Doctoral School of Business Administration

THESIS SYNOPSIS

Rácz Dávid Andor

Anomalies around reports of stock earnings and of fund management

Ph.D. dissertation

Supervisors:

Dr. Csóka Péter és **Dr. Pintér Miklós**
Professor Associate professor

Budapest, 2019

Department of Finance

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TABLE OF CONTENTS

1. RESEARCH BACKGROUND AND OBJECTIVES

In the financial markets there are many abnormalities and market failures. Two of these are analysed in the dissertation, which are connected by a logical clamp that, by knowing and appropriately managing both, investors can avoid inefficiencies that reduce investors' utility as they lead to suboptimal decisions, missed profits or avoidable losses and ultimately lead to high levels of social costs.

One of the anomalies analysed around the period of quarterly reports of exchange listed companies is a question of market efficiency, which can be analysed by the presence of abnormal returns. This pricing anomaly is relevant for the investor because if in the period before and after the earning reports the abnormal returns show typical mispricing trends the investor would like to recognize them in order to increase his own utility by taking advantage through trading of the existing arbitrage-like opportunities, whereby the mispricing would cease and the market pricing would return to its real and effective value. Alone the aggregate market capitalization of exchange listed companies constituting the S&P 500 is about 22 trillion U.S. dollars[1], so the potentially affected wealth effected by this market failures is enormous in size worldwide. We are searching the answer to the question whether (1) in the quarterly reports of S&P 500 index shares the direction and magnitude of EPS surprises determines the price reactions, and what is the interval at which abnormal returns occur. A further question is whether (2) in case of stock market companies that operate in the technology sector and that have a more uncertain assessment due to greater vagueness, the experienced abnormal exchange reactions outweigh that of companies belonging to the general stock market.

The other anomaly analysed in the dissertation is experienced in assessing the performance of investment funds in the manipulation of performance measures, through which investment fund managers can improve their performance without real added value in order to attract more investors and capital. However, it should be noted that activity called performance manipulation by the literature is in vast majority of cases not an illegal act or fraud, but rather a misleading activity. In doing so, the investment fund manager knowingly or unconsciously conducts an investment activity that increases only the value (and indirectly his own

1 http://siblisresearch.com/data/total-market-cap-sp-500/

commission) of classic performance measures, but not the utility of the rational investor (although the mystified investor suffering from behavioural distortion might rejoice), and thus it constitutes of suboptimal investment decisions. Ingersoll et al. (2007) demonstrated that well-constructed performance measures starting from a utility-based approach can be used to eliminate the problems arising from the manipulation of classic performance measures. Their value can only be increased by investment decisions where the investment manager has additional information relative to the market or is able to create real added value in the possession of his timing and selection capability.

There are basically two types of performance manipulation: one is return smoothing, when by the creative assessment of illiquid or hard-to-evaluate assets the fund manager tries to smooth out possible loss periods and thus artificially reduces the standard deviation and thereby increases the detected risk-adjusted performance. This type of activity in the Hungarian market can practically be ruled out, as a separate and independent custodian assesses and publishes the net asset value of the funds per unit daily in general. The other method is the topic of dynamic manipulation, where the investment fund manager makes its investment strategy conditional on its recent performance and not merely on a rational analysis of the market situation. For example, he flees into risk-free assets to the remainder of the year to protect the return premium compared to the benchmark that has already been achieved in the first part of the year. However, the problem with this activity is that it can lead to suboptimal investment decisions that, while protecting or improving detected performance, are damaging to investors because they do not increase investor utility and skip promising investment opportunities due to exaggerated risk avoidance.

Market failures resulting from performance manipulation can cause serious, social-scale damage, as investment decisions based on manipulated returns and performance measures will be sub-optimal, i.e. investment market participants will not allocate capital to the investments funds, in which they would have invested, if they invested not based on the manipulated and misleading classical measures but on the basis of real performance. Thus, in the end, capital does not flow through investment funds to companies which could have performed the most efficient, most value-added investments from the inflow of funds, thus missed profit occurs on a social level and valuable investments are cancelled. Only in the US

16 trillion dollars of assets are found in the management of actively managed investment funds about[2].

In case of Hungarian absolute return funds, we seek traces of return distortions due to return manipulation or suboptimal investment decisions on the one hand by comparing the rankings of the Manipulation-proof Performance Measure (MPPM) developed by Ingersoll et. al. (2007), and also of the version by Brown et al. (2010) to the rankings of classic performance measures, and on the other hand with the help of the Doubt Ratio, which based on the MPPM, as a manipulation detecting indicator as well as additional manipulation detecting methods, such as the Bias Ratio and the discontinuity analysis, and also with the analysis of investment policies.

[2] https://seekingalpha.com/article/4213088-lipper-u-s-mutual-funds-etps-q3-2018-snapshot

2. RESEARCH METHODOLOGY

2.1. Methodology of event study

We seek an answer to the question, if abnormal returns as a result of the given event (in the dissertation the quarterly company earnings report) can be observed. We mostly rely on studies by MacKinlay (1997), Binder (1998), Kothari and Warner (2007) and Corrado (2011), which discuss this analysis procedure extensively. The initial task is to define the event of interest and the related event window, the period around the event over which prices will be examined:

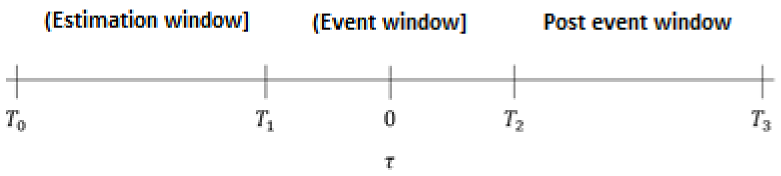

Figure 1: Timeline of an event study (MacKinlay, 1997, p. 20).

The running index of returns is τ, and the stages of the study are: τ=0 is the date of the event, $T_0 + 1 \leq \tau \leq T_1$ is the estimation window, and $T_1 + 1 \leq \tau \leq T_2$ is the event window. In this case $L_1 = T_1 - T_0$ is the length of the estimation window, and $L_2 = T_2 - T_1$ is the length of the event window.

By using the market model to estimate the expected returns the abnormal returns can be calculated as follows:

$$AR_{i\tau} = R_{i\tau} - (\hat{\alpha}_i + \hat{\beta}_i R_{m\tau}) \quad ,$$

where $AR_{i\tau}$ is the abnormal return of security *i*, $R_{i\tau}$ és $R_{m\tau}$ are returns of share *i* and of the market portfolio in the period τ. $\hat{\beta}_i$ is the estimated regression coefficient for the sensitivity to market return and $\hat{\alpha}_i$ is the parameter that helps fitting.

Abnormal returns within the event window must be aggregated in two dimensions, according to the time interval and groups corresponding to the size and direction of the EPS surprise, so we can get the cumulative average abnormal returns at any (τ_1, τ_2) interval in the event window.

$$\overline{CAR}(\tau_1,\tau_2) = \sum_{\tau=\tau_1}^{\tau_2} \overline{AR}_\tau \quad ,$$

$$var\left(\overline{CAR}(\tau_1,\tau_2)\right) = \sum_{\tau=\tau_1}^{\tau_2} var(\overline{AR}_\tau) \quad ,$$

Based on all these, it is possible to test the following null hypothesis if the cumulative average abnormal yield has a normal distribution with a zero expected value:

$$\theta = \frac{\overline{CAR}(\tau_1,\tau_2)}{\sqrt{var\left(\overline{CAR}(\tau_1,\tau_2)\right)}} \sim N(0,1) \quad .$$

In the case of the second hypothesis, we examine whether the results obtained from the two samples are significantly different from each other, do they have the same expected value and variance distribution. We apply the two-sample t-test for the cumulative abnormal returns measured in the (–10,10) interval. In this case we examine the following hypothesis pair:

$$H_0: \quad \overline{CAR}_{SP}(-10{,}10) = \overline{CAR}_{SPIT}(-10{,}10) \quad ,$$
$$H_1: \quad \overline{CAR}_{SP}(-10{,}10) \neq \overline{CAR}_{SPIT}(-10{,}10) \quad ,$$

where the lower indices denote the sample from the given stock index, and in this case we, again, compare the positive and negative EPS-report categories in pairs. In this case t-statistics can be calculated with the following formula:

$$t = \frac{\overline{CAR}_{SP}(-10{,}10) - \overline{CAR}_{SPIT}(-10{,}10)}{\sqrt{s_{SP}^2/N_{SP} + s_{SPIT}^2/N_{SPIT}}} \quad ,$$

where N_{SP} és N_{SPIT} are the number of items in the test category of the corresponding indices.

2.2. Covering the traces of performance manipulation with the help of the MPPM, the Doubt Ratio, the Bias Ratio, and the discontinuity analysis

Comparing the ranking of classical measures to the ranking of the MPPM, rank correlation

The detection of manipulated performance or distorted returns due to suboptimal investment decisions is possible by comparing the ranking of classical measures to the ranking of manipulation-proof indicators (MPPM). Since the values of classical measures can be distorted, while the values of MPPMs cannot due to their construction, so differences in the ranking may indicate the return manipulation, which can be measured by the rank correlation. The MPPM version by Ingersoll et al. (2007) and Brown et al. (2010) can be calculated with the help of the formulas below:

The MPPM advised by Ingersoll et al. (2007) is the following:

$$\hat{\Theta} = \frac{1}{(1-\rho)\Delta t} \ln\left(\frac{1}{T}\sum_{t=1}^{T}\left[\frac{1+r_t}{1+r_{ft}}\right]^{1-\rho}\right) ,$$

where $\hat{\Theta}$ gives an estimate on the risk adjusted return premium of the investment fund. For a given $\hat{\Theta}$, the portfolio's score is the same as the annualised return of a continuously compounded risk-free asset, which is higher than the risk-free rate by the value of $\hat{\Theta}$. r_t is the return of the fund, r_{ft} is the risk-free rate and ρ is the relative risk aversion ratio.

Brown et al. (2010) used the following simplification, approximation of MPPM:

$$\hat{\Theta}(\rho) = \frac{1}{\Delta t}\left\{\bar{x} + \frac{1-\rho}{2}(s_x^*)^2\right\} ,$$

where $\bar{x}$ is the average of the excess return and$(s_x^*)^2 = s_x^2(T-1)/T$ is the variance of the excess return calculated from the sample, ρ is the relative risk aversion factor.

Doubt Ratio

This MPPM version Brown et al. (2010) enabled the simple calculation of the implied risk aversion factor which the authors called Doubt Ratio (DR):

$$\text{Doubt Ratio} = \text{DR} = \frac{\hat{\Theta}(2)}{\hat{\Theta}(2)-\hat{\Theta}(3)} + 2 \approx \frac{2\bar{x}}{(s_x^*)^2} + 1 .$$

An extremely high doubt ratio suggests extreme risk aversion, which is a potential sign of performance manipulation. According to Brown et al. (2010) page 58. table 11. 80% of funds with Doubt Ratios above 150 were also found as manipulated by alternative statistical approaches.

Alternative manipulation detecting methods

The signals of the Doubt Ratio can be compared with the alternative manipulation detecting statistical methods. While the Doubted Ratio measures the changes in the implied risk aversion ratio from the MPPM values, there are such other techniques, which infer from the specificities of the return distribution, and/or from the return distribution around 0, the potential return smoothing or other manipulation, or return distortions due to suboptimal decisions.

Abdulali (2006) introduced the Bias Ratio to analyse the returns of hedge funds, with the help of which one can filter out hedge funds that are presumed to employ return smoothing or other manipulations mainly through their portfolio items which are seldom-priced or have difficult-to-assess net asset values. It measures the shape of the distribution of returns in a critical interval of one standard deviation around the 0 rate, indicating those hedge funds or investment funds, where the potential of return smoothing ermges.

$$\text{Bias Ratio} = \frac{\text{Observed frequency} \quad (r_i): r_i \in [\ 0,\ \ +1.0\sigma\ ]}{1+\ \ \text{Observed frequency} \quad (r_i): r_i \in [\ -1.0\sigma,\ \ 0\ )} \ ,$$

where [0.0, +1.0σ] is a closed interval, including 0, inclusive of returns up to + 1 standard deviation. The [-1.0σ, 0.0) is a half-closed interval from the return -1 standard deviation to 0, including the -1 standard deviation, but not 0. Observed returns are indicated by r_i. According to Abdulali (2006) investment funds or hedge funds above the median level of calculated Bias Ratios for a given investment style should be analysed further.

In discontinuity analysis, we look for signs of discontinuity in the distribution of investment funds around 0. To perform this analysis, the distribution of returns must be plotted on a histogram. Choosing class width is a critical issue for the analysis, following Bollen and Pool (2009) the formula below is advisable to be used based on Silverman (1986):

$$h \ = \ 0{,}9 \min \left[\sigma \, ; \, \frac{Q3 - Q1}{1{,}34}\right] N^{-0{,}2} \quad ,$$

where h is the class width, σ is the standard deviation of returns, N is the number of observed returns, Q3 and Q1 are the appropriate quartiles. According to Bollen and Pool (2009) when determining both h and plotting the histograms, we ignore the round 0 returns as they do not represent return smoothing but missing data or lack of trading.

In terms of the frequency of the positive and negative returns around 0, it is possible to consider how the frequency of yields around 0 statistically compares to the normal distribution with the same expected value and standard deviation as the observations. The statistical test, the values of which can be used to evaluate the course of the distributions shown on the histograms based on Bollen and Pool (2009), as well as Burgstahler and Dichev (1997) is the following:

$$Z = \frac{f - Np}{\sqrt{Np(1-p)}} \quad ,$$

where f is the frequency observed in a given class interval, N is the number of observations, p is the expected value of a class interval based on the normal distribution.

3. MAIN RESULTS

3.1. Share price reactions under the influence of quarterly reports

The share price reactions observable around quarterly reports of stock companies were analysed, in which the strength of market efficiency was assessed by measuring the presence of abnormal yields around the publication of the quarterly reports. To do this 16-quarter reports of the 45-45 biggest and most liquid components of the S&P500 and S&P500 IT indices, 720-720 element samples were analysed. The samples were split into additional subgroups according to whether the surprise in earnings per share is very good, good, neutral, bad or very bad news for the market.

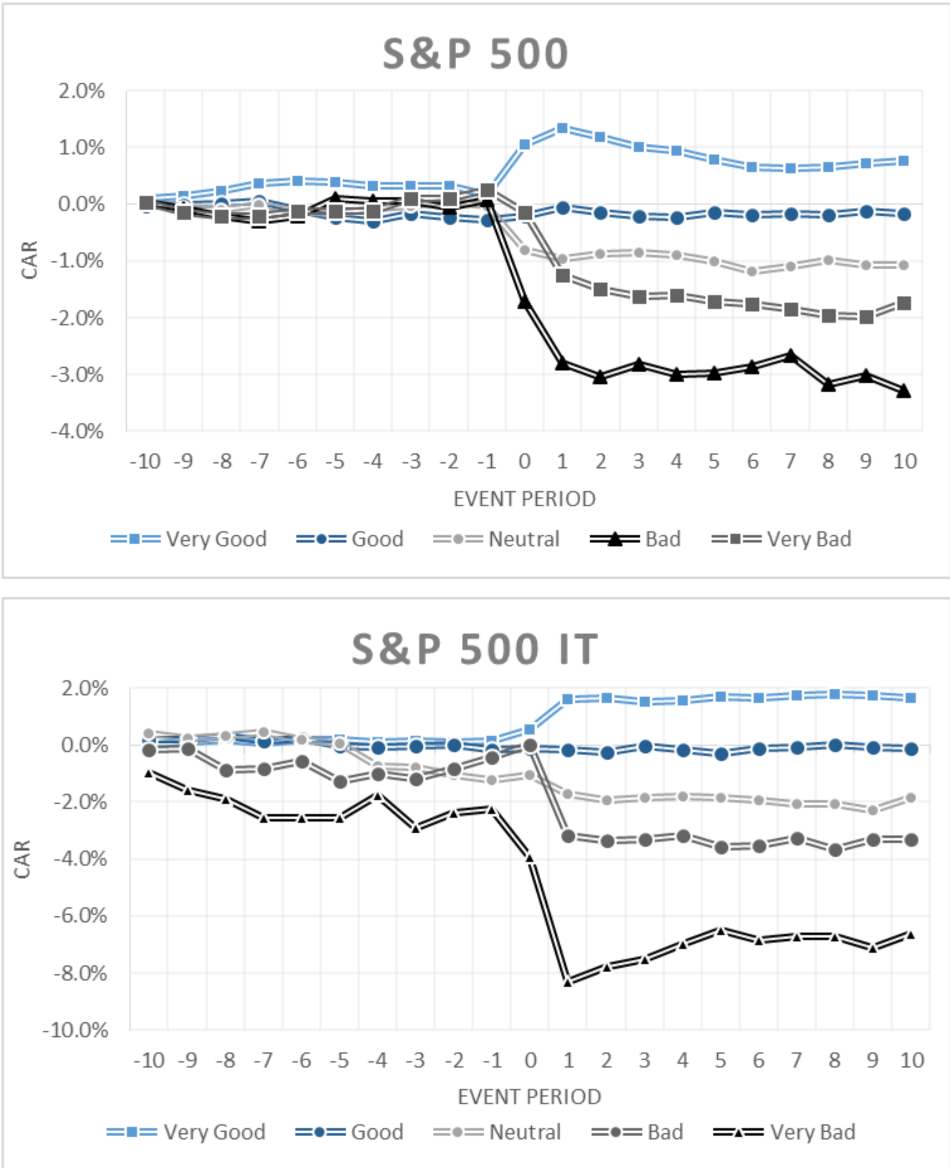

Figure 2: Cumulative average abnormal returns of the five groups in the time interval around the event of the samples taken from the two equity indices in case of very good, good, neutral, bad and very bad subgroups.

The first statement of our first test hypothesis was approved: the direction and magnitude of surprise in companies' profitability determines how stock prices change due to company reporting. At the same time, there is a shift in the level and direction of the cumulative abnormal yields observed for each newsgroups to negative price reactions, as a significant positive yield is only seen in the very good news group, while in the good news group there is no longer a significantly different yield from 0, while in the neutral news group we see negative cumulative abnormal yields, but in the bad and very bad news group, its degree exceeds the level of the neutral group.

S&P 500	τ_1,τ_2	*CAR*	*s*	θ	*Degree of freedom*	$t_{0,975}$	$t_{0,995}$	*p*
Very good news	-10 , 10	0.77%	0.30%	2.54	329	1.97	2.59	0.0114
	-10 -1	0.17%	0.21%	0.84	329	1.97	2.59	0.4037
	0 , 10	0.60%	0.22%	2.72	329	1.97	2.59	0.0069
	0 , 1	1.17%	0.09%	12.55	329	1.97	2.59	0.0000
	2 , 10	-0.58%	0.20%	-2.91	329	1.97	2.59	0.0038
Good news	-10 , 10	-0.17%	0.33%	-0.53	205	1.97	2.60	0.5952
	-10 -1	-0.28%	0.22%	-1.27	205	1.97	2.60	0.2073
	0 , 10	0.11%	0.24%	0.47	205	1.97	2.60	0.6382
	0 , 1	0.23%	0.10%	2.29	205	1.97	2.60	0.0231
	2 , 10	-0.12%	0.21%	-0.56	205	1.97	2.60	0.5771
Neutral news	-10 , 10	-1.08%	0.51%	-2.13	90	1.97	2.63	0.0357
	-10 -1	-0.04%	0.35%	-0.11	90	1.97	2.63	0.9133
	0 , 10	-1.04%	0.37%	-2.84	90	1.97	2.63	0.0055
	0 , 1	-0.91%	0.16%	-5.87	90	1.97	2.63	0.0000
	2 , 10	-0.12%	0.33%	-0.38	90	1.97	2.63	0.7071
Bad news	-10 , 10	-3.27%	0.92%	-3.54	29	1.97	2.76	0.0014
	-10 -1	0.08%	0.64%	0.13	29	1.97	2.76	0.8984
	0 , 10	-3.36%	0.67%	-5.02	29	1.97	2.76	0.0000
	0 , 1	-2.89%	0.29%	-10.12	29	1.97	2.76	0.0000
	2 , 10	-0.47%	0.61%	-0.78	29	1.97	2.76	0.4444
Very bad news	-10 , 10	-1.73%	0.68%	-2.54	62	1.99	2.66	0.0136
	-10 -1	0.26%	0.47%	0.55	62	1.99	2.66	0.5825
	0 , 10	-1.99%	0.49%	-4.04	62	1.99	2.66	0.0002
	0 , 1	-1.51%	0.21%	-7.19	62	1.99	2.66	0.0000
	2 , 10	-0.48%	0.45%	-1.07	62	1.99	2.66	0.2878

Table 1: The cumulative average abnormal returns of the sample from the S&P 500 index, the standard deviation of these returns, test statistics, critical values, p-values for the very good news, good news, neutral news, bad news and very bad news groups and for various time intervals.

However, **the second statement of our first test hypothesis is rejected**, the impact of the new information on the post-notification trading days is no longer observed and no trend develops in the direction of surprise (in fact, in the very good news group of the S & P 500, we see a significant price adjustment). Thus, the analysis confirms that the market for shares in the selected sample is moderately efficient.

S&P 500 IT	τ_1,τ_2	CAR	s	θ	Degree of freedom	$t_{0,975}$	$t_{0,995}$	p
Very good news	-10 , 10	1.63%	0.33%	4.95	410	1.97	2.59	0.0000
	-10 -1	0.16%	0.23%	0.69	410	1.97	2.59	0.4895
	0 , 10	1.48%	0.24%	6.18	410	1.97	2.59	0.0000
	0 , 1	1.44%	0.10%	14.13	410	1.97	2.59	0.0000
	2 , 10	0.04%	0.22%	0.17	410	1.97	2.59	0.8661
Good news	-10 , 10	-0.11%	0.47%	-0.22	192	1.97	2.60	0.8235
	-10 -1	-0.15%	0.32%	-0.45	192	1.97	2.60	0.6512
	0 , 10	0.04%	0.34%	0.12	192	1.97	2.60	0.9022
	0 , 1	-0.01%	0.15%	-0.07	192	1.97	2.60	0.9405
	2 , 10	0.05%	0.31%	0.17	192	1.97	2.60	0.8642
Neutral news	-10 , 10	-1.86%	0.70%	-2.65	74	1.99	2.64	0.0098
	-10 -1	-1.25%	0.48%	-2.57	74	1.99	2.64	0.0121
	0 , 10	-0.62%	0.51%	-1.21	74	1.99	2.64	0.2298
	0 , 1	-0.45%	0.22%	-2.07	74	1.99	2.64	0.0418
	2 , 10	-0.17%	0.46%	-0.36	74	1.99	2.64	0.7183
Bad news	-10 , 10	-3.30%	1.20%	-2.74	25	2.06	2.79	0.0111
	-10 -1	-0.44%	0.83%	-0.53	25	2.06	2.79	0.6035
	0 , 10	-2.86%	0.87%	-3.29	25	2.06	2.79	0.0030
	0 , 1	-2.75%	0.37%	-7.39	25	2.06	2.79	0.0000
	2 , 10	-0.12%	0.79%	-0.15	25	2.06	2.79	0.8837
Very bad news	-10 , 10	-6.63%	1.60%	-4.15	14	2.14	2.98	0.0010
	-10 -1	-2.26%	1.10%	-2.05	14	2.14	2.98	0.0597
	0 , 10	-4.37%	1.16%	-3.78	14	2.14	2.98	0.0020
	0 , 1	-6.03%	0.49%	-12.24	14	2.14	2.98	0.0000
	2 , 10	1.66%	1.05%	1.59	14	2.14	2.98	0.1339

Table 2: The cumulative average abnormal returns of the sample from the S&P 500 IT index, the standard deviation of these returns, test statistics, critical values, p-values for the very good news, good news, neutral news, bad news and very bad news groups and for various time intervals.

3.2. Differences in the effects of the EPS surprise

In the very good, very bad and neutral news groups there is a significant difference between the cumulative abnormal returns of the S&P 500 and S&P 500 IT indices on the normal significance levels, and the S&P 500 IT newsgroups have a higher rate of cumulative abnormal yields between the two indices. However, in the good and bad news groups there is no meaningful difference between the two indices in the magnitude of the abnormal yields experienced. In relation to the good news group, this is not a surprising development in the context that in both cases, we saw yields that were not significantly different from 0 in the earlier part of the analysis in this news group, or, if we consider that due to a shift towards negative price-reactions, this newsgroup counts as the origin of the newsgroups.

On the basis of the results, **we generally accept the second hypothesis** that in the technology sector there is a stronger surprise effect on the share prices compared to the one seen in the general stock market.

	t-stat	*Degree of freedom*	$t_{0,975}$	$t_{0,995}$	*p*
Very Good	-37.08	726.1	-1.96	1.96	0.0000
Good	-1.66	338.6	-1.97	1.97	0.0971
Neutral	8.09	131.1	-1.98	1.98	0.0000
Bad	0.10	46.6	-2.01	2.01	0.9234
Very Bad	11.63	15.2	-2.13	2.13	0.0000

Table 3: T-statistics of the difference between the cumulative average abnormal returns of the samples from the S&P 500 and the S&P 500 IT indices for the very good news, good news, neutral, bad news and very bad news groups for the (–10,10) interval

3.3. Detecting the traces of return manipulation and return smoothing with different methods on Hungarian absolute return funds

The second market failure we are testing, the distortion of returns due to performance manipulation or suboptimal investment decisions that are observable around investment fund managers' reports, by which the investment fund manager can knowingly or unconsciously improve its *detected* performance by classical indicators, without increasing investor utility with investment decisions that create real added value. We used manipulation-proof performance measures (MPPMs), a manipulation-signaling measure created from them, the Doubt Ratio, as well as further alternative methods and measures, like the Bias Ratio and the discontiunity analysis to detect traces of performance manipulation or suboptimal investment decisions on data of Hungarian absolute return funds.

Our analysis counts as a new result as no other example is known yet to show the traces of return manipulation in the scientific literature for Hungarian investment funds. For our calculations, we used the daily price data of 31 Hungarian absolute return funds covering a 7-year interval. According to our results, the **rank correlation** between the MPPM and Sharpe ratios is in the 0.76-0,82 range, which is higher than the range around 0.7 of international examples, but indicates a level of **difference** compared to the classic measures that **can be caused by some level of return manipulation** or return smoothing.

Sharpe-MBTM(2)	0.8202
Sharpe-MBTM(3)	0.8024
Sharpe-MBTM(4)	0.7617

Table 4: Rank correlations between the Sharpe-ratios and the MPPM for different risk aversion factors.

Another new result of our calculations contributing to the literature is that, **in contrast to the close overlap of the Doubt Ratio with alternative return manipulation detecting methods** observed in the literature (Brown et al. (2010), 80% match), **the results of our analyzed sample were mixed**: The alternative methods reported potential anomalies from the 31 investment funds in 10 cases, i.e. some yield manipulation or suboptimal investment decisions were most likely, whereas the Doubt Ratio only identified 4 investment funds as suspicions. In case of the former, the confirmation by the discontinuity analysis is in 4 out of 10 cases, while in case of Doubt Ratio it is only confirmed 1 out of 4.

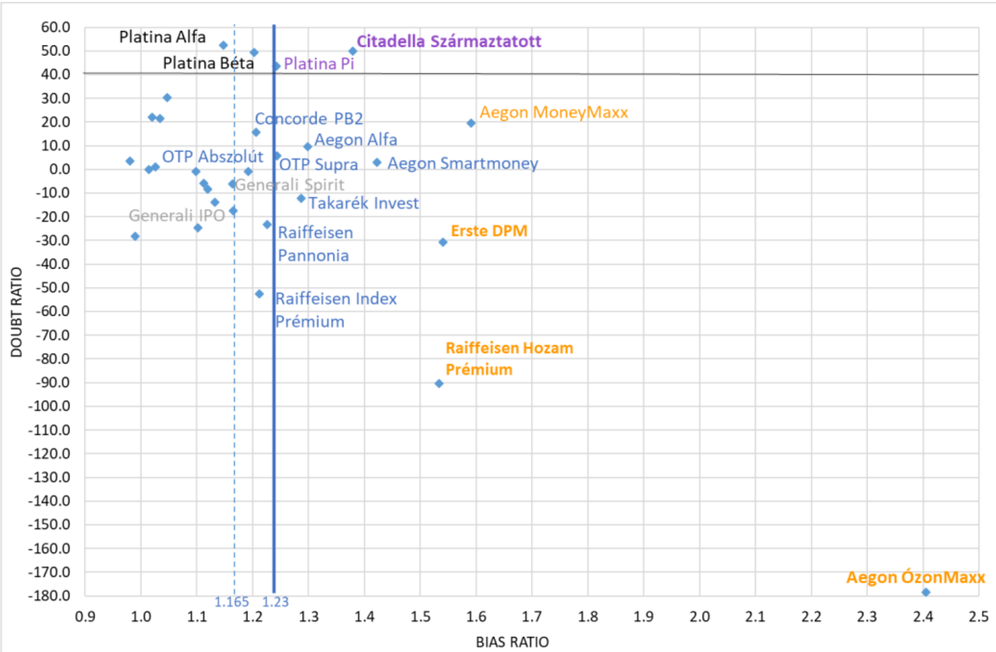

Figure 3: Comparing the values of the Bias Ratio with the Doubt Ratio.

Overall, according to our results, the Bias Ratio has proved to be a better pre-screening tool for more detailed analysis of return manipulation (e.g. with discontinuity analysis, with the overview of the investment policy) than the Doubt Ratio. At the same time, we must take into account that the Doubt Ratio could be used only through the identification of outliers on the sample analyzed, since the critical value of 150 was not achieved by any investment fund and the analysis was made on a relatively small sample, Thus, it cannot be regarded as generally demonstrated that this difference would be the same on larger samples.

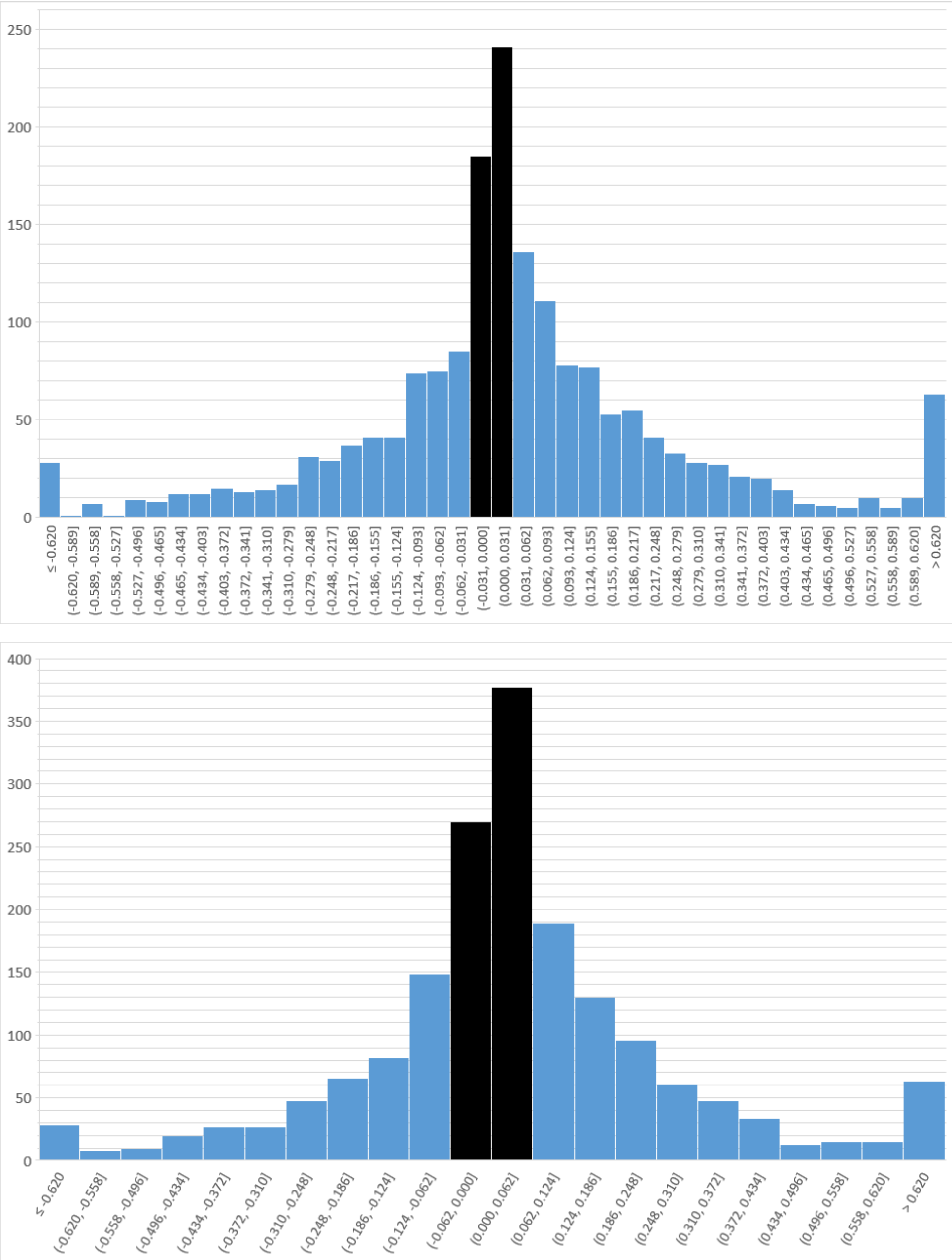

Figure 4.: Discontinuity analysis of the Concorde Citadella investment fund's returns adjusted by the risk-free rate around 0.

Based on investment policies and interviews with investment managers, **only in case of one fund, the Concorde Citadella fund could the simultaneous suspicious signals given by several methods be considered as justified**, and this fund was marked as suspicious by both the Doubt Ratio and the Bias Ratio. In the case of this fund, the existence of distortion due to **sometimes sub-optimal investment decisions** seems well founded in the knowledge of investment policy.

A new approach was also taken when a graphical representation of blatant deviations from the group average was used to segregate suspicious investment funds, both in terms of the Doubt Ratio and the Bias Ratio.

As a new result, we have also shown that **the linear approximation of MPPM by Brown et al. (2010) is less punishing risk compared to the Ingersoll et al. (2007) calculation**. The higher value differences experienced between Ingersoll et al. (2007) and Brown et al. (2010) methods in MPPM are generally inherited enlarged to the Doubt Ratio calculated from them.

We recommend using the following protocol to filter performance manipulation: 1. The discontinuity analysis of investment funds with a Doubt Ratio of more than 150, and the assessment of the Bias Ratio according to the median rule. 2. A graphical representation of the values of the Bias Ratio and Doubt Ratio in the Bias Ratio-Doubt Ratio space and, subsequently based on the deviation from the group average, the discontinuity analysis of the returns of investment funds that appear to be outliers. 3. Discontinuity analysis of investment funds with Bias Ratios higher than the median. 4. An overview of investment policies to understand the underlying investment decisions that can strengthen or refute the potential existence of suboptimal decisions, or weaken the reliability of statistical methods, for example if the composition of the investment fund is overweighed with fixed-income assets, or when the fund operates as fund of funds and always allocates the vast majority of its capital into investment funds.

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