Is there causal relationship between the value of the news and stock returns?

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We introduce the application of event study methodology in conjunction with the theory of information entropy. This new mean of time series analysis creates connection between the value of the news announcement and the behaviour of stock prices. As we make distinction between the rates of "surprise" of a particular news announcement the corresponding return behaviour can be assessed more efficiently. We find in our empirical application that the announcements of profitability ratios at different entropy values explain the behaviour of cumulated abnormal returns.

KEYWORDS:
Financial applications, financial and stock market.

In the case of modelling time series (of share prices) the researcher is facing two contradictory statistical characteristics: on one hand time series are long with high frequency (advantageous), but on the other their volatility (variance) is rather high (disadvantageous). In order to overcome the problem of high volatility countless models have been proposed in the literature. Methods concerned with the variance of time series can be divided into two groups: in the *first* improvement of model specifications or estimation of parameters can be found, while in the *second* the transformation of time series into a more homogenous set is proposed. Event study methodology belongs to the second group, which grants the foundation of behavioural finance.

The foundation of event study methodology was introduced in our prior study (*Bedő–Rappai* [2004]), when we demonstrated the determination of abnormal and cumulative abnormal returns and also the means of event analysis. Our sole objective in that study was to scrutinize the impact of "good" and "bad" events, whether they effect share prices differently. We based our hypothesis on the findings of *Hong, Lim* and *Stein* [2000], which highlighted the differing behaviour of share prices at the occurrence of positive and negative news. At the end of that study we took an attempt to build trading strategy based on our finding, with little success.

In this study we take the analysis a step further by connecting the behaviour of the share price and the impact of a particular event, by assessing the relationship between the rate of surprise at the release of company data and the price reaction. To assess the behaviour of share price we calculate cumulative abnormal returns – spread between the realized and estimated returns – around the release of return on equity (ROE) and earnings per share (EPS) figures. The flow of the cumulative abnormal return determines whether investors are able to correctly "price" the particular company share. Using past ROE and EPS data we calculate the probability of occurrence of the last ROE and EPS figures, which allow us to specify the corresponding entropy value. This entropy value enables us to state whether the announcement of ROE and EPS ratios were considered a "surprise" or not. By observing entropy values in conjunction with cumulative abnormal returns conclusions can be drawn concerning the effect of news' "surprise" on price disturbances.

The remainder of the paper is as follows. In the first section we review the basics of event study methodology to calculate abnormal and cumulative abnormal returns. In the second section we introduce the method of event "valuation" to use the distribution of return on equity and earnings per share data in order to establish the entropy indicator. Section 3 introduces the data under analysis, data transformation and indicators. In section 4 results are presented and analysed. We summarize our conclusions in section 5.

1. Review of event study methodology

Assessing the value of an instrument – traded on an open market – around the appearance of particular information allows the researcher to identify the economic meaning of the underlying event. In financial research event study methodology has been used both to determine the value of certain information affecting economic performance and to specify the efficiency of markets in order to draw conclusion regarding the behaviour of market participants.

By applying the method one is able to compare the "normal" return to the one actually is occurring on the open market. The gap between the two returns will reveal the meaning of the information, whether market participants have correctly assessed the upcoming event or have been able to adjust to the new circumstances. The release of the information concerning the event in question is put in the centre of the window at time *T*. (See Figure 1.) In the pre-event period the precision of market anticipation appears which also provides a signal about the channels through which the information spreads out into the market. In case of gradual increase of the spread between normal and actual returns one can state that the news penetrated the market through informal channels are available only to a few investors. In the post period the speed of investor reaction or in another word their ability to adjust to the new circumstances will be assessable.

Figure 1. The design of time window around the event and the position of the estimation period
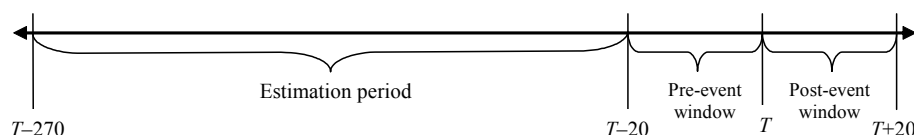
To determine the normal rate of return actual returns in the *estimation period* are inputted into a simple model. The length of the estimation period, in our view should at least be 250 units long, which is in the current case measured in day. In order to determine the normal rate of return the researcher can choose from three types of models typically applied in the literature: *1.* market adjusted model, *2.* mean adjusted model, and *3.* market model.

The market adjusted model assumes that the best predictor of the normal rate of return for a given security is the current return on the market. The market return is predominantly equivalent to a market wide index.

$$E\left(r_{it}\right) = \hat{r}_{it} = r_{mt} \,, \qquad\qquad /1/$$

where the expected (normal) return on security *i* in period *t* is equal to the actual rate of return on market index *m* in period *t*.

The normal return generated by the mean adjusted model is the average of actual returns of security i for the time period $t = 1, 2, 3, ..., T$.

$$E\left(r_{it}\right) = \hat{r}_{it} = \overline{r}_i = \left(1/T\right)\sum_{t=1}^{T} r_{it} \ . \tag{/2/}$$

The market model[1] is equivalent to an ordinary least square (OLS) method, wherein returns on a given security i are regressed against the concurrent return on the market m.

$$E\left(r_{it}\right) = \hat{r}_{it} = \alpha_i + \beta_i r_{mt} + \varepsilon_{it} \ . \tag{/3/}$$

The dependent variable is the expected return on security i in period t. On the right hand side α is the intercept, β is the slope coefficient, ε is the error term, and the independent variable is the market index in period t.

In case of the previously described three models estimation biases can arise as the result of unsynchronized trading or low liquidity, which is caused by low trading volume of the particular security. In order to overcome these obstacles literature offers several solutions, which are detailed in *Bedő–Rappai* [2005]. These solutions either propose modifications in the estimation methods or take an attempt to alter the specification of the model.

Meanwhile *Varga–Rappai* [2002] take another approach in the estimation of the slope parameter β by suggesting the application of GARCH specification for the random variable.[2] By using GARCH specification the residual term in the usual OLS model /3/ is not treated as a white noise term but its variance is estimated as a series of past innovations, where $\rho(L)$ and $\theta(L)$ are the standard lagged polynomial terms. This is pursued in order to eliminate the bias generated by the autocorrelation in the volatility of the time series. The proposed model is the following:

$$Var\left(\varepsilon_t \,|\, \varepsilon_{t-1}, \varepsilon_{t-2}, ...\right) \sigma_t^2 = \omega + \rho(L)\,\sigma_{t-1}^2 + \theta(L)\,\xi_t^2 \ . \tag{/4/}$$

It can empirically be proven that the GARCH (1.1) specification is sufficiently able to correct the problem, which implies that our model is reduced to the following form:

$$\begin{aligned} r_{it} &= \alpha + \beta r_{mt} + \varepsilon_t, \\ \sigma_t^2 &= \omega + \rho\,\sigma_{t-1}^2 + \theta\,\varepsilon_{t-1}^2. \end{aligned} \tag{/5/}$$

As it was stated before all the previously described models are to determine the normal return, which is compared against the actual rate of return of the securities.

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[1] First proposed by *Fama et al.* [1969].
[2] See also *Engle* [1982].

The difference between the normal return ($\hat{r}_{it}$), and the realized rate of return (r_{it}) is called abnormal return, which is calculated from the first day of the pre-event window (*T–20*) until the last trading day of the post-event window (*T+20*). The formula of the abnormal return is as follows:

$$AR_{it} = r_{it} - \hat{r}_{it} .$$ /6/

In order to eliminate all idiosyncratic effects that arise on the individual security level one has to calculate abnormal return for several securities with the same event allocated at time *T* (announcement of EPS or ROE ratios). Abnormal returns generated for securities under analysis have to be averaged cross sectional for each trading day. This is depicted in equation /7/.

$$\overline{AR}_t = \frac{1}{N} \sum_{i=1}^{N} AR_{it} ,$$ /7/

where *N* is the number of securities with calculated abnormal return for the given date *T*.

To be able to assess the tendency of change of abnormal returns throughout the event window *cumulative abnormal return* is calculated. This allows us to study the pre and the post event window, specifically to understand the precision of anticipation of market actors and the diffusion of information after the release of the news. The beginning of accumulation is at day *K* until trading day *L*.[3] The formula of cumulative abnormal return calculated for security *i* is as follows:

$$CAR_i^{K,L} = \sum_{t=K}^{L} AR_{it} .$$ /8/

By cross sectional averaging individual cumulative returns we obtain the global cumulative return for the total portfolio, which takes the following form:

$$CAR^{K,L} = \frac{1}{N} \sum_{i=1}^{N} CAR_i^{K,L} .$$ /9/

CAR values in the negative dimension imply "pessimism" in the market as the realized returns are lower than the normal ones (this is valid if we assume that the model which generates normal returns is correct). When CAR values are positive the market is said to have too "optimistic" expectations in relation to the event. If the market correctly values an event than the CAR value is 0.

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[3] *K* is the first day of the event window (*T–20*), while *L* is the last day of the event window (*T+20*).

In the following sections when referring to announcement of company data we mean the release of ROE and EPS news, which will be put in the focus of our empirical analysis. The meaning and descriptive statistics of the two fundamental ratios are discussed in the data description section of the paper.

2. Value of a news, entropy of an event – methodology, hypotheses

One of the most well known axiom of information theory states that as the probability of occurrence of an event increases the level of surprise decreases, due to the diminishing rate of information content of the news.[4] In case of particular news let us call the measure of information content *discrete information*, which is indirectly proportional to the probability of occurrence of the event that the news describes. To formalize discrete information, in compliance with all properties, the most appropriate functional form is the following:

$$h(p) = c \log \frac{1}{p},$$
/10/

where $h(p)$ a is the measure of discrete information, p is the a priory probability of occurrence of the event, c and the base of the logarithm are constant.

In practice the constant c usually takes the value of one, while the base of the logarithm takes the value of 2 or e. In case the base of the logarithm is 2 the unit of information is referred to as *bit*, while if base value is e the unit of information is called *nit*. As the probability of occurrence of an event takes the value of 0.5 the information content of the news describing the underlying event is one:

$$h(0.5) = \log_2 \frac{1}{0.5} = 1 \, bit,$$
/11/

or

$$h(0.5) = \ln \frac{1}{0.5} = 0.693 \, nit.$$
/12/

To present how entropy value is determined let us use the following example. As it appears in the quarterly financial statements of General Electric Ltd., a company well known in Hungary, the return on equity figures in the past 16 years fluctuated between 14.12 and 26.52 percent. The distribution of the 66 data occurring in the past is presented in Figure 2.

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[4] The concept of entropy is known not only in information theory but in thermodynamics and in statistical mathematics as well. Information entropy is also referred to as Shannon's entropy in honour of *Claude E. Shannon*, who in his 1948 paper introduced the concept (*Shannon* [1948]).

Figure 2. The distribution of quarterly ROE ratios of General Electric Ltd. between 1990 and 2006
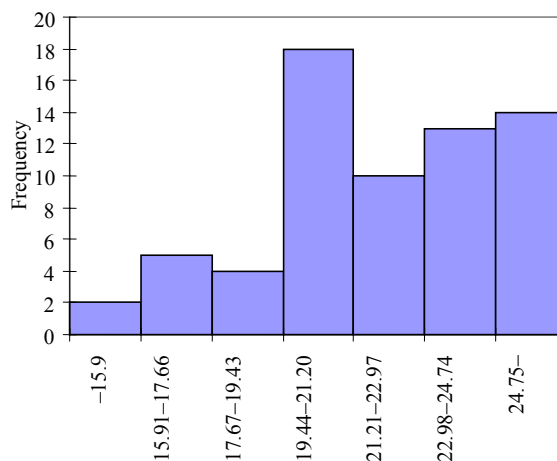
When creating the histogram we converted continuous ROE values into a frequency table by applying the usual conventions to determine the number of frequency classes, and the length of frequency classes (*Hajdu et al.* [1994]). To proceed with our example consider General Electrics' ROE value as of the first quarter of 2006, was 9.49. This implies that this value belongs to the first frequency class resulting in a 0.03 estimated probability of occurrence, which is based on our previous sample. From this estimated probability of occurrence the value of the news is the following:

$$h(0.03) = \log_2 \frac{1}{0.03} = 5.04 \; bit \; , \tag{13}$$

or

$$h(0.03) = \ln \frac{1}{0.03} = 3.50 \; nit \; . \tag{14}$$

To interpret these values by themselves is a rather difficult task, while the fact that the relationship between the probability of occurrence of ROE ratio and the level of the entropy value is inverse, implies that as uncertainty increases the level of surprise as well.

Based on the previously introduced definitions we will present the concept of information entropy, which is the expected value of the distribution of individual news values. Information entropy measures the *uncertainty* of an empirical distribution, which equals to the average of the ''surprises'' that the occurring news generate. In another words it is equivalent to the weighted average of the surprises associated with the news that arrive:

$$H(p) = \sum_{i=1}^{k} p_i \log \frac{1}{p_i} = -\sum_{i=1}^{k} p_i \log p_i \, . \qquad \text{/15/}$$

In light of the fact that the probability of occurrence of an event can take the value of 0, and inasmuch as

$$\lim_{x \to 0} x \log \frac{1}{x} = 0 \, , \qquad \text{/16/}$$

at elements of $H(p)$ with the property of $p_i = 0$ the value will be zero. As the value of the probability of occurrence have no dimension information entropy is measured either with bit or nit just as discrete information.

With regards to the previous definitions the entropy function, in case of $k=2$ takes the following form (implicitly $p_2 = 1 - p_1$):

Figure 3. The entropy function plotted against the probability of occurrence of the event
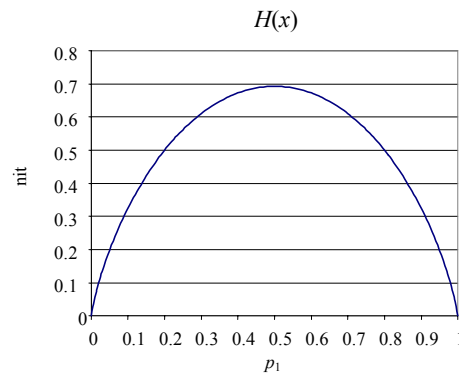
As it appears from Figure 3 the minimum and maximum points of the functions are 0 and ln2 (log$k$ in general). The maximum of the function is at "total equality", in another word where

$$p_1 = p_2 = 0.5 \, , \qquad \text{/17/}$$

than

$$H(p) = -2 \times 0.5 \times \ln 0.5 = -\ln 0.5 = 0.693 \, nit \, , \qquad \text{/18/}$$

or equivalently

$$H(p) = -2 \times 0.5 \times \log_2 0.5 = -\log_2 0.5 = 1 \, bit \, . \qquad \text{/19/}$$

Note that while the maximum of the function is always at "total equality" as the number of events increase the information content of the value increases as well. To illustrate it consider the case when

$$p_1 = \ldots = p_4 = 0.25 ,$$ /20/

which implies

$$H(p) = -4 \times 0.25 \times \log_2 0.25 = -\log_2 0.25 = 2 \; bit .$$ /21/

Such a case entails that the occurrence of events with equal probabilities generates higher rate of surprise, due to, in statistical terms the lack of concentration.

In order to compare entropy values based on different frequency tables we introduce *relative entropy*, which takes the following form:

$$H_r(p) = \frac{H(p)}{\log k} .$$ /22/

The measure of relative entropy lies between 0 and 1 and as its relative characteristic implies it is without dimension.

Continuing our previous example, the frequency table based on the ROE ratios of General Electrics Ltd. is presented in Table 1.

Table 1

Frequency table of General Electrics' ROE ratios

ROE	Frequency	p_i
– 15.90	2	0.03
15.91 – 17.66	5	0.08
17.67 – 19.43	4	0.06
19.44 – 21.20	18	0.27
21.21 – 22.97	10	0.15
22.98 – 24.74	13	0.20
24.75 –	14	0.21
Total	*66*	*1.00*

As a consequence the entropy value, using natural based logarithm is as follows:

$$H(p) = \sum_{i=1}^{k} p_i \ln \frac{1}{p_i} = 0.03 \times \ln \frac{1}{0.03} + \ldots + 0.21 \times \ln \frac{1}{0.21} = 1.76 \; nit .$$ /23/

The relative entropy is:

$$H_r(p) = \frac{H(p)}{\ln k} = \frac{1.76}{\ln 7} = 0.904 \ . \qquad\qquad /24/$$

Given that the maximum of relative entropy is 1, this result shows that the future announcements of ROE ratios can generate significant surprise. If the relative entropy value is one, than the probability distribution of ROE values in the past are even.

As we have introduced how news is valuated and price behaviour is scrutinized let us define our hypotheses:

Hypothesis 1: As the probability of occurrence of certain ROE and EPS figures decrease the absolute values of abnormal and cumulative abnormal returns at $t = T$, $t = T–20$, $t = T+20$ increase.

Hypothesis 2: As the value of the relative entropy tends to unity the absolute value of abnormal and cumulative abnormal returns at $t = T$, $t = T–20$, $t = T+20$ increases.

3. Data description

Our sample consists of 65 shares of publicly traded companies on the New York Stock Exchange (NYSE) and National Association of Security Dealers Automated Quotation (NASDAQ), which are constituents of Dow Jones Composite Index (DJCI) as of the first quarter of 2006. Share price and company data were acquired from Reuters database, which is a global vendor of financial data, news and analysis. To calculate abnormal and cumulative abnormal returns daily share prices were used, while return on equity (ROE) and earnings per share (EPS) ratios are based on quarterly financial data. The time series of ROE and EPS ratios reach back to the second quarter of 1992, AR and CAR are determined for the four quarters of 2005.

To determine market response to company event ROE and EPS announcements were put into the zero time period of the event window (see Figure 1). When conducting event study calculations we designed the event window with a –20, +20 bound, which implies that the window starts twenty days before and ends 20 days after the announcement of ROE and EPS ratios. The length of the estimation period is 250 trading days, which implies that the estimation period starts 270 days before the announcement of the financial ratios.

Return on equity is defined as the ratio of net income to shareholders' equity. Earning per share (EPS), which is the portion of the company's profit allocated to each outstanding share of common stock, is defined as the net income minus dividend on preferred stock to average outstanding share. These measures have been frequently used as performance indicators in the financial literature.

Table 2

Return on equity and earnings per share ratios in the sample at 2006Q1

Indicator	Mean	SD	Minimum	Median	Maximum
ROE (percent)	15.78	76.02	-2671.74	14.16	2931.37
EPS (USD)	1.58	2.28	-41.94	1.56	14.27

Note. ROE is the net income/shareholders' equity, EPS is the net income dividend on preferred stock/average shares outstanding. SD is the standard deviation. Number of firms in the sample is 65, the length of the time series of financial ratios is 65 quarters from 1990 Q1 until 2006 Q1.

Source: In this and in the following table Reuters database and the authors' computation.

Table 2 reveals summary statistics for the two performance measures. The ROE indicator exhibits substantial variation on its level as depicted by the standard deviation. The minimum and maximum figures in case of the ROE indicator are the result of the extremity of AMR Corporation, which is positioned in the air transportation industry (see the industry distribution of companies in the Appendix). The maximum appeared in the first quarter of 2003, while the minimum at the end of the same financial year. Although it does not imply a significant downturn in the performance of the company, since the positive figure in the first quarter was the result of a negative net income and shareholders' equity. By the end of the financial year the denominator (shareholders' equity) became positive, while the net income remained negative yielding a negative ROE indicator.

Table 3

Entropy indicators for the ROE and EPS ratios, AR and CAR values at t = T, t = T–20, t = T+20.

Indicator	Entropy indicator	Mean	SD	Minimum	Median	Maximum
ROE	H(bit)	2.1363	0.5587	0.2262	2.3323	2.7725
	H(nit)	1.4808	0.3872	0.1568	1.6166	1.9218
EPS	H(bit)	2.2336	0.4558	0.1371	2.3522	2.7599
	H(nit)	1.5482	0.3159	0.0950	1.6305	1.9130
CAR	$t = (-20)$	0.0025	0.0112	−0.0177	0.0004	0.0506
	$T = 0$	0.0058	0.0394	−0.0948	0.0004	0.1478
	$t = 20$	0.0099	0.0611	−0.1185	−0.0005	0.2572
AR	$t = (-20)$	0.0018	0.0078	−0.0135	0.0006	0.0352
	$T = 0$	0.0004	0.0153	−0.0633	0.0004	0.0419
	$t = 20$	0.0012	0.0066	−0.0073	0.0004	0.0344

Note. SD is standard deviation, H(bit) is the entropy index, the base of the logarithm is 2, H(nit) is the entropy index with natural base logarithm. CAR is the cumulative abnormal return, AR is the abnormal return $t = T$–20 and $t = T$+20 are the boundaries of the event window, $t = T$ is the announcement date. N for the number of firms is 65.

Using the return on equity and earnings per share data sets the value of announcements of the two indicators are calculated in nit and bit as well. The descriptive statistics of the entropy indices for the two types of news are indicated in Table 3, which also contains the descriptive statistics of abnormal and cumulative abnormal returns generated with formulae /7/ and /9/. The variation of the two entropy indices is low, which implies that the values of the news (ROE and EPS announcements) between the 65 companies are not too distinct. The maximum entropy index reveals the value with the largest surprise, in another word the company that this value belongs to has the highest uncertainty in its performance. It further entails that the value of information is the highest in case of this particular security as the foresee ability is the lowest in this instance. The minimum entropy values were generated by companies that have rather constant, predictable performance. The value (or uncertainty) of the ROE and EPS news are quite similar meaning that investors are able to utilize both performance indicators by bearing similar risk in the analysis.

Interestingly AR figures in the three points of the event window show that the precision of investors, implied by the actual return is the highest at the announcement day (mean of 0.04 percent). 20 days before and after the information release realized returns are 0.18 and 0.12 percentage points away from the normal returns respectively. While the mean of AR figures is the lowest at $t = 0$ the variation is the highest at the same time, which entails increasing uncertainty. The higher standard deviation naturally is the result of the higher maximum and minimum values. An investor, who goes long at the beginning of the day and shorts the same share at the end of the trading session can end up with either –0.633 percent or 0.419 percent of abnormal rerun implying loss or gain respectively.

By observing cumulative abnormal returns the tendency of AR development can be understood. The discrepancy between the normal and the actual returns is the lowest before the release of the information. In this period the variation of this spread is also the lowest compared to the announcement date and the period that follows. As the announcement takes place the uncertainty enhances ($\text{SD}(t_{-20}) = 1.12\%$; $\text{SD}(t_0) = 3.94\%$), that results in the decrease of the precision of anticipation ($\text{mean}(t_{-20}) = 0.25\%$; $\text{mean}(t_0) = 0.58\%$). This trend continues after the announcement by almost reaching the mean of 1 percent of cumulative abnormal return with 6.11 percent of standard deviation. A person investing into the share that produces the maximum (minimum) CAR value is able to earn 26 percent more (12 percent less) return than the normal, estimated by our model.

4. Results

Following the previous line of argument we determine certain dependent variables that are to be estimated with high level of precision in order to be able to build an efficient trading strategy. Based on this requirement we specified four variables to

be estimated. The dependent variables and the reasoning for their selection are the following.

>*1*. Abnormal return at the time of the news announcement (*AR0*); we argue that the uncertainty around the occurrence of the news must have an effect on prompt reactions of share prices.
>
>*2*. The maximum deviation from the estimated daily returns during the 20 days time period subsequent to the announcement. In another word the maximum absolute value of daily abnormal returns (*maxAR*). In our view there is a deterministic relationship between the value of the news (rate of surprise) and the deviations of returns from the estimated ones following the announcement.
>
>*3*. The maximum value of the cumulated abnormal returns during the 20 days following the announcement: this implies the maximum of the absolute value of the cumulative abnormal return in the post event window (*maxCAR*).
>
>*4*. Finally the cumulative abnormal return measured at the last day of the post event window (20th day of the post event window – *CAR20*). Based on our findings discovered in our previous study we can state that by the 20th day following the announcement share prices return to their "normal" tendencies. Following this argument we are interested, whether we can generalize on this in the current case as well.

The descriptive statistics of the previously described dependent variables appears in Table 4.

Table 4

Descriptive statistics of dependent variables

Variables	Mean	Standard deviation	Minimum	Maximum
AR0	0.000418	0.0152941	−0.0633	0.0419
maxAR	0.019393	0.0114395	0.0083	0.0633
maxCAR	0.053439	0.0456879	0.0114	0.2572
CAR20	0.009946	0.0610757	−0.1185	0.2572

Note. AR0 is the abnormal return on the day of announcement of ROE and EPS ratios, *maxAR* is the maximum absolute value of abnormal return values in the 20 days time period subsequent to the announcement, *maxCAR* is the maximum absolute value of cumulated abnormal return values in the 20 days time period subsequent to the announcement, and *CAR20* is the cumulative abnormal return at the 20th day subsequent to the announcement.

Note that values in Table 4 are based on time series of daily returns, which implies that to transform these values to an annual scale they have to be multiplied by

365. The fact that standard deviation values equal or greater to the average values should not be surprising as in time series analysis this characteristic is a common one.

4.1. The effect of the value of the news on returns

In the first phase of our empirical analysis we investigate the consequences of the value of news (level of EPS, ROE ratios) release on the dependent variables. Interestingly enough the average of the news values (in case of *EPS_NEWS* – 2.26 nit, and for *ROE_NEWS* 2.31 nit) implies that the average of the probability of occurrence is around 10 percent. One can predict from the histograms of independent variables that the distributions of news values are close to normal, which implies results similar to the Bera–Jarque test results. (See Table 5.)

Table 5

Bera–Jarque test, and p-values of independent variables

Variables	Bera–Jarque	*p*-value
EPS_NEWS	2.057	0.357
ROE_NEWS	0.515	0.773

This entails that the assumption of normality in case of both independent variables is feasible.

In light of our hypotheses we can state that value of the news has a positive relationship with the rate of surprise. In another word there is a strong correlation between the independent and dependent variables.

Table 6

Correlation coefficients of dependent and independent variables*

Dependent variables	Independent variable	
	EPS_NEWS	*ROE_NEWS*
AR0	−0.141	0.030
maxAR	0.066	0.016
maxCAR	−0.220	0.314
CAR20	−0.135	0.090

* Table 6 is a segment of a correlation matrix. The remaining parts of this matrix are irrelevant to the current argument.

In case of 65 observations the hypothesis of independence can be rejected at the 5 percent significance level if the absolute value of the correlation coefficient is greater than 0.278. In our particular case this implies that the relationship between the *ROE_NEWS* and the cumulated abnormal returns by the 20th day of the post event window is statistically significant. This result is in line with our hypothesis as the high level of uncertainty around the event generates a long lasting disturbance in stock prices, which results in a continuous deviation of daily returns from the estimated ones.

Meanwhile our further assumptions of causality between the rate of surprise and return variables are not supported by the correlation coefficients. This implies that a model based on the previous dependent and independent variables is unable to describe the mechanism of stock prices around the release of the assessed events.

4.2. The predictability of announcements and the abnormal returns

As we were unable to detect significant relationship between the value of the announced news and the abnormal returns subsequent to the announcement we argue that market participants had already factored the volatility of the particular news into their expectations. We have presented the calculation of the value of the news announcement with the application of entropy and relative entropy. The relative entropy value tends to 0 (H_r) entails that the news is rather predictable, while H_r closer to 100 percent is likely in case of uncertainty of future announcement.

The mean of relative entropy values, in case of EPS and ROE announcements, are 76 and 79 percent respectively, while for individual stocks the deviation is on a much wider scale (for EPS announcements individual stocks deviate between 5 and 98 percent, for ROE announcements between 8 and 98 percent).

We assumed that the value of the news announcement is not particularly able to explain the behaviour of abnormal returns subsequent to the event because the historical volatility of entropy values for stocks are also considered by investors. This implies that for a share with hectic announcements in the past newly occurring salient news will not be as credible as for a share with constant performance. As credibility alters abnormal returns differ as well. To assess this assumption we calculated the correlation matrix of the relative entropy values and abnormal return variables (introduced in the previous section).

However, the absolute values of correlation coefficients in Table 7 exceed values in Table 6 statistically significant result is solely detectable in the case of ROE and *maxCAR* variables. Consistent with our previous line of argument we examine whether individual news announcement values and the predictability of the news together have an influence on the behaviour of time series of returns. We selected linear regression models to assess this relationship, which is justified by the presented normality of the datasets.

Table 7

Correlation coefficients of dependent and independent variables
(relative entropy values)

Dependent variables	Independent variables	
	EPS_H_r	ROE_H_r
AR0	0.151	0.145
maxAR	−0.122	−0.212
maxCAR	−0.070	−0.403
CAR20	0.218	−0.154

In order to generate more informative results, beyond the determination of explanatory power of the outcomes we applied stepwise method (*Mundruczó* [1981]). Table 8 shows the output of the stepwise regression. Table 8 contains only those estimated parameters of independent variables and their *t*-statistics (*t*-statistics with value of one is included, with 0.5 is excluded) that according to the stepwise regression method exceeded the average level of statistical significance. Coefficients with explanatory power were adjusted to the number of independent variables (see adjusted R^2 in Table 8).

Based on the output of the regression analysis we can conclude that the explanatory power of the optimal models is rather low. The only variable with acceptable explanatory power was the one that was constructed from the cumulated abnormal returns. It is not surprising that the correlation matrix reveals that the predictability of maximal cumulated abnormal return is the highest; while it is promising that the same is true for the cumulative abnormal return by the 20th day subsequent to the event. (See Table 8.)

Table 8

Results of the step wise regression analysis

Independent variables	Dependent variable							
	AR0		maxAR		maxCAR		CAR20	
	$\hat{\beta}$	t-statistics	$\hat{\beta}$	t-statistics	$\hat{\beta}$	t-statistics	$\hat{\beta}$	t-statistics
Constant	−0.0012	−1.218	−0.0026	−4.407	0.0088	3.216	-0.0013	-0.348
EPS_NEWS	−0.0004	−1.871	0.0002	1.045			-0.0021	-2.458
ROE_NEWS					0.0011	1.987		
EPS_H_r	0.0018	1.376					0,1530	3.150
ROE_H_r	0.0011	1.092	−0.0014	−1.941	-0.0080	-2.991	-0.0066	-1.723
R^2	0.040		0.031		0.187		0.150	

Though we did not find any model that contains all independent variables at a high enough level of explanatory power, nevertheless the variable that is to represent the impact of the announcement of ROE is present in each model. Furthermore the fact that most of the coefficients are of negative sign indicates that unexpected announcements and hectic past announcement structures make investors "resistant" implying low level of effect on stock prices.

5. Conclusion

It has been presented that the event study methodology can be sufficiently extended as independent variables instead of just being binary variables (occurrence of news indicate the value of 1, no news = 0) represent the value of the news that had been announced in the middle of the event window ($t = 0$).

We were able to prove that from among the conventional dependent variables the aggregate of the deviations from the actual return series (cumulated abnormal return) is the only one, which can be predicted with certainty while individual deviations (daily abnormal returns) and daily returns are still unpredictable in light of the news announcement.

Regression analysis reveals that the announcement of the earnings per share data generates a higher impact on share prices as opposed to the return on equity ratio. This implies that investors are rather using EPS to specify the performance of their company. In light of entropy values ROE data seems to be more relevant as investors become resistant to extremely turbulent announcement history, which results in lower impact of announcements on share prices.

Finally we suggest that from our dependent variables investor public should utilize the maximal deviation from actual return time-series, which is represented by the maximal cumulated abnormal return. As this variable was predicted with the highest precision we recommend its application in hedging strategies, which might generate extra return around the date of the announcement of financial indicators.

Appendix

Distribution by industry of sample firms as of 31 December 2005.

Industry	Number of companies
Aerospace and military technology	2
Automobiles	1
Banking	1
Beverages and tobacco	1
Broadcasting and publishing	1
Business and public services	5
Chemicals	1
Data processing and reproduction	2
Electrical and electronics	1
Electronic components and instruments	1
Energy sources	2
Financial services	2
Food and household products	2
Health and personal care	3
Industrial components	1
Insurance	1
Leisure and tourism	2
Machinery and engineering	1
Merchandising	2
Metals – non ferrous	1
Telecommunications	2
Transportation – airlines	5
Transportation – road and rail	8
Transportation – shipping	2
Utilities – electrical and gas	14
Multi-industry	1

Note. N for number of companies in the sample is 65.
Source: Reuters database and authors' computation.

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