Analysis of How Underlying Topics in Financial News Affect Stock Prices Using Latent Dirichlet Allocation

Stefan Feuerriegel  
University of Freiburg  
Freiburg, Germany  
stefan.feuerriegel@is.uni-freiburg.de

Antal Ratku  
University of Freiburg  
Freiburg, Germany  
antal.ratku@hotmail.com

Dirk Neumann  
University of Freiburg  
Freiburg, Germany  
dirk.neumann@is.uni-freiburg.de

Abstract

Companies listed on the stock markets are typically obliged to publicly disclose any information that might have a significant influence on their stock prices. This transparency regulation is intended to ensure that all market participants have access to the same information. The corresponding press releases are one of the most reliable news sources concerning a company’s operations. Interestingly, even though researchers have investigated the timing of releases, research has invested little effort into examining the underlying news topics. In this paper, we analyze the effects of topics found in such corporate press releases on stock market returns in the German market. We determine the topic of ad hoc announcements by using Latent Dirichlet Allocation. Effectively, we succeed in extracting 40 topics. As hypothesized, the effect of these topic groups differ greatly from each other. Some topics have no resulting effect on abnormal returns of stocks, whereas other topics, such as drug testing, exhibit a large effect.

1. Introduction

Identifying the factors that influence stock price changes has always been a critical research question. A widely accepted financial theory, namely the semi-strong form efficiency of capital markets, argues that all publicly available information is immediately and fully reflected by stock prices [1].

Lately, it has become a widely accepted approach to not only include quantitative but also qualitative information with the aim of explaining stock price dynamics as a response to given financial events [2]. Such qualitative information is embedded in financial announcements supplied by the companies, either unintentionally or deliberately. For instance, the wording of corporate press releases might serve as indicators for the future performance of the companies or signal the expected outcomes of business projects.

Having the impact of news on the stock prices in mind, managers have a strong incentive to intentionally influence the stock prices in a favorable way by sugarcoating the communication style of a news disclosure. The inclusion of text messages changes the main impetus away from traditional financial research towards the subject of textual news processing capabilities of electronic markets, which lies in the center of the information systems discipline [3]–[8]. Recent research (e.g. [9]–[12]) aimed at measuring the impact of textual news on stock prices. Interestingly, even though the focus is devoted to the textual content of messages, related works [13] rarely attempted hitherto to look at understanding the underlying stories of text messages.

It is, however, a well-accepted fact that the news content significantly determines the stock price reaction. For example, the news release of a large incoming order may not substantially affect stock prices, as the large incoming orders typically contain comprehensive exit options that render this news release meaningless. In contrast, reports on the financial performance may, on the contrary, have a strong impact on the prices, especially when they contain surprises.

In this paper, we address the question of automatically identifying the underlying topics of news releases by using the Latent Dirichlet Allocation (LDA) method. The idea of the LDA is that each document contains unobservable (latent) topics, which in turn are determining the distribution of used words. Thus, the latent topics can be identified using the observed word documents. Once we have identified the topics, we can analyze which news topics translate into non-zero stock market returns. We carry out our study using German ad hoc press releases from companies whose...
shares are traded on the German stock market. Consequently, our research questions can be summarized as follows:

- **Research Question 1:** Which topics can be identified in German ad hoc announcements?
- **Research Question 2:** How frequently are extracted topics covered in financial news disclosures?
- **Research Question 3:** How do abnormal stock returns react to news belonging to the identified topics?

The answers to the aforementioned research questions reveal some general features of corporate press releases and explain which topics of news announcements play a significant role in invoking stock market returns.

The remainder of this paper is structured as follows. Section 2 reviews previous research that studies both financial news disclosures and how different types of changes in corporate disclosures translate into stock market reactions. In order to combine both approaches, Section 3 describes our research methodology in order to study the (abnormal) stock market returns corresponding to news topics. This methodology is used to provide descriptive statistics of the underlying news corpus and to answer our research questions in Section 4. Our findings and outlook for future research are summarized in Section 5.

### 2. Related Work

In this section, we present the relevant literature that is of primary interest when considering our research questions directions: first, we review references which examine stock market returns related to equity issues, corporate takeovers and management changes. Second, we present studies that analyze news disclosures from companies whose stocks are exchange traded.

#### 2.1. Changes in Corporate Fundamentals

Equity issues, corporate takeovers and management changes represent crucial milestones in the life of an enterprise. Consequently, these three events are expected to have a significant effect on the stock price of traded companies.

Related research developed a theoretical framework [14] for analyzing stock price reactions to share issues under asymmetric information. One of the most important conclusions of this research is that stock prices are a decreasing function of the issue size. An empirical study [15] on this topic investigated the stock price effects of seasoned equity offerings and found that the announcements of such offerings significantly reduce stock prices. Similarly, stock prices adjust after announcing common stock offerings, with a negative price change on average [16]. In addition, a theoretical framework for equity issue decisions was proposed in [17] in order to show empirically that stock prices drop at the announcement of the issue.

The stock price effects of mergers and corporate takeovers have also been widely studied. One of the earliest pieces of literature in the field [18] found a large and swift positive market reaction in the price of target firm shares with a public announcement of a merger proposal. Likewise, the target firms achieve significantly positive abnormal returns on the announcement day [19]. Moreover, the paper finds that abnormal returns are also positive for bidding firms, although they are not significant.

#### 2.2. Financial News Disclosure

In certain cases, firms are legally obliged to publish all relevant information at a certain point of time and therefore do not have the possibility to time the disclosure of bad and good news. However, in such situations, they might be able to communicate the different pieces of information in different styles [20] as reflected by the corresponding wording.

Managers may also use press releases voluntarily to reduce the information asymmetry and, thereby, the risk associated with their enterprise [21]. When such disclosures contain favorable information about the firm, the firm specific risk – represented by the cost of capital and the volatility of stock returns – shrinks significantly. On the contrary, disclosure of unfavorable information is followed by an increase in these measures [22].

Recent research [4], [5], [23]–[26] uses the same news corpus (ad hoc announcements) as data for their paper and examine the stock price effects of ad hoc disclosures on the German stock markets. These disclosures are compulsory press releases about circumstances that might have a significant influence on either the stock prices of listed companies or the creditworthiness of bond emitting firms. The study reveals that news is reflected in the stock prices approximately half an hour after the publication of the press release and the effect on abnormal prices caused by such a release is less severe for larger companies.

### 3. Research Methodology

This section presents the underlying research methodology. First of all, Section 3.1 introduces the
text mining techniques to transform the ad hoc announcements into a machine-readable format. We then give an overview on the Latent Dirichlet Allocation method in Section 3.2, which we utilize to extract the topics from the ad hoc press releases. The extracted topic is then linked to abnormal returns, that are calculated according to Section 3.3.

### 3.1. Text Mining Process

We transform the announcements into a machine-readable format by the following preprocessing step, which are as follows:

- **Noise removal.** Most announcements contain general information on the releasing company, such as the address of headquarters or contact information. This type of content does not provide any relevant information regarding the underlying event, so we remove these parts and focus only on the main body of the announcement. In addition, some common words and phrases, introduced by the publishing company, such as “Corporate-news announcement sent by DGAP” are also removed from the corpus.

- **Stop word removal.** So-called stop words such as the, is, from do not contribute to the informative value of the announcement and, consequently, we remove these words from the corpus.

- **Stemming.** In this step, we reduce the inflected words to their stems by using the Porter stemming algorithm.

- **Document-term matrix.** In the final step of the preprocessing phase, we create a document-term matrix since it enables us to numerically represent which words or phrases are present in an article. Then, we apply a tf-idf weighting (i.e. term frequency-inverse document frequency) to identify the most relevant words in the documents [27], [28].

### 3.2. Latent Dirichlet Allocation

The Latent Dirichlet Allocation is a generative probabilistic model [29], which is frequently used in text mining to perform topic extraction. The underlying data, in our case the news corpus, is considered to be originating from a generative process that contains hidden variables. In the case of topic extraction, the Latent Dirichlet Allocation assumes that there exists \( K \) pre-specified topics \( \beta_{1:K} \) (i.e. the hidden variables) over the collection of documents under research, where every topic \( \beta_{k} \) is defined as a distribution over a fixed vocabulary. Furthermore, each document is assumed to be created in a two-stage process (see Fig. 1):

1. A distribution over topics is chosen randomly for each document. The topic distribution for document \( d \) is denoted by \( \theta_d \), where \( \theta_{d,k} \) represents the proportion of topic \( k \) in document \( d \).
2. Then, we continue for each word in the document as follows:

   - A topic from the distribution \( \theta_d \) is chosen randomly. This topic assignment for the \( n \)-th word in document \( d \) is denoted by \( z_{d,n} \) and the topic assignment for all the words in document \( d \) is represented by \( z_d \).
   - A word is randomly chosen from the distribution over the fixed vocabulary corresponding to the topic assignment \( z_{d,n} \). The \( n \)-th word in document \( d \) is represented by \( w_{d,n} \), while \( w_d \) represents the observed words in document \( d \).

With this notation, the generative process of the allocation is defined as

\[
P(\beta_{1:K}, \theta_{1:D}, z_{1:D}, w_{1:D}) = \prod_{d=1}^{D} \prod_{n=1}^{N_d} P(z_{d,n} | \theta_d) P(w_{d,n} | \beta_{1:K}, z_{d,n}) .
\]

(1)

The dependencies specified in Eq. (1) define the Latent Dirichlet Allocation, for example, that the probability of observing a word \( w_{d,n} \) is dependent on the topic assignment \( z_{d,n} \) and all of the topics \( \beta_{1:K} \). As only documents are observable, the Latent Dirichlet Allocation aims to unveil the hidden structure of the topics, namely, the topic distribution over each document and the topic assignment over each document and each word, given the observed documents. Hence, the posterior computational problem is

\[
P(\beta_{1:K}, \theta_{1:D}, z_{1:D} | w_{1:D}) = \frac{P(\beta_{1:K}, \theta_{1:D}, z_{1:D}, w_{1:D})}{P(w_{1:D})},
\]

(2)

where the denominator represents the probability of observing a corpus of any topic structure. Since the number of topic structures is exponentially large, this denominator and also the fraction as a whole cannot be computed in practice. Probabilistic models, such as the Latent Dirichlet Allocation, thus aim to approximate the posterior. This approximation can be achieved either by sampling-based algorithms, such as the Gibbs sampling [30], or by variational algorithms. The latter assume a parameterized family of distributions over the hidden structure of topics (i.e. topic distributions over each document and the topic assignment over each
document and each word) in order find a member of the distribution family that is closest to the posterior.

In our research, we use the variational expectation-maximization (EM) algorithm [31], where the word count in each document follows a Poisson distribution, the distribution of topics \( \theta_{d,D} \) is from Dirichlet distribution and the topic assignment for each word in each document \( z_{d,n} \) follows a multinomial distribution [32].

In this paper we employ the state-of-the-art method [33], the Latent Dirichlet Allocation rather than a Latent Semantic Analysis (LSA). The LSA received heavy criticism lately, due to its inadequate statistical foundation. In fact, the LSA erroneously assumes Gaussian noise on term frequencies, which empirically follow a Poisson distribution. The extension of the LSA, the probabilistic version of LSA (pLSA), regards each word in a document as a sample from a mixture model representing different topics. The pLSA thus models the probability that word-document combinations occur as a mixture of conditionally independent multinomial distributions. However, the pLSA model is also incomplete, as it provides no statistical model at the document level. It can be shown that this limitation results in severe overfitting. However, the LDA builds upon this shortcoming by using a Dirichlet prior for the topic distribution within documents [32].

3.3. Event Study Methodology for Calculating Abnormal Returns

One of the most common ways to study stock price reactions from news disclosures is to use the event study methodology [34], [35]. We now utilize this approach to measure the stock price reaction caused by ad hoc announcements. Thus, we first predict a normal return in the absence of such a news release. Following this, we calculate the abnormal return as the difference between the actual and the normal return.

Both abnormal and normal returns are necessary to understand the theoretical framework [35], which is built upon the assumptions of capital market efficiency and stock prices as reflecting all available information on the market. Given these assumptions, we can expect that the abnormal return following the disclosure of new and relevant information is mostly due to the news release. Then, the abnormal return can be regarded as some kind of excess return caused by the news release.

This paper incorporates the event study methodology [34] as follows:

- **Event of interest.** We examine the price changes caused by regulated ad hoc announcements from listed German firms. These ad hoc announcements are a compulsory means of informing investors about events that might have a substantial impact on stock prices, as well as the creditworthiness of firms emitting bonds.

- **Event window.** As we incorporate daily stock price changes, we choose the event window to be the day of publication. We then calculate the cumulative abnormal return \( CAR_{-29,-4} \) in a window ranging from 29 until 4 trading days prior to the news release in order to account for the possibility of insider trading and information leaks. Similarly to previous research [36], our measure represents pre-announcement short-term stock performance.

- **Normal returns.** In our study, we calculate the normal return, i.e. the expected return in the absence of a news release, based on the market model [35]. The market model assumes a stable linear relation between market return and normal return. The market is then modeled as

\[
R(t) = \alpha + \beta R_m(t) + \varepsilon_t \quad \forall t \in T, \quad (3)
\]

where \( \varepsilon_t \) is a zero mean disturbance term. We model the market return \( R_m(t) \) using a commodity index, namely, the CDAX composite index, along with an event window \( T \) of 10 trading days prior to the event.

- **Abnormal returns.** Abnormal returns are defined as the difference between the actual and the normal return of a security at time \( \tau \). The actual return \( R(\tau) \) is measured by the price change of the security, while the normal return originates from the market model. Then, the abnormal return \( AR(\tau) \) at an event \( \tau \) is calculated via

\[
AR(\tau) = R(\tau) - E[R(\tau) | \neg X_\tau], \quad (4)
\]

where \( E[R(\tau) | \neg X_\tau] \) represents the expected return in the absence of an event \( X_\tau \).
4. Evaluation

After introducing the above methodology, we now utilize it in order to perform topic extraction. Thus, this section presents the findings of our study, more precisely, we investigate how ad hoc news disclosures affect returns in the German stock market. First of all, Section 4.1 details the news corpus that we use in our analysis. Afterwards, we present our results regarding how stock market returns correspond to financial news disclosures according to the extracted topic.

4.1. News Corpus

Our news corpus originates from German regulated ad hoc announcements\(^1\). We choose this data source primarily because the DGAP is a market leading company in the field of legally obligatory publications in Germany. Moreover, the companies are bound to disclose these ad hoc announcements as soon as possible through standardized channels, thereby enabling us to study the short-term effect of news disclosures on stock prices.

Our collected announcements originate from the beginning of January 2004 until the end of June 2011\(^2\). We investigate such a long time period to avoid the possibility of analyzing only news driven predominantly by a single market event, for example, the financial crisis. In addition, we apply the following filter rules to our news corpus according to language and releasing company. First, news announcements with fewer than 50 words are removed from our corpus. Second, we focus only on ad hoc press releases from German companies which are written in the English language. Third, we reduce our original data set to those firms whose stock prices have a value of at least €5. The reason behind this is that the so-called penny stocks with a lower stock price tend to react more unsystematically to news announcements and, consequently, may introduce a larger noise component to our data. All in all, our final data set consists of 7645 ad hoc announcements along with related control variables. These news disclosures originate from a total of 499 companies, with a median of 10 announcements per firm. The minimum number of news disclosures per firm was 1, while the maximum was 225.

We gather the financial data of the releasing companies from Thomson Reuters Datastream. We retrieve the company-specific information, such as company sector and book-to-market value, with the help of the International Securities Identification Numbers (ISIN) that appears first in each of the ad hoc announcements. The stock price data and information about other indicators before and on the day of the announcement are extracted using the corresponding trading day.

4.2. Topic Extraction in Ad Hoc Announcements

Since the ad hoc announcements do not include topic labels identifying their content, it is part of our analysis to extract the corresponding topics. For this purpose, we use the Latent Dirichlet Allocation\(^3\) on the document-term matrix of our news corpus.

**Research Question 1: Which topics can be identified in German ad hoc announcements?**

To perform the Latent Dirichlet Allocation, we have to choose ex ante the number of topics that we want to identify. The Latent Dirichlet Allocation is different from other machine learning algorithms where one optimizes, for example, the number of clusters by cross-validation, heuristics or the so-called Elbow plow. In contrast, we have to choose the number of extracted topics and so decided to run our analysis with 40 topics extracted from the underlying corpus. This choice is justified by our experiments in which we varied the number of topics, since we tested a wide range, from merely 5 topics up to 150 topics, finding affirmative insights as follows: for fewer than 40 topics, we quickly run into problems since important and inseparable topics are merged together. When allocating more than 40 topics, the Latent Dirichlet Allocation seems to find company-specific news rather than logically similar topics. Keeping the above arguments in mind, we decided to set the number of topics to 40 in this paper. This magnitude is similar to the number used by [13].

As described in Section 3.2, the Latent Dirichlet Allocation determines a topic distribution \(\theta_d\) for each news disclosure \(d\). In our research, we assign to each news disclosure the associated topic with the highest probability. For instance, if the distribution over topics \(\theta_d\) places a probability of 40% on Topic 1, a probability of 35% on Topic 2 and a probability of 25% on Topic 3, we then regard the news disclosure to be of Topic 1. This method is a reasonable simplification of the underlying problem of topic determination and avoids calculating a very complicated statistical model, while making our results easier to interpret. Choosing

---

1. Kindly provided by Deutsche Gesellschaft für Ad-Hoc-Publizität (DGAP).
2. Announcements were available only until the month June 2011 for research.
3. The Latent Dirichlet Allocation is performed using the R package *topicmodels* [31].
topics according to the topic with the highest probability seems reasonable, since selected topics occur with a probability larger than 50% and often close to 100% for most announcements.

We have now extracted a news topic for each ad hoc announcement. As a next step, we link each of these news disclosures to their corresponding stock market data, namely, both the stock market returns and the industrial sector. Consistent with previous works [7], we have difficulties retrieving data for all disclosures. It turns out that only a few announcements belong to Topic 31 (Nordic Branches), of which we cannot acquire financial data for each. As a consequence, Topic 31 was extracted as part of the Latent Dirichlet Allocation, though it will not appear in the figures/tables of the following sections. In addition, we assigned the label Renewable Energy twice: Topic 2 covers especially technologies (with a focus on solar power), while Topic 26 addresses projects (mostly related to wind power).

4.3. Frequency of Extracted Topics across Industry Sectors

After having extracted the topics with the highest probability and assigned these to each announcement, we proceed to study how many ad hoc announcements belong to each topic.

Research Question 2: How frequently are extracted topics covered in financial news disclosures?

As ad hoc announcements are disclosed by companies from various sectors, it seems to be a logical step to examine the number of announcements for each topic with respect to the industry sectors as well. Therefore, we identify the sectors of the releasing companies and group them into 8 comprehensive categories, namely, Software and Computer Services, Financial and Insurance Services, Beverages and Consumer Goods, Healthcare, Real Estate Services, Automobiles, Machines and Transportation, Energy and Industrial Engineering and Other Services.

Figure 2 shows the number of ad hoc announcements for each combination of topic and sector. By looking at the news frequency among the topics and industry sectors, we can draw some general conclusions from Figure 2. First of all, there are some topics which are sector-specific, such as Topic 3, Topic 8 or Topic 15. However, there are news topics which appear almost evenly distributed across all sectors, such as Topic 7, Topic 14 or Topic 24; these correspond to the topics of Management Changes, Mergers and Acquisitions and Earnings Report, respectively.

In order to provide an explanation for this topic distribution, we extract the most common words from each topic. Although the extracted words are already stemmed as a result of the text mining algorithm, we can still identify the original form. As a consequence, we find that, on the basis of the most frequent words, the majority of topics can be clearly identified. Furthermore, our assumption of sector-specific and general topics is also supported by the results. The subjects of extracted topics that we can clearly identify based on the most common words are included in Figure 2 next to the topic number.

We now look at some illustrative examples: the most common stemmed words in Topic 8 are patient, studi, treatment, genmab, cancer, develop, clinic and phase. From these phrases, we deduce that Topic 8 is associated with drug testing. This assumption is reinforced by the fact that Topic 8 was identified as a sector-specific topic of the Healthcare sector. Another clear example is supplied by Topic 7, in which the most frequent terms are board, manag, member, supervisori, chairman, execut, appoint, director and CEO. This topic resembles announcements of changes in company leadership or the appointment of new managers. Furthermore, we see that announcements categorized into Topic 7 are relatively evenly distributed across the industry sectors, which supports our hypothesis of this topic being related to general business news.

Although the majority of latent topics can be connected to either industry-specific or general business procedures, some topics seem to be rather company related. One possible argument for this is that certain companies publish a larger number of announcements during the period under study and these announcements may contain similar expressions or phrases. Consequently, the Latent Dirichlet Allocations might perceive these announcements as a separate topic.

4.4. Abnormal Returns across Extracted Topics

We now investigate the stock price reaction to financial news disclosures across the extracted topics.

Research Question 3: How do abnormal stock returns react to news belonging to the identified topics?

In order to answer this question, we calculate the distribution of abnormal stock market returns following each news disclosure. The reason for choosing abnormal stock market returns is that we want to exclude confounding influences from market movements and, instead of the nominal return, prefer the abnormal return on the trading day. Afterwards, we group these according to the extracted topics and visualize the
results in the form of boxplots. The boxplots grouped by news topic are presented in Figure 3. In order to make interpretation easier, we highlighted a 0% abnormal return by a red vertical line. As additional information, we provide the number of announcements belonging to the respective topics on the right-hand side of Figure 3.

Based on Figure 3, we can deduce the following finding: the median abnormal return following a financial disclosure is, for most news topics, relatively close to zero. News belonging to only a few topics tends to strongly deviate from this observation. For example, topics with large non-zero abnormal returns are drug testing (Topic 8) and reports on future firm development (Topic 38). Altogether, we can summarize our observations as follows:

- **Positive Market Reaction.** We see evidence of positive medians for abnormal returns for the following news topics. These are technology development (Topic 1), renewable energy (Topic 2), drug testing (Topic 8), medical research (Topic 15), Baltic branches (Topic 32) and reports related to entertainment (Topic 35).

- **Neutral Market Reaction.** In contrast to expectations, some topics have a median stock return
Figure 3. Boxplots comparing stock market reaction (i.e. abnormal returns on trading day) to financial disclosures with respect to their extracted topic (where Topic 31 is omitted as no stock market data could be retrieved). The red line indicates a zero abnormal return. Each boxplot shows the median abnormal return (vertical lines); the horizontal lines denote 0 %, 25 %, 50 % and 75 % percentiles.

close to zero. Examples (partly unexpected) are management changes (Topic 7) and capital increase (Topic 33). A possible explanation might be that these announcements were expected by the market and thus have already been incorporated into prices.

- **Negative Market Reaction.** There is only one news topic that translates into negative returns. Here, reports on future firm development (Topic 38) are linked to a negative median stock return.

The aforementioned findings provide interesting results when studying the information processing of financial disclosures. Previous research [13] identified topics such as management changes, corporate strategy and legal documents as of great importance for stock market returns. However, some of our topics are more specialized and narrowly focused as a methodological advantage of our statistical learning approach. That is, we extracted additional topics that also link to positive median stock market returns, while other topics do not play a significant role in the German market. Overall, this shows how news topics affect stock market returns.
We conclude that the underlying topics of corporate press releases relate to the stock market reaction. Our paper reveals interesting managerial implications. Our findings provide decision support for managers by addressing which news topics actually matter for investors. This altogether helps managers prioritizing on which news to invest more efforts when writing. In addition, we contribute to the existing body of decision support research how narrative content of disclosures can provide decision support for investors.

5. Conclusion

It is a well-known fact that the underlying content of news announcements convey information that is processed and subsequently reflected in stock market prices. However, not all news has the same effect on prices. We expect the strength in affecting abnormal returns to depend upon the topics that are described in the news announcements. Unfortunately, the tagging of news announcements is not very useful since it only superficially categorizes articles. In this context, we use a Bayesian framework to extract the underlying latent topics. Once we identify the topic model, we can explore how stock market returns depended upon the various topic groups.

More specifically, we analyze the impact of topics found in ad hoc announcements on the German stock market. To carry out such a comprehensive analysis, we determine the topics of each individual press release and include them in our model. Topic determination is achieved via the use of Latent Dirichlet Allocation. We assign a meaning to some of the latent topics by examining the most common words associated with them. In order to estimate the stock market effect, we calculate the abnormal returns for each stock on the disclosure date to eliminate confounding effects. Our evaluation identifies topics with no resulting impact on abnormal returns of stocks, whereas other topics, such as drug testing, exhibit a large effect.

Our study opens up several avenues for future research. First, other topic determination mechanisms should be researched and compared with the Latent Dirichlet Allocation. An objective mechanism should also be developed for the choice of topic numbers [37], which would also have to avoid over- and underfitting. Second, the stock price effects of news announcements should be further examined in other markets. Additional research is necessary to verify and extend our approach in terms of robustness. Therefore, we plan to carry out an analogous study on American markets using the 8-K filings, whose purpose is similar to that of regulated German ad hoc announcements.

References


