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DO DIVIDEND SHOCKS AFFECT EXCESS RETURNS? AN EXPERIMENTAL STUDY**

ABSTRACT: *The dividend announcement of a company is an informational event that can cause underreaction, momentum, overreaction, post-dividend announcement drift, and mean reversion. It is the uncertainty surrounding dividend announcements that leads to such behavioural phenomena. Most authors consider that underreaction occurs after dividend shocks because new information about the dividend is being slowly and gradually built into the stock price. The effect of dividend shocks is often reflected in excess returns, which can last up to one year after the shock.*

The experiment described in this paper tests whether statistically significant excess returns are realized after a shock dividend announcement. Participants trade with the stocks of two companies, which only differ by dividend-generating stochastic process. The dividend process of Company 2 is a Merton-style jump-diffusion process (consisting of two parts: Brownian motion and Poisson jump), while the dividend process of Company 1 contains only the Brownian motion component. Statistically significant excess returns are expected when trading with Company 2 stocks. An autoregressive model is applied in order to test this hypothesis. The conclusion is that a dividend shock is followed by statistically significant excess returns in 20 of the 22 experiments, which implies that markets are inefficient after sudden and large changes in dividends. Underreaction and discount rate effects are identified.

KEY WORDS: *excess returns, dividend shock, uncertainty, experimental study, behavioural finance*

JEL CLASSIFICATION: C92, G02, G12, G14

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1. INTRODUCTION

The fundamental information that shows a company's financial health, financial position, and earnings ability includes cash flow, dividends, and earnings per share. Dividend announcements transmit important information about past, present, and expected future earnings. An increase in dividends is considered good news as it usually signals that managers are predicting that the company will generate higher cash flows in the future. By contrast, a decrease in dividends is considered bad news, since investors understand it as a decline in the earning power of the company. Significant excess returns are generated around the time of a dividend announcement because a certain amount of time is needed for the information about the sudden dividend change to be built into stock prices. Even before the dividend announcement date, positive or negative excess returns are realized because market participants form expectations and estimate the dividend amount that will be declared.

Fracassi (2008) summarizes the key ways in which dividends impact stock prices: they signal a company's performance, indicate the company's life cycle phase via free cash flow estimation, decrease agency costs, and reveal managers catering to investors who prefer dividends over capital gains (catering theory of dividends).

The behavioural characteristics of market participants, observed through their reaction to new information about dividends, include underreaction and overreaction. Barberis et al. (1998) define underreaction as the stock price's slow and delayed reaction to the information announcement, as the new information is not built into the stock price straight away but over a period of up to 12 months. As a consequence, the momentum effect appears, which means that a pattern of increasing or decreasing price movement is formed that lasts up to 1 year after the information announcement. Both underreaction and momentum are short-run phenomena. Overreaction, on the other hand, is manifested in the longer term, up to 3 to 5 years after the information announcement. The 'winners' are companies whose stock prices increase due to a positive dividend announcement, while the 'losers' experience a decrease in stock prices. Winners' stocks become overvalued at a certain point and start to bring low returns, and as a result the mean reversion phenomenon occurs.

The effect of dividend announcements on excess returns differs between markets because of different dividend tax regulations, market microstructures, the level of information asymmetry, etc. Dewenter and Warther's 1998 study compares the relationship between dividend changes and stocks' rates of return in the USA and Japan, in the context of higher levels of information asymmetry and agency conflict in the USA. The information content of dividends is lower in the USA than in Japan, so stocks' rates of return in the USA are more sensitive to dividend changes. The authors notice that in Japan dividends and their changes are more in line with changes in corporate performances than in the USA. Regarding information asymmetry, Trifunović (2008) points out that the equilibrium price has a dual role in competitive markets with asymmetrically informed agents. As in Walrasian equilibrium, price is an indicator of relative scarcity. Transmission and aggregation of agents' private information are additional roles of the equilibrium price. Each agent learns about the private information of the other agent through equilibrium price analysis, which means that their cognitive abilities are higher than those of a Walrasian agent.

The hypothesis tested in this paper is that dividend shocks, i.e., large and sudden changes in dividends, have a significant impact on stocks' excess returns. An economic experiment is designed and conducted to test this hypothesis. There are two companies with fundamentally different dividend-generating processes. Company 1 stocks have stable dividends, while in Company 2 stocks dividend shocks can occur with defined probability.

An autoregressive model, estimated by the OLS method, is implemented, with excess returns as the dependent variable. The most important explanatory variables for testing the hypothesis are lagged dummy variables. If the lagged dummy variable's coefficient estimations are positive and statistically significant, it is inferred that dividend shock has a statistically significant effect on stocks' excess returns in the following observed trading periods, and that after dividend shocks, markets are inefficient.

Using an experiment to test the efficient market hypothesis, i.e., to check whether price equals fundamental value, is both important and advantageous. Firstly, it is very hard to calculate the fundamental value of stocks in real life, for reasons such as variable discount rates, investors' different risk premia that vary through time, the difficulty of forecasting expected dividends, etc. Kirchler (2009) points out that even after decades of trying, there is no reliable and universally accepted model for calculating the fundamental value of stocks. The advantage of this experiment is that it can analyse causal relations between two or more variables while avoiding the confounding effects of external variables. In most previous experimental studies the fundamental value of stocks has been determined in one of two ways: either as a deterministically declining linear function of time, where the stocks' fundamental value is equal to the product of the remaining number of periods and the expected value of the dividend, or as a non-stationary stochastic process, which is preferable. Secondly, data for scientific research and analysis, for example, on order flow or investors' course of action in foreign exchange markets, is often impossible to obtain via field research, most often because of confidentiality issues. In such cases, experiment is valuable and the only possible method of collecting data. Thirdly, a positive aspect of experimental methodology is that it allows measuring otherwise unobservable variables, like expectations, risk attitudes, and participants' preferences and strategies.

However, experimental methodology also has several drawbacks. Firstly, participants' behaviour in an experimental lab and in real life can be very different. Motivating participants to behave in the experiment in the same way as they would in a real market situation is a challenge for researchers, who have to design the experiment to simulate reality as much as possible. Researchers face the problem that virtual money, i.e., virtual currency, is used in the experiment (experimental currency unit[1]). As a consequence, there is a risk that gambling behaviour and the house-money effect will emerge among the participants. Experimenters try to mitigate or even eliminate hazardous behaviour by letting part of the total participants' payoff vary according to their success in the experiment. Secondly, the disadvantage of experiments is that no one can become bankrupt. As we know, in reality market participants lose all their assets in the case of bankruptcy, while in the experiment they have neither losses nor gains, i.e., they break even. There are two options for experiment participants in the case of bankruptcy: either to leave the experiment or to invest a show-up fee and continue with the experiment. The disadvantage of the first option is decrease in the number of participants, which can have an adverse effect on the research's conclusions.

The rest of the paper is organised as follows. In the second section I provide a review of the literature that deals with the relationship between sudden and unexpected dividend jumps and excess stock returns. This section provides the theoretical and empirical background of the paper. The experiment design is explained in the third section. Section four presents and discusses the research results. The fifth section presents the concluding remarks. The two appendices contain the experiment instructions and additional figures.

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1 ECU = experimental currency unit. The currency used in experiments is, most often, invalid currency, such as the Gulden, Thaler, etc., which is converted into official currency by applying a predefined exchange currency rate when paying participants.

2. LITERATURE REVIEW

The literature review is divided into two parts: 1) research that studies the relationship between dividends and stock price (company's value); 2) research that focuses on the relationship between dividend shocks and excess stock returns.

2.1. Relationship between dividends and stock price

In the literature there is no consensus on the relationship between dividends and stock prices. Most authors claim that a direct relationship exists, but there are also those who claim that dividends are irrelevant to the market price and value of a company.

Graham and Dodd (1951) claim that an increase in dividends causes an increase in stock prices, resulting in a decrease in the cost of equity. Lintner (1956) considers that dividends affect a company's value, which is demonstrated by Gordon (1958) in his dividend discount model. On the other hand, Miller and Modigliani (1958) claim that dividends are irrelevant to a company's value and that financial decisions do not affect the cost of capital and the value of a company. According to this stance, dividends only have informational content and only convey information on how successful a company is in its operating and investment activities. Finally, there is the hypothesis that dividend taxation affects stocks' rate of return: an increase in dividends has a negative impact on stocks' rate of return because of the high taxes paid on cash dividends.

A significant number of papers (e.g., Pettit 1972, Aharony and Swary 1980, Miller and Rock 1985, John and Williams 1985, Charest 1978, Below and Johnson 1996) confirm the information content of dividends hypothesis (ICH): an increase in dividends affects the increase in stocks' rate of return because of reduced information asymmetry between managers and investors.

There are studies which refute the ICH, such as Watts (1973) and Black and Scholes (1974). Watts (1973) analyses whether investors can forecast a company's future earnings on the basis of past and current dividends. The period between the earnings announcement and the dividend announcement is short, so it is often very difficult to separate the effects of these two events. Watts (1973) is sceptical about the possibility of testing the ICH, since he considers it impossible to examine whether information conveyed through dividends has not already been discovered by investors through other means.

Black and Scholes (1974) consider it impossible to show whether the expected stock returns differ between stocks that have high and low dividend yields, either before or after tax. The authors claim that it is impossible to identify whether dividend policy has an effect on stock prices, and if it does, what kind of effect it has.

Hail et al. (2014) are concerned with changes in the information content of dividends when informational shocks occur. The information shocks that are considered are the mandatory adoption of international financial reporting standards (IFRS) and the adoption of laws regulating insider trading. The use of these standards and laws decreases the level of information asymmetry between managers and shareholders, so cash dividends are a less important channel for providing investors with information about the quality of a company. In such situations it is easier for managers to change the dividend policy without significantly impacting the share price.

2.2. Relationship between dividend shocks and excess stock returns

If markets are efficient, information on dividend changes should be instantly built into the price so that excess returns do not emerge. The stock price should equal the fundamental value, making it impossible to realize profit from stock mispricing.

Pettit (1972) calculates abnormal returns as the difference between stocks' realized rate of return and stocks' expected rate of return, in line with the stocks' systematic risk measured by beta coefficient. There are seven possible scenarios regarding dividends: absence of dividend payment, dividend decrease, unchanged dividends, an increase in dividends at a growth rate of up to 10%, an increase in dividends at a growth rate of between 10% and 25%, an increase in dividends at a growth rate higher than 25%, and the initial dividend payment. The companies in the sample are classified into groups according to two criteria, the amount of earnings and dividends. The author analyses the monthly abnormal performance index values[2] for each scenario regarding dividends, and separately for companies that had positive performances measured by earnings and for companies that had negative performances. The graph is given in Figure 1.

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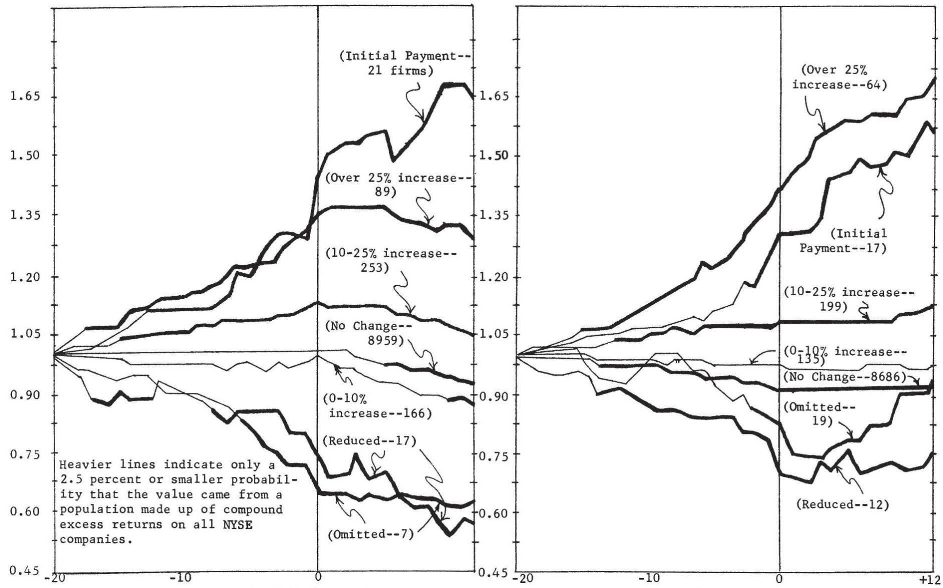
2 For more information on calculating the monthly abnormal performance index, see Pettit, R. R., (1972).

Figure 1: Abnormal Performance Index



Months Relative to Announcement — Months Relative to Announcement

Positive Earnings Performance — Negative Earnings Performance

Source: Pettit, R.R., (1972), p. 1003.

It can be seen that market participants react to information about dividend changes, especially when there are significant increases or decreases. The greatest effect of the dividend announcement on excess returns is observed in the month when the announcement occurs. Before the dividend announcement, dividend forecasting on the basis of available information results in anticipation effects. Excess stock returns continue to fluctuate randomly, so neither underreaction nor overreaction is observed. The exception is companies that are paying a dividend for the first time. Their excess stock returns continue to rise up to 12 months after the dividend announcement, which means that the market did not react instantly and completely to the initial dividend announcement.

Watts (1973) concludes that when positive dividend shocks occur there are positive abnormal price changes, and vice versa in the case of negative dividend shocks. However, he considers cumulative abnormal returns resulting from dividend shocks to be insufficient to cover the transaction costs that appear in transactions made in order to change the portfolio structure.

Aharony and Swary (1980) arrive at the following conclusions. If there were no dividend changes, the abnormal return would not be significantly different from zero, while the cumulative abnormal return would be very low. In the case of an announcement of dividend growth the abnormal return is positive, on average. In the case of a dividend decrease announcement the abnormal returns are negative, on average. Abnormal returns are statistically significant on the day of the dividend announcement and the previous day. The absolute value of an abnormal return is higher in the case of a dividend decrease announcement than in the case of a dividend increase announcement. The authors conclude that the ICH is valid and that markets are efficient in semi-strong form, since dividend changes significantly affect abnormal returns only on the dividend announcement day and the preceding day. During these two days the new dividend information is already being built into the stock price.

Charest (1978) concludes that markets are inefficient, since there are very high excess returns after the announcement of significant dividend changes, especially if there is a decrease in dividends. He notices underreaction on the New York Stock Exchange, since the market is not able to instantly process all the dividend information. He observes companies that had stable dividends over a period of two years, followed by a sudden change in dividends. Companies that announced an increase in dividends recorded significantly positive abnormal returns, and vice versa for companies that announced a decrease in dividends. The absolute value of abnormal returns is higher in the case of dividend decrease.

Benesh et al. (1984) and Eades et al. (1985) conclude that a dividend decrease has a stronger effect on changes in stock prices and stock returns than a dividend increase. This is because managers will decrease dividends as a last resort if negative future performance is expected, so a decrease in dividends is an informationally richer event than an increase in dividends. Benesh et al. (1984) conclude that, regarding positive dividend changes, the strongest market reaction is recorded in cases of initial dividend announcements and when dividends are paid again after a long period of time. In such cases, abnormal returns are high because these dividend changes are least expected by the market.

De Bondth and Thaler (1985) and Chopra, Lakonishok, and Ritter (1992) examine whether financial markets overreact to unexpected information and whether potential overreaction has an effect on stock returns after adjustment for size and systematic risk. De Bondth and Thaler (1985) conclude that stock losers outperform stock winners after a period of 3 years. Chopra, Lakonishok, and Ritter (1992) find that after 5 years the portfolios of stock losers statistically significantly outperform the portfolios of stock winners, at a an annual level of 5% to 10%. Investors are prone to overestimate recent events and information (representativeness heuristic) but to underestimate earlier fundamental data (base rate neglect). They are very often myopic, so required returns are based on current earnings to a greater extent than on long-term dividend forecast. Using a database that covers 1871 to 1978, Shiller (1988) notices that stock prices are more volatile than dividends, so dividend changes cannot sufficiently explain stock price changes.

Dhillon and Johnson (1994) analyse the impact of dividend changes on stock and bond prices and test the information content of both the dividend hypothesis and the wealth redistribution hypothesis for shareholders and bondholders. The ICH tells us that after the announcement of a dividend increase, bond prices should increase, while the wealth redistributon hypothesis says that the bond price will decrease. The authors find that after a sudden dividend jump, stock prices rise while bond prices fall, and vice versa. When there is sudden dividend drop, stock prices fall, while bondholders earn significant excess returns. Dhillon and Johnson (1994) conclude that their findings are in accordance with the wealth redistribution hypothesis.

Below and Johnson (1996) analyse stock price reaction to increases and decreases in dividends, depending on the market phase, i.e., whether it is a bull or bear market. They find that abnormal returns are the highest when investors are most surprised: when there is a dividend decrease in bull markets and when there is a dividend increase in bear markets.

Lee (1995) analyses the effects of temporary and permanent dividend shocks on changes in stock price. He concludes that stock price reacts significantly to both types of shock: the initial reaction to the temporary shock is as strong as to the permanent shock. Investors are often unable to separate temporary changes in dividends from permanent changes, so imperfect dividend information leads to excessive volatility in stock returns.

Forni et al. (2016) find that investors are often unable to separate dividend shock from noise shock, so react to both. Noise shock does not have anything to do with changes in a company's fundamental indicators. The authors notice that noise is often one of the main causes of price bubbles, as in the dotcom bubble. Investors were enthusiastic about new technology and expected that dotcom companies would be very profitable, so prices rose due to self-fulfilling expectations. However, many of the companies made losses and never paid dividends, so the price bubble was entirely the consequence of noise shock. When investors realized that the companies would not pay dividends and that most of them were speculative and not even close to profitable, as had been believed, and that most of them generated losses, the price bubble burst. The dotcom bubble is an interesting example of a significantly negative dividend shock, in terms of the total absence of dividends, and of a shock's impact on stock prices.

Cochrane et al. (2008) use the methodology of two Lucas (1978) trees with identical and independent distributions, thus considering two trees instead of one and introducing interesting dynamics into the model. In the case of my experiment, Company 2 represents one tree, while the second tree corresponds to Company 1. The size of both trees is fixed, which means that stock supply is fixed.

When there is change in dividends, investors rebalance their portfolios, which causes stock prices to change. If the percentage of dividends given by one tree increases, its expected return rises. Positive dividend shock causes a rise in current prices and returns, but also affects the rise in future expected returns. Returns are excessively volatile. A positive dividend shock of one stock drives a decrease in the portfolio weight of the second share and a decrease in its expected return. During the share valuation process, investors perceive the second share to be less valuable in comparison to the whole market, although its fundamentals have not changed. The discount rate effect appears, because the investors' attention is completely focused on the stock whose dividends suddenly rose.

In repeated sessions in an experimental environment, with experienced participants who have already participated in two experiments, Hussam et al. (2008) test whether dividend shocks cause rational price bubbles and whether price bubbles can restart. They conclude that dividend shocks can cause price bubbles even when participants are experienced. Stock turnover was high in experiments with both experienced and inexperienced participants; prices were high; while the duration of bubbles was a little bit shorter in the experiments with experienced participants. Dividend shock was created in the following way: after two experiments where the dividend could take one of the following values {0, 8, 28, 60} with equal probability, the third experiment had a new experimental design: the dividend could take one of the following five values {0, 1, 8, 28, 98} with equal probability. The expected value of the dividend increased slightly, from 24 to 27, while the variance increased significantly, from 715 to 1,966. It is obvious that after the dividend shock the participants needed time to adjust to the new environment and that experience can decrease price bubbles only in stable environments without shocks.

3. EXPERIMENT SETUP

It is very important to design the experiment so that it resembles reality as much as possible, and to simultaneously control the research, specify explanatory and dependent variables, eliminate the impact of external variables on the dependent variable, and achieve internal and external validity of the experiment. It is also important to determine the number of sessions, periods, and participants in the experiment. It is especially important to find a way to motivate participants to behave realistically so that the experiment results are externally valid. The experiment was programmed and conducted with z-Tree 3.5.1. by Fischbacher (2007), which is client-server software developed to implement economic experiments. In order to analyse the relationship between dividend shock and excess returns, two companies have stocks in the experiment market: Company 1 stocks have more stable dividends and serve as a control asset, while Company 2 stocks can expect to experience dividend shocks.

3.1. The experiment stock market

The experiment simulates trading in stocks on the stock exchange by the continuous trading method. Participants may submit market and/or limit orders, and matching is done in real time. Several orders can be submitted during one period. Orders can be cancelled. Participants can choose to invest in three available investment alternatives: 1) stock of Company 1; 2) stock of Company 2; 3) savings deposits. The only difference between the two companies is the stability of dividend payments. The participants do not know the probability of dividend payments, the amount of dividends that will be paid, or any parameter of the stochastic process generating dividends. They only know that Company 1 stock pays stable dividends, while Company 2 dividends are more volatile, so they trade in conditions of uncertainty. The dividends are generated by a stochastic, non-stationary process, according to the following formulae:

Company 1 stocks:

$$d_t = d_{t-1} * (1 + \mu * \Delta t + \sigma * \sqrt{\Delta t} * e_t) \tag{1}$$

Company 2 stocks:

$$d_t = d_{t-1} * (1 + \mu * \Delta t + \sigma * \sqrt{\Delta t} * e_t) + [J_t - \lambda * \Delta t] * k \tag{2}$$

where d_t = dividend in period t; d_{t-1} = dividend in period $t-1$; $\Delta t = 0.25$ (duration of a period in which dividend change is recorded); $\mu_1 = \mu_2 = 5\%$ (drift);

$\sigma_1 = \sigma_2 = 20\%$ (standard deviation of a process); $\lambda = 0.1$ (coefficient); $k = 100\%$ (jump in percentages); d_0 = 50 ECU (initial value of a dividend); J_t = jump indicator, where jump occurs with a probability equal to $\lambda * \Delta t$. Thus, stochastic processes that generate dividends have the same diffuse component for both stocks (Brownian motion process), while the dividend process for Company 2 stock has a Poisson jump in addition. From formulas (1) and (2) it can be concluded that the expected value of both processes is the same. However, the experiment lasts for a limited number of trading periods, not to infinity. The probability of a jump is $\lambda * \Delta t$ which equals 2.5% in this example when the jump indicator takes the value of 1, and 0 in all other cases. Therefore it is possible that a dividend jump never happens during the experiment, or that it happens once or several times, but in all other periods, when J_t takes the value of 0, the second component of the dividend process decreases the Stock 2 dividend. From all the abovementioned it can be concluded that Company 2 stock is a riskier investment. Dividend shocks are permanent: after a dividend jump the dividend continues to stochastically oscillate around a new higher level, which can be concluded from formula (2). Dividends are paid to participants at the end of each trading period.

The experiment has two treatments, where the only difference is the interest rate. The treatment that represents expansionary monetary policy has an interest rate of 1%, while the treatment that represents contractionary monetary policy has an interest rate of 7%. During a treatment the interest rate remains constant. At the beginning each participant has the same endowment, which consists of 50,000 ECU and 20 shares in both companies. Participants can borrow from banks and pay interest. The maximum loan amount is 40% of the initial endowment, or 20,000 ECU. If the loan is taken as a cash overdraft, participants can be in the red for a maximum of three consecutive time periods, which is the maximum repayment period. Therefore, experiment participants must settle their obligations to the bank in a timely fashion. If participants cannot get out of the red they become bankrupt and sell market orders are automatically submitted for all their stocks, so there is a fire sale. When a participant's cash account balance becomes positive, the participant becomes active in the experiment again. Participants who ensure liquidity of the stock exchange in this way are sometimes unjustifiably called irrational investors. The decision to borrow is usually rational, caused by their intention to realize positive financial leverage. The decision to sell shares even at low market prices is not caused by their inability to make rational economic decisions: rather, due debts force them to behave in this way.

Interest on savings is paid into a cash account after each trading period in which the account balance is positive after matching stock exchange orders. Hence, a positive cash account balance is automatically treated as savings. Since in the same trading period the cash account balance can be either positive or negative, which means that it is impossible to simultaneously save and borrow, there is no difference between active and passive interest rates because the bank's profit is irrelevant to this research. Thus the interest rate received on savings is equal to the interest rate paid on debts.

The participants' goal is to maximize cumulatively realized profit, so they change the initial portfolio structure through trading on the experiment stock market. It is expected that their decisions will depend on whether they trade with Company 1 or Company 2 stocks, whether a dividend shock occurs or is expected, and whether monetary policy is contractionary or expansionary. Participants can make a profit in the experiment through three channels: 1) dividends, 2) interest on savings, and 3) realized capital gains.

3.2. Experiment participants and method of motivation

The experiment participants were undergraduate students in their third or fourth (final) years of study and Masters students at the Faculty of Economics, University of Belgrade, who had taken courses in Corporate Finance, Financial Markets, and/or Security Analysis. Some prior knowledge of these fields was necessary to understand the experiment design and the way the experiment stock exchange functioned.

A market consisted of 20 participants and thus sufficient traders to ensure adequate liquidity in the experiment stock exchange. The experiment was repeated 11 times with an interest rate of 1%, each time with 20 different participants. The experiment was also repeated 11 times with an interest rate of 7%, each time with 20 different participants. However, the same 20 students participated in both treatments, so the total number of participating students was 220.

To motivate the participants in the experiment, each participant received a fixed show-up fee of 200 RSD. A second amount of money was dependent on their success in the experiment, measured by the cumulatively realized profit. The total amount of money paid to participants was 116,600 RSD.

3.3. Experiment implementation

The experiment was conducted in two phases: 1) trial experiment, and 2) final experiment. All students participated in both phases of the experiment, so their participation in the experiment was uniform. The trial phase of the experiment necessarily had several sub-phases, because experimental economics is still in its early stages in Serbia, the students had not had the opportunity to participate in either experimental stock exchange simulation or the real stock exchange, and in Serbia the legal form of public limited company has a short history. First, the participants were given experiment instructions that they studied on their own, after which the instructions were thoroughly explained by the experimenter in an interactive environment. The basic idea of the first trial experiment was to familiarize participants with the experiment environment, experiment laboratory, and z-Tree software. They then traded for between 15 and 20 trading periods. The second trial experiment took place a few days later, since the ultimate goal of the trial experiments was to train participants to take part in the research and to eliminate confounding variables such as participants' confusion, disorientation in the experimental environment, misunderstanding of the experiment rules, etc.

Finally, the experiments were conducted whose data is analysed and interpreted in the fifth section of this paper. The duration of one treatment was between 80 and 90 trading periods, each trading period lasting between 40 and 50 seconds. Both the treatment and the trading period ended randomly, with the aim of reducing the possibility of participants adapting their portfolio optimization strategy by knowing when the session ended and of eliminating the possibility of using the backward induction method.[3] The information relevant to decision-making was displayed to participants during and after each trading period. At the end of the experiment, participants were asked to complete a questionnaire, aimed at estimating and understanding their strategies in the profit maximization process.

3.4. Internal and external validity of the experiment

The internal validity of the experiment, i.e., the existence of a basis for drawing conclusions regarding the causal relationship between the study variables, is provided by controlling the external variables, which may adversely affect the research results. Repetition and counterbalancing were used as control techniques. Repetition means that the same group of subjects participated in both treatments, so each participant controlled himself/herself and both treatments were uniform in terms of participants' characteristics.

3 The backward induction method first defines the solution to the final stages, i.e., participants define strategies for the last trading period. They then go back to the beginning of the experiment period by period, forming optimal choices for previous periods up to first trading period.

Inter-subjective counterbalancing was applied in order to avoid confounding sequential variables having a negative impact, i.e., the order of treatments impacting on the dependent variable. Half of the participants passed first through the contractionary monetary policy treatment and then through the expansionary monetary policy treatment, and vice versa for the other half.[4] The dividend is the only fundamental measure that affects share price, so the expected excess return of Company 2's stocks should be a consequence of its dividend shocks. The unobservable variable problem is reduced or even eliminated, thus facilitating testing the existence of a rational bubble. Homogenization is achieved by holding all other variables in the experiment (initial endowment of money, initial endowment of stocks, maximum loan amount) constant, while only the independent variable, i.e., the interest rate, varies. The dependent variable is the stock price.

External validity, i.e., the basis for generalizing the research results from the sample to the population and from specific to different conditions and procedures, is provided via: 1) the motivation of the participants in the experiment, 2) an experiment design which simulates reality as much as possible, and 3) statistical tests of significance.[5]

4. RESULTS AND DISCUSSION

In the treatment where the interest rate was 1% the dividend jump for Company 2 stocks occurred in the 21st period, when the dividend per share increased from 51 ECU to 148.38 ECU. This is a huge jump of 97.38 ECU in absolute value and 191% in relative value. It was expected that most of the experiment participants would notice the dividend shock either immediately or after a few periods. It was also expected that the shock would have a significant impact on excess returns. Since the shock occurred in the 21st period and the experiment lasted 80 to 90 periods, it was logical that participants would expect the shock to happen again, once or several times. When results are analysed the excess returns caused by this kind of self-fulfilling expectation are often noticed in the later periods. In the 7% interest rate treatment two dividend shocks occurred. In the 21st period the dividend increased from 26.39 to 48.39 ECU, i.e., by 22 ECU or 83.36%. In the 39th period the dividend per share grew from 39.58 to 75.24 ECU, i.e., by 35.66 ECU, which is a growth of 90.1%. There were two jumps in this treatment, but they were smaller than in the 1% interest rate treatment.

4 Todorović, D., (2008). *Metodologija psiholoških istraživanja.* Centar za primenjenu psihologiju, Beograd, Srbija, p. 97-98.

5 Ibid, p. 84.

The dependent variable is Company 2 stock excess returns, defined as the difference between the Stock 2 rate of return (*rS2*) and Stock 1 rate of return (*rS1*) in the basic regression. The experiment participants focused on the data concerning dividends per share and both companies' stock prices. This approach to defining excess returns was chosen to see how much higher Stock 2 returns were than Stock 1 returns, since a Company 2 dividend shock occurred or was expected. The data was transformed logarithmically. Excess returns, as the dependent variable (ExR2), is regressed on the following explanatory variables: lagged values of Stock 1 and Stock 2 dividend growth rates, i.e., *rD1* and *rD2* respectively, lagged values of Stock 1 and Stock 2 rates of return, i.e., growth rates (*rS1* and *rS2* respectively), lagged values of the dependent variable (*ExR2*) and lagged values of the dummy variables (*v1* and *v2*):

$$\begin{aligned} ExR2_t = {} & \alpha + \beta_1{*}rD1_{t-1} + \beta_2{*}rD1_{t-2} + \ldots \beta_k{*}rD1_{t-k} + \gamma_1{*}rD2_{t-1} + \gamma_2{*}rD2_{t-2} + \ldots \\ & + \gamma_k{*}rD2_{t-k} + \delta_1{*}rS1_{t-1} + \delta_2{*}rS1_{t-2} + \ldots \delta_k{*}rS1_{t-k} + \eta_1{*}rS2_{t-1} + \eta_2{*}rS2_{t-2} + \ldots \\ & + \eta_k{*}rS2_{t-k} + \varphi_1{*}v1_{t-1} + \varphi_2{*}v1_{t-2} + \ldots \varphi_k{*}v1_{t-k} + \psi_1{*}v2_{t-1} + \psi_2{*}v2_{t-2} + \ldots + \\ & + \psi_k{*}v2_{t-k} + \omega_1 ExR2_{t-1} + e_t \end{aligned} \tag{3}$$

where α, β_1, β_2, …, β_k, γ_1, γ_2, …, γ_k, δ_1, δ_2, …, δ_k, η_1, η_2, …, η_k, φ_1, φ_2, …, φ_k, ψ_1, ψ_2, …, ψ_k i ω_1 are regression parameters, *k* is the number of lags, and e_t is the stochastic error term. Lagged values of dividend growth rates are used because the information about the dividend in some period is known at the end of the period, so the information can only affect the experiment participants' decisions in the following period(s). Lagged values of stock price growth rates are included in the regression equations, since prices from the previous period(s) often have an effect on the current period price. In the 1% interest rate treatment there is a dummy variable for the 21st period (*v1*), while in the 7% interest rate treatment there are two dummy variables, one for the 21st period (*v1*) and the other for the 39th period (*v2*). The dummy variable takes the value of 1 in the periods when a dividend shock occurs and the value of 0 in all other periods. It is expected that the dividend jump will affect excess returns not only in the following period but also in the several next periods. As dividends are announced in each period, so the reaction of excess returns to the dividend shock may be different to the reaction in the case of dividend announcements on a quarterly or annual basis. Thus, excess returns could be expected in non-consecutive time periods. It is possible to estimate regression equations using the OLS method, since the time series are given in their stationary form of growth rates or differences between growth rates. The results of regression estimations are given in Tables 1 and 2.

Table 1: Effects of dividend shocks on Company 2 stock excess returns, r = 1%

r = 1%				
Experiment ID	Variable	Coefficient	t-value	p-value
1	constant	0.0058	-0.40	0.69
	rD1(-1)	-0.2996	-2.47	0.02**
	rD2(-1)	0.1956	2.75	0.008***
	V1(-5)	0.2818	2.22	0.03**
	V3	0.3643	2.89	0.005***
	V4	-0.3584	-2.88	0.005***
	S= 0.1231;Q(12) = 11.68 (0.47); JB = 0.20 (0.91); SC = -1.0901; R^2 = 0.38; adjR^2 = 0.34			
2	constant	0.0023	0.17	0.87
	rD1(-1)	-0.4338	-3.81	0.00***
	rD2(-1)	0.2566	3.69	0.00***
	rD1(-2)	-0.5223	-4.04	0.00***
	rS2(-2)	0.3206	2.88	0.005***
	V3	0.4733	3.66	0.00***
	S= 0.1209; Q(12) = 12.92 (0.38); JB = 3.50 (0.17); SC = -1.1450; R^2 = 0.40; adjR^2 = 0.37			
3	constant	-0.0189	-1.26	0.21
	rD1(-1)	-0.4590	-3.68	0.00***
	rD2(-1)	0.3002	4.10	0.00***
	rS2(-1)	0.2302	1.86	0.07*
	V1(-7)	0.3006	2.44	0.02**
	V1(-9)	0.2136	1.69	0.097*
	V1(-12)	0.2750	2.21	0.03**
	S = 0.1204; Q(12) = 15.18 (0.23); JB = 0.15 (0.93); SC= -1.0732; R^2 = 0.47; adjR^2 = 0.42			
4	constant	0.0198	1.15	0.25
	rD1(-1)	-0.5944	-4.15	0.00***
	rD2(-1)	0.2115	2.52	0.014**
	rS2(-2)	0.2658	2.35	0.02**
	rD1(-3)	-0.2548	-1.80	0.08*
	V3	-0.5220	-3.41	0.00***
	S = 0.1507; Q(12) = 3.94 (0.98); JB = 0.22 (0.90); SC = -0.6936; R^2 = 0.39; adjR^2 = 0.35			

r = 1%				
Experiment ID	Variable	Coefficient	t-value	p-value
5	constant	-0.0157	-0.97	0.33
	rD1(-1)	-0.4867	-3.60	0.00***
	rD2(-1)	0.1499	1.94	0.06*
	EXR2(-2)	-0.2203	-2.16	0.03**
	V1(-3)	0.2834	2.07	0.04**
	V1(-10)	0.3813	2.75	0.008***
	S = 0.1356; Q(12) = 12.66 (0.39); JB = 0.55 (0.76); SC = -0.8944; R^2 = 0.32; adjR^2 = 0.27			
6	constant	0.0035	0.21	0.83
	rD1(-2)	-0.3624	-2.65	0.0099***
	rD2(-2)	0.2161	2.86	0.006***
	V1(-8)	0.3038	2.11	0.04**
	V1(-9)	0.2542	1.76	0.08*
	V3	-0.4993	-3.49	0.00***
	V4	-0.4132	-2.87	0.005***
	S = 0.1416; Q(12) = 15.70 (0.21); JB = 1.13 (0.57); SC = -0.7744 ; R^2 = 0.37; adjR^2 = 0.32			
7	constant	-0.0082	-0.52	0.61
	rD1(-1)	-0.2910	-2.28	0.03**
	rS2(-1)	0.4163	3.75	0.00***
	EXR2(-2)	-0.2577	-2.51	0.015**
	V1(-4)	0.4216	3.11	0.00***
	V1(-8)	0.3822	2.79	0.007***
	S = 0.1322; Q(12) = 8.06 (0.78); JB = 2.02 (0.36); SC = -0.9414; R^2 = 0.39; adjR^2 = 0.34			
8	constant	-0.0018	-0.13	0.90
	rD1(-1)	-0.2856	-2.43	0.018**
	rD2(-1)	0.3656	4.75	0.00***
	rD1(-2)	-0.3788	-2.86	0.006***
	rS2(-2)	0.2006	1.92	0.06*
	V1(-7)	0.2749	2.23	0.03**
	V3	-0.3535	-2.73	0.008***
	S = 0.1202; Q(12) = 9.31 (0.68); JB = 0.74 (0.69); SC = -1.0968; R^2 = 0.46; adjR^2 = 0.41			

r = 1%				
Experiment ID	Variable	Coefficient	t-value	p-value
9	constant	0.0028	0.27	0.79
	rD1(-1)	-0.1774	-2.03	0.046**
	rD2(-1)	0.1061	2.10	0.04**
	rD2(-3)	0.0883	1.72	0.09*
	V1(-2)	0.2042	2.25	0.03**
	V1(-4)	0.1723	1.88	0.06*
	V1(-6)	0.2274	2.46	0.02**
	V3	-0.3762	-5.79	0.00***
	S = 0.0902; Q(12) = 10.07 (0.61); JB = 0.05 (0.98); SC = -1.6344; R^2 = 0.49; adjR^2 = 0.44			
10	constant	-0,.027	-0.18	0.86
	rD1(-1)	-0.3339	-2.69	0.009***
	rD2(-1)	0.2756	3.74	0.00***
	rD2(-2)	0.1961	2.87	0.005***
	rS2(-3)	0.6668	3.48	0.00***
	EXR2(-3)	-0.3878	-2.21	0.03**
	V1(-3)	0.2235	1.67	0.0997*
	V3	0.4072	2.82	0.006***
	S = 0.1330; Q(12) = 14.37 (0.28); JB = 0.20 (0.90); SC = -0.8780; R^2 = 0.37; adjR^2 = 0.31			
11	constant	0.0068	0.46	0.64
	rD1(-1)	-0.2973	-2.46	0.02**
	rD2(-1)	0.2106	3.00	0.00***
	V1(-7)	0.2173	1.70	0.09*
	V3	-0.3460	-2.72	0.008***
	S = 0.1255; Q(12) = 8.41 (0.75); JB = 0.95 (0.62); SC = -1.0976; R^2 = 0.24; adjR^2 = 0.20			

Notes: The asterisks ***, **, and * indicate 1%, 5%, and 10% significance levels respectively. OLS regression results are shown.
Source: Results of the experiment analysis conducted by the author in EVIEWS software

Table 2: The effects of dividend shocks on Company 2 stock excess returns, r = 7%

r = 7%				
Experiment ID	Variable	Coefficient	t-value	p-value
1	constant	0.0057	0.37	0.71
	rD1(-1)	-0.4822	-3.07	0.00***
	rD2(-1)	0.3047	2.86	0.00***
	rS2(-1)	0.2651	1.73	0.09*
	V2(-2)	0.2972	2.15	0.03**
	V3	-0.3749	-2.72	0.008**
	S = 0.1345; Q(12) = 10.26 (0.59); JB = 2.60 (0.27); SC = -0.9261; R^2 = 0.36; adjR^2 = 0.32			
2	constant	-0.0005	-0.36	0.72
	rD1(-1)	-0.6087	-3.75	0.00***
	rD2(-1)	0.3187	2.96	0.00***
	rD2(-3)	0.2364	2.19	0.03**
	rD2(-4)	0.2419	2.23	0.03**
	V2(-5)	0.2532	1.80	0.08*
	S = 0.1387; Q(12) = 15.94 (0.19); JB = 1.71 (0.42); SC = -0.8651; R^2 = 0.35; adjR^2 = 0.30			
3	constant	-0.0032	-0.19	0.85
	rD1(-1)	-0.7328	-4.17	0.00***
	rD2(-2)	0.3219	2.75	0.008***
	EXR2(-3)	0.2745	2.74	0.008***
	V2(-3)	0.3421	2.13	0.04**
	S = 0.1503; Q(12) = 4.83 (0.96); JB = 0.17 (0.92); SC = -0.7373; R^2 = 0.33; adjR^2 = 0.30			
4	constant	0.0021	0.11	0.92
	rD1(-1)	-0.4089	-1.91	0.06*
	rS2(-1)	0.5470	4.22	0.00***
	V1(-1)	0.3160	1.75	0.08*
	V1(-7)	0.3355	1.86	0.07*
	S = 0.1788; Q(12) = 14.36 (0.28); JB = 1.27 (0.53); SC = -0.3989; R^2 = 0.26; adjR^2 = 0.22			

r = 7%				
Experiment ID	Variable	Coefficient	t-value	p-value
5	constant	-0.0143	-1.01	0.32
	rD1(-1)	0.8478	-5.86	0.00***
	rD2(-1)	0.3047	3.15	0.00***
	rS1(-1)	-0.3669	-2.83	0.006***
	rD2(-2)	0.2214	2.31	0.02**
	V2(-4)	0.2657	2.15	0.04**
	V3	0.5345	4.33	0.00***
	S = 0.5696; Q(12) = 12.97 (0.37); JB = 2.50 (0.29); SC = -1.0771; R^2 = 0.57; adjR^2 = 0.53			
6	constant	-0.0236	-1.32	0.19
	rD1(-1)	-0.3378	-1.81	0.07*
	V2(-5)	0.3856	2.54	0.013**
	V2(-8)	0.2624	1.72	0.09*
	V2(-9)	0.3356	2.21	0.03**
	V3	-0.4123	-2.69	0.009***
	S = 0.1503; Q(12) = 10.59 (0.56); JB = 2.17 (0.34); SC = -0.6901; R^2 = 0.28; adjR^2 = 0.22			
7	constant	-0.0173	-1.10	0.27
	rD2(-1)	0.3667	3.57	0.00***
	rS2(-1)	0.2913	2.80	0.007***
	V1(-5)	0.4144	3.05	0.00***
	V2(-2)	0.2867	2.09	0.04**
	V2(-6)	0.2721	1.97	0.052*
	S = 0.1347; Q(12) = 15.64 (0.21); JB = 2.11 (0.35); SC = -0.9212; R^2 = 0.36; adjR^2 = 0.32			
8	constant	-0.0172	-1.05	0.30
	rD1(-1)	-0.5503	-3.24	0.00***
	rD2(-1)	0.4510	4.06	0.00***
	rD2(-3)	0.3029	2.69	0.009***
	rS2(-3)	0.2413	1.78	0.08*
	V1(-2)	0.3956	2.69	0.009***
	V1(-5)	0.2501	1.71	0.09*
	V2(-2)	0.5043	3.46	0.00***
	S = 0.1400; Q(12) = 15.13 (0.23); JB = 0.16 (0.92); SC = -0.7527; R^2 = 0.49; adjR^2 = 0.43			

r = 7%				
Experiment ID	Variable	Coefficient	t-value	p-value
9	constant	-0.0084	-0.60	0.55
	rD2(-1)	0.5375	5.52	0.00***
	rS1(-1)	-0.3841	-2.93	0.00***
	rD1(-3)	-0.4971	-3.42	0.00***
	V1(-4)	0.2261	1.75	0.08*
	S = 0.1279; Q(12) = 10.94 (0.53); JB = 1.50 (0.47); SC = -1.0749 ; R^2 = 0.40; adjR^2 = 0.37			
10	constant	-0.0195	-1.09	0.28
	rD2(-1)	0.3339	2.83	0.006***
	V2(-2)	0.4600	2.97	0.00***
	V1(-9)	0.3213	2.09	0.04**
	S = 0.1525; Q(12) = 16.48 (0.17); JB = 2.08 (0.35); SC = -0.7481; R^2 = 0.24; adjR^2 = 0.21			
11	constant	-0.0087	-0.63	0.53
	rD1(-1)	-0.5860	-3.999	0.00***
	rD2(-1)	0.2014	2.12	0.04**
	V1(-2)	0.4809	3.96	0.00***
	V2(-4)	0.2449	1.998	0.049**
	V1(-7)	0.2048	1.68	0.096*
	V3	-0.4543	-3.69	0.00***
	S = 0.1204; Q(12) = 12.22 (0.43); JB = 2.03 (0.36); SC = -1.1059; R^2 = 0.46; adjR^2 = 0.42			

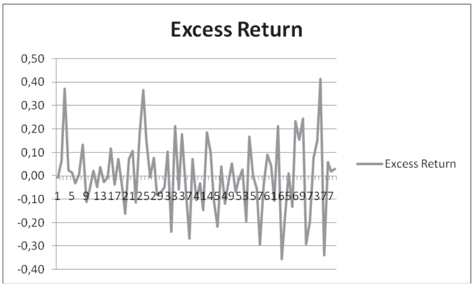
Notes: The asterisks ***, **, and * indicate 1%, 5%, and 10% significance levels respectively. OLS regression results are shown.
Source: Results of the experiment analysis conducted by the author in EVIEWS software

From the previous two tables it can be concluded that after a dividend jump announcement, dividend shock significantly positively affected excess returns in several periods in 9 out of 11 experiments when the interest rate was 1%, and in all experiments when the interest rate was 7% – the dummy variables' coefficients are positive and statistically significant. The result is intuitively clear: after a dividend shock there is a significant increase in demand for Company 2 stocks, which effects an increase in their excess returns. My interpretation of the dummy variable coefficient estimation, e.g., in experiment ID 5 with 1% interest rate, is that dividend shock effects an increase in the excess returns level of 28.34 percentage points on average in the third period after the dividend shock. When the value of this coefficient estimation is added to the constant estimation the new level of the excess returns time series in the third period after the shock is

26.77%. The number of trading periods in which dividend shock significantly affects stock returns differs from experiment to experiment: it can be one, two, or even three, often non-consecutive trading periods. There are two dividend shocks in the 7% interest rate treatment. Excess returns sometimes appear after only one of the two shocks, and sometimes after both dividend shocks. The quality of the regression model is solid in all 22 experiments. It is estimated on the basis of the following information: standard error of the regression (S), Box-Ljung statistic on the 12th lag (Q12), Jarque-Bera statistic (JB), Schwarz information criterion (SC), coefficient of determination (R^2), and adjusted coefficient of determination (adjR^2).

Plots of excess returns as a function of the number of trading periods in both treatments in all experiments are shown in Figures 2 and 3.

Figure 2: Excess returns as a function of number of trading periods, r=1%



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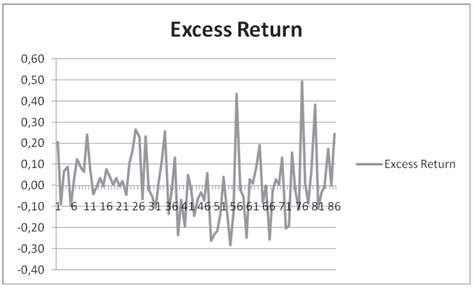

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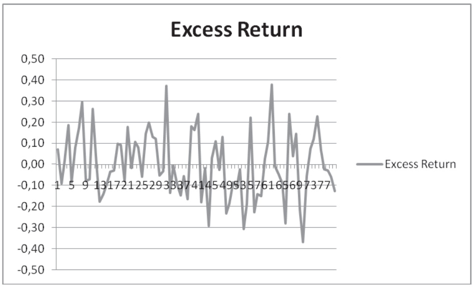

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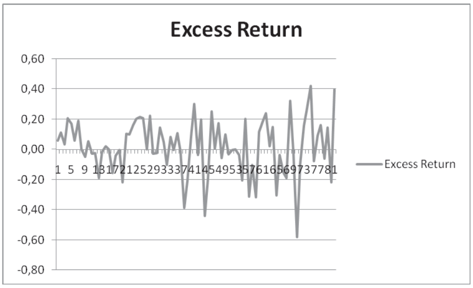

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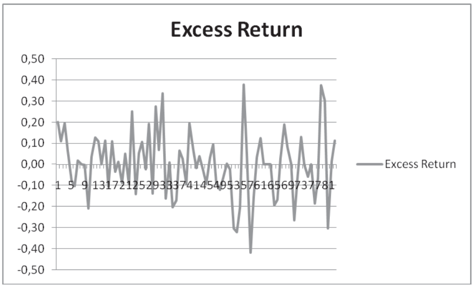

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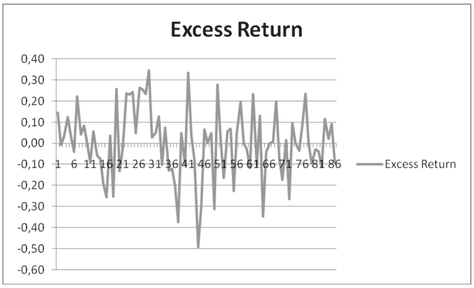

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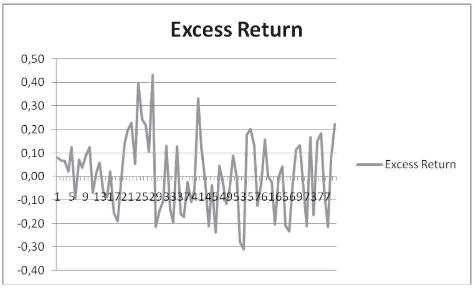

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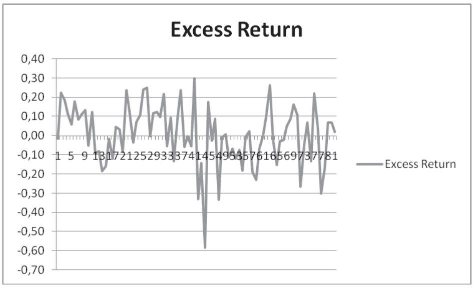

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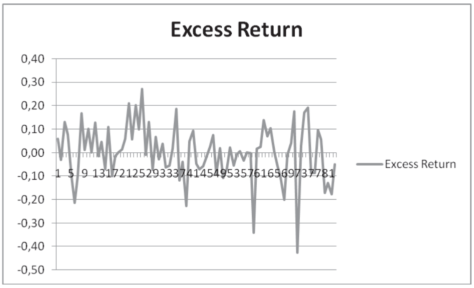

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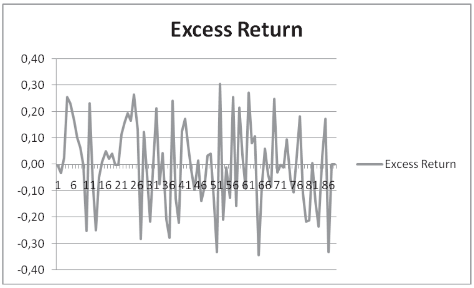

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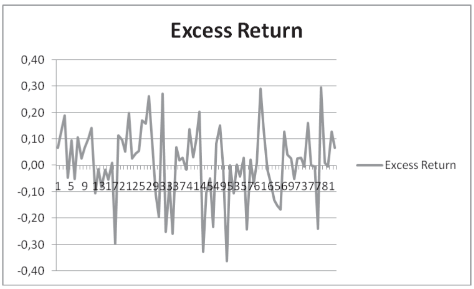
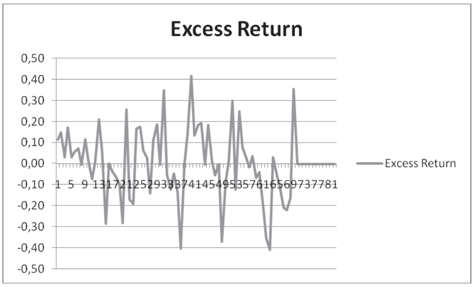


Experiment ID = 11

Source: Outputs of experiment conducted and analysed by the author

Figure 3: Excess returns as a function of number of trading periods, r=7%



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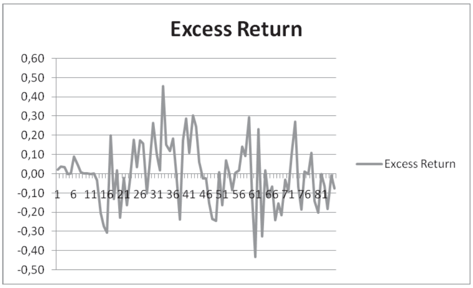

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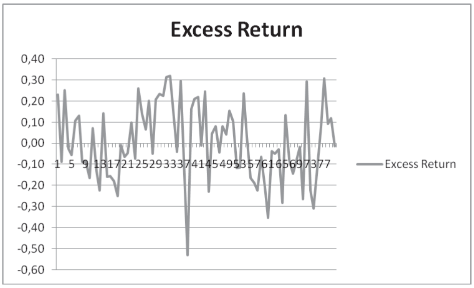

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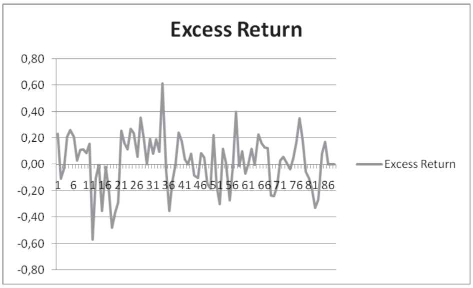
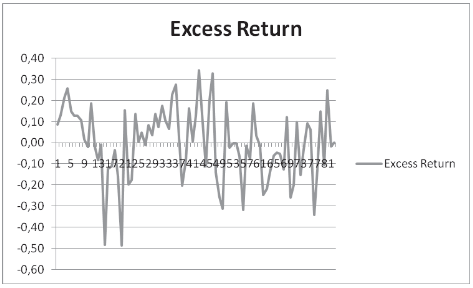


Experiment ID = 4

Experiment ID = 5



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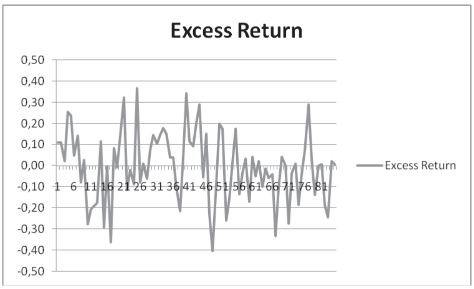

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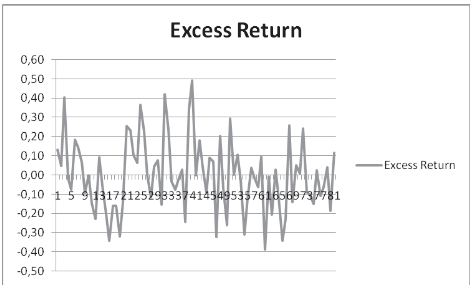

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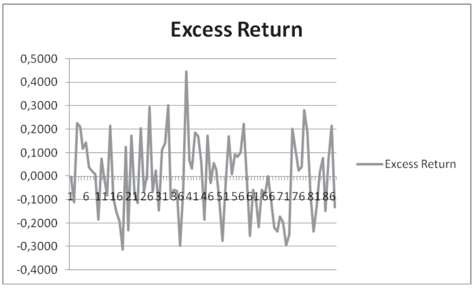

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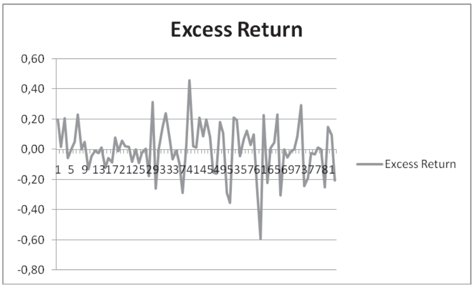

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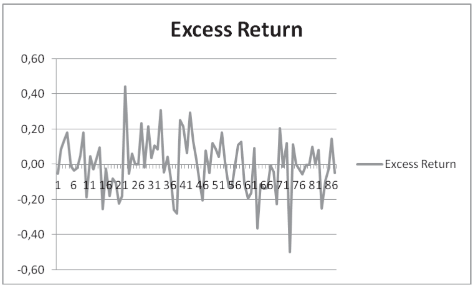


Experiment ID = 11

Source: Output of experiment conducted and analysed by the author

The significantly positive coefficients of the dummy variables suggest that markets are inefficient when a dividend jump occurs. A dividend jump results in the emergence of significant excess returns. Since the experiment participants had information about previous dividends and prices, it appears that markets are inefficient in semi-strong form when dividend jumps occur and in several periods after that. However, it is necessary to see what happens to cumulative excess returns. If the market is efficient as a whole, cumulative excess returns and average excess returns should not be significantly different from zero. Indeed, average excess returns are not statistically different from 0 in all 22 experiments, as shown in Tables 3 and 4.

Table 3: Test of EMH by testing average excess returns, r = 1%

r = 1%			
Experiment ID	**Average Value**	**t-statistic**	**p-value**
1	0.0028	0.16	0.87
2	0.0119	0.73	0.47
3	0.0007	0.04	0.97
4	0.0169	0.83	0.41
5	0.0005	0.03	0.97
6	0.0030	0.16	0.86
7	0.0082	0.47	0.64
8	0.0042	0.24	0.81
9	0.0000	-0.0007	0.9994
10	-0.0018	-0.11	0.92
11	0.0079	0.52	0.60

Source: Outputs of experiment conducted and analysed by the author

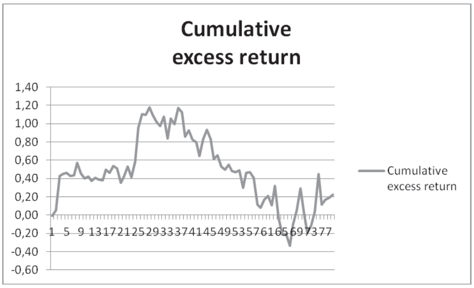
Table 4: Test of EMH by testing average excess returns, r = 7%

r = 7%			
Experiment ID	**Average Value**	**t-statistic**	**p-value**
1	0.0025	0.14	0.89
2	-0.0054	-0.31	0.76
3	0.0022	0.11	0.91
4	0.0177	0.82	0.41
5	-0.0015	-0.07	0.94
6	-0.0017	-0.07	0.93
7	-0.0051	-0.29	0.77
8	-0.0012	-0.06	0.96
9	-0.0050	-0.29	0.77
10	-0.0014	-0.08	0.94
11	-0.0035	-0.21	-0.83

Source: Outputs of experiment conducted and analysed by the author

There follow graphs of the cumulative excess returns for each of the 22 experiments.

Figure 4: Cumulative excess returns, r = 1%



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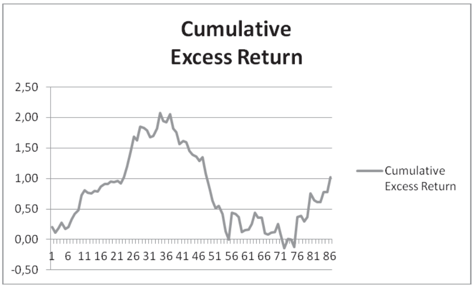

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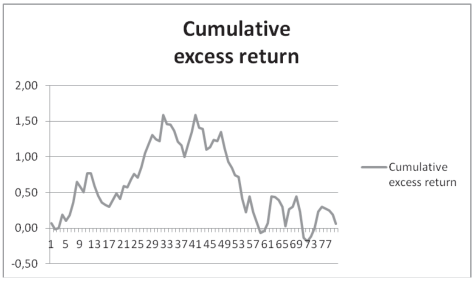

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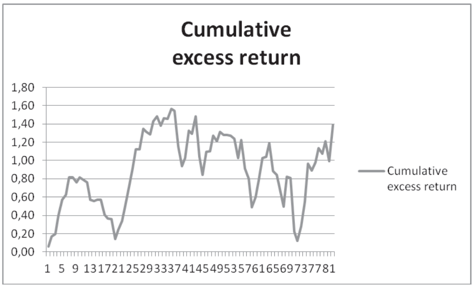

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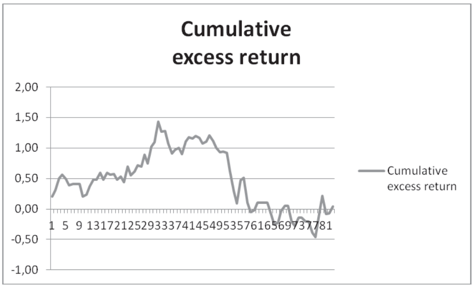

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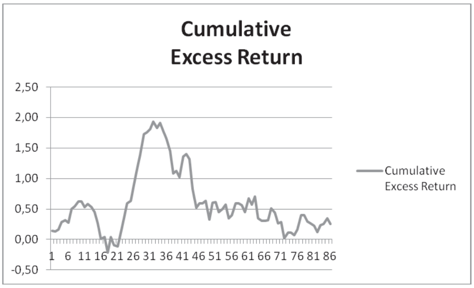

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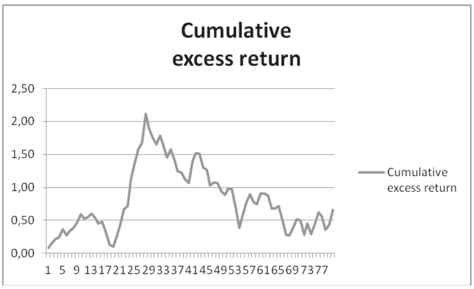

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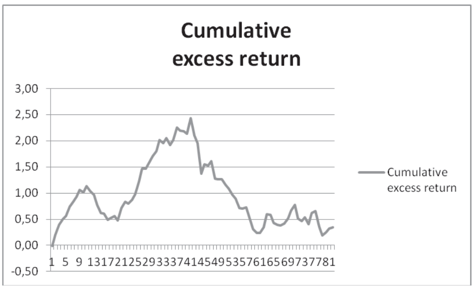

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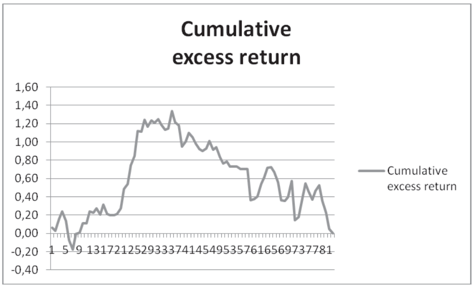

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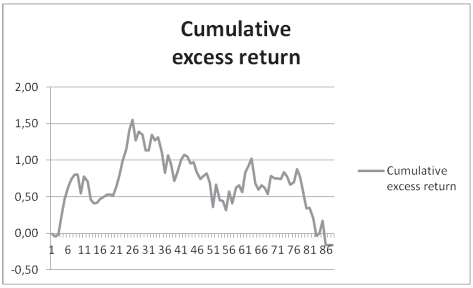

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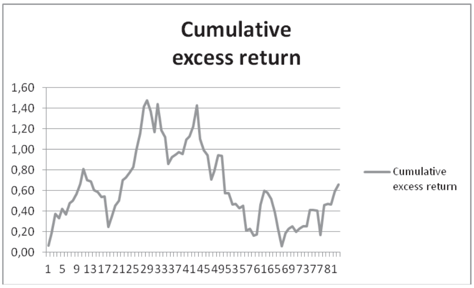
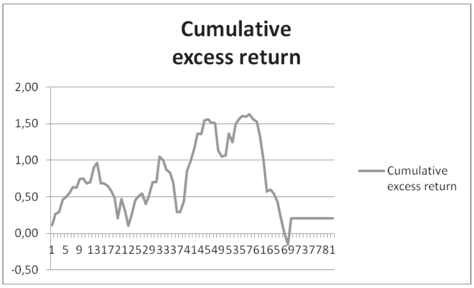


Experiment ID = 11

Source: Outputs of experiment conducted and analysed by the author

Figure 5: Cumulative excess returns, r = 7%



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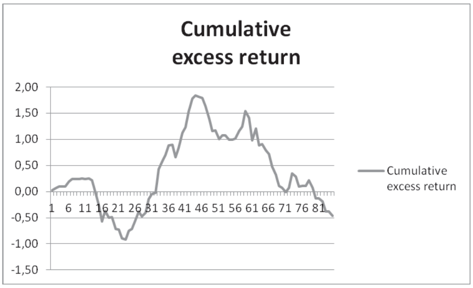

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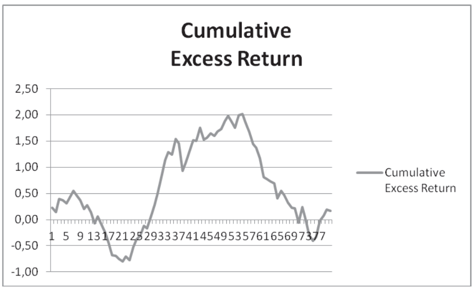

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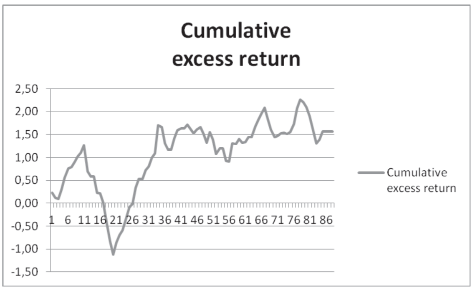

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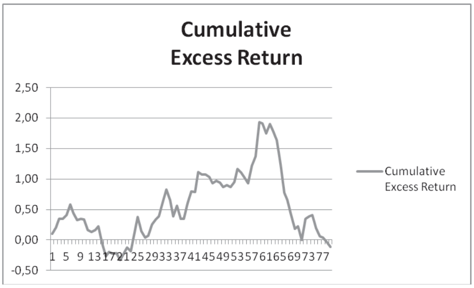

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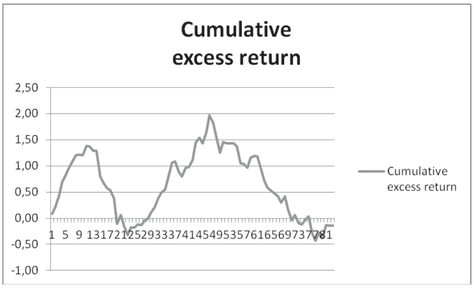

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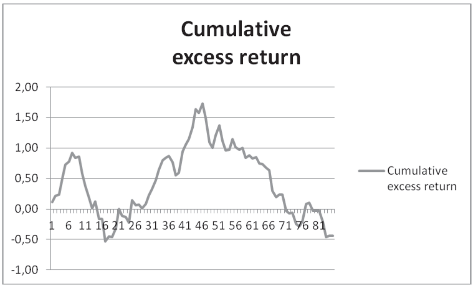

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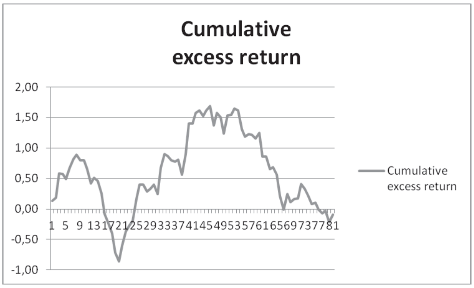

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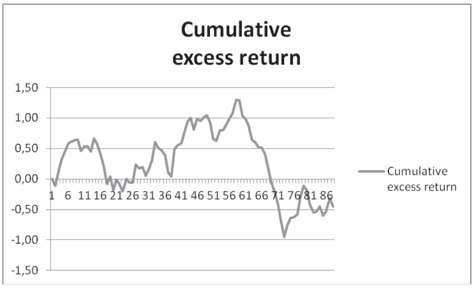

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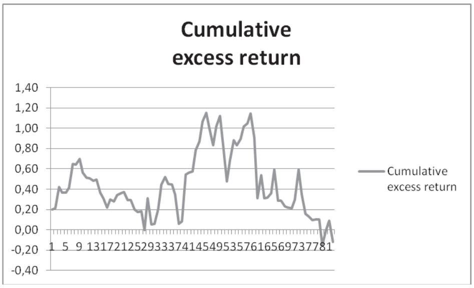

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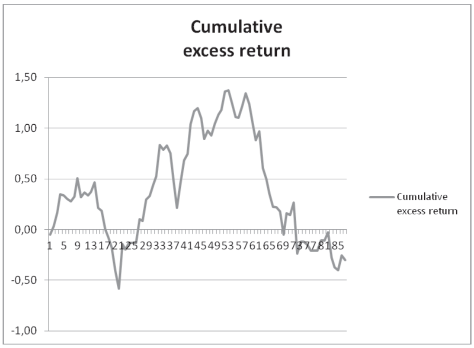

Experiment ID = 11

Source: Output of experiment conducted and analysed by the author

The cumulative excess returns are positive in most periods during all experiments. The participants that were first to notice the dividend shock could earn significant excess returns by selling Company 1 stocks and buying Company 2 stocks before their price grew considerably.

The behavioural phenomena of underreaction and the discount rate effect were observed in the experiment. The information about the dividend jump gradually builds into stock prices in the several following trading periods (up to 12 periods). The decrease in Stock 1 price is due to Stock 2 dividend shocks.

Two additional regression equations were tested. In one of them, excess returns are defined as the difference between the Company 2 stock price growth rate and the market rate of return, i.e., the stock exchange index rate of return. The idea is to find out how much higher the Stock 2 rate of return is than the average stock exchange rate of return. The stock exchange rate of return is calculated as the quantity-weighted averages of Stock 1 and Stock 2 rates of return. In the third type of regression, excess return is calculated as the difference between Stock 2 rate of return and the required rate of return according to the Capital Asset Pricing Model (CAPM). The beta coefficient is calculated as the slope coefficient of the security characteristic line (SCL). This method of calculating excess returns is applied in papers that analyse dividend shocks in stock exchanges in the real world rather than in experiments. The results obtained from these two regression equations are similar to those from the basic regression, but are less convincing.

5. CONCLUSION

This paper tests the relationship between stocks' dividend shocks and excess returns in an experimental environment. The experiment was designed so that the participants traded with two stocks: Company 1 stocks that paid stable dividends, and Company 2 stocks that paid volatile dividends with the possibility of a dividend shock in the form of a Poisson jump.

If the market is efficient, all fundamentally relevant information and dividend shock information should be instantly reflected in stock prices. Excess returns must not exist and the price must equal the fundamental value. Hence, stocks must be correctly priced, without the possibility of earning profit through mispricing. This is not the case in the trading periods after dividend shocks.

Regression equations were estimated in order to test the hypothesis that dividend shocks have a statistically significant impact on excess returns. The results of the regression model estimations show that the stated hypothesis is justified: dividend shocks caused excess returns in 20 out of the 22 conducted experiments. This means that the market was inefficient in the period when the dividend shock occurred, and also in some trading periods after the shock. These portfolio returns are higher than the returns the portfolio should earn in line with its systematic risk, which is not in accordance with the efficient market hypothesis. The behavioural phenomenon of underreaction is observed, since the dividend shock information is not instantly built into the stock price and the effects of the shock extend into several following periods. The second noticed behavioural phenomenon is the discount rate effect, i.e., a decrease in Company 1 stock price due to Company 2 dividend shocks, regardless of Company 1 fundamentals. Cumulative excess returns were mostly positive in all experiments.

Future research should test whether dividend shock effects differ under different monetary policies. In the 7% interest rate treatment it was logical that participants focused more on savings than on dividends and capital gains. When dividend shock happens, the surprise and the effect on excess returns should be higher than in the 1% interest rate treatment. However, in the 1% interest rate treatment it was rational to borrow money in order to achieve high rates of return, because of the positive effects of financial leverage. The aim of the research was also to test the effect of sudden dividend decreases on stocks' rate of return. It is interesting to see if there is a significant migration of demand to Company 2 stocks when a dividend shock occurs, and whether such migration of demand has an effect on the appearance of rational price bubbles.

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APPENDICES

A1. Experiment instructions

Dear Participant,

The economic experiment in which you are participating concerns making investment decisions in the financial market. Depending on your decisions, you can earn a certain amount of money that will be paid to you in cash after the experiment ends. It is important that you listen and read these instructions very carefully. During the experiment you should act as you would in a real life situation, with the goal of maximizing your cumulatively realized profit, i.e., maximizing your utility function.

You can make a profit (variable: Cumulatively Realized Profit) through realizing capital gains in the trade and through dividends and interest. At the end of the experiment you will be paid according to the profit you have made, in the following manner: The whole cumulatively realized profit made by all the participants is summed. After that, the share of an individual participant's cumulatively realized profit in that sum is found. That percentage is multiplied by the available budget to obtain the payable amount.

Please, do not communicate with each other during the experiment!

The market consists of 20 participants. At the beginning of the experiment each participant has an initial endowment of 50,000 monetary units, 20 stocks in Company 1, and 20 stocks in Company 2. The initial, i.e., the opening stock prices are yesterday's closing prices and are equal to the present value of future dividends. The treatment lasts between 80 and 90 trading periods and ends randomly. Each trading period lasts between 40 and 50 seconds, and also ends randomly. In between the trading periods you will see a display with certain information (i.e., the display stage). Each inter-period lasts 10 seconds.

You have 3 investment alternatives:

1. To invest in Company 1 stocks
2. To invest in Company 2 stocks
3. To invest in savings deposits with interest rate *r*, which is equal to 1%[6].

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6 In the first treatment, all interest rates for savings and borrowings were 1%. In the second treatment, all interest rates for savings and borrowings were 7%.

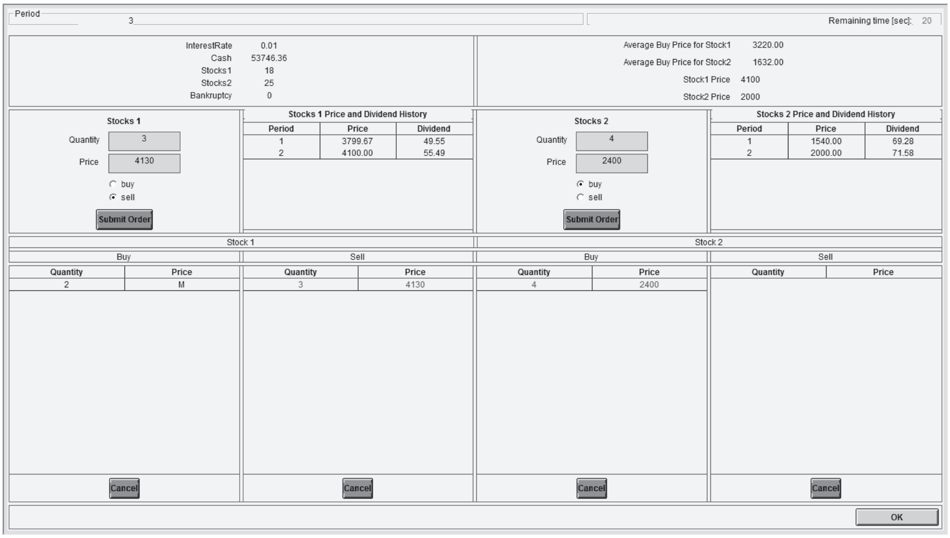
Interest is calculated and paid into your cash account in every trading period in which, after stock transactions and matching of orders, you have a positive amount of money left in your cash account (when you are 'in the black').

You can also borrow money, i.e., go 'into the red'. The maximal allowed debt, resulting from the trade in both companies' stocks, is equal to 20,000 monetary units, i.e., 40% of the initial cash amount of 50,000. You pay interest on the borrowings at the interest rate *r* in every trading period in which you are in the red.

If you are in the red for 3 consecutive time periods, you go bankrupt. The bankruptcy variable counts the number of consecutive time periods during which you are in the red. Bankruptcy means that all of your stocks are automatically sold at market price. When you get out of the red, you continue the experiment as before.

Dividends are paid after each trading period. A dividend is generated through a stochastic process. The only known information is that Stock 1 dividends are more stable, and Stock 2 dividends are more volatile.

Figure A1.1. Stock order display.



Source: A hypothetical z-Tree output made by the author

The display provides the following information:

1. Number of the period in progress
2. Remaining trading period time
3. Interest rate on savings and borrowings
4. Cash account balance
5. Number of Company 1 and Company 2 stocks respectively
6. Bankruptcy variable counter
7. Average price at which your stocks were bought
8. Prices of Company 1 and Company 2 stocks respectively, calculated as the volume weighted average prices (VWAPs) of the transactions that took place in the previous period
9. Table showing the historical VWAP and dividends per share in the previous trading periods
10. Stock market board.

During trading you can place limit or market orders. For limit orders you need to define the quantity (field: "Quantity") of Company 1 or Company 2 stocks that you want to buy or sell, and the price (field: "Price") for each company stock (the maximal price at which you would buy, i.e., the minimal price at which you would sell the stocks). For market orders, you need to decide how many stocks you want to buy/sell, leaving the "Price" field empty, shown on the stock market board as "M". The quantity, i.e., the number of stocks, and the stock price have to be integers. There are price fluctuation zones of +/–30% of the previous period's VWAP, meaning that you can only enter a price within that range. Next, you select the "buy" or "sell" button. You place your order by clicking the "Submit Order" button. Your order will be coloured blue. At any moment you can withdraw a placed order by selecting it and clicking on the "Cancel" button. When you have placed all your orders you can click the "OK" button or wait for the time to run out (which is between 40 and 50 seconds), after which the inter-period automatically occurs, i.e., the display stage. If all participants in the experiment click "OK" before the 40-50 seconds run out, the display stage automatically occurs.

In one period you can place multiple orders, but they all have to be either "buy" or "sell". Of course, during the same period you can sell Company 1 stocks while buying Company 2 stocks, and vice versa. As you place the orders they will appear on the stock market board, where they are ranked by price priority. Market orders have priority. When it comes to limit orders, the priority for "buy" orders is participants offering the highest price (Best Bid), so at the Buy, i.e., Bid, side, the limit orders will be ranked from the highest to the lowest price. This is reversed for the "sell" limit orders. Priority is given to the participant offering the lowest price (Best Ask), so the limit orders at the Sell, i.e., Ask, side will be ranked from the lowest to the highest price. If there are two or more participants offering the same price, priority is given to the order that was placed earlier (i.e., the time priority criterion is applied). If there is a market order on both the Bid and Ask sides, the matching will be done by the previous period's closing price (the volume weighted price of all the realized transactions in the last period).

The rules of the continuous trading method are applied to order matching. I will explain this method by using an example before the experiment starts.

Table A1.1. The example of the continuous trading method: placed orders

Subject	Buy/Sell	Quantity	Price
1	Buy	2	1000
2	Sell	2	900
3	Sell	1	930
4	Buy	2	M
5	Buy	1	1100
6	Sell	2	1030
7	Buy	3	M
8	Sell	3	1010
9	Buy	3	1020
10	Sell	2	890

Source: A hypothetical example by the author

Table A1.2. Example of the continuous trading method: order matching

<table>
<tr><th>Subject</th><th>Buy</th><th>Subject</th><th>Sell</th><th>Transaction</th></tr>
<tr><td>4</td><td>2 at M</td><td>10</td><td>2 at 890</td><td rowspan="5">2 at 890 (Subject 4 buys, subject 10 sells.)</td></tr>
<tr><td>7</td><td>3 atM</td><td>2</td><td>2 at 900</td></tr>
<tr><td>5</td><td>1 at 1100</td><td>3</td><td>1 at 930</td></tr>
<tr><td>9</td><td>3 at 1020</td><td>8</td><td>3 at 1010</td></tr>
<tr><td>1</td><td>2 at 1000</td><td>6</td><td>2 at 1030</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>7</td><td>3 at M</td><td>2</td><td>2 at 900</td><td rowspan="4">2 at 900 (Subject 7 buys, subject 2 sells)
1 at 930 (subject 7 buys, subject 3 sells)</td></tr>
<tr><td>5</td><td>1 at 1100</td><td>3</td><td>1 at 930</td></tr>
<tr><td>9</td><td>3 at 1020</td><td>8</td><td>3 at 1010</td></tr>
<tr><td>1</td><td>2 at 1000</td><td>6</td><td>2 at 1030</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>5</td><td>1 at 1100</td><td>8</td><td>3 at 1010</td><td rowspan="3">1 at 1100 (Subject 5 buys, subject 8 sells)</td></tr>
<tr><td>9</td><td>3 at 1020</td><td>6</td><td>2 at 1030</td></tr>
<tr><td>1</td><td>2 at 1000</td><td></td><td></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>9</td><td>3 at 1020</td><td>8</td><td>2 at 1010</td><td rowspan="2">2 at 1010 (subject 9 buys, subject 8 sells)</td></tr>
<tr><td>1</td><td>2 at 1000</td><td>6</td><td>2 at 1030</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>9</td><td>1 at 1020</td><td>6</td><td>2 at 1030</td><td rowspan="2">The end!
(These transactions remain unrealized)</td></tr>
<tr><td>1</td><td>2 at 1000</td><td></td><td></td></tr>
</table>

Source: A hypothetical example by the author

After each period the Cash Account balance and the number of stocks, i.e., the Trade Account balance, are updated.

Figure A1.2. Information summary after a trading period

Source: Hypothetical z-Tree output by the author

The following information will be shown:

1. Number of the trading period which has just ended
2. Display stage remaining time, in seconds
3. Number of Company 1 stocks in your possession
4. Number of Company 2 stocks in your possession
5. Volume weighted average price of Stock 1 from the previous period
6. Volume weighted average price of Stock 2 from the previous period
7. Dividend per Company 1 stock
8. Dividend per Company 2 stock
9. Bankruptcy variable counter
10. Your Cash Account balance
11. The interest earned on savings or paid for borrowings
12. Total dividends on both companies' stocks
13. Realized capital gains/losses
12. Cumulative realized profit (which determines the payments for participants)
13. Table in which the following is shown:
    a) which orders you placed (Company 1 or Company 2 stocks, order type (buy or sell), quantity and price (for limit order only);
    b) which orders were realized (the number of stocks bought/sold and the transaction price).

You can wait for 10 seconds to run out, after which the new trading period automatically occurs, or you can press "OK" when you are ready for the next trading period. The next period will start either when all the participants press "OK" before 10 seconds run out, or when they run out.

Profit is calculated by the formula:

Profit = Dividends +/- Interests +/- Realized capital gain/loss

When calculating the realized capital gains/losses, the average price method is used for the purchase price. The information each participant gets concerns only his/her own profit and the amount he/she obtains at the end of the experiment.

In order to receive payment, at the end, you should write down your full name on the Address form.

Please answer the questions from the questionnaire at the end of the experiment.

Thank you for participating in the experiment!

Dragana Draganac

A2. Questionnaire for the participants

1. Which component(s) of the total realized profit did you focus on in the treatment with lower interest rate (1%)?
   a) dividends
   b) capital gain
   c) interest
2. Which component(s) of the total realized profit did you focus on in the treatment with higher interest rate (7%)?
   a) dividends
   b) capital gain
   c) interest
3. Did you conduct a technical analysis during the experiment?
   a) yes
   b) no
   c) sometimes

4. Did you conduct a fundamental analysis during the experiment?
   a) yes
   b) no
   c) sometimes
5. Briefly explain the portfolio optimization strategy you used in the lower interest rate treatment.
6. Briefly explain the portfolio optimization strategy you used in the higher interest rate treatment.

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