects at the end of every experimental session.

4. RESULTS AND DISCUSSION

4.1. Descriptive statistics

The purpose of the descriptive analysis is to study the evolution of average prices in relation to the fundamental value. Figure 1 provides information of the relationship between average prices ($\overline{P}$) and fundamental values (FV) within the 12 experimental markets. Each graph represents a market characterized by a change in the fundamental value and average prices related to treatments T1 and T2.

Figure 1 shows underreaction in all 12 experimental markets. Indeed, the stocks were undervalued in bullish and overvalued in bearish markets. When the fundamental values reached extreme minimal values, the subjects did not issue enough selling orders to allow prices to reach this fundamental value and preferred to keep their stocks. Although purchase orders at prices approaching the fundamental value existed in the order book, the subjects did not agree to sell the stocks in their possession at low prices. Similarly, when the fundamental value increased, the subjects negotiated the stock at a price below the fundamental value. Those subjects wishing to sell stocks submitted prices around the fundamental value, but buyers preferred to purchase stocks at lower prices.

Mispricing between prices and fundamental values remained even during the final periods of the experimental sessions. This suggests that the learning effect was low and did not have an impact on the subjects' trading strategies. This result is in line with those of Theissen (2000), which shows that the learning effect has no impact on the improvement of informational efficiency.

Table 1 provides a brief overview of the descriptive statistics for each market and each treatment. Underreaction exists if the relative change in the fundamental value $DFV_t = (FV_t - FV_{t-1})/FV_{t-1}$ from one period to another is accompanied by a smaller relative price change $D\overline{P}_t = (\overline{P}_t - \overline{P}_{t-1})/\overline{P}_{t-1}$.

This table shows the standard deviations of both relative changes in the fundamental value and the average prices. We calculated the ratio of these two standard deviations to study the price elasticity. This table also shows the levels reached by the fundamental values and average prices.

Figure 1. Fundamental values (FV) and average prices for the two treatments (T1 and T2) over the trading periods

In all 12 markets, the standard deviation of returns is less than the standard deviation of changes in fundamental values. The mean of the ratio of standard deviations is equal to 0.66 and 0.73, respectively, for treatments T1 and T2. This result suggests that prices adjust less to the fundamental value in the first treatment. In some of the markets, the standard deviation of the price change is only around half the standard deviation of changes in the fundamental value. This is the case for the T1-M4 and T1-M6 markets. Thus, a change in the fundamental value of an EU is accompanied by a smaller price change.

We also studied the minimum and maximum levels reached by the fundamental value and the relative market prices. Generally, prices did not adjust to the fundamental value in either case. Indeed, the values in column Min*(FV)* are lower than those in column Min$(\overline{P})$ in 11 of the experimental sessions. The only exception relates to the T1-M5 session. In this market, the minimum fundamental value is 15.02 EU, and prices fell to 14.46 EU. This observation can be explained by the mimetic behavior of the subjects. Observing the offers of other participants in the order book, they embarked on massive selling operations. During this experimental session, the fundamental value reached 36 EU (see Figure 1) and the subjects cashed significant dividends. Afterwards, the fundamental value began to decline until reaching 15 EU during period 23. The subjects observe the dividends on the trading screen for the current period (1.50) and the next three (1.48, 1.39, 1.47) and believe that holding the stock become too risky. In this context, it seems more interesting to sell the stock and to collect more interest. Comparison of columns Max*(FV)* and Max$(\overline{P})$ also shows that prices did not adjust to the fundamental value when they reached their maximum values. The values in column Max$(\overline{P})$ are lower than those in column Max*(FV)* for the 12 experimental sessions, which demonstrates that trading between subjects did not allow the prices to reach extreme fundamental values.

From these statistics, we can conclude that the participants underreacted to information in the experimental markets. Following the announcements of increases and decreases in dividends, prices adjusted only partially to the fundamental value.

Table 1. Under-reaction to information - Descriptive statistics

	$\sigma(\mathrm{DFV})$	$\sigma(D\overline{P})$	$\frac{\sigma(D\overline{P})}{\sigma(DFV)}$	Min (FV)	Min $(\overline{P})$	Max (FV)	Max $(\overline{P})$
			Treatment T1				
T1-M1	0.096	0.082	0.85	19.71	22.19	37.12	34.09
T1-M2	0.115	0.086	0.75	11.85	14.65	25.46	25.28
T1-M3	0.090	0.066	0.73	17.91	18.93	35.82	33.95
T1-M4	0.157	0.088	0.56	9.91	15.52	27.19	25.11
T1-M5	0.111	0.089	0.80	15.02	14.46	36.34	31.34
T1-M6	0.204	0.103	0.50	10.30	13.95	33.07	31.24
Mean	**0.129**	**0.086**	**0.66**				
			Treatment T2				
T2-M1	0.096	0.080	0.84	19.71	21.36	37.12	35.02
T2-M2	0.115	0.079	0.69	11.85	15.03	25.46	23.94
T2-M3	0.090	0.081	0.90	17.91	18.11	35.82	32.90
T2-M4	0.157	0.097	0.61	9.91	14.61	27.19	26.65
T2-M5	0.111	0.096	0.86	15.02	17.59	36.34	34.50
T2-M6	0.204	0.129	0.63	10.30	14.00	33.07	31.91
Mean	**0.129**	**0.093**	**0.73**				

Ti-Mj represents the experimental session Mj (from 1 to 6) of the treatment Ti (T1: treatment with disclosure of the dividend for the current period and the next three periods; T2: Treatment with disclosure of the dividend for the current period only); FV: fundamental value; $\overline{P}$*: average price;* $\sigma(DVF)$ *: standard deviation of fundamental value change;* $\sigma(D\overline{P})$ *: standard deviation of average prices change.*

4.2. Econometric estimation of underreaction

The underreaction of investors to information exists if prices adjust weakly to the fundamental value. As the result, we can study the adjustment of prices to new information by running the following panel data regression for each of the two treatments:

$$\Delta\overline{P}_{i,t} = \alpha + \beta\Delta FV_{i,t} + \varepsilon_{i,t} \tag{4}$$

All variables in our model are expressed in first difference in order to avoid spurious regressions, where $FV_{i,t}$ is the change in the fundamental value and $\Delta\overline{P}_{i,t}$ is the change in the average price established in the market following the disclosure of the information. The index i represents the experimental session from 1 to 6 for each treatment and t is the trading period from 2 to 24. It is possible to test directly the null hypothesis $H_0\colon \beta = 1$ (EMH) versus $H_1\colon \beta < 1$ (underreaction). Nevertheless, equation (4) suffers from the autocorrelation problem. (We run equation 4 for each treatment and we obtain the Durbin-Watson statistics (DW) respectively equal to 2.51 for T1 and 2.47 for T2. If there is no serial correlation the DW statistic will be around 2.). Kirchler (2009) solved this problem by including lagged values both in the dependent and explanatory variables to eliminate any autocorrelation.(To solve the residual autocorrelation, Kirchler (2009) integrates three lags for the dependent and explanatory variables in their model.) In our case we test for the presence of two lags both in $FV_{i,t}$ and $\Delta\overline{P}_{i,t}$. Our equation (4) therefore takes the following form:

$$\Delta\overline{P}_{i,t} = \alpha + \beta_0\Delta FV_{i,t} + \sum_{l=1}^{2}\beta_l\,\Delta FV_{i,t-l} + \sum_{l=1}^{2}\gamma_l\,\Delta\overline{P}_{i,t-l} + \varepsilon_{i,t} \tag{5}$$

Hence, the change in the average price of this period ($\Delta\overline{P}_{i,t}$) depends on changes in the fundamental value of the current period ($\Delta FV_{i,t}$) and the last two periods ($\Delta FV_{i,t-l}$) and on changes in the mean prices ($\Delta\overline{P}_{i,t-l}$) of the past two periods. If information is immediately integrated into prices, the coefficient β_0 should be equal to 1 (β_0=1). The significance of the difference from 1 of this coefficient is studied using the Wald test. We include both cross-section and period fixed effects in each panel regression for T1 and T2. Additionally, we applied the White's diagonal covariance method to account for heteroskedasticity in the disturbances. The results are shown in Table 2.

The coefficients of $\Delta FV_{i,t-l}$ (l = 0, 1 and 2) are between 0 and 1 and are significant. The most important value is that of $\Delta FV_{i,t}$ (l = 0). The coefficient β_0 is higher for the second treatment (0.654 for T2 against 0.488 for T1) which confirms that the underreaction is more pronounced in the first treatment. This is explained by the fact that the subjects in the second treatment were more responsive to the disclosure of new information. The two coefficients β_0 are significantly lower than 1 (p value = 0.000 for both treatments). Thus, if we retain the definition that information is immediately incorporated into prices (β_0=1) then the underreaction hypothesis is confirmed (H1) in each of the two treatments. Our results are in line with those obtained by Kirchler (2009).

The variables $\Delta\overline{P}_{i,t-l}$ (l = 1 and 2) have a negative and significant impact on the change of current prices in both treatments. We can explain this result by suggesting that subjects are more focused on the evolution of the fundamental value rather than on changes in previous average prices (Kirchler, 2009). This result is also consistent with Grinblatt and Han (2005), who show a strong return reversal effect for short and long horizons.

Table 2. The regression results of under-reaction to information

$$\Delta\overline{P}_{i,t} = \alpha + \beta_0 \Delta FV_{i,t} + \sum_{l=1}^{2} \beta_l \Delta FV_{i,t-l} + \sum_{l=1}^{2} \gamma_l \Delta\overline{P}_{i,t-l} + \varepsilon_{i,t}$$

Variables		***T1***	***T2***
α		-0.102 (-1.002)	-0.005 (-0.055)
ΔFV		0.488*** (10.702)	0.654*** (15.280)
ΔFV_{-1}		0.409*** (5.881)	0.169* (1.762)
ΔFV_{-2}		0.229*** (2.936)	0.246** (2.574)
$\Delta\overline{P}_{-1}$		-0.415*** (-3.883)	-0.282** (-2.496)
$\Delta\overline{P}_{-2}$		-0.186** (-1.987)	-0.237** (-2.071)
Fixed effects		CS&P	CS&P
DW		2.033	2.090
R^2		0.737	0.810
n		126	126
Wald P:	$\beta_0 = 1$	0.0000	0.0000

T1: treatment with disclosure of the dividend for the current period and the next three periods; T2: Treatment with disclosure of the dividend for the current period only; $\Delta\overline{P}$ *: average prices change;* ΔVF *: fundamental value change;* ΔFV_{-1} *and* ΔFV_{-2} *: the two lags of* ΔFV*;* $\Delta\overline{P}_{-1}$ *and* $\Delta\overline{P}_{-2}$ *: the two lags of* $\Delta\overline{P}$*; t-statistics are provided in parentheses; DW: Durbin-Watson statistic;* R^2*: coefficient of determination; n: number of observations; Wald P: probability value of the Wald test for the null hypothesis.*

CS: cross-section fixed effects; P: period fixed effects

****: significant at 1% level; **: significant at 5% level; *: significant at 10% level.*

Thus, the current price change is a function of changes in the fundamental value. However, trading between participants did not allow prices to adjust fully to the fundamental value, which confirms H1. The current price change also depended on past prices changes, which corroborates the study by De Bondt and Thaler (1985). Winning stocks in the past tended to generate lower performance and losing stocks led to higher future returns.

4.3. Underreaction and disposition effect

The experimental method allows exact calculation of the average purchase price of the stock for each subject. This average purchase price (*APP*) was calculated using the weighted average cost method. The reference price (*RP*) is the purchase price of the stock at the aggregate level. It was calculated at the beginning of each trading period, as follows:

$$RP_t = \frac{1}{n}\sum_{i=1}^{n} APP_{i,t} \quad (6)$$

Where n is the number of subjects participating in the experimental session and t is the number of periods ranging from 1 to 24.

In our experiments, the current price and the average purchase price of each subject were shown on the trading screens and subjects compared the current price to their average purchase price. In some cases, there were subjects in a gain position and others in a loss situation. The aggregate capital gain (*G*) indicating the difference between the average price of the period and the reference price determined if the stock was negotiated from a paper gain or paper loss situation at the aggregate level. We calculated the variable *G* as follows:

$$G_t = \frac{\overline{P}_t - RP_t}{\overline{P}_t} \quad (7)$$

A positive (or negative) *G* meant that subjects negotiated the stock with a paper gain (or loss) at the aggregate level.

To test whether an underreaction to information is more pronounced when most subjects negotiated a stock with a paper loss (H2), we decomposed the variable ΔFV of the panel data regression (5) into two variables. The first, denoted $\Delta FV.G^-$, is the change in the fundamental value when the subjects are in a paper loss position (G < 0). The second, denoted $\Delta FV.G^+$, is the change in the fundamental value when the subjects negotiated a stock with a paper gain (G > 0). Formally:

$$\Delta FV.G^- = \Delta FV * d_1 \text{ where } d_1 = \begin{cases} 1 \text{ if } G < 0 \\ 0 \text{ otherwise} \end{cases} \quad (8)$$

$$\Delta FV.G^+ = \Delta FV * d_2 \text{ where } d_2 = \begin{cases} 1 \text{ if } G > 0 \\ 0 \text{ otherwise} \end{cases} \quad (9)$$

The specification to test is as follows:

$$\Delta\overline{P}_{i,t} = \alpha + \beta_{01}\Delta FV.G^{-}_{i,t} + \beta_{02}\Delta FV.G^{+}_{i,t} + \sum_{l=1}^{2}\beta_l\,\Delta FV_{i,t-l} + \sum_{l=1}^{2}\gamma_l\,\Delta\overline{P}_{i,t-l} + \varepsilon_{i,t} \tag{10}$$

If the underreaction to a change in the fundamental value is more pronounced when subjects are in a paper loss situation, then the coefficient of the variable $\Delta FV.G^{-}$ should be less than the coefficient of the variable $\Delta FV.G^{+}$. However, if the β_{01} and β_{02} coefficients are of the same size and less than 1, then the underreaction exists both when subjects are in paper gain and loss situations. The results of the regression model (10) are shown in Table 3.

Table 3. Under-reaction to information as function of paper gains and losses

$$\Delta\overline{P}_{i,t} = \alpha + \beta_{01}\Delta FV.G^{-}_{i,t} + \beta_{02}\Delta FV.G^{+}_{i,t} + \sum_{l=1}^{2}\beta_l\,\Delta FV_{i,t-l} + \sum_{l=1}^{2}\gamma_l\,\Delta\overline{P}_{i,t-l} + \varepsilon_{i,t}$$

Variables		T1	T2
α		-0.176 (-1.633)	-0.114 (-1.188)
$\Delta FV.G^{-}$		0.393*** (5.553)	0.529*** (8.119)
$\Delta FV.G^{+}$		0.585*** (11.578)	0.783*** (16.298)
ΔFV_{-1}		0.417*** (6.052)	0.149 (1.544)
ΔFV_{-2}		0.224*** (3.004)	0.231** (2.595)
$\Delta\overline{P}_{-1}$		-0.408*** (-3.906)	-0.237** (-2.146)
$\Delta\overline{P}_{-2}$		-0.181** (-2.127)	-0.215** (-2.093)
Fixed effects		CS&P	CS&P
DW		2.005	2.088
R^2		0.750	0.827
n		126	126
Wald P:		$\beta_{01} = 1$	0.0000
Wald P:	$\beta_{02} = 1$	0.0000	0.0000
	$\beta_{01} = \beta_{02}$	0.0334	0.0000

T1: treatment with disclosure of the dividend for the current period and the next three periods; T2: Treatment with disclosure of the dividend for the current period only; $\Delta\overline{P}$: average prices change; $\Delta FV.G^{-}$: the change in the fundamental value when subjects are in a paper loss position (G<0); $\Delta FV.G^{+}$: the change in the fundamental value when subjects are in a paper gain position (G>0); ΔFV_{-1} and ΔFV_{-2}: the two lags of ΔFV; $\Delta\overline{P}_{-1}$ and $\Delta\overline{P}_{-2}$: the two lags of $\Delta\overline{P}$; t-statistics are provided in parentheses; DW : Durbin-Watson statistic; R^2: coefficient of determination; n: number of observations; Wald P: probability value of the Wald test for the null hypothesis.

CS: cross-section fixed effects; P: period fixed effects

****: significant at 1% level; **: significant at 5% level; *: significant at 10% level.*

The coefficients of the variables $\Delta FV.G^{-}$ and $\Delta FV.G^{+}$ are, respectively, 0.393 and 0.585 for the first treatment, and 0.529 and 0.783 for the second. They are significant at the 1% level. Thus, the reaction of the subjects was reflected in the prices, both when a stock was traded with a paper gain and with a paper loss. The Wald test shows that these coefficients are significantly different from 1 (p value = 0.000 for both treatments). Thus, underreaction exists when the subjects are in paper gain or paper loss positions at the aggregate level[38]. These results demonstrate that, with respect to the change in the fundamental value (ΔFV), the price adjustment ($\Delta\overline{P}$) is low when most investors are in a paper gain situation (G> 0) or in a paper loss situation (G <0). Thus, the price changes are lower than those of the fundamental value in paper gain and loss situations.

The coefficient of $\Delta FV.G^{-}$ is significantly less than the coefficient of $\Delta FV.G^{+}$ in both treatments. This result shows that underreaction is more pronounced when most of the subjects negotiated the stock with a paper loss, which strongly confirms the hypothesis 2. When most of the subjects are facing a paper loss, i.e. the average price is lower than the aggregate purchase price, stock prices underreact to news. Thus, reluctance of some subjects to sell their losing stocks prevented the adjustment of prices to the fundamental value. However, prices were more elastic to changes in the fundamental value when most of the subjects held a stock with a paper gain, i.e. the average price is higher than the aggregate purchase price. These results confirm that the disposition effect induces an underreaction to information.

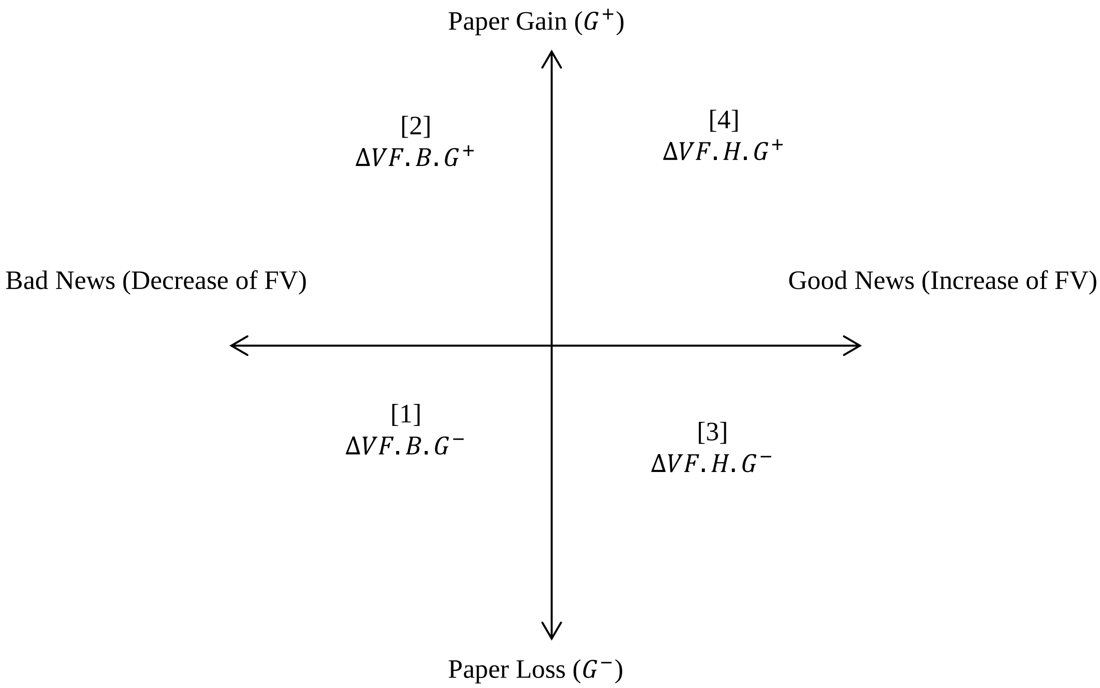
4.4. Underreaction, quality of news and disposition effect

Hypothesis H3 states that when most of investors are facing a paper gain, stock prices underreact to positive news, and when most of investors are facing a paper loss, stock prices underreact to negative news. In our experimental setting, an increase in the fundamental value was considered as good news and a decrease in the fundamental value as bad news. Upon the arrival of information (good or bad), a

[38] For example, a positive G means that subjects negotiate the stock with a paper gain at the aggregate level, i.e. the average price is higher than the aggregate purchase price. Under these conditions, most investors trade the stock with a paper gain while the others trade the stock with a paper loss.

stock was traded either at a paper loss or a paper gain at the aggregate level. The interaction of these two variables involved four situations in which subjects could be involved: [1] a decrease in fundamental value and a paper loss: $\Delta FV.D.G^{-}$, [2] a decrease in fundamental value and a paper gain: $\Delta FV.D.G^{+}$, [3] an increase in fundamental value and a paper loss: $\Delta FV.I.G^{-}$, and [4] an increase in the fundamental value and a paper gain: $\Delta FV.I.G^{+}$.

Figure 2. Four situations as function of news (Good, Bad) and paper gain (G^{-}, G^{+})



Formally:

$$\Delta FV.D.G^{-} = \Delta FV * d_1 \; where \; d_1 = \begin{cases} 1 \; if \; \Delta FV < 0 \; and \; G < 0 \\ 0 \; otherwise \end{cases} \quad (11)$$

$$\Delta FV.D.G^{+} = \Delta FV * d_2 \; where \; d_2 = \begin{cases} 1 \; if \; \Delta FV < 0 \; and \; G > 0 \\ 0 \; otherwise \end{cases} \quad (12)$$

$$\Delta FV.I.G^{-} = \Delta FV * d_3 \; where \; d_3 = \begin{cases} 1 \; if \; \Delta FV > 0 \; and \; G < 0 \\ 0 \; otherwise \end{cases} \quad (13)$$

$$\Delta FV.I.G^{+} = \Delta FV * d_4 \; where \; d_4 = \begin{cases} 1 \; if \; \Delta FV > 0 \; and \; G > 0 \\ 0 \; otherwise \end{cases} \quad (14)$$

Using panel data regression (5), the ΔFV variable is replaced by the four variables $\Delta FV.D.G^{-}$, $\Delta FV.D.G^{+}$, $\Delta FV.I.G^{-}$ and $\Delta FV.I.G^{+}$. The specification to test is as follows:

$$\Delta\overline{P}_{i,t} = \alpha + \beta_{01}\Delta FV.D.G^{-}_{i,t} + \beta_{02}\Delta FV.D.G^{+}_{i,t} + \beta_{03}\Delta FV.I.G^{-}_{i,t} + \beta_{04}\Delta FV.I.G^{+}_{i,t} + \sum_{l=1}^{2}\beta_l \, \Delta FV_{i,t-l} + \sum_{l=1}^{2}\gamma_l \, \Delta\overline{P}_{i,t-l} + \varepsilon_{i,t} \quad (15)$$

One should expect coefficients β_{01} and β_{04} to be less than 1 and coefficients β_{02} and β_{03} to be equal to 1. This suggests that β_{01} should be less than β_{02} for decreases in fundamental value, and β_{04} should be less than β_{03} for increases in fundamental value. Table 4 shows the results of the regression model.

The variables $\Delta FV.D.G^{-}$, $\Delta FV.D.G^{+}$, $\Delta FV.I.G^{-}$ and $\Delta FV.I.G^{+}$ have a positive and significant impact on the dependent variable. According to the Wald tests, all the values of β_0 are less than 1. This result shows that subjects underreact to good and bad news when they are facing a paper gain and a paper loss.

The null hypothesis $\beta_{01} = \beta_{02}$ is accepted for both treatments, suggesting that no difference in reaction to decreases in fundamental value is detected. This shows that participants underreacted in the same way to a reduction in the fundamental value of the stocks they possess in situations of paper gain or paper loss. Dividend decrease announcements are thus poorly perceived and the disposition effect has no impact on price formation.

In contrast, the null hypothesis $\beta_{03} = \beta_{04}$ is rejected. The coefficient of the variable $\Delta FV.I.G^{-}$is lower than that of $\Delta FV.I.G^{+}$. So, underreaction to an increase in fundamental value is more pronounced when most of the subjects were facing paper losses. The variable $\Delta FV.I.G^{+}$ has the highest coefficient in both treatments. It is equal to 0.625 and 0.790, respectively, in the first and second treatments. This result suggests that underreaction is less pronounced when the changes in the fundamental value and the paper gain have a positive sign. When subjects are in a paper gain position, prices adjust to the fundamental value, since buyers want to take the maximum dividends while sellers want to concretize their paper gains. Since most of the subjects were in a paper gain position, the stock offer is important, which improves the adjustment degree of prices to the fundamental value. These participants sell their stocks to maximize their money holding (and thus their wealth) and take more interest at the end of the trading periods. As a consequence, paper gains and losses influenced the behavior of the subjects when good news was announced, which allowed us to conclude that the disposition effect alters the price formation for positive changes in the fundamental value.

Table 4. Under-reaction to information as function of news and paper gains and losses

$$\Delta\overline{P}_{i,t} = \alpha + \beta_{01}\Delta FV.D.G^{-}_{i,t} + \beta_{02}\Delta FV.D.G^{+}_{i,t} + \beta_{03}\Delta FV.I.G^{-}_{i,t} + \beta_{04}\Delta FV.I.G^{+}_{i,t} + \sum_{l=1}^{2}\beta_l\,\Delta FV_{i,t-l} + \sum_{l=1}^{2}\gamma_l\,\Delta\overline{P}_{i,t-l} + \varepsilon_{i,t}$$

Variables		*T1*	*T2*
α		-0.122 (-0.687)	0.004 (0.031)
$\Delta FV.D.G^{-}$		0.479*** (4.791)	0.627*** (7.252)
$\Delta FV.D.G^{+}$		0.490*** (4.207)	0.738*** (8.672)
$\Delta FV.I.G^{-}$		0.212* (1.708)	0.325*** (2.634)
$\Delta FV.I.G^{+}$		0.625*** (6.955)	0.790*** (10.698)
ΔFV_{-1}		0.396*** (5.542)	0.139 (1.458)
ΔFV_{-2}		0.214*** (2.918)	0.222** (2.348)
$\Delta\overline{P}_{-1}$		-0.397*** (-3.601)	-0.239** (-2.253)
$\Delta\overline{P}_{-2}$		-0.206** (-2.406)	-0.236** (-2.154)
Fixed effects		CS&P	CS&P
DW		2.005	1.996
R2		0.759	0.835
n		126	126
Wald P:	$\beta_{01} = 1$	0.0000	0.0000
	$\beta_{02} = 1$	0.0000	0.0028
	$\beta_{03} = 1$	0.0000	0.0000
	$\beta_{04} = 1$	0.0001	0.0055
	$\beta_{01} = \beta_{02}$	0.9381	0.3532
	$\beta_{03} = \beta_{04}$	0.0024	0.0008

T1: treatment with disclosure of the dividend for the current period and the next three periods; T2: Treatment with disclosure of the dividend for the current period only; $\Delta\overline{P}$: average prices change; $\Delta FV.D.G^{-}$: Decrease of the fundamental value when subjects are in a paper loss position; $\Delta FV.D.G^{+}$: Decrease of the fundamental value when subjects are in a paper gain position; $\Delta FV.I.G^{-}$: Increase of the fundamental value when subjects are in a paper loss position; $\Delta FV.I.G^{+}$: Increase of the fundamental value when subjects are in a paper gain position; ΔFV_{-1} and ΔFV_{-2} : the two lags of ΔFV; $\Delta\overline{P}_{-1}$ and $\Delta\overline{P}_{-2}$: the two lags of $\Delta\overline{P}$; t-statistics are provided in parentheses; DW : Durbin-Watson statistic; R^2: coefficient of determination; n: number of observations; Wald P: probability value of the Wald test for the null hypothesis.

CS: cross-section fixed effects; P: period fixed effects

****: significant at 1% level; **: significant at 5% level; *: significant at 10% level.*

5. CONCLUSION

This research studied the impact of the disposition effect on price formation. In accordance with the experimental design, the participants were continuously informed of the fundamental value of a stock and their reference prices. This framework is powerful to test the relationship between the disposition effect and the underreaction to news without making auxiliary assumptions related to the estimation of theoretical returns in event studies.

The results show that prices do not adjust to the fundamental value when they reach the maximum and minimum values. The price changes are lower than the fundamental value changes in all the experimental sessions, which suggest underreaction to information. When most of the subjects held a stock with a paper gain, the prices are more elastic to changes in the fundamental value. However, the underreaction is more pronounced when the subjects trade stocks with a paper loss. Thus, the reluctance of subjects to sell losing stocks prevented the adjustment of prices to the fundamental value. Holding losing stocks breaks the supply and demand of the stock, and implies a low price adjustment. This result confirms that the disposition effect induces an underreaction to information.

The underreaction of the subjects following a negative change in the fundamental value is of the same magnitude whether they were in a paper gain or a paper loss situation. However, underreaction to an increase in the fundamental value is more pronounced when the participants are facing a paper loss. The price adjustment is the most important when the change in the fundamental value is positive and the subjects are in a paper gain position. The sellers of a stock in a paper gain position wished to concretize their unrealized gains and, in turn, collect interest, and buyers wanted to collect more dividends by increasing the number of stocks they held.

The results of this research may interest several actors. If investors are aware of the impact of the disposition effect on price formation, their reaction to good or bad news will not be affected by their paper gain or loss; but will be influenced by the information content of the announcement. This will contribute to greater informational efficiency. Our research may also be useful to arbitrageurs in enabling them to build strategies that will allow stock prices to reach their fundamental values. Finally, the study of the impact of the disposition effect on price formation allows managers of rated companies to predict the extent of underreaction to information. When most investors trade a stock with a paper gain, the information will be incorporated quickly into stock prices. However, if a stock is traded with a paper loss at the aggregate level, underreaction will be pronounced.

In this paper, we studied the impact of the disposition effect on stock price formation without considering the impact on trading volumes. Our analysis focused on the price adjustment in the presence of paper gain and paper loss situations. We have shown that holding losing stocks prevents the adjustment of prices and implies an underreaction to information. A search path is to study trading volumes in paper gain and paper loss situations. This line of research may be conducted using aggregate or individual data.

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Appendix A. Experimental instructions for treatment T1

Dear Participant! You will participate to an experimental session. We ask you that you please refrain from talking to other participants.

Background of the experiment

All participants will negotiate the stocks of a fictitious company for 20 to 30 consecutive periods (years). Each period will last 100 seconds. At the beginning of the experiment, each participant is endowed with 1000 experimental units (EUs) and 50 stocks.

Characteristics of the market

The only fundamental information you receive is the dividend of the stock. The dividend follows a random walk process without drift (randomly change at the beginning of each period).

$$D_t = D_{t-1} + \varepsilon_t$$

D_t is the dividend for the current period t and ε_t is a normally distributed random variable with a mean of zero and a variance of 0.16. The dividend for the first period is set at 2 EUs per stock held.

At the beginning of each period, each subject knows the dividend for the current period and coming dividends for the next three periods. The market is characterized by a symmetric information structure. Therefore, all participants receive every period the same information. At the end of each period, you will cash the current dividend for each stock you own. A risk-free interest rate of 3% is paid for money holdings in each period. The risk-adjusted interest rate for the stock valuation is equal to 10% per period. In addition to dividends displayed on the trading screen, the fundamental value (FV) is also provided to all participants. It is calculated by applying the dividend discount model and assuming that the last dividend is constant and perpetual:

$$FV_t = \sum_{i=t}^{t+2} \frac{D_i}{(1+r_e)^{i-t}} + \frac{D_{t+3}/r_e}{(1+r_e)^3}$$

Example: Dividends of this period (t) and the next three periods (t+1, t+2 and t+3) are 2.00; 1.92; 1.83 and 1.71. The FV is calculated as follows: 2 + 1.92/1.1 + 1.83/1.12 + 1.71/0,1/1.13 = 18.14. This value is shown in the top left of the trading screen.

Trading mechanism

Trading will occur with a continuous double auction market mechanism. For each bid and ask that you enter, you have to insert the price and the number of stocks you want to trade. Prices should include a maximum of 1 decimal place. Exchange takes place without transaction costs. The stock price will be determined by your and other interventions in the market. You will be free to determine the number of offers to submit. Short selling and buying on credit are not allowed.

A participant wishing to submit a limit order must specify the price and the number of stocks. A limit purchase offer is only valid if the proposed price is higher than the best offer on the market at the time of the proposal. A limit sale offer is only valid if the proposed price is lower than the best offer on the market at the time of the proposal. The offer is then publicly communicated to all participants. The best offer may be accepted at any time by another participant. Orders at market price are executed instantly. Partial execution of limit orders is possible, and in such cases a transaction is concluded at the price offered for the desired quantity.

Wealth

At any time, your wealth is equal to the sum of money you hold and the market value of your stocks (the number of stocks you hold multiplied by the current price). So, your wealth will change in real time according to changes in the market price, even if you took no action in the last transaction.

When you purchase stocks, your money holdings decrease and the number of your stocks increase immediately. Similarly, when you sell stocks your cash holdings increase and the number of your stocks decreases immediately. Thus, your wealth is a function of the orders you place and offers you accept. At the end of each trading period, an interest rate of 3% per year on your money holding and dividends for your stocks will be added to your cash.

Example: Suppose that at the end of a given period, you have 57 stocks with a market price of 23.8 and 808.2 EUs in cash. If the dividend of the period is 2.00, your wealth increases from 2164.8 to 2303.46 (Interest (808.2 * 3 % = 24.24) and dividends (57 * 2.00 = 114)).

Trading screen

The trading screen which is the main screen of the experiment serves as an interface for participants. It allows you to place your bids and asks, to accept the offers of the other participants and to observe in real time all the information that may interest you. Among this information: the dividends, the fundamental value of the stock, the number of stocks you own, your money holding, your current wealth, orders placed by all participants and the market price of the current trading period (see Figure A1).

In addition to this information, you are provided your average purchase price which is calculated using the weighted average cost method. This price change when you purchase stocks, but not when you sell. It is equal to the fundamental value of the stock at the beginning of the experiment.

Example: You have 40 stocks with an average purchase price of 22 EU. If you buy 10 stocks for 25 EU, your average purchase prices will rise from 22 to 22.6 EU.

[(40 * 22) + (10 * 25)] / (40 + 10) = 22.6 EU.

Subject profit

Each subject's profit at the end of the experiment is calculated in Experimental Units and is equal to the sum of the profits over all the 20-30 trading periods of the session. For a given period, the profit is equal to the change in the wealth.

On the basis of the final profit, each participant is assigned a rank. Your rank only depends on your trading performance. A voucher-based tournament incentive structure is used. The value of the voucher awarded is between 0 and 30 €. The table below assigns the value of the voucher.

Table A1. Ranks and vouchers

Your rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Voucher (€)	30	25	20	15	15	15	10	10	10	0	0	0	0	0

History screen

After each period, a history screen provides a short summary on the dividend and the fundamental value, your average purchase price, the closing price and your profit of the trading period (see Figure A2)

Figure A1. Trading screen (T1)

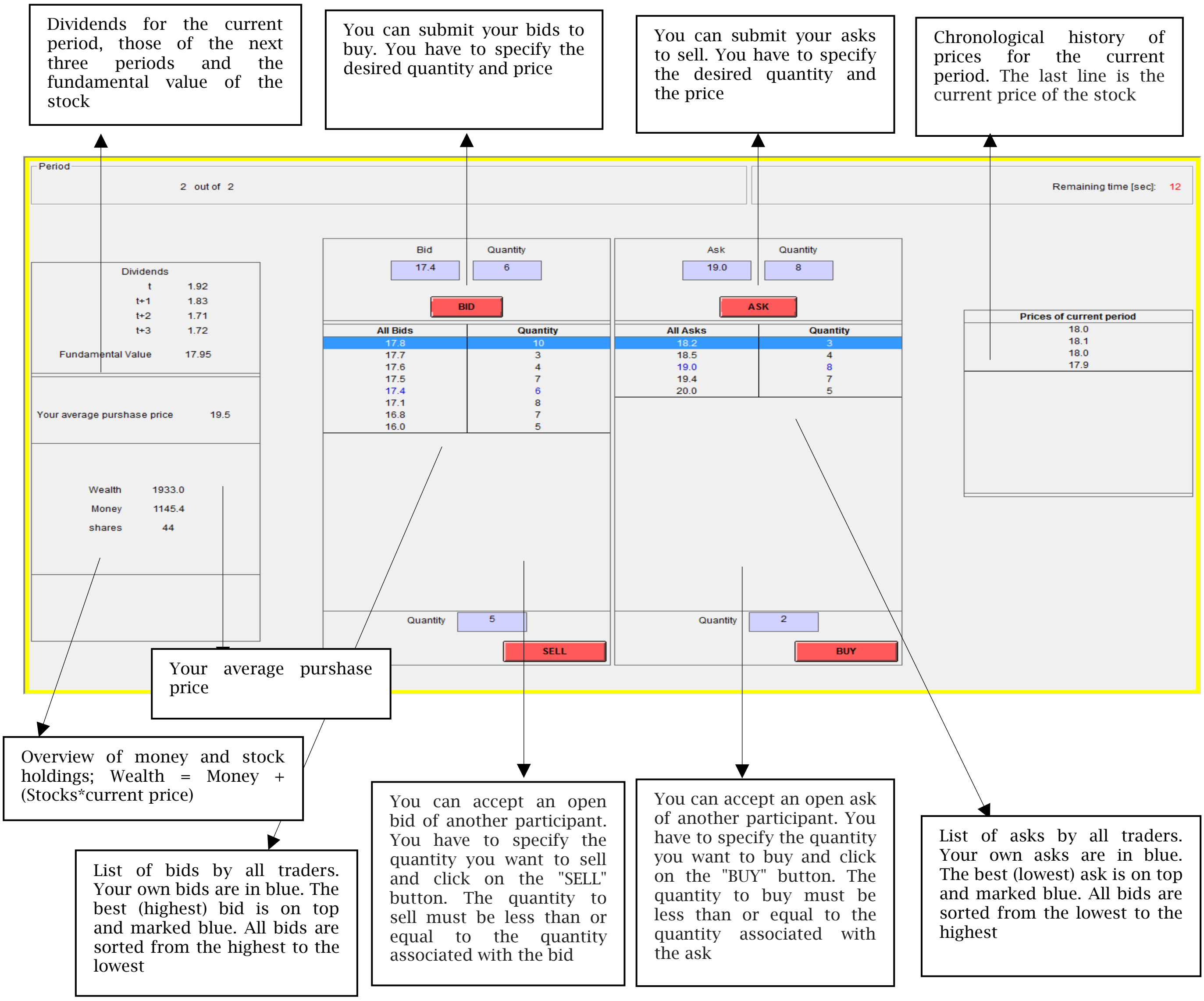
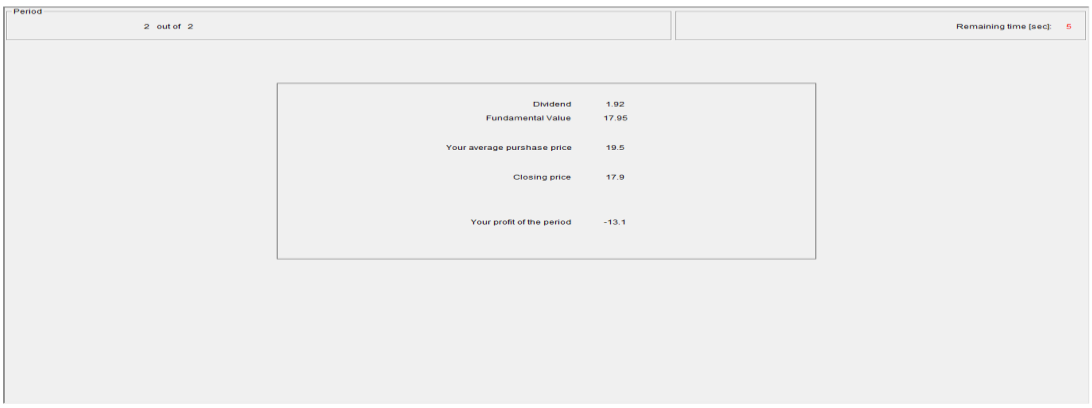


Figure A2. history screen (T1)



Experimental instructions for treatment T2

The instructions for T2 were identical to those for T1 with the exception of the dividend information level.

The only fundamental information you receive is the dividend of the stock. The dividend follows a random walk process without trend (randomly change at the beginning of each period). The dividend for the first period is around 2 EU. At the beginning of each period, each participant is informed only of the dividend for the current period. In addition to the dividend displayed on the trading screen, the fundamental value (FV) of the stock value is also provided to all participants. It is calculated using the following formula:

$$FV_t = \frac{D_t}{10\%}$$

The trading screen is above (Figure A3). The history screen is the same as Treatment T1.

Figure A3. Trading screen (T2)