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David Langley
TNO and University of Groningen, Netherlands, david.langley@tno.nl

Jan-Willem Tel
Veneficus, Utrecht, Netherlands, janwillemtel@gmail.com

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Langley, David J., TNO and University of Groningen, Netherlands, david.langley@tno.nl

Tel, Jan-Willem, Veneficus, Utrecht, Netherlands, janwillemtel@gmail.com

Abstract

Due to the increasing prevalence of IT-mediated communication between firms and their stakeholders in digital ecosystems, it is particularly important to add to theory in the Information Systems area on firm reactions during online anti-firm episodes (AFEs). Specifically, the current study addresses both (a) whether firm interventions during a crisis have an effect on the AFE, both in terms of the growth of the episode and the sentiment expressed by the social media users, and (b) how different firm intervention strategies affect the AFE. Drawing from the research area of conflict management from psychological science, we apply the Situational Crisis Communication Theory to develop hypotheses on four relational styles which firms may apply in their IT-mediated crisis management activities. Analyzing 325 AFEs, we show that firm responses can be a double-edged sword. The firm runs the risk of attracting extra attention to the crisis, but is at least able to influence the sentiment of the discussion in its favor. A wholly new finding is that when a firm's reaction avoids the specific criticism of an ongoing crisis, instead aiming to bolster the firm's reputation, this is most beneficial to the firm, both for reducing AFE growth and increasing pro-firm sentiment.

Keywords: Digital ecosystems, Social interactions, Herding, Crisis communication.

1 Introduction

Well-known firms frequently experience short-term reputational crises when stakeholders in their ecosystems, including customers or other parties, turn against the firm (Choi and Lin 2009), in what we term "anti-firm episodes" (AFEs). The people involved in an AFE are not only directly influenced by the crisis at hand, but also by each other. As such, they may react to the crisis situation because of the strength of feeling they experience, or their expression of dismay could be triggered by their perception of the behavior of others (Aggarwal et al. 2012).

This process of firm-customer interaction is a key part of the dynamics within the business ecosystem (Jackson 2012; Gobble 2014). When introducing the term 'ecosystem' into the business management field, Moore (1993) explicitly mentioned a range of factors, beyond the network of inter-firm relationships, which make up the ecosystem: "*Business ecosystems condense out of the original swirl of capital, customer interest, and talent generated by a new innovation, just as successful species spring from the natural resources of sunlight, water, and soil nutrients*" (Moore, 1993, p. 76).

The rise of the internet and social media has changed this process significantly (Park and Lee 2009). These technologies offer people the opportunity to influence each other more directly than before, even without the involvement of traditional media. This makes the process of AFEs much faster and more hectic, and puts firms under pressure to react within a shorter time frame.

However, there is a lack of theory on how firm reactions influence those taking part in an AFE via social media. A firm's natural tendency will be to try to decrease the growth of the AFE, and to create more pro-firm sentiment, but theory currently offers little guidance about the optimal strategy for the long-term development of solid relationships within the digital ecosystem (Watson-Manheim and Bélanger 2007; Johnson and Cooper 2009; Gao et al. 2015). Applying conflict resolution theory from the

area of social psychology, we explore the effects of firms' crisis management responses during IT-mediated AFEs. We hypothesize that the firm interventions, such as press releases, media interviews and also online posts, influence the behavior of the "herd" of people active in the episode. Specifically, different reaction strategies will generally lead to different effects whereby a new repertoire of IT-mediated relationship management strategies may emerge.

Consequently, in this paper, we model the behavior of the herd taking part in an AFE, and the influence a firm can have on this herd by reacting to the crisis at hand. To do this, we develop an analytical model, which is an extension of the Generalized Bass Model (Bass et al. 1994), we analyze a large number of AFEs and measure changes when firms react, in terms of the growth of the herd, as well as the sentiment of the messages posted by members of the herd.

2 Theoretical Framework

2.1 IT-mediated conflict resolution

Research shows that firms that invest time and resources to take into account the legitimate interests of a range of stakeholders in their ecosystem, including investors, legislators, customers, and partner organizations, will gain positive effects for the business, in terms of the conventional performance metrics, including profitability, sustainability and growth (Campbell 2007; Freeman 1984). For example, Henisz et al. (2014) find that by adopting a cooperative stance and by reducing conflict with stakeholders, firms improve their financial valuation.

In relation to knowing how to react in response to public conflict situations, conflict resolution theory provides a clear rationale that firms must not ignore the public's concerns (Nabatchi 2012). Much of the criticism which is expressed online may not come from actual customers of the firm, but simply from those aware of the problem, and those who enjoy joining in and expressing their indignation. Nevertheless, every person taking part in the AFE displays a legitimate interest in the firm; whether or not the firm has a corresponding interest in these people is not the prime concern; theory dictates that the firm should take their interests into account (Donaldson and Preston 1995; Tjosvold 2008).

As IT is increasingly used to enable communication beyond the firm's boundaries, it provides direct and immediate links between a firm and a wide range of interconnected stakeholders (Driessen et al. 2013). As such, the target audiences for firms' stakeholder management activities have become complex, and include not just formal bodies but many disparate groups including NGOs, social and environmental pressure groups, as well as a plethora of online media groups and news aggregators (Brennan and Merkl-Davies 2014). In particular, social media networks (Kane et al. 2014) are proving to be a highly potent means of influencing audiences, and so external stakeholders increasingly make skillful use of social media to mobilize support and exert pressure on firms (Luo 2009; Luo and Zhang 2013; Luo, Zhang and Duan 2013). This means that firms too need to improve their use of social media, in order to fulfil their stakeholder management objectives, and they need to take into account the interests of the highly diverse social media users (Driessen et al. 2013).

This situation is made more challenging as, in times of crisis or when firms come under intense criticism, social media users consider the information they access through social media to be more credible than the traditional mass media coverage (Jin et al. 2011; Sweetser and Metzgar 2007). So, not only do firms need to improve their use of online communication channels, they also must be aware that their IT-mediated responses will be leading in terms of their influence on many of their most vocal stakeholders (Jin et al. 2011).

In a study of 63 firms from a range of industry sectors, Benitez-Amado and Walczuch (2012) show that a proactive corporate environmental strategy mediates the effect of IT capability on firm performance. They show that this proactive strategy preempts any criticism from external stakeholders. Indeed, environmental concerns have been shown to be one of the key topics driving consumer pressure on firms (Roh et al. 2015).

Nevertheless, despite the urgent need for firms to understand how to manage reputational crises through IT-mediated communication, there is a lack of research investigating the effect of different response strategies. In this paper we address this issue and attempt to contribute to IS theory development by borrowing from crisis communication literature. In particular, we make use of a theory stemming from conflict management, Situational Crisis Communication Theory (Coombs 2007), to investigate effects of firm response strategies to AFEs on social media.

2.2 Situational Crisis Communication Theory

During an AFE, when many people become involved, or if the firm believes it may suffer reputational damage, that firm may feel the need to intervene. The intention of such an intervention is to de-escalate the AFE in one of two ways. First, the firm may intend to reduce the herd's growth by offering information to dissuade people from contributing to the online discussion. Second, although it may not always be possible to prevent the AFE from growing, the firm can attempt to sway the opinion of contributors to the discussion such that they are less negative about the firm. In this sense, they can offer information to convince people to spread opinions in favor of the firm's situation. Such interventions are typically made via various media channels, including by means of a press release, giving interviews to journalists, as well as by making use of the firm's social media channels.

The content of such de-escalation interventions are classified by the Situational Crisis Communication (SCC) Theory (Coombs 2007; see Table 1). SCC theory highlights three primary strategies, which can be ordered based on the extent to which the firm accepts responsibility for the crisis. First, the "Deny" strategy explicitly distances the firm from the topic of the crisis, refusing to accept any responsibility. Typically, this involves blaming other stakeholders or claiming that the accusations are completely unfounded. Second, the "Diminish" strategy does accept some degree of responsibility for the problem at hand. By using this approach the firm plays down the significance of the issue, either by claiming that it was beyond their control or that the consequences are minor. Third, the "Rebuild" strategy goes the furthest in accepting responsibility for the problem, whereby the firm attempts to stimulate a positive public attitude by expressing regret and offering apologies.

Apart from these three primary strategies which deal with the purported problem head-on, a secondary strategy is highlighted by SCC theory. With this "Bolster" strategy, the firm does not refer to the crisis problem specifically, but instead attempts to influence opinion about the firm in general. Typically, this involves highlighting the firm's positive track record and trying to stimulate sympathy for the firm's predicament. Note that the three primary strategies are mutually exclusive, while the secondary strategy "Bolster" can be used in combination with any one of them.

Primary crisis response strategies
Deny crisis response strategies
Attack the accuser: Crisis manager confronts the person or group claiming something is wrong with the organization.
Denial : Crisis manager asserts that there is no crisis.
Scapegoat : Crisis manager blames some person or group outside of the organization for the crisis.
Diminish crisis response strategies
Excuse: Crisis manager minimizes organizational responsibility by denying intent to do harm and/or claiming inability to control the events that triggered the crisis.
Justification : Crisis manager minimizes the perceived damage caused by the crisis.
Rebuild crisis response strategies
Compensation : Crisis manager offers money or other gifts to victims.
Apology : Crisis manager indicates the organization takes full responsibility for the crisis and asks stakeholders for forgiveness.

Secondary crisis response strategies
Bolstering crisis response strategies
Reminder : Tell stakeholders about the past good works of the organization.
Ingratiation : Crisis manager praises stakeholders.
Victimage : Crisis managers remind stakeholders that the organization is a victim of the crisis too.

Table 1. Firm intervention categories from Situational Crisis Communication Theory (Coombs 2007)

3 Hypothesis development

3.1 Effects of firm reactions on growth of anti-firm episodes on social media

A number of authors have referred to social media as bringing about an echo-chamber effect, whereby a small number of opinions or pieces of information are repeated throughout social networks (e.g. Colleoni et al. 2014). During an AFE, information provided by the targeted firm itself is highly likely to undergo such a process of being passed on through social media networks whereby many people repeat the same message, or a small number of different messages, about the firm's reaction. Indeed, there is anecdotal evidence from numerous organizations which suggests that firms have learned that in many cases the best course of action is to remain silent and not to "fan the flames." This position is in line with findings from Dimitrov (2015). However, to date this idea has not been empirically examined in the IS literature. As such, we expect that firm interventions in general are positively associated with the growth of the AFE.

As for the effects of different response strategies, there is a lack of research and theory describing how different reactions affect the behavior of the online herd, above and beyond the general echo-chamber effect described above (Langley et al. 2014). We posit that the number of messages posted by concerned consumers will be affected by the extent to which people consider the debate to be worth the effort of continuing. Sometimes, they see that it may still be worth piling more pressure on the firm as the resolution of the conflict could still go in their favor. Other times, they may consider the discussion more or less closed, and not worth spending more resources on. According to Intergroup Conflict Theory (Tajfel and Turner 1979), conflict between subordinate and dominant groups – such as, in our case, consumers and firms – drives feelings of social competition such that each group will try to "beat" the other by imposing its viewpoint. As in any competition, people are motivated to try harder to win when they believe that there is a good chance of success. The energy that people from the subordinate group are willing to put into fighting the conflict will therefore be reduced in two situations: when the dominant party appears very strong and difficult to beat, or when the dominant party appears to capitulate. Relating this idea to SCC theory informs our hypothesis development as we can see that these two situations of diminishing willingness to further engage in the conflict relate to two of the primary response strategies of SCC theory; namely Deny strategies, in which the firm appears strong and unwilling to compromise on its position, and Rebuild strategies, in which the firm accepts responsibility for the crisis and offers some form of recompense. This leaves the other primary response strategy, Diminish, as a reaction which is most likely to show the consumers involved in an AFE that there is still a good chance of success, if they can increase the pressure on the firm. As such we hypothesize:

Hypothesis H1: Firm reactions during online AFEs will increase the growth of the herd, whereby the Diminish response strategy will lead to more growth than Deny or Rebuild strategies.

In terms of the secondary response strategy described by SCC theory, the Bolster strategy, there is also no theory describing its effect on the growth of online herds during conflict situations. Again, we posit that the size of the herd will be influenced by the extent to which people consider the conflict worth the extra effort of continuing the fight. The basis of the Bolster strategy is to soften feelings of external stakeholders to the firm, by highlighting a good track record and by currying favor through compliments or other means. This will reduce the antagonistic feelings of some of the people considering

continuing the discussion, and will most likely lead to a reduction in their willingness to post more messages. This idea is aligned with psychological theory on antagonism, which includes the desire to see another party be harmed, as a strategy designed to produce a net benefit for one's in-group (Parks, Joireman and Van Lange 2013). These authors suggest a psychological mechanism through which this happens: "When people are involved in conflict or are upset about something, it is quite natural to become "focused" on the concrete and the here and now." (idem, p. 150). As the Bolster strategy helps focus herd members on the longer term, positive performance of the firm, this strategy can be expected to reduce this antagonistic feeling, and thus the motivation to continue the discussion. Therefore, we propose:

Hypothesis H2: The effect of the Bolster strategy during online AFEs will be to reduce the growth of the herd.

3.2 Effects of firm reactions on sentiment in anti-firm episodes on social media

Following the theory of Normative Judgment (Gibbard 1990) feelings of moral concern can be assuaged by exposure to arguments promoting the other's position. Therefore, we expect that communication on the part of a firm caught up in an AFE which offer information promoting a pro-firm position will generally reduce the negativity within the herd of consumers. The extent to which this occurs will depend very much on other conditions, such as the strength of feeling of the herd, and how well the firm manages to convince people of its position. Nevertheless, we expect that across a large number of AFEs we will see a general decrease in negativity when firms make an intervention.

Again we see no theory which directly accounts for differences between the effects of the three primary response strategies on sentiment within the herd. In this case, we apply the idea that the feelings of moral outrage underlying sentiment within the AFE relate to the set of ethical norms which the people hold. According to the Theory of Normative Judgment, people determine the wrongness of an action by making judgments about when blame is appropriate, and about the reasonableness of guilt on the part of the wrong-doer and resentment on the part of others (Gibbard 1990). Gibbard holds that normative judgments imply an acceptance of norms, including acceptable actions, beliefs and feelings in certain circumstances. When a firm adheres to those norms by explaining its position and claiming moral acceptability this will likely reduce the negative feelings of the consumers, whereas when the firm's communication conflicts with those norms the negative feelings will be intensified. Relating this to SCC theory, there are two primary response strategies that adhere to the consumers' moral norms: the Rebuild strategy, where the firm accepts responsibility for the problem at hand, and the Diminish strategy, where the firm offers extenuating circumstances or minimizing the perceived damage. The other primary strategy, Deny, does not adhere to the consumers' moral norms but claims that there is no crisis, or tries to shift the blame to another party. Therefore, we propose:

Hypothesis H3: Firm reactions during online AFEs will increase positive sentiment within the herd, whereby the Deny response strategy will lead to less positive sentiment than Diminish or Rebuild.

As for the secondary response strategy described by SCC theory, the Bolster strategy, once again there is no theory describing its effect on the sentiment within online herds during conflict situations. We propose that the sentiment within the herd will be influenced by the extent to which people consider the firm to adhere to, or oppose, their moral norms. The Bolster strategy does not address the conflict directly, but offers some other information or argument to curry favor with the AFE. This is likely to be related to shared norms and issues which most people agree on. Thus, following Gibbard (1990), we expect that when a discredited firm provides information relating to these shared norms, the acceptability of its position in the wider context becomes more acceptable to herd members. By highlighting past good works of the organization, or claiming victimage such that the circumstances of the situation have led to the firm suffering too, the basis for moral outrage is weakened. As such, we propose:

Hypothesis H4: The effect of the Bolster strategy during online AFEs will be to increase positive sentiment toward the firm within the herd.

4   Methodology

4.1   Data collection

We used data from 325 AFEs of 53 different brands. The data were collected by adhering to a detailed protocol and the firms were selected from the EURIB top 100 "indispensable brands" (EURIB 2014), a survey held in the Netherlands asking people which brands they found indispensable. Priority was given to firms of brands higher on the list. After selecting a firm, its associated activity on social media in the period 2011-2014 was mapped through a database that maintains an archive of a wide variety of social media posts relating to many industries: Radian6. As such, we collected all social media messages posted about each AFE's target firm's brand. This online activity mostly consisted of posts on Twitter (81% in the entire dataset), but also covered many other social media platforms, such as forums and blogs.

The social media activity related to a firm was used to identify peak days, in which the activity was more than three standard deviations above the average activity. We made this arbitrary choice so as to limit our data set to the small set of days that the firm was an unusually strong focus of online discussions. We experimented with applying a cut-off at two standard deviations, but this resulted in too many episodes in which the herd sentiment was not particularly strong. Conversely, a cut-off at four standard deviations resulted in too few episodes for the analysis. To take account of changing levels of general social media activity during the four year data collection period, we did not consider the overall average social media activity, but rather a moving average of one hundred days, comparing each day with the fifty days before and after it.

When a day's social media activity relating to a firm exceeded this threshold, we investigated why there was a peak by examining the topic of the AFE, and news messages in traditional media that were released the same day. The episodes were only included in the analysis if the main topic of discussion was indeed negative with respect to the firm. For each AFE, a number of key words that had to do with its topic were identified. The firm or brand name was always a key word. All posts containing the key words were counted as part of the AFE. The first and last days of the episode are defined as the first and last days that had more activity than the cut-off of one percent of the peak day's activity level. This cut-off was chosen to provide a consistent start and end point, including as many of the extra social media posts due to the AFE as possible, whilst attempting to exclude the normal background firm-related social media activity.

After identifying the episodes, the content of all posts containing key words was collated. This contained the text of the post, its date and time (specific to hour of the day) and the website it was posted to. This source is also used to categorize the message using three categories: consumer posts, mainstream media, such as major newspapers' websites or other important news websites, and secondary media, such as minor news sites and news aggregators. The source website does not fully determine the category a post ends up in, since comments on news sites fall in the consumer category.

Up until three months after the beginning of an episode, the social media activity related to a firm was assessed to find subsequent sub-episodes on the same topic. In this case, the threshold was set to one standard deviation above the local average.

Finally, we searched for company interventions, such as press releases, interviews and social media posts from the firm, which were issued during the AFE. The interventions were classified by hand using the four strategies defined by Coombs (2007), and described above in Table 1.

4.2   Adding an intervention function to the Generalized Bass Model

To model how consumers influence each other, one can use the Generalized Bass Model (GBM) (Bass et al. 1994; Fan, Che, and Chen 2017). This model takes into account both the direct influence a cause has on social media users and the indirect effect, caused by people influencing each other. The latter effect is called social contagion, or word-of-mouth. The GBM is often used to describe this social con-

tagion and, more generally, the adoption of ideas or products by a general public. The generalization specifically deals with interventions, that have an effect on consumer growth.

The model assumes a fixed "market potential", the number of people that can and will be reached, towards which the population grows asymptotically. The rate of growth depends on the difference between the population who adopt and the market potential, as follows.

$$H'(t) = x(t)(p+q)(H(t)/m)(m-H(t))$$

With m, p, and q fixed parameters. More specifically, we have:

- m, the market potential;
- p, the external influence parameter;
- q, the internal influence parameter;
- $H(t)$, the size of the AFE at time t;
- $H'(t)$, the growth of the AFE at time t;
- $x(t)$, the intervention function.

Note that this describes the AFE cumulatively, meaning that at a certain hour, the posts being sent are represented by the growth of the AFE. In other words, the steeper the curve, the more activity there is on social media. p and q are parameters that influence this growth. p can be thought of as the parameter of direct influence of the cause on the AFE, while q can be thought of as the AFE participants influencing each other.

The intervention function $x(t)$ can take various forms. We developed a novel intervention function that captures the transient nature of firm interventions during AFEs. The interventions are modelled by peaks that start in the hour of the intervention and then dampen out exponentially during the hours that follow. So an intervention will have the form ce^{-bt}, which is plotted in Figure 1. b and c are parameters of the intervention. b is always positive and models the damping of the intervention's effect. c models the size of the effect. This can also be a negative number, which indicates the intervention having a negative effect on the episode growth, which is often what the intervention is intended to do. However, it is not necessarily negative, because an intervention could also increase the growth, thereby worsening the AFE from the firm's perspective.

Apart from the firm intervention, we also use this intervention function to model media interventions. We consider mainstream media messages and secondary media messages to be interventions as well. This gives an intervention function, which has the following formula:

$$x(t) = max(0;\ 1+c_1 e^{b1(t-a1)} I_{t \geq a1} + c_2 e^{b2(t-a2)} I_{t \geq a2} + \cdots + c_n e^{bn(t-an)} I_{t \geq n})$$

This intervention function has a term for every intervention. $I_{t \geq a}$ is a function that is zero before time $t=a$, 1 from that time on. This makes sure that the term is set to zero at all times before the intervention starts. Note that if there are no interventions, the intervention function is equal to one. If the terms are less than minus one at a certain time, the intervention function is set to zero, since the growth of the cumulative AFE cannot be negative. The parameters of all mainstream media interventions during an AFE are set to be equal, as well as the parameters of all secondary media interventions. This means that, although there is no limit on the number of media interventions during an episode, there is a maximum of six intervention parameters during an episode: b and c for three categories of interventions: firm interventions, mainstream media, and secondary media.
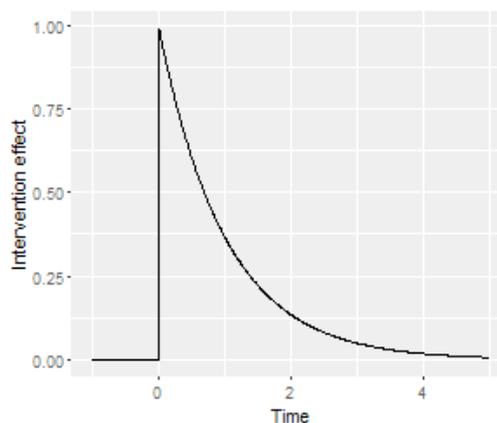
Figure 1: Model of the intervention function

4.3 Sentiment analysis

Traditional sentiment analysis uses a division into classes based on emotion. For the specific purpose of AFEs, it makes more sense to use as a distinction whether or not a post is pro- or anti-firm, i.e. to detect stance. After all, this is what is interesting from the firms perspective. These categories do not always line up with the traditional sentiment categories based on the emotional connotation of words in general use. Often, anti-firm posts will be angry or sad, but they can also be happy, for example in the case of schadenfreude (i.e. pleasure derived from another's misfortune). In the end, the goal of an intervention is to turn people towards being more positive about the firm, not necessarily to make them happy. Therefore, we developed a novel sentiment analysis procedure whereby the posts were divided into three categories: pro-firm, neutral, and anti-firm.

We approached the sentiment analysis as a text classification problem to be solved using machine learning. To be able to use a supervised learning approach, a set of training data was created for each AFE separately. This is because the specific pro- or anti-firm terms differ widely across AFEs.

From the large amount of data collected we select fifty posts used as training data based on the following three criteria:

1. Frequency of occurrence, whereby we selected the most frequently occurring posts. Posts occur more than once for example when a tweet is retweeted.

2. Distribution over time. The AFE was divided in 10 timeslots with an equal number of posts, whereby from each timeslot at least one post was selected

3. Diversity. Posts that are very similar to a post already in the training set would not be selected. Similarity was measured using a string similarity algorithm (Python Software Foundation 2015).

The aim of this selection is to optimize the performance of the classifier by creating a diverse set of training data, while keeping the manual annotation effort to a minimum.

After these fifty posts had been selected, they were used as a training set for the naïve Bayes learning algorithm (Witten 2005). As features for the learning algorithms the 10.000 most common words in the complete dataset and a list of emoticons were used. Several machine learning algorithms were tried: support vector machines, nearest neighbor, decision trees, and naïve Bayes, but they yielded only small differences. In the end, naïve Bayes was selected since it is quick and intuitive. This model was used to categorize all posts in the episodes that were not manually annotated. In some cases there was not enough training data for an episode to train a classifier. We only train a classifier if the episode contained more than two pro or neutral posts, and at least ten posts after checking for diversity. In this case, the classifier was trained using the other episodes about the same firm. On the rare occasion that these episodes contained too few positive or neutral ones as well, a general model was used to categorize the posts using all episodes from all firms.

To test how well this matches with manual categorization, we manually categorized all posts of five episodes (average of 397 posts per episode). This resulted in accuracy numbers and F-measures for each model used: the episode model had and accuracy of 0.70 and an F-measure of 0.51, which made it more suited than the firm model (based on all episodes relating to that firm) (0.65 and 0.44 respectively) and the general model (based on all episodes of all firms) (0.53 and 0.28). In total, 18,166 posts were categorized manually, and another 743,374 were categorized automatically.

This process results in a categorization of all posts, using three categories: pro, neutral, and anti. This can be used to compare the sentiment in different episodes, or compare sentiment before and after an intervention.

5 Results

5.1 Descriptive results

In the research, 325 AFEs were examined, 133 of which were sub-episodes. These AFEs concerned 53 different firms, which means there were 6.1 episodes per firm in the investigated period of four years. Of the 325 episodes, 176 (54%) had firm interventions.

There is a clear difference between AFEs with firm intervention and AFEs without intervention: AFEs in which the firm decided to intervene were significantly larger (average of 2176 posts versus 1612 posts) and had more pro-sentiment. However, the causality of this comparison could run either way.

The sequential AFEs were smaller than non-sequential ones, but this is partly due to the way of selecting the AFEs. Sequential episodes were less likely to have a firm intervention and received less attention from traditional media, possibly due to their smaller size.

Table 2 shows how many times the different intervention strategies occurred.

	With bolster	Without bolster	Total
Deny	13	40	53
Diminish	16	61	77
Rebuild	4	42	46
Total	33	143	176

Table 2. Frequencies of the different intervention strategies

It is clear that the secondary strategy bolster is used quite rarely; in 33 of the 176 interventions.

The largest episode consisted of 40,332 posts. We did not analyze episodes smaller than 100 episodes, due to model limitations. The average number of posts in the episodes in our database was 1917 (geometric mean 850, median 669). On average, episodes lasted 7.8 days (geometric mean: 5.5, median: 6).

When it comes to sentiment, the vast majority of posts were anti-firm: 87.5% were anti-firm, 6.2% were neutral, and 6.3% were pro-firm.

5.2 Hypothesis testing

The parameters *b* and *c* describe the effect of a company intervention. Of these two, *c* is most important, since it describes the immediate effect. Figure 2 shows histograms of *c*.

From these histograms, is it immediately clear that by far most interventions result in a positive value for c, indicating that they are associated with extra growth of the herd. Indeed, 77% of company inter-

ventions has a positive effect on growth, with the average value for c being 4.7 (standard deviation 5.1). There is no reason to assume the interventions that work have a longer lasting effect, since there is no significant correlation between b and c. To test Hypothesis 1, we need test whether c differs significantly from zero. Since we cannot assume normality, as confirmed by the Shapiro-Wilk test, we apply the non-parametric Mann-Whitney U test. In line with hypothesis H1, this shows that c does differ significantly from zero ($p < 1*10\text{-}15$): firm interventions are positively associated with the growth of the AFE.
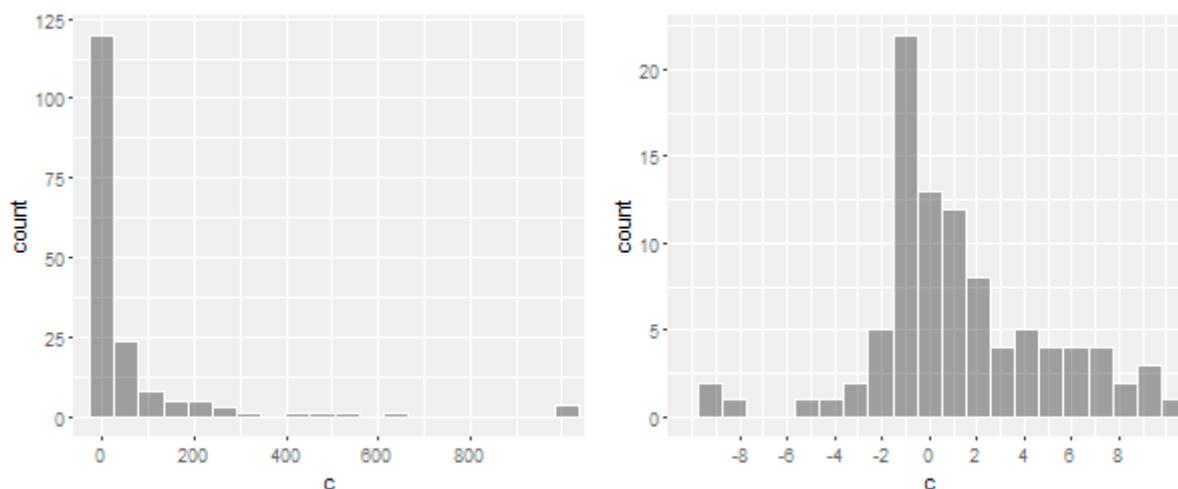

Figure 2: Histograms of the size of the effect of the firm intervention, c. On the left is the full histogram. On the right is a partial view, that shows all values smaller than 10.

Table 3 shows the average and median of the intervention c, as well as the sentiment shift, for the different intervention strategies.

Strategy	Average c of intervention	Median c of intervention	Sentiment shift
Deny	56.0	5.9	3.9%
Diminish	77.8	9.8	1.9%
Rebuild	51.9	9.3	2.0%
Bolster	28.7	2.5	9.9%
Total	64.5	7.5	2.5%

Table 3. Effects of different intervention strategies on AFE growth and sentiment

We find, once again in support of hypothesis H1, that growth of the herd in response to the firm interventions is strongest for the Diminish strategy. It appears that this strategy gives disgruntled consumers the idea that the battle is worth continuing, as compared to the Deny and Rebuild strategies. However, the Mann-Whitney U test indicates that the difference between these classes is not significant. We conclude that hypothesis H1 is partly supported.

When we assess the effect of the Bolster strategy on herd growth, we find it has a positive effect. This appears to be contrary to hypothesis H2 in which we proposed that the Bolster strategy would reduce antagonistic feelings in the herd. However, a Mann-Whitney U test indicates that *c* is significantly smaller for Bolster interventions than for the primary response strategies. When firms intervene in an online AFE the herd size grows, but this growth is smallest when they apply the secondary Bolster strategy. We conclude that hypothesis 2 is supported.

Turning to the effect of firm reactions on pro-firm or anti-firm sentiment within the herd, we look at the percentage of pro-firm posts before and after the intervention to calculate the sentiment shift. We also investigate the immediate sentiment shift, by comparing the sentiment in the five hours before and after the intervention. Figure 3 shows histograms of these shifts. It is clear that most shifts are small when measured in percentage points, which is compatible with the observation that the overwhelming majority of posts are not positive. 65% of sentiment shifts were positive. The average overall sentiment shift is +2.5% and differs significantly from zero (*p=0.027* for a t-test, *p=0.002* for a Mann-Whitney U test). When looking only at the shift close to an intervention, the sentiment shift does not differ significantly from zero. We conclude that Hypothesis 3 is supported: firm interventions lead to an increase in pro-firm sentiment within the AFE. However, the effect is small, and does not necessarily happen immediately. This delay is possibly an effect of the nature of AFEs on social media, in which interventions need some time to reach a large group of consumers by word-of-mouth due to the asynchronous nature of many social media platforms.

Assessing the differences between reaction strategies, both a regular t-test and a Mann-Whitney U test do not indicate significant difference in sentiment shift when comparing Deny interventions to Diminish or Rebuild interventions. We conclude that hypothesis H3 is partly supported: there is a consistent pro-firm shift after firm interventions, but no difference between primary response strategies.

In line with our expectation in regards to hypothesis H4, a Mann-Whitney U test indicates that the shift towards more pro-firm sentiment is significantly greater for Bolster interventions. This was carried out as a two sided test, with a p-value of 0.0036. Consequently, a one-sided test would yield a p-value of 0.0018. We conclude that hypothesis H4 is supported: the more a firm highlights its positive reputation, unrelated to the topic of the AFE, the stronger the intervention will increase pro-firm sentiment.
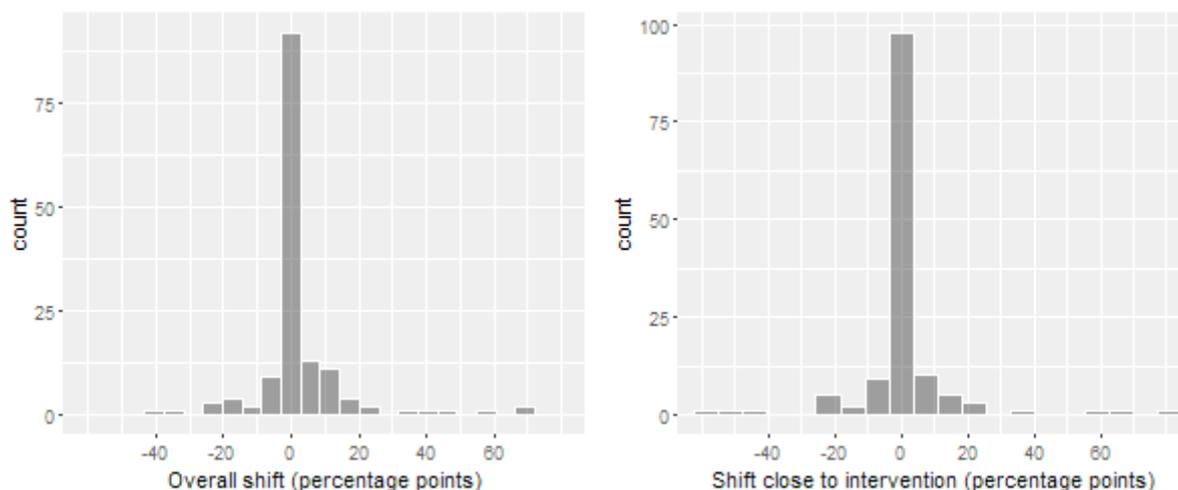

Figure 3: Histograms of the shift in sentiment during an intervention. The figure on the left shows the shift in pro-sentiment in the entire episode. The figure on the right shows the shift in posts close to the intervention.

5.3   Comments on endogeneity

With this type of research methodology, making use of real-world data, there is always the question of endogeneity. For example, it is possible that firms might anticipate that the size of an AFE will grow and decide to intervene because of this. So it is quite possible that the size of the AFEs might have grown in the absence of these interventions. By comparing the size of AFEs in which firms do not intervene to AFEs in which firms intervene, one might wrongly conclude that firms should not intervene. That is why we assess the change in growth from the moment of the firm intervention and it is why we include a large number of AFEs in our analysis. Our model assesses the effect of each firm reaction strategy within its own AFE, and we do not base our findings on a simple comparison be-

tween AFEs with or without firm reactions. Although we cannot claim that our findings prove causality between the firms' interventions and the effects on the herds, our continuous data combined with our time-dependent analysis reduces the likelihood of endogeneity. For hypothesis 1, we see consistent AFE growth immediately after firm interventions. Assuming this level of prescience by firms to be highly unlikely, our time-dependent data appears to preclude endogeneity in this respect. Similarly for hypothesis 2, the consistent finding that the secondary Bolster strategy leads to a lower AFE growth than the primary strategies alone, immediately after the intervention, suggests that endogeneity here is unlikely. For hypothesis 3 on the sentiment shift, the immediate effect after interventions is less clear. Here we are less confident in precluding endogeneity as it may be that firms decide to intervene when it appears that the herd sentiment is shifting in their favor. Finally, the strong and immediate effect of the Bolster strategy on herd sentiment, given our time-dependent data, argues against endogeneity.

6 Discussion

6.1 Theoretical implications

Due to the increasing prevalence of IT-mediated communication between firms and their stakeholders in digital ecosystems, it is particularly important to add to theory in the Information Systems area on firm reactions during online AFEs. The present study has three main theoretical contributions to the literature on the dynamics of stakeholder relations within business ecosystems, and in particular on determining optimal strategies for the long-term development of solid relationships through the use of online social media (Watson-Manheim and Bélanger 2007; Johnson and Cooper 2009; Gao et al. 2015). First, we propose that when a firm intervenes in an AFE this may have two different effects. On the one hand, the attention the firm gives to the AFE provides some justification or legitimacy to the topic, leading to more people expressing their interest or indignation. Because of the dynamics of social media, the echo-chamber effect (Colleoni et al. 2014) contributes to the herd growth brought about by the firm intervention. So, by joining in the discussion surrounding a crisis, firms actually fan the flames. This idea is supported by our findings comparing AFEs with and without firm interventions, and of our model analysis showing a clear growth effect from the moment of the interventions. On the other hand, by stating the firm's position and offering some explanation, the intervention is able to sway the opinion of some of the social media users. This effect was supported by our findings: not only do AFEs in which a firm intervenes attract more pro-firm sentiment, but the model analysis shows a clear pro-firm sentiment shift from the moment of intervention. What this means for theory is that firm crisis response during an IT-mediated AFE can be a double-edged sword. The firm runs the risk of attracting the public's attention to the crisis, but is at least able to influence the discussion in its favor.

Second, when addressing specific primary intervention strategies, whereby the firm directly addresses the topic of the AFE, we develop the idea that bringing the debate to a swift conclusion – either by categorically dismissing the problem, or by fully accepting the blame and working towards rebuilding – will minimize herd growth. When the firm accepts that there is a problem but tries to diminish the firm's responsibility or the harm done, this emboldens the protesters to continue their fight. These primary strategies also have an effect on the sentiment within the herd in that they all convince some consumers to express more pro-firm sentiment. However, we did not observe significant differences between the strategies in this respect.

Finally, we build on theory describing secondary response strategies where the firm does not directly address the topic at hand, but highlights the firm's positive reputation, praises the consumers and claims victimage. We hypothesize that this strategy will decrease herd growth, due to a reduction in the consumers' antagonistic feelings because of positive information about the firm becoming salient. We also hypothesize that this Bolster strategy will increase pro-firm sentiment, as it strengthens the alignment of moral norms between the firm and the consumers. Both of these hypotheses are supported.

Added to these theoretical implications, methodologically we also propose a novel sentiment analysis approach which is applicable to cases where pro-firm or anti-firm sentiment is more relevant than general lexicographic analysis. Despite some extra manual analysis, in our case of 50 messages per AFE, we are able to automatically assess large numbers of online messages with an accuracy level similar to that of leading general sentiment and text mining tools.

6.2 Practical implications

When faced with an online mass of negative people, the natural tendency of a firm will be to try to decrease the growth of the AFE, and to create more pro-firm sentiment. The managers will most likely ponder whether or not to intervene, being aware that they might only make things worse, and if they do decide to intervene they will wonder what they should say about the crisis at hand. From the findings of this study, when looking at the short-term, it seems in general unwise for a firm to intervene. No matter what strategy is used, interventions are far more likely to encourage growth, rather than inhibit it, which may only serve to exacerbate reputational damage. As far as influencing the firm-related sentiment, a statistically significant improvement can be realized, but one has to keep in mind that this effect is small; a vast majority of the AFE participants will remain negative towards the firm. Since the increased growth of the AFE is quite large and the shift in sentiment is only small, intervening does not seem like a wise decision when only considering the short-term effect on the AFE. We must state that the present study did not assess long term effects on firm reputation or performance.

Despite this, there are times when a firm is compelled to react, such as when the clamor for explanation becomes intense. When choosing which specific strategy to use when intervening, firms should consider using the secondary strategy, "Bolster", far more often than is currently the case. It is by far the least applied strategy – In our dataset, firms applied this strategy in just over 10% of the AFEs – but our findings indicate that the consequences of this strategy, both in terms of AFE growth and pro-firm sentiment, are in line with the outcome desired by the firm. Clearly, this easily implementable finding could have important practical implications.

Overall, it is salient to note that, when it comes to AFE interventions, there is no clear recipe that guarantees success for the firm. Each AFE has its own specific circumstances and for each of the episodes in our dataset a team of professionals had thought long and hard about whether or not to intervene, and, if so, which strategy to apply. We do not expect that our model will replace managers responsible for social media communication any time soon, but it may be used as a supporting mechanism.

6.3 Limitations, and future directions

Like any research, the present study is not without its shortcomings. First, we intentionally focused on the short-term effects of firm interventions, which are immediately visible during an AFE. Studies of offline crisis episodes also often assess short-term effects (e.g. King and Soule 2007), but these are obviously not the only effects that should be considered. An interesting topic for future research is to follow a firm's reputational and performance metrics through a longer period of time and to assess any lasting effects of IT-mediated AFEs.

Second, an unexpected finding of the present study is the lack of difference between the effects of different intervention strategies on sentiment within the AFE herd. We cannot explain why this came about, and we are keen to discuss other possible ways of investigating this issue.

Finally, the approach we took in this research was to analyze the AFEs retrospectively. It would be useful for firms if they were offered tools to map the progression of an AFE in real-time, and especially to be able to quickly assess whether an intervention is likely to be appropriate, and if so, which one. Obviously, not only firms could make use of such tools, but also public pressure groups and NGOs could use them to optimize the stakeholder pressure they put firms under.

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