Intraday price reaction to filing bankruptcy and restructuring proceedings - the evidence from Poland

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Abstract: Digitization has transformed and changed the stock markets all over the world, those rapid changes are especially easy to catch in developing market, where using digital technologies gives a competitive advantage. This chapter presents such possibilities of receiving extra opportunities when the ICT are implemented. This research is focused on the price reaction of shares listed on the Warsaw Stock Exchange to filing bankruptcy and/or restructuring applications. Event study was adopted as the research method, and it was performed at ten, five and one-minute intervals. Based on the results of the research, it was found that this reaction is very quick, as it takes 1-2 minutes after the information on bankruptcy and restructuring applications was made public. Significantly higher negative above-average rates of return were obtained when information on bankruptcy applications was made public. Moreover, the stock price response was more sudden when the information was made public outside the trading session.

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In general, this confirms that the functioning of the Electronic System for Information Transmission in Poland reduces the asymmetry of information between investors and contributes to an increase in market efficiency. In other words, it can be said that the digitalization of analysed type of information has a positive effect because it reduces information asymmetries. However, the conducted research also showed that there is a time gap of seven minutes on average on the market between the submission of information about the application and the reaction of investors to such information. The existence of this gap has been confirmed only for applications published during an ongoing trading session. The fact that there is an identified time gap on the market may be used by investors who, using automated trading systems, will take a short position on the relevant assets in advance of traditional investors. So the space for developing Information and Communication Technologies is still very vast in the Polish capital market especially using high-frequency trading. What is more, this research was possible only because of used digital technology systems (ESPI and bossa.pl) which include all necessary information and data with minute accuracy.

Keywords: market efficiency, bankruptcy, price reaction, event study, Information and Communication Technologies (ICT).

1. Introduction

Already at the end of the 20th century and the beginning of the 21st century, research was conducted showing that ICT tools can reduce information asymmetry and support market efficiency. In particular, the development of the Internet contributed to this (Wysocki 1998, Antweiler and Frank 2004). Lee et al. (2019) distinguished two ICT diffusion on stock market efficiency effects. On the one hand, it can support the flow of information, which has a positive impact on market efficiency. On the other hand, it may spread false information and contribute to reducing market efficiency. These authors undertook research aimed at determining the impact of ICT diffusion on the market efficiency and verifying which of the above-mentioned effects prevails. Their research shows that stock markets in countries with high ICT diffusion are efficient while stock markets in countries with low or medium ICT

diffusion are not all efficient. Moreover, the effect of ICT diffusion in reducing market noises was more significant than its effect on magnifying the noises (Lee et al. 2019).

The doubts about whether the Internet, will significantly reduce the cost of obtaining capital through public or quasi-public offering can be also found in Black (1998). The author states that the most important single barrier standing between small companies and capital providers is information asymmetry. The Internet is not a solution/tool for potential investors for verifying, the quality of the information that a company provides. What is more, it was also showed that the level of the digitalization does not affect profitability (Niemand et al. 2020). This research was prepared on data from the banking sector. The weak role of ICT diffusion in improving economic growth in middle and low-income countries is also shown in Cheng et al. (2021). But the authors also state that in high-income countries ICT diffusion can improve economic growth. Very similar conclusions, to presented above, can be found in Yartey (2008). In that article also is emphasized that for countries with underdeveloped financial markets ICT diffusion can give negative results.

In Poland, the ESPI (Electronic System for Information Transmission) system is an ICT system, certain tool facilitating the transfer of digitalization information in a standardized form between companies listed on the Warsaw Stock Exchange and investors. As part of this system, the companies present all relevant information on an ongoing basis, including data on filed bankruptcy applications or the introduction of restructuring proceedings. The purpose of this chapter is to analyse the reaction of share prices to the information provided in the ICT system called ESPI about filing applications for bankruptcy or restructuring proceedings against companies listed on the Warsaw Stock Exchange. We anticipate that the functioning of such ICT system should contribute to reducing the asymmetry of information between investors and, at the same time, increasing market efficiency. Event analysis was used as a research method and it was carried out in an ultra-short period, i.e. within 120 minutes after such information appeared in ESPI, taking into account minute data. For the purposes of this chapter, it was assumed that ultra-short time applies to minute data and a period shorter than one session day. In some publications, the term intraday is used, and this one is used in this publication as well. Few similar studies have been reported so far, mainly for the US market, but only using daily or longer data. For example, Schatzberg and Reiber (1992) noted a short-term effect of the share prices reverse of American companies for which chapter 11 was claimed, i.e. after significant price drop during the application period, a surplus return rate was generated. An analogous effect was achieved by Datta and Iskander-

Datta (1995) and Dawkins et al. (2007). Coelho and Taffler (2009) examined the long-term effect for US companies applying for chapter 11. As for the analysis of events in minute intervals, the ones examined included, among others, the impact of the following events on share prices: publishing information about new share issues (Barcley and Litzenberg, 1988), the occurrence of price shocks (Zawadowski et al., 2006), submitting of stock market recommendations (Bradley et al., 2014), the publication of macroeconomic data (Hanousek et al., 2009). Depending on the research periods and the types of events and markets, the adjustment of prices to the emerging information usually took place within a few minutes (Patell and Wolfson, 1984; Robertson et al. 2007). Busse and Green (2002) proved even that this adjustment could be made faster, because within seconds after the positive information is revealed. Reacting to negative data takes longer, up to 15 minutes. The research conducted in Poland has so far focused on the reaction of the Warsaw stock exchange indices WIG and WIG20 to data on the macroeconomic situation in the United States (Będowska-Sójka 2010; Gurgul et al., 2013; Suliga and Wójtowicz 2013) and were conducted in 5-minute intervals. Price reactions to digital information about filed bankruptcy or restructuring applications were not analysed.

As it was shown at the beginning ICT developing has an impact on market efficiency. The market efficiency theory is associated with Fama (1965a, 1965b, 1970) who was awarded the Nobel Prize in 2013. The foundations of this theory, however, can be found much earlier, at the beginning of the 20th century, when Bachelier (1900) developed the random walk theory. In the same period as Fama, also Samuelson proposed the efficient market hypothesis (Delcey, 2019). According to that theory, the prices of the securities reflect all information concerning them. Fama (1970) formalized and presented the assumptions of this theory, presenting three forms of information efficiency, i.e. weak (historical information is included in the price), semi-strong (both historical and publicly available information is included in the price) and strong (all information, both publicly available and available to selected groups, e.g. investors, management board, is reflected in the price). This theory, although still alive, is subject to criticism, and there are still disputes regarding its assumptions and verifiability (Schwert 2003; Malkiel 2003; Fama, Thaler 2016). There have been many studies showing anomalies that allow achieving the so-called above-average rates of return [Dimson (Ed.) 1988; Latif et al. 2011]. The concepts of price overreaction and underreaction were proposed, undermining the assumptions of market efficiency hypothesis (Dreman 1982; De Bondt, Thaler 1985; Howe 1986). The noisy trading theory was also created by Black (1986), which was later developed by Trueman (1988) and De Long et al. (1990). The latter

proposed a division into noise traders and sophisticated investors. Noise traders behave irrationally and believe they have additional information that affects the value of the shares. This information may come from various sources, e.g. technical analysts, investment advisors. They are also often characterised by excessive subjective confidence in making investment decisions. This results in a situation in which share prices significantly differ from their internal value. Sophisticated traders are perceived as persons who make rational investment decisions taking into account accurate information. Therefore, in their case, the price adjusts quickly to the emerging relevant information and reflects the intrinsic value of the share. Depending on which group dominates the stock market, it is more or less effective.

Apart from the introduction that shows the theoretical framework and background, the chapter structure is as follows. The next section presents the research methodology. The results are included in section 3. The last part is devoted to discussing the findings and implications of our research.

2. Materials and Methods

The selection of observations for the sample was carried out as follows. First, all current digital reports from the ESPI system submitted by companies listed on the Polish stock market in the period 6.10.2004-31.12.2019 and available at http://biznes.pap.pl/pl/reports/espi/company/82,2018,0,0,1 were analysed. Out of 367,365 reports, those concerning the filing of bankruptcy applications or restructuring proceedings by companies from the Warsaw Stock Exchange listed in the continuous system were selected. The observations, which were disrupted during the research period were omitted.

Ultimately, data for 51 applications were obtained. The sample was also divided into several categories:

- type of application submitted (restructuring - first group, bankruptcy - second group),
- time of publication of information about the submitted application (during the session – the first group, before or after the session - second group).

The breakdown into the above groups is shown in Table 1.

Table 1 Test sample characteristics

	BANKRUPTCY	RESTRUCTURING	SUM
BEFORE AND AFTER SESSION	10	22	**32**
DURING SESSION	5	14	**19**
SUM	**15**	**36**	**51**

Source: Own study.

To evaluate the reaction of share prices to the information presented above, an event studywas applied, which can be used to assess market efficiency and at the same time allows to estimate above-average rates of return during the period of the event (Konchitchki and O'Leary 2011; Kothari and Warner 2007). The calculations were carried out in program R, based on the event study package by Schimmer et al. (2015), which was adapted for minute analysis.

The basis for the assessment of the examined effect will be the following interest rates, determined based on logarithmic rates of return for the analysed companies and the benchmark (WIG index):

$$AR_{i,t} = R_{i,t} - (\alpha_i + \beta_i * R_{m,t})$$

$$AAR = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t}$$

$$CAR(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{i,t}$$

$$CAAR = \frac{1}{N}\sum_{i=1}^{N} CAR(t_1, t_2)$$

Where,

- Ri,t - the rate of return for company "i" on day "t",

- Rm,t - the rate of return for the WIG index on day "t",
- αi, βi - the estimated market-based model parameters.
- AR - abnormal return,
- AAR - average abnormal return,
- N - number of analysed event in each group (for example 15 for liquidation bankruptcy proceedings),
- CAR - cumulative abnormal return,
- t1 - the beginning of the research window (in this study always 5 minutes before the event),
- t2 - the ending of the research window (in this study always 120 minutes after the event),
- CAAR - cumulative average abnormal return.

Data on prices of particular assets and the benchmark, which were used to determine the logarithmic rates of return of the surveyed companies were obtained from the website https://info.bossa.pl/notowania/pliki/intraday.

Additionally, a market model was used to determine the AR (abnormal return) rate. Due to low market liquidity, the models for the AR rate were determined based on the daily data from 110 observations seven days before the information was published. The study window, however, ranges from 5 minutes before the event to 120 minutes after the event (the 10, 5 and 1-minute intervals after the event were used).

Statistical tests that were used to assess whether the submission of the analysed applications has a statistically significant impact on share prices are (the literature source for the test is given after the colon):

- for rates AR and CAR:
    - T-test, Gurgul (2019).
- for rates AAR and CAAR:
    - Kolari and Pynnönen adjusted Patell or Standardized Residual Test (Adj. Patell Z), Kolari and Pynnönen (2010).

The above methodology together with the created breakdowns of the applications from Table 1 allows assessing whether the type of application (restructuring, bankruptcy) has an impact on the emergence of above-average rates of return on the market that would be statistically significant. Moreover, the second breakdown (applications submitted during the session or outside the session) allows the assessment not only whether the above rates are present, but also with what average delay the market reacts to the publication of information about insolvency, and thus how much time investors need to respond to the emergence of new information using the available information and technology tools.

3. Results

3.1 Analysis of data for a ten-minute interval

The results for all surveyed companies, without division into groups presented in Table 1, are presented in Figure 1 and Table 2.
Figure 1 shows how AAR rates developed in 10-minute intervals after the event.

Figure 1

Based on the data presented in Figure 1, it can be concluded that, up to five minutes before the occurrence of an event, the surveyed companies had an above-average positive (although low) rate of return. On the other hand, after ten minutes from the occurrence of an event, the highest negative rate of return was recorded at a level exceeding -5%, further significant drops are visible after 30 and 50 minutes after the occurrence of an event. However, the last drop not exceeding -2% was observed 90 minutes after the event.
Table 2 presents the results of the statistical test for the tested ten-minute intervals.

Table 2 Statistical test results for the surveyed sample of companies n=51.

	AAR											
Test	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)	(100)	(110)	(120)
Adj. Patell Z	-7.291 (***)	-1.041	-4.266 (***)	0.09	-4.367 (***)	0.329	0.316	0.18	-2.148 (**)	0.93	-0.196	0.05

If the significance was at α=0.01 then the symbol (***) was used, for α=0.05 (**), for α=0.1 (*)
Source: Own study.

The applied statistical test did not show the occurrence of above-average statistically significant rates of return in the time before the event, therefore, for the sake of clarity, these data are not presented in the table above. The results of the testing performed are consistent with the previous graphical data analysis. It turned out that above-average negative and statistically significant rates of return were recorded ten, thirty, fifty and ninety minutes after the event occurred. However, for the first three mentioned moments, statistical significance was observed at the level of $\alpha = 0.01$, while in the ninetieth minute it was at the level of $\alpha=0.05$. In the remaining analysed periods, it was not found that the value of above-average rates of return was statistically significant.

Based on the above results, Table 3 presents the value of basic descriptive statistics and T-test results for AR and CAR rates at the previously indicated statistically significant points of the study.

Table 3 Descriptive statistics value for statistically significant ten-minute intervals and CAR rate.

Descriptive statistic	AR(10)	AR(30)	AR(50)	AR(90)	CAR
Mean	-5.6%	-3.3%	-2.2%	-1.5%	-9.5% (CAAR value)
Median	-1.1%	0.0%	0.3%	0.2%	-8.2%
Standard Deviation	12.7%	12.0%	9.3%	9.0%	22.1%
Kurtosis	17.1	19.2	23.6	43.2	0.0
Skewness	-3.6	-4.2	-4.3	-6.3	-0.5
Range	82.0%	74.4%	67.1%	67.2%	93.4%
Minimum	-74.4%	-68.6%	-56.3%	-62.4%	-65.9%
Maximum	7.5%	5.9%	10.8%	4.8%	27.6%
Number of negative AR's[1]	32 (8)	26 (4)	25 (5)	22 (2)	x
Number of positive AR's[1]	19 (0)	25 (0)	26 (0)	29 (0)	x
Number of negative CAR's[1]	x	x	x	x	33 (6)
Number of positive CAR's[1]	x	x	x	x	18 (0)

Source: Own study.

[1] The number of AR and CAR rates that were statistically significant at least at $\alpha=0.05$, is presented in brackets.

The data in Table 3 are the basis for the following conclusions:

- The above-average negative rates of return appear already in the first examined moment after the event, i.e. after ten minutes. The reaction to the release of information about the submitted application is the strongest at the time of its release, and the subsequent drops are smaller and appear after longer periods. This suggests that the market is adapting the share price to new information that has emerged.
- The average value of the cumulative rates of return for all analysed events is -9.5%, which clearly indicates that the appearance of information about the submitted application causes, on average, a significant discount of shares of such a company within the examined 120 minutes.
- Moreover, the shorter the time from the appearance of the information, the greater the variability of the obtained return rates within the examined sample, which is evidenced by the decreasing value of the standard deviation.
- In the analysed sample, significant differences were also observed between the minimum and maximum values of the tested rates of return. The lowest rates of return are also several times higher than the observed maximum rates of return. The value of the presented range also proves that the rates of return are highly diversified.
- The number of all above-average negative rates of return is higher than the number of above-average positive rates of return for the surveyed companies in the first two distinguished moments of the survey. After fifty and ninety minutes after the occurrence of the event, there were more companies for which above-average positive rates of return were recorded, however, as indicated earlier, the values of these positive rates of return are much lower than of the negative ones. It is worth mentioning here that, after the T-test was carried out, no above-average positive and statistically significant rate of return was recorded in the sample, as evidenced by the values presented in brackets.
- Moreover, in the analysed period, 33 companies achieved negative cumulative values of above-average return rates, and for eighteen companies, submission of the application was not associated with obtaining a negative, above-average cumulative return rate.

Also, the value of the test for the CAAR rate turned out to be statistically significant at the significance level of $\alpha = 0.01$. This means that, on average, the companies examined had an

above-average negative cumulative rate of return in the examined period of five minutes before and 120 minutes after the announcement of an event.
The following figures - Figure 2 and Figure 3 show the value of the AAR rate in successive ten-minute intervals, but these values apply to companies broken down by type of submitted application and it is a restructuring application and a bankruptcy application, respectively. Each figure also shows whether the value of the calculated test statistic was statistically significant, and the following rule was adopted for the determinations used in the graphs: If the significance was at the level of $\alpha = 0.01$, then the symbol (***) was adopted, for $\alpha = 0.05$ (**), for $\alpha = 0.1$ (*), statistically insignificant results were marked with the symbol (), only if they were previously identified as statistically significant moments for the entire study sample.

Figure 2

In the case of applications for restructuring, in the first examined time interval, as for all of the analysed applications, there was the biggest drop in the quotations of the companies in question, which was close to -6%. It was a drop with the highest considered significance level. In the thirtieth and ninetieth minutes, statistically significant (for $\alpha = 0.05$) above-average return rates were also recorded, but the considered declines amounted to nearly -2%. In the fiftieth minute, there was also a drop in quotations, but it amounted to less than -1% and turned out to be statistically insignificant. In the remaining time intervals, no statistically significant above-average rates of return were recorded either.

Figure 3

For bankruptcy applications, it can be noticed that the lowest rate of return appears in the thirtieth minute after the announcement of the event, that is a drop of -7%. Moreover, over -5% drop was observed in the fiftieth minute. Both of the above drops were statistically significant for the highest level of significance. Also in the first time interval, a significant drop of the listed shares, reaching -4%, was observed. However, it did not turn out to be statistically significant, just like a slight drop in the ninetieth minute.

For bankruptcy applications, therefore, a stronger effect can be observed after a longer period than for restructuring applications. It can be assumed that despite the use of numerous analytical tools, investors need more time in the event of bankruptcy applications to thoroughly assess the situation and take appropriate actions related to the sale of shares. This situation is also consistent with the previously presented conclusions that investors need more time to include more negative information in the valuation.
Table 4 presents the values related to CAAR rates, broken down into the groups of companies examined above.

Table 4 Test statistics value for CAAR rate by type of application submitted.

Grouping Variable	CAAR Value	pos:neg CAR	Number of CARs considered	Adjusted Patell Z
RESTRUCTURING	-7.1%	14:22	36	-1.98 (**)
BANKRUPTCY	-15.2%	04:11	15	-2.12 (**)

Source: Own study.
In the case of both examined groups, the CAAR rate value turned out to be statistically significant, for $\alpha = 0.05$. It should be noted that in the case of bankruptcy applications, the average value of above-average cumulated drop was more than twice as high as in the case of restructuring applications. What is more, both analysed groups also show a significant advantage of negative CAR rates over positive CAR rates, for the surveyed companies.
In the next step, AAR rates for the surveyed companies are presented, but broken down by the moment of announcing the application.

Figure 4

The data presented in Figure 4 are the basis for the conclusion that if the information about the submitted application appears at a time when there is no active session (late afternoon, night or morning hours), then immediately after the opening of the next session there is a sharp sale of shares of such companies. The value of the AAR rate after 10 minutes is close to 8%, which is influenced by the accumulation of orders placed at the opening of the session. To verify whether the analysed drops occur earlier, research was also carried out for five-minute and one-minute intervals, which is presented later in this chapter. In subsequent moments analysed, statistically significant, above-average negative return rates with the

highest level of significance were recorded. For the remaining ten-minute intervals, there were no above-average rates of return that would be statistically significant. It can also be observed that the given values of AAR rates for applications submitted outside a session are characterised by considerable variability. Twenty minutes after the application, for example, the value of AAR rate is positive.

Figure 5

A different course of the AAR rates can be seen for the applications emerging during the session. Apart from the previously identified test moments as statistically significant, there is also a statistically significant value (for $\alpha = 0.05$) at the twentieth minute. For these applications, it can be seen that although the first decline occurs immediately, it is almost four times smaller than in the case of applications submitted outside the session. There is no effect of the accumulation of orders, which was visible in the second group of applications, submitted outside the session. For the applications submitted during the session, one can see a gradual reduction in the price of the shares for thirty minutes after the event is announced. In the tenth and twentieth minute, the drops are close to -2%, and in the thirtieth minute, there is the largest one-off drop of nearly -4%. Importantly, the latter drop is statistically significant at the level of $\alpha = 0.01$, and the other two previously mentioned at the level of $\alpha = 0.05$. There was no statistically significant above-average negative rate of return at the 50th minute, and there was a slight but positive rate of return at the 90th minute. Importantly, for applications submitted during the session, after 30 minutes, a comparable drop in the value of shares is observed (-7.8%), as for applications submitted outside the session at the first ten-minute measurement (-7.7%). It can therefore be concluded that the market needs additional twenty minutes for applications submitted during the session to reach the level of drop adequate to that observed for requests submitted outside the session. Besides, for applications submitted during the session, the observed drops are less pronounced, as there are no longer statistically significant drops in the fiftieth and ninetieth minute.

This is also confirmed by the data for the CAAR rate, which are contained in Table 5. It is also a signal for companies that a lower overpricing of shares takes place if information about the proceedings occurs during the session and not outside it.

Table 5 Test statistics value for CAAR rate due to the time of application.

Grouping Variable	CAAR Value	pos:neg CAR	Number of CARs considered	Adjusted Patell Z
OUTSIDE THE SESSION	-12.0%	11:21	32	-2.88 (***)
DURING THE SESSION	-5.2%	07:12	19	-1.46 ()

Source: Own study.

The average value of drops for applications submitted outside the session is more than twice as high as the average value of drops for applications submitted during the session. Moreover, the calculated value of the test statistics does not constitute a basis for stating that the cumulative drops obtained for applications submitted during the session are statistically significant. However, for the second group of applications, there are no doubts as to the statistical significance of the obtained results.

3.2 Analysis of data for a fiveminute interval

The research carried out in the ten-minute interval allowed to identify key moments for the researched groups of companies, which are important for the conducted analysis. In the next step, a five-minute and one-minute interval study was carried out to obtain in-depth information on the previously indicated moments after the event. Figure 6 shows the cumulative results for the tested sample for a five-minute interval.

Figure 6

The data presented in Figure 6 corresponds to the data presented in Figure 1. It turns out that the highest drops recorded in the first 10-minute interval are a consequence of cumulative drops in the fifth and then in the tenth minute after the event occurred. In both of these moments, the drops amounted to over -2.5%, which resulted in such significant drops in the first interval in Figure 1. This means that the reaction of investors to the occurrence of an event is even faster for some companies, as a statistically significant overestimation takes place already in the fifth minute after the event and continues in the next five-minute interval.

A similar situation occurs 30 minutes after the event. In Figure 1, a statistically significant negative rate of return of α=0.01 was observed at this point. The five-minute interval study shows that the 30-minute discount is the cumulative value of negative returns from 25 and 30 minutes. Both these rates were statistically significant at α=0.1 level. The situation of the fifty-minute study remained unchanged. Both for the ten-minute and five-minute intervals, above-average negative rates of return were observed at this point. Also, no statistically significant negative return rate was observed after 45 minutes for the five-minute interval, which indicates that the negative drops from the fiftieth minute (in a test with a ten-minute interval) are not due to an accumulation of negative return rates from the forty-fifth and fiftieth minute of the test. The rate obtained in the ninetieth-minute window was also not statistically significant, as the other rates determined for the remaining moments in the one hundred and twentieth-minute window.

Figure 7

As shown in Figure 7, in the case of the five-minute interval, only the drops for the first two intervals, after five and ten minutes from the occurrence of the event, are statistically significant. Both of these drops are statistically significant at α=0.01. The remaining moments, previously identified as key moments, i.e. the thirtieth and fiftieth minute, do not show return rates that would be above-average and statistically significant. It can be seen that the earlier (in the test with the ten-minute interval) diagnosed drops from the 30th minute are preceded by stronger discounts from the twenty-fifth minute. On the other hand, for the fiftieth minute, a negative above-average rate of return was observed (-0.5%), but it is preceded by an average positive rate of return in the forty-fifth minute. Moreover, it can be seen that for the five-minute interval in the case of restructuring applications, there is no significant differentiation in the achieved rates of return. Most of the results are in the range (-1%, 1%). A greater variability was noted for bankruptcy applications, as shown by the data in Figure 8.

Figure 8

As shown by the course of the AAR curve, it can be seen that in the case of bankruptcy applications, there are two moments with above-average negative rates of return, and these are the thirtieth and fiftieth minutes after the occurrence of the event. The negative impulse from the fiftieth minute is located in the vicinity of two moments with above-average positive rates of return. Interestingly, a five-minute interval study indicates a certain pattern. Before the event, the companies recorded slight positive rates of return, the occurrence of the event

contributes to the appearance of an above-average negative rate of return in the fifth minute, and this rate is not statistically significant. However, the drops are not continued with such strength in the following minutes of the test, i.e. tenth and fifteenth minute. In the twentieth minute, there is a positive rate of return, followed by significant discounts of the twentieth and thirtieth minute. A similar situation occurs at another important point of the test. After a positive forty-fifth minute return rate, a significant negative above-average rate of return occurs. Such a course indicates that the appearance of a positive return rate encourages investors to sell off their shares and avoid companies for which unfavourable information appears. And such a positive rate of return allows compensating for at least a small part of the losses previously incurred as a result of the event.

Also, the second division made for the test, grouping the applications into those submitted during the session and outside the session in a five-minute interval, leads to new conclusions and is the basis for maintaining the previously diagnosed regularities based on the test with a ten-minute interval. The results of the test for the five-minute interval for applications submitted outside the session are presented in Figure 9.

Figure 9

Figure 9 and the data contained therein are the basis for the conclusion that the declines for applications submitted outside the session are sudden and occur immediately at the opening of the following session. The most significant drops were already noted in the first possible interval for this test that is in the fifth minute. Another above-average negative return rate appears in the tenth minute, which also contributed to significant drops in the ten-minute interval test. What is more, it can be seen that the statistically significant drops from the thirtieth minute in the test with the ten-minute interval have been broken down into drops from the twenty-fifth minute of -1% and drops from the thirtieth minute of -2%. Another above-average and a statistically significant rate of return occurs at the fiftieth minute, and what the ten-minute interval study did not show, in the fifty-fifth minute there is an above-average positive rate of return, which is statistically significant for $\alpha = 0.05$. Based on the data from Figure 9, it can also be concluded that the variability of the obtained rates of return for applications submitted outside the session is much greater than the variability for applications submitted during the session, for which the AAR value is presented in Figure 10.

Figure 10

Importantly, applications that appear during the quotation process are subject to a delay of at least five minutes in the reaction of investors to the event. Figure 10 shows that the occurrence of an event has practically no impact on the quotations of the surveyed companies. The value of the AAR rate in the fifth minute does not deviate from the level that can be observed five minutes before the event. Only in the tenth minute, one can see an above-average negative rate of return, reaching nearly two per cent. At no other time of the study, with the use of the five-minute interval for this group of companies, was the statistically significant above-average rate of return. Importantly, the drops that started in the tenth minute last continuously until the thirtieth minute, and it is only in the thirty-fifth minute that an above-average positive return rate exceeding the level of 1.5% can be observed. The use of research with a five-minute interval allows therefore to identify a certain "time gap", which consists in the fact that an investor looking for above-average profits should take a short position on the market in less than five minutes after being informed of the company's bankruptcy or restructuring. Such above-average profits will appear if the application is made during the session and investor behave as described above. The key to the success of such an operation may be the use of an automated transaction system that will interpret and properly use the occurring event. Such a short position should be closed at the latest within the thirtieth minute after the event.

3.3 Analysis of data for a minute interval

In the next step of the study, an analysis for the minute interval was performed. Due to the previously obtained results, the results presented below range from 5 minutes before the event to 12 minutes after the event. Such an analysis should allow for capturing the key differences between the examined groups of companies in the first moments after the publication of information on the application and even better to identify the previously found time gap.

Figure 11

As shown in Figure 11, the tested companies are characterized by a statistically significant, above-average return rate in the first minute after the occurrence of the event. These drops reach almost 1.5%. Also in the seventh and ninth minute, there are revaluations of these actions reaching almost -1%, with the first drop being statistically significant for α=0.1, while for the second one no statistical significance was observed at the studied levels. It is the drops from the first, seventh and ninth minutes that are the reason for the statistically significant drops in the fifth and tenth minutes for the five-minute interval, and in the tenth minute for the ten-minute interval.

Figure 12

Figure 12 shows the values of the AAR rate for the published information on the restructuring applications. The data in figure 12 are the same as those in figure 11. Also in the first, seventh and ninth minute, the most significant drops were recorded. At the first two mentioned moments, the above-average negative rates of return were statistically significant at the level of $\alpha = 0.05$. Moreover, the drops for restructuring applications are slightly higher than for all the companies surveyed.

Figure 13

In the analysed window shown in Figure 13, there were no statistically significant rates. The situation was similar for this group of companies in the test with the five-minute and ten-minute intervals. However, in the case of publication of information about bankruptcy, drops can be observed in both the first and second minute of analysis. They are at the level of -1% and -2% respectively, which indicates a significant downward correction of the shares of these companies in the first two minutes after the information appeared. In the subsequent minutes of the study, the course of quotations with little volatility can be observed, different from that for restructuring application or for all surveyed companies.

Figure 14

For the group of applications that were submitted during the session, statistically significant drops in the first (for $\alpha = 0.01$) and seventh minute (for $\alpha = 0.05$) can be observed in the first twelve minutes after the resumption of quotations. A significant drop in the tested sample also appears in the ninth minute, but it is not statistically significant, despite its value close to -1.5%. Moreover, it was also observed that the sudden reaction in the first minute was accompanied by another negative rate of return in the second minute of the quotation. These four drops in the first, second, seventh and ninth minute amount together to nearly 7%, which affects the previously presented results for five-minute and ten-minute intervals.

Figure 15

The data presented in Figure 15 are the basis for the statement that the previously identified time gap in the study with a five-minute interval is even longer and amounts to an average of seven minutes. The minute analysis shows that the first drops for companies for which information appears during quotation occur in the eighth and ninth minutes. Importantly, these declines are not statistically significant, and their size is nearly five times smaller than in the case of the data presented for companies for which the information appears outside the session. The data obtained in the minute analysis confirms the existence of a time gap that can be exploited by using automatic trading systems, which has already been signalled.

4. Conclusions

The conducted research showed that there is a time gap of seven minutes on average on the market between the submission of information about the application and the reaction of investors to such information. The existence of this gap has been confirmed only for applications published during an ongoing trading session, as if information about the submitted application appears outside the duration of the trading session, then there is no such gap. Then investors' immediate reaction to the opening of the following session is observed, which manifests itself in significant drops in quotations:

- -2.5% in the first minute of the one-minute interval study.
- -4% and -3% in the first two five-minute intervals, i.e. in the fifth and tenth minute.
- -7.5% in the first ten-minute interval.

All of the above-mentioned drops are statistically significant at the highest significance level assumed in the study, equal to $\alpha=0.01$.

The fact that there is an identified time gap on the market may be used by investors who, using automated trading systems, will take a short position on the relevant assets in advance of traditional investors. Moreover, it has been shown that the depth of the drops for applications made during an ongoing session is much lower than for events that occur outside the ongoing session. It turned out that if the digital information about the submitted application appears during a session, then on average, such a company records an above-average drop in the value of its shares by nearly 5%, but it is not a statistically significant drop and covers the range from 5 minutes before the event to 120 minutes after the event. On the other hand, if the information about the submitted application appears outside the ongoing session, the transfer of investors' reactions to the session on the next working day results in a significantly higher average overpricing of shares of such companies, which is 12% and is statistically significant. Paradoxically, it turned out that it is more advantageous for the owners of companies information about the application for insolvency proceedings to be disclosed during the session because then the average above-average declines are not only lower but also have a less volatile course.

The second part of the study, which divided the conclusions drawn into those concerning bankruptcy and restructuring, leads to the following conclusions. First, bankruptcy applications have more than double the above-average cumulative rate of return, which is over -15%. Meanwhile, for restructuring applications, this figure was -7.1%. For both groups, the calculated cumulative values were statistically significant for $\alpha=0.05$. These values were observed in the examined window, i.e. from five minutes before the event to one hundred and twenty minutes after the event with a ten-minute interval. Secondly, applications for restructuring have the most significant drops in the first ten minutes after the occurrence of the event, while bankruptcy applications have the highest drops in the thirtieth and fiftieth minutes. Such results were obtained for the test with a ten-minute and five-minute interval. In addition, in the first twelve minutes after the occurrence of the event, with a one-minute interval test, it was observed that restructuring applications were characterised by higher volatility of above-average return rates than bankruptcy applications.

All this conclusion shows that digitalization gives a great opportunity for incorporating new investments strategies. The accessible of data is here a positive side of developing ICT.

Further studies on the diagnosed time gap should assess whether it is shortening over time and with the development of information technology and transactional systems. For the time being, such a study could give a distorted picture of the actual situation due to a small number of cases in such groups.

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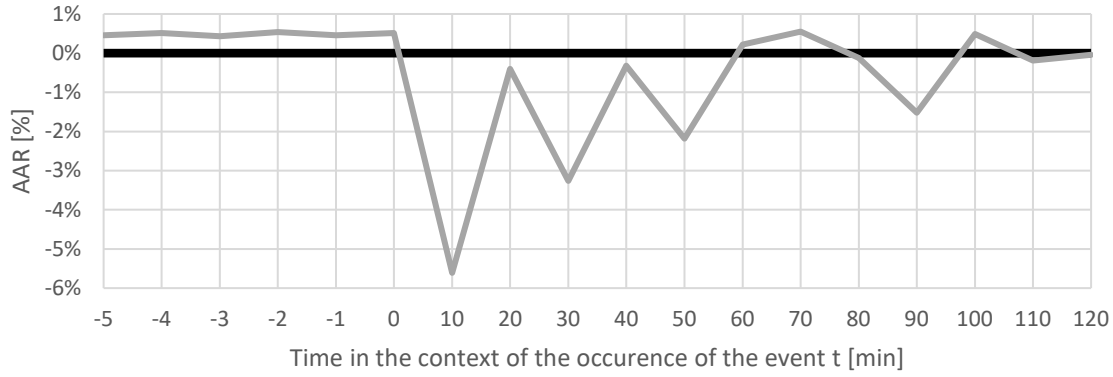
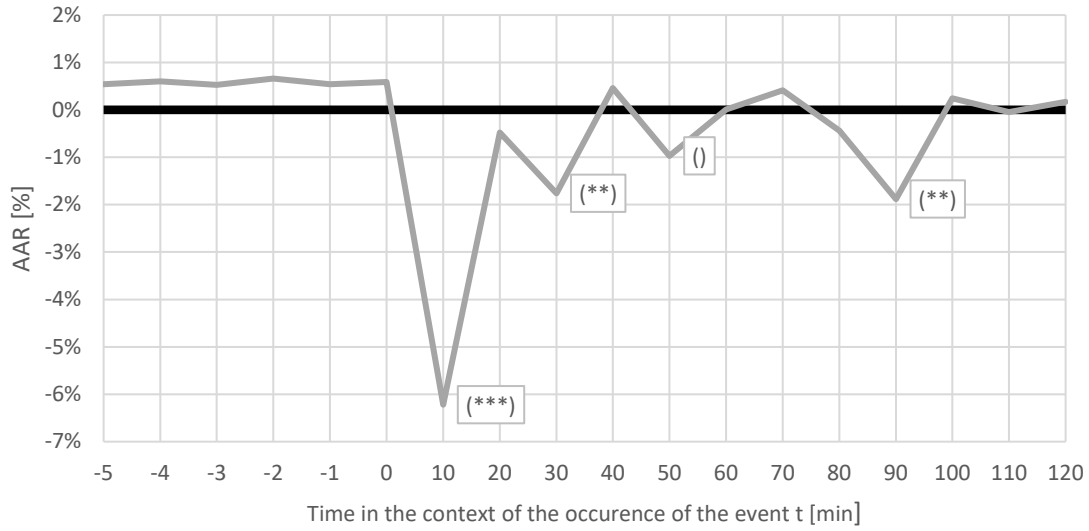
Figure 1 The value of the AAR rate for the sample of companies n=51, for a ten-minute interval.



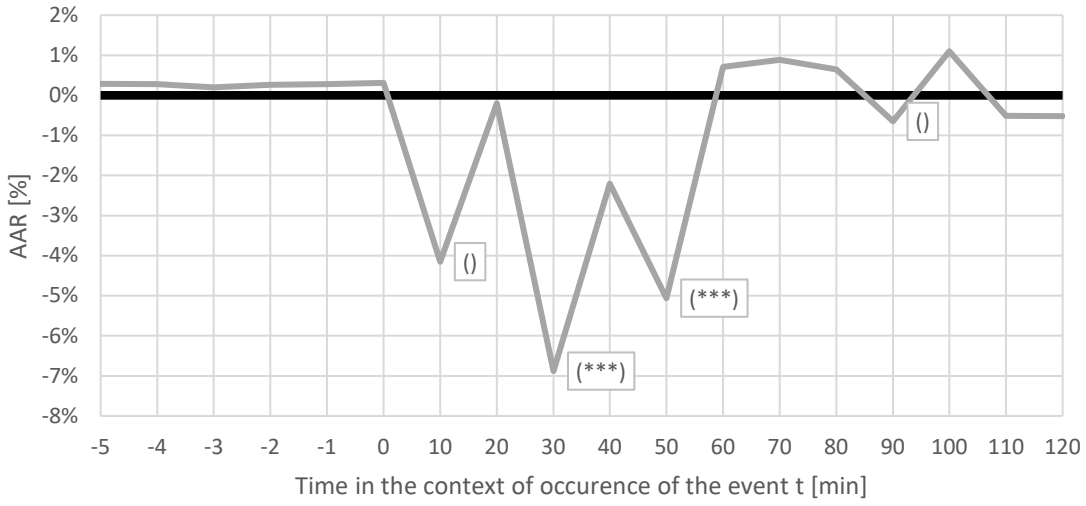
Source: Own study.

Figure 2 Value of the AAR rate for restructuring applications n=36, for a ten-minute interval.



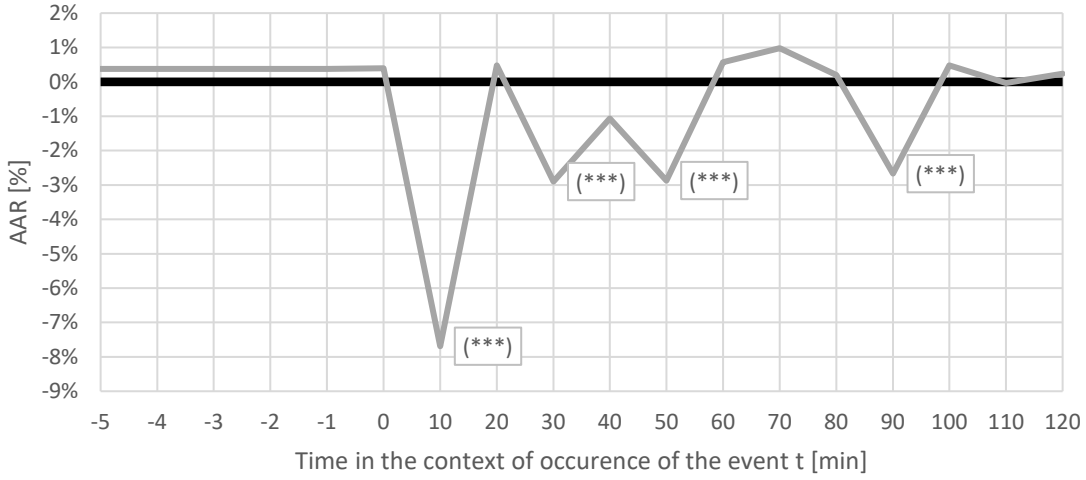
Source: Own study.

Figure 3 Value of the AAR rate for bankruptcy applications n=15, for a ten-minute interval.



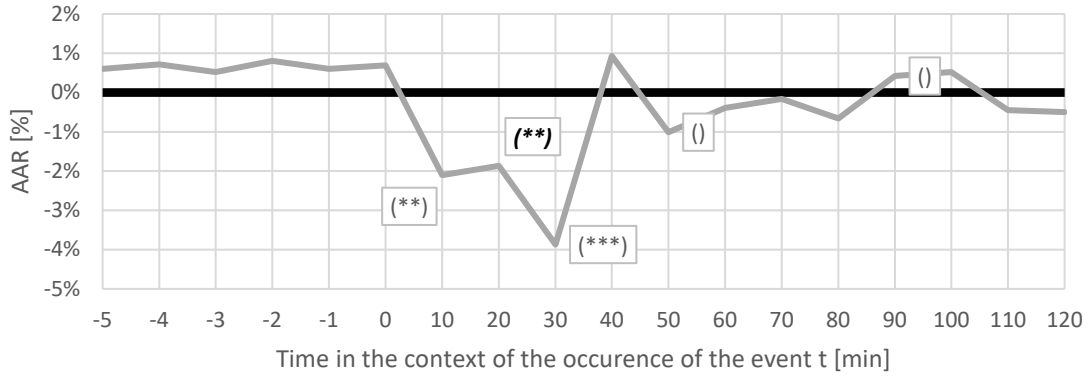
Source: Own study.

Figure 4 Value of the AAR rate for applications submitted outside the session n=32, for a ten-minute interval.



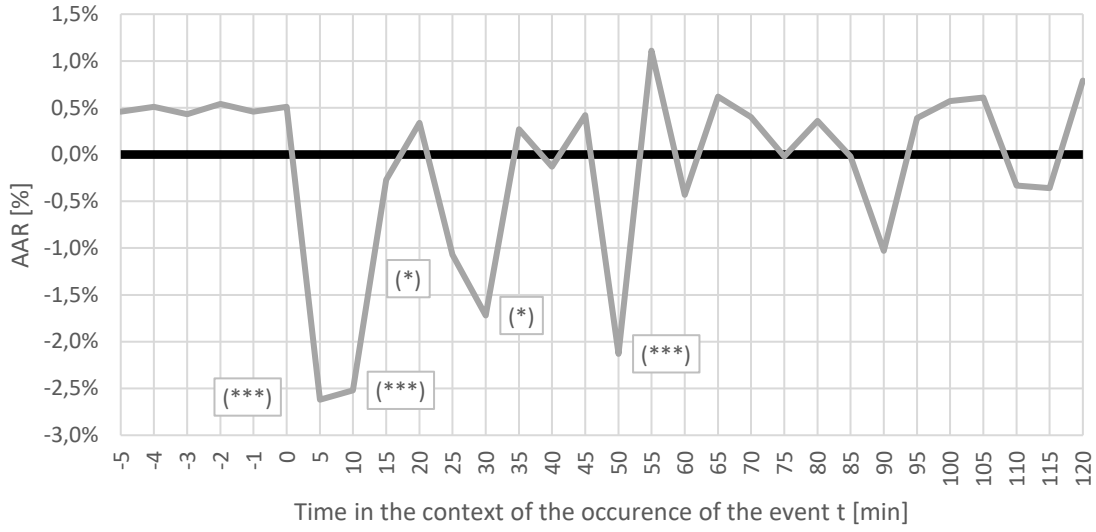
Source: Own study.

Figure 5 Value of the AAR rate for applications submitted during the session n=19, for a ten-minute interval.



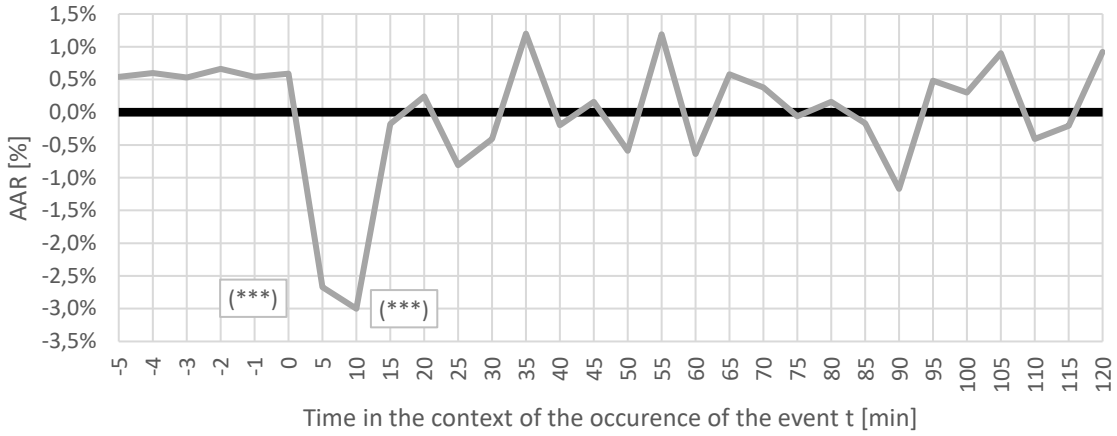
Source: Own study.

Figure 6 The value of the AAR rate for the examined sample of companies n=51, for the five-minute interval.



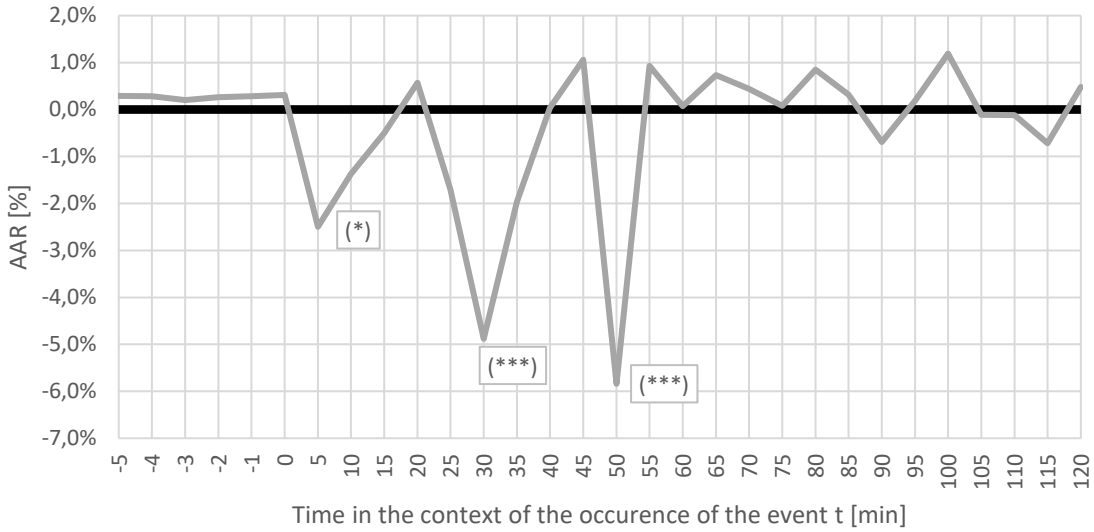
Source: Own study.

Figure 7 Value of the AAR rate for restructuring applications n=36, for a five-minute interval.



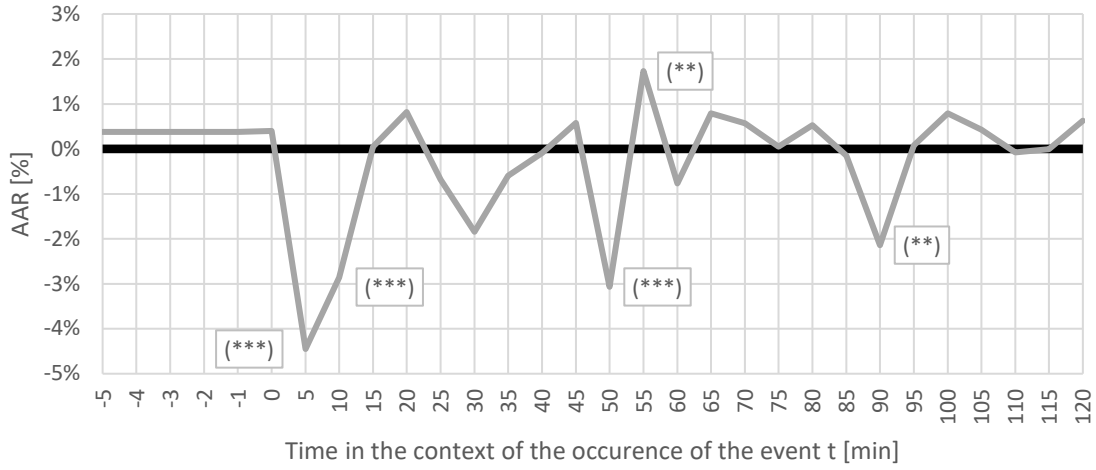
Source: Own study.

Figure 8 Value of the AAR rate for bankruptcy applications n=15, for a five-minute interval.



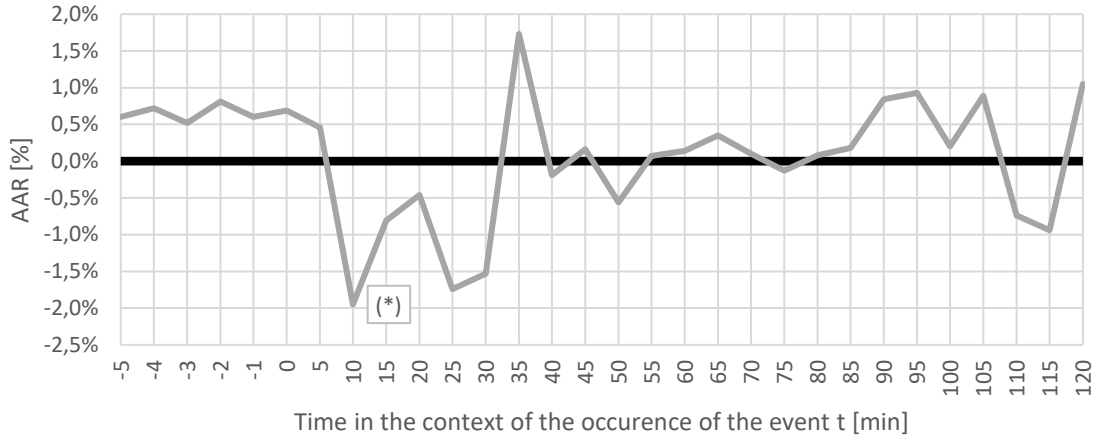
Source: Own study.

Figure 9 Value of the AAR rate for applications submitted outside the session n=32, for a five-minute interval.



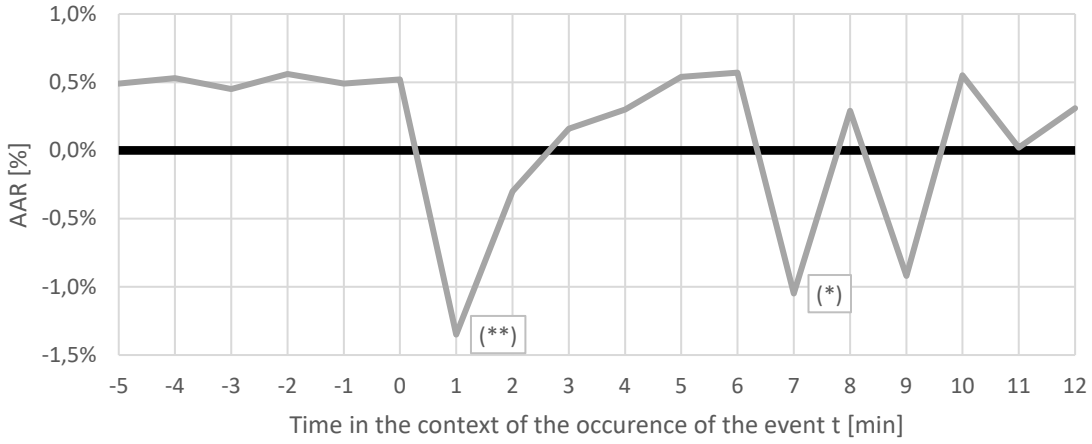
Source: Own study.

Figure 10 Value of the AAR rate for applications submitted during the session n=19, for a five-minute interval.



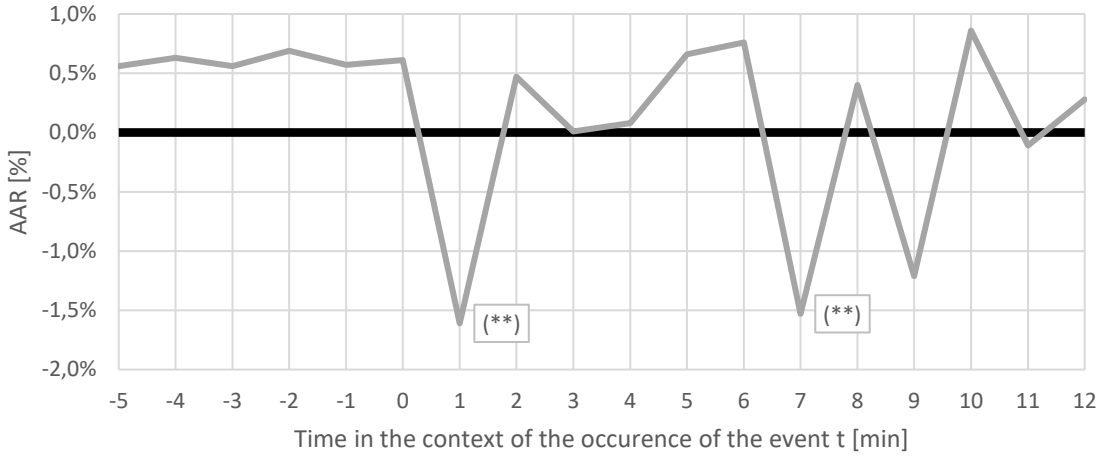
Source: Own study.

Figure 11 The value of the AAR rate for the examined sample of companies n=51, for the one-minute interval.



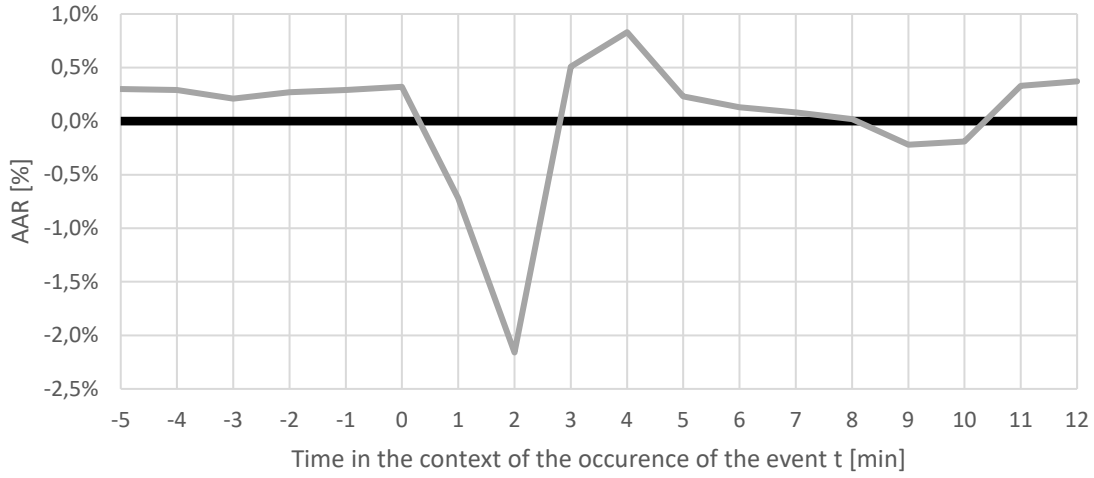
Source: Own study.

Figure 12 Value of the AAR rate for restructuring applications n=36, for a one-minute interval.



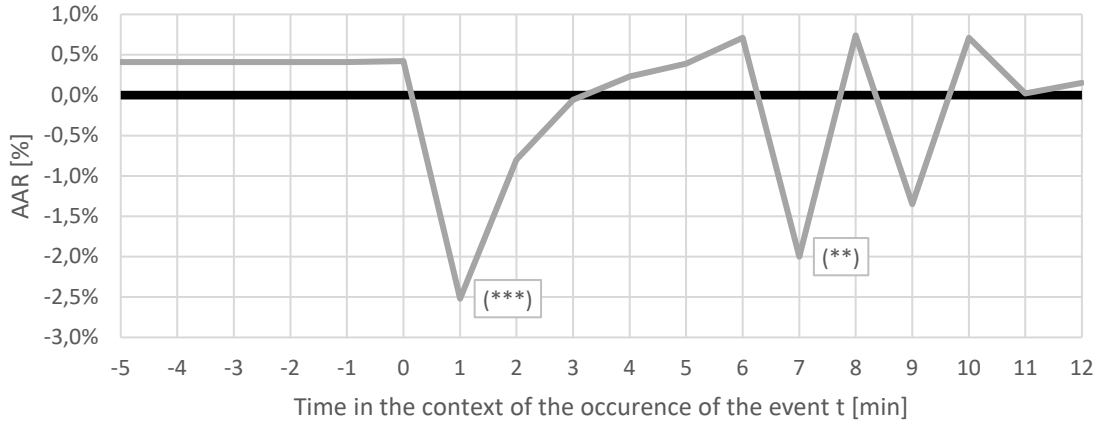
Source: own study

Figure 13 Value of the AAR rate for bankruptcy applications n=15, for a one-minute interval.



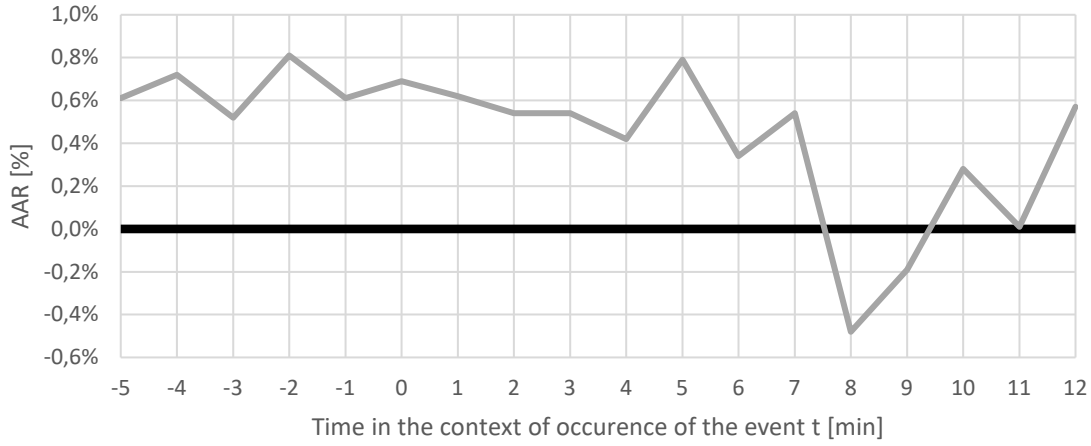
Source: Own study.

Figure 14 Value of the AAR rate for applications submitted outside the session n=32, for a one-minute interval.



Source: Own study.

Figure 15 Value of the AAR rate for applications submitted during the session n=19, for a one-minute interval.



Source: Own study.