The Role of Social Media in Providing Crisis Information in China: A Critical Evaluation of the Tianjin Fire Incident

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Abstract   This paper focusses on the information asymmetry in crisis news after a serious incident in Tianjin, China, in 2015. The incident caused enormous damage and resulted in societal unrest because of the lack of reliable information from the formal media channels. Social media — micro blogs — played a major role in reporting on crisis situations. We divided netizens (i.e., the citizens of the net) into high and low types according to their information-critical level to the crisis news. The data shows information deterioration on the crisis news, related to the netizens' information-critical level. For the traditional media there is the opportunity to use information quality distortion to make more marginal profits. This is possible only if the citizens' information stays under a certain quality level. The result is overprovision of low quality news and high quality news driven out of the market, whereupon adverse selection (i.e., a lack of symmetric information) appears. However, by adopting a process view, we found self-correcting mechanism (i.e., dying out of rumors) of the social media communities in China. We provided a agent-base model and simulation to show that the more media exist in the market, the faster speed of the information deterioration, but also the capacity to 'discuss' rumors.

Keywords   social media in China; crisis communication; adverse selection; deteriorating news; self-correcting mechanisms

1   Introduction

At the 12th of August, 2015, a severe physical incident in the Binhai New Area of Tianjin, a major port city in northeastern China, caused serious damage, killed many people and injured hundreds. Two explosions happened shortly after another, after which a fire continued to burn for several days causing a series of explosions:

At 22:50, a big fire broke out in the harbor cargo warehouse, nine fire brigades and three professional teams, organized by port office of Tianjin, took immediate part in rescue operations.

At 23:34, the first explosion happened as a result of the fire. According to a witness "there was a loud crash and the floor shaking like an earthquake happened". About 30 seconds after

the first explosion, a more powerful one happened and formed a big mushroom cloud. The shock-wave that affected the area in a 3 kilometer radius destroyed the nearby building. It was estimate afterwards by the experts that the impact of the second explosion was equivalent to 21t TNT.

At 23:40, the Tianjin fire station sent nine more fire brigades and 35 firefighting trucks to the scene. The direct rescue operation lasted until 2:00 the next day, and there were hundreds of people injured.

This incident was widely covered in the international news media[1], but the local Chinese media refused to report on Tianjin explosion. After the incident, the Tianjin Television (TJTV) was screening a film, a cartoon and a Korean drama series, and until the next morning there were no reports on the incident on the Moring News TV. None of the other Tianjin TV channels reported on the incident. The only responsive formal media was the Tianjin government press office microblog that released a first message at 03:52, 13th of August, only a day after the incident. The official media was not only very late in reporting about the accident, but it provided false information about the air pollution issues. Days after the explosion the cause was still unknown. Some local reporters complained that they were blocked from reporting about the explosions[2].

The incident not only caused enormous damage in terms of casualties and property loss, but it resulted also in a huge public opinion crisis and societal unrest. The netizens (i.e. citizens of the net) frustration with the way the incident was covered by the formal news channels was confirmed in interviews that we held shortly after the Tianjin incident and the majority of the respondents prefer not believe the official data presented by media authority. We made a randomly interview with 33 Tianjin citizens on their attitudes about the Tianjin fire incident. Here is an interview excerpt that covers the response of several residents:

Researcher What do you think about the accident?

Resident 1 "It's awful. The government should be held responsible for it, how can the warehouse be so close to a residential area store which contained so many hazardous chemicals, it must be a result of corruption ..."

Resident 2 "It's ridiculous, there were so many firemen being sent into the burning building, but still they failed to stop the explosion, I have to say some institutions are somewhat incapable ..."

Researcher What do you think about the emergency measures?

Resident 3 "I am not sure, but there must be something really wrong, otherwise there cannot be explosions twice ..."

Resident 4 "It was much more serious, the data presented to the public was deceptive. There were much more death and injured, as far as I know, there were 92 firemen that put themselves into harm's way, into the fire, and never came back ..."

Researcher How did you receive information about the accident?

Resident 1 "through cell phone newspapers"

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[1] For example by the BBC: http://www.bbc.com/news/world-asia-33900268.

[2] https://www.hongkongfp.com/2015/08/13/cnn-local-chinese-media-struggle-to-report-on-tianjin-explosion/ and http://www.bbc.com/news/world-asia-china-33908168.

Resident 4 "On the website ..."

Resident 5 "Mainly by WeChat and by reading microblogs, which are more reliable ..."

It was not for the first time in China that social media — in particular micro blogs — played a major role in reporting on crisis situations. After the Wenzhou Train Collision in 2011, the formal news channels and the authorities had a hard time to report on the crisis. Netizens started to inform each other about the incident and the response to it[1–3]. As citizens in the city failed to get reliable information from the official media channels and the formal authorizes, social media started to function as an alternative source to fill the information gap.

Crises create extreme demands for information from the public[4]. Increasingly, social media have a huge impact on the way citizens create, share, and distribute emergency information and information about the response to the crisis[5]. In a recent study, Jong and Dückers[6] introduced the echo-effect to describe the dissemination 'history' of posted social media messages (in their case tweets) containing rumors about an incident that happened in the Netherlands, and the continuous posting of new by the same source building upon these rumors. At the same time, they found self-correcting mechanisms of social media communities that verified information through the 'wisdom of the crowd'. This insight inspired us to explore the relationship between the news from official media channels and the social media rumor mill in China after the Tianjin explosion accident. Given the idea that the social media in China produces the same kind of shallow infotainment, unverified information and misinformation as elsewhere in the world[7], our hypothesis is that we will find similar echo-effects and self-correcting mechanisms in China after a serious physical incident that turned into a social crisis. We will address the following research question:

RQ What are the dynamics of the messages on the Tianjin incident by the traditional and social media and what are the consequences for the (quality of) the news spread though these channels?

The remainder of this paper is organized as follows: First we position our argument in the broader context of crisis information about the Tianjin explosion incident. We will give brief review of the related research into crisis communication and introduce a media-market metaphor. We then will present a content analysis of the information posted on formal and social media news channels. Next, an ideal typical model is presented with which we will analyze the media as market place, including the equilibrium and solution of the model. By using the model, we will show a simulation of the possible evolution path. Finally, in the concluding section we discuss our results and propose further research.

2   The Role of Social Media in Crisis

The emergence of social media over the last decade has enormous potential to influence information-sharing within societies worldwide[8] and generates the possibility to consult a massive number of sources. It has changed the way individuals understand the world, and how people respond to crisis events[9–11].

In the age of information news will be disseminated by any kind of media almost instantly and hypertext capabilities on the web may lead to more dynamic dissemination of information[12]. From the perspective of social psychology, Oh, Agrawal and Raghav Rao[5]

explored the conditions under which social media would degenerate into a rumor mill during social crisis by analyzing user-generated content from Twitter. They revealed that information with (a) no clear source provided, (b) personal involvement and (c) anxiety during crisis were the three most significant factors in causing rumors on social media. Their study showed the potential of the social media as an alternative source of emergency information but at the same time the information is often "fabricated" and reported "unverified events", and "misinterpretation"[13]. In situations of information asymmetry C decisions made in transactions where one party has more or better information than the other C citizens look for various sources of crisis information[14, 15].

The reaction to the Tianjin incident was no exception to this pattern — It illustrated the enormous potential of micro-blogs for the construction of a collective debate on crisis and on-line action in China. It made visible that the Chinese netizens on-line activism broadened the attention from political to social, national affairs including crisis.

2.1 The News Market

In general, at times of incidents that turn into crisis, it is hard, both for citizens and for responding professionals to make sense of crisis information, mainly because of situational uncertainty, information overload, and the unpredictability of the situation[16]. The official media system traditionally plays a vital role in the covering of the news, however — and this is not just true for China — at times of crisis they have a hard time to mutually generate news with citizens[17]. Generally speaking, the media (has to) spend a lot of time, money and manpower to produce accurate and high quality and 'validated' information about an accident. The social media information maker, on the contrary, can spread low quality information easily, and almost without any costs or previous investments. Yet, rather than relying upon — and trusting — formal media, citizens still turn to social media sources and information resources at hand. Social media in crisis situations becomes a collective rumor mill[5].

Whereas rumors can be seen as information coming from an unclear source, rumoring at times of crisis, however, should not just to be considered as in contrast to the truth (although they can hold irrelevant and untrustworthy information) but as a way to collectively make sense of the crisis situation[18]. Framed this way, rumoring must be seen as improvised news that functions as a way to create some kind of common understanding, helping citizens to cope with the uncertainty of extreme situations. At the same time the posted news on the social media websites on incidents — such as the Wenzhou Train Collision and the Tianjin Explosions — can be ambiguous and contradictory at times, adding to the social unrest instead of answering it.

If we treat the (crisis) information as a market commodity, this process can be seen as 'trading information' and explained by Akerlof's[19] classic lemons market: The average payout rate is too low for high income consumers, who drop out of the market, reducing the quality of the pool. This process implies that the payout gets deteriorated even more and the process repeats itself until only the lowest income type remains. The lemon stand for the product (i.e., 'crisis information') that is found to be defective only after it has been bought. This is in particular problematic in situations of information asymmetry, in which the one has more or better information than the other which we found it can also be used in the crisis information

disseminating. In the context of a more restrictive political setting in China towards the use of social media[20], this takes place without the engagement of the independent bodies that can provide — at least partial — answers on the basis of thorough investigations and verification mechanisms.

2.2 Text Analysis of the Tianjin Incident

When we put "Tianjin Binhai Explosion" into a search engine, we obtained numerous of media reports and comments by netizens mainly claiming on damage, emergency management, pollution, corruption and causes of the accident. We collected 1.146.592 original posts or reposts containing keywords related to the above issues posted by media (with certain organization names instead of individuals) on the Weibo (China's Twitter-like microblogging) and webpages online between on 13th, Aug, 2015 and 4th, Sep, 2015. We used "Red Wheat" software, which is widely used on public opinion monitoring in China, to do the analysis. The software enabled us to export the issues captured by using keywords in a certain period. Figure 1 presents the most important news messages by the formal authorities and the messages posted by netizens on the Sina microblog, Bulletin Board System and web pages.
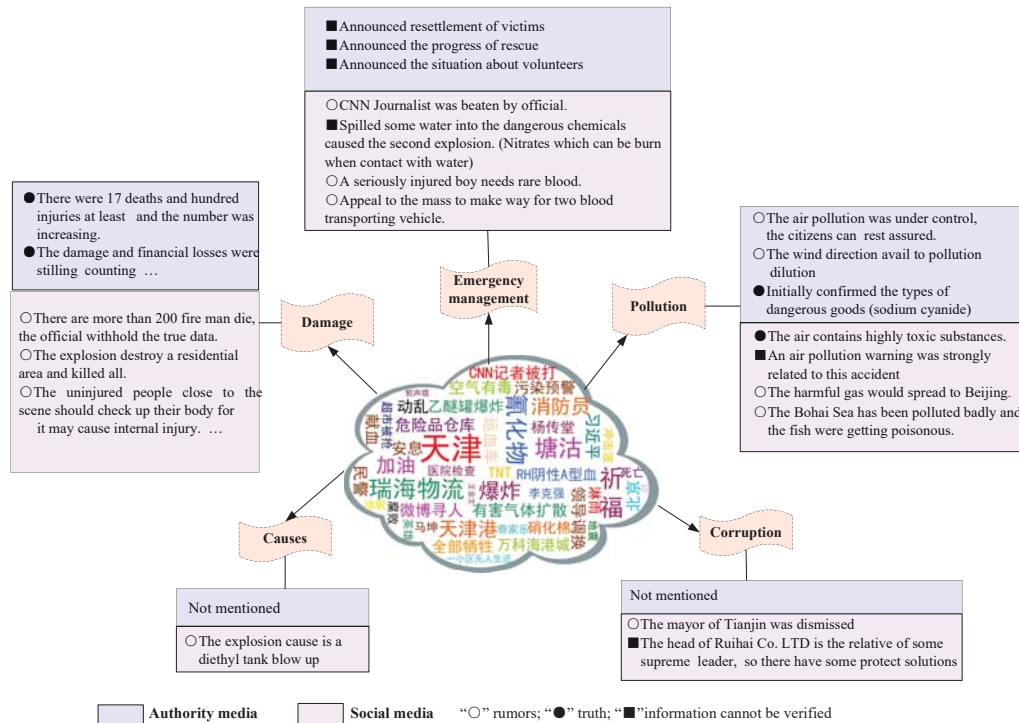

Figure 1 Topical issues on the social and the authority media

Through a first analysis of the information resources, we classified the posts and reposts by three main kinds: 1) Rumors (i.e., information with no clear source); 2) News reports repeating the information provided by the formal authorities; 3) Emotional expressions, i.e., anxiety, such as prayers for the injured and for Tianjin city as a whole. The dynamics (i.e., the change over time) of these categories are presented in the Figure 2(a)/(b) below.
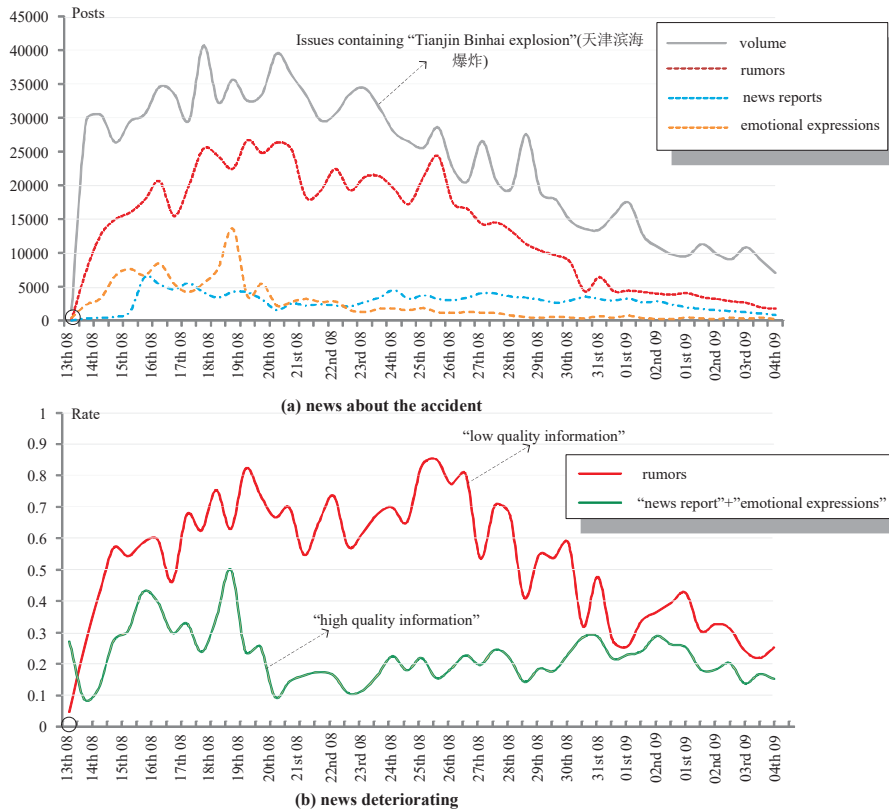
Figure 2 The amount of posts and reposts on the incident over time

Figure 2(a) shows that the posts containing rumors were in the majority, and they increased the fastest. In contrast, the positive, blessing attitudes experienced a downward trend.

Apparently more media would hold mainstream critical attitudes from a public opinion crisis as a by-product of this serious accident. We added the "news report" and "emotional expressions" together as the relatively "higher quality" information and regard the rumors as "lower quality" information and then calculate their percentage of the whole issues. The evolution process is presented in Figure 2(b). We can see low quality type information increasing faster than higher quality ones. Eventually, however, the low quality information clearly shows a downward trend.

3 Agent-Based Model on the Crisis Information 'Market'

In the classic Akerlof[19] lemons market the idea is that, if buyers were to pay the price corresponding to the average quality of the assets in the market, sellers holding the best assets might not wish to trade. Realizing this, sellers would then reduce their offers and end up trading with a small fraction of the buyers or none at all. If intervention is absent, trade either completely stops or slows down. Depending on the time nodes, transaction can be divided into two types: Ex-ante and ex-post. Generally, the ex-ante information asymmetry can result in a situation in which the information superior party hides information deliberately in order to

obtain additional income, then causing the adverse selection phenomenon. This can happen on the media market too[21].

For example, assume that in the market a number of suppliers offer a range of products (we regard the crisis information as a product) whose quality can be expressed by a quantity $q \in [0,1]$ which is uniformly distributed. Let the expected value $E(q) = 0.5$. A number of buyers will to pay a price $P(q)$ (the time spend to pay attention to the news). If the consumer cannot fully assess the quality of the news, the consumer would estimate it as having the average quality $\bar{q}$ of the products offered on the market. Then they will offer a price $P(\bar{q})$ related to the average quality. In this situation only the sellers whose products are of quality $q \leq \bar{q}$ will offer them for sale (the inferior quality news products can be zero-costs) and earn profits (earn form click rate). However, the above average quality news might have higher costs. That is (how) the asymmetric information destroys the market mechanism.

3.1 The Disseminating of Crisis News

In order to better understand how the crisis information 'market' works, we developed an agent-based model. With this ideal typical model we are able to simplify the situation, and do an analysis of the possible behaviors of the different media from the perspective of adverse selection theory.

Suppose the disseminating of crisis news is a market on which media organizations are trading with netizens. Suppose also that the news has two categories: The type H means trustworthy news about the crisis, and the type L means groundless allegation or rumors about the crisis. In theory, the H type is produced against a higher cost, because to verify and to overcome misinterpretation of the information takes a lot of time and recourses. Apparently, the media just providing H news may attract less attention by the audience and the media will make losses. A traditional solution for this problem is to add a positive subscription fee for the H news and put a certain amount of injected advertisements on their page with the news. However, it makes no sense to impose a subscription fee for public crisis news on net, therefore alternative measures are increasing advertisements and use quality distortion as screening instruments.

Consider a market for homogeneous media products of public crisis news (like Tianjin Binhai explosion). There are two types of consumers for this news:

1) $type(h)$ represents the group that is looking for alternative news sources meaning that they have a higher information critical level;

2) $type(l)$ represents the group that 'blindly' believes any news posted, in other words, this group has a lower information critical level. A proportion γ is of $type(h)$, while a proportion is of $type(l)$.

Netizens have certain demands to get the highest utility from media, the utility of a netizens of i from consumption of news is

$$V_i = U_i - \alpha - \beta_i + v_i, \tag{1}$$

where U_i is the people's utility from consuming the news products and does not need to identify the facticity. α stands for the amount of injected advertisements, $p \geq 0$ stands for the time cost made by people to pay attention to the media. Usually the media can make a certain

profit by increasing visitor volume. $\beta_i > 0$ measures the $type(i)$ aversion to time costs. Usually implies that $type(l)$ consumers need to spend more time to identify the news and q denotes the quality of the news. $v_i \geq 0$ is an measurement of $type(i)$' s information-critical (satisfaction to the trustworthy news) to the news' quality, we normalize $v_L = 0$ to simplify the calculations, having no impact on the results.

Then the media can provide the news $N = (p, \alpha, q)$. Accordingly, let δ_i denote the measurement of the propaganda value for the news to netizens of type i, usually $\delta_h > \delta_l$. Every commercial activity has costs, and this includes fixed cost $F \geq 0$ and marginal cost $c > 0$, which is integrant for each company involved in the market. Usually the quality of products can influence the marginal cost in a convex way and we can let the cost be $0.5\varphi q_i^2$ where $\varphi > 0$ is a parameter that measures how costly the provision of the quality is[22].

Putting the above together, for the netizen i may concern the news, $N = (p, \alpha, q)$ can make a marginal profit of

$$\pi = \alpha\delta_i + p - c - \frac{1}{2}\varphi q^2. \tag{2}$$

It should be noted that there is a precondition: all consumer's attention to the news can make profits[3] for the media that make the market efficient. The condition $U_i/\beta_i \geq F + c$ for $i \in \{h, l\}$ implies that the trading could get Pareto optimal. This condition is to be hold in throughout the paper.

To address the research question about the relation between the authority media and social media, we will discuss two extreme cases. In the first extreme case, monopoly media, the crisis news is absolutely monopolized by the authority media, no other social media has access to the information market. In the second extreme case competitive media, the news market is completely free, authority media is in equal competition with the social media.

3.2 Monopoly Media Case

To facilitate deduction, we consider the market to be dominated by a single authority media firm (monopoly situation). In this case, we consider the media to have full information about the *two types of consumers* (traditional and netizens), in order to get a broader audience, the monopolist has to consider the participation constraints for different type consumers, as well as to ensure that the non-negativity constraints. The monopolists program thus has to solve:

$$\max \ \gamma\left(\alpha_h\delta_h + p_h - c - \frac{1}{2}\varphi q_h^2\right) + (1 - \gamma)\left(\alpha_l\delta_l + p_l - c - \frac{1}{2}\varphi q_l^2\right) - F$$

$$\text{s.t.} \ \begin{cases} U_h - \alpha_h - \beta_h p_h + v_h q_h \geq 0, \\ U_l - \alpha_l - \beta_l p_l \geq 0, \\ \alpha_i \geq 0, \ \ p_i \geq 0. \end{cases} \tag{3}$$

It is easily to get the solution of Equation (3) that $p_h = 0$, $\alpha_h = U_h + (\delta_h/\varphi_h)v_h^2$, $q_h = (\delta_h/\varphi_h)v_h$ for h type and $p_l = 0$, $\alpha_l = U_l$ and $q_l = 0$ for the l type. The monopolist will provide zero quality news to the l types as they are not concerned about it. For the h types, they will receive certain positive quality news which related to φ, it may drop as the results of

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[3]Here profit is virtual variable; not just money, but a measurement of the benefit from spreading the news.

cost control. The monopolist will provide efficient news according to customer's willingness to accept advertising, in order to get most rent. However, public news is so special that customer will use quality deterioration to decrease marginal costs. When $\gamma < 0.5$, low quality news will occupy the market.

The scenario presented above is not the case in reality — usually the monopolist can't discriminate the two types. There are two strategies for the monopolist media: 1) Put the news to the whole market; 2) Provide one kind of news to one type alone. Apparently the first choice is reasonable. Then the monopolist has to solve:

$$\max_{q_h, q_l} \quad \gamma\left(\alpha_h \delta_h + p_h - c - \frac{1}{2}\varphi q_h^2\right) + (1 - \gamma)\left(\alpha_l \delta_l + p_l - c - \frac{1}{2}\varphi q_l^2\right) - F$$
$$\text{s.t.} \quad \begin{cases} \alpha_l - \alpha_h + \beta_h(p_l - p_h) - v_h(q_l - q_h) \geq 0, \\ \alpha_h - \alpha_l + \beta_l(p_h - p_l) \geq 0. \end{cases} \tag{4}$$

The solution to the formula (4) depends on the proportion of the two types. Generally there will be more low types than higher ones ($\gamma < 0.5$). To solve this formula, we should set threshold level. Let:

$$\begin{cases} h = \sqrt{2\varphi(\delta_h - \delta_l)(\beta_h - \beta_l)^2 c/\delta_l(1 - \delta_h \beta_l)^2}, \\ \bar{v}_h = \sqrt{(U_l - U_h)\varphi/\delta_h}, \\ \bar{v}'_h = \sqrt{2\varphi(\delta_h - \delta_l)c/(\delta_l \delta_h^2)}. \end{cases} \tag{5}$$

The low type solution of formula (4) is same to the formula (3) results. The news quality of high type result as follows:

$$\begin{cases} \text{if } v_h \in [0, h), \quad q_h = (1 - \delta_h \beta_l)v_h/\varphi(\beta_l - \beta_h), \\ \text{if } v_h \in [h, \bar{v}_h), \quad q_h = (U_l - U_H)/v_h, \\ \text{if } v_h \in [\bar{v}_h, \infty), \quad q_h = \delta_h v_h/\varphi. \end{cases} \tag{6}$$

We present the solution of the monopoly media graphically in Figure 3, after the analysis of competitive media case to make a comparative study.

3.3 Competitive Media Case

In times of information society, numerous media enter the information market. We consider that the news is homogeneous except for the quality and the market is absolutely free for competition. First of all, we use the full information as a benchmark. The constrains for Nash equilibrium are well known:

1) Media firms have to earn non-negative profits;

2) There are no contracts for the media but they provide $N = (p, \alpha, q)$ do make a profit. With this constraints we should solve $\max \ U_i - \alpha_i - \beta_i p_i + v_i q_i$, then the solution is $p_h = 0$, $\alpha_h = c/\delta_h + (\delta_h/2\varphi_h)v_h^2$, $q_h = (\delta_h/\varphi_h)v_h$ for high type and $p_l = 0$, $\alpha_l = c/\delta_h$ and $q_l = 0$ for the low type. Again, we turn to the case of asymmetric information, the agents have to solve

$$\max \ \gamma(U_h - \alpha_h - \beta_h p_h + v_h q_h) + (1 - \gamma)(U_l - \alpha_l - \beta_l p_l)$$
$$\text{s.t.} \quad \begin{cases} \alpha_h \delta_h + p_h \geq c + 0.5\varphi q_h{}^2, \\ \alpha_l \delta_l + p_l \geq c + 0.5\varphi q_l{}^2. \end{cases} \tag{7}$$

The solution of Equation (7) shows that the l type has the same result as the non-asymmetric situation. The high type result as follows:

$$\begin{cases} \text{if } v_h \in [0, {}_h), & q_h = (1 - \delta_h\beta_l)v_h/\varphi(\beta_l - \beta_h), \\ \text{if } v_h \in [{}_h, \bar{v}'_h), & q_h = \sqrt{2(\delta_h - \delta_l)c/\varphi\delta_l}, \\ \text{if } v_h \in [\bar{v}'_h, \infty), & q_h = \delta_h v_h/\varphi. \end{cases} \quad (8)$$

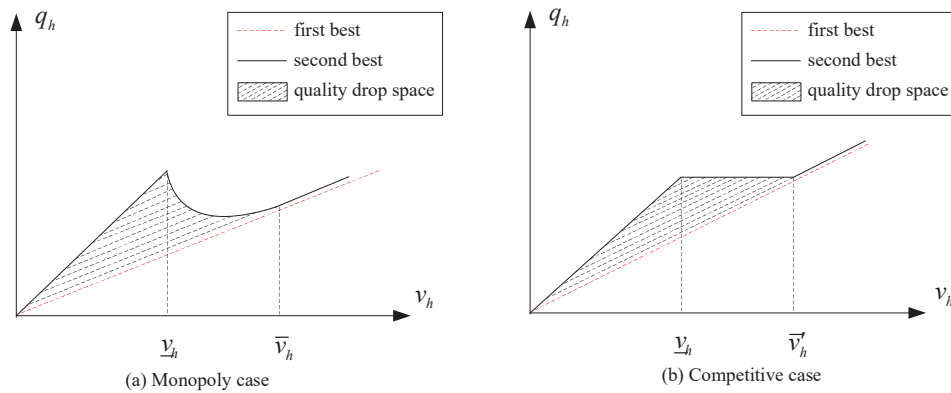The graphical representation of the solutions are presented in Figure 3 below.

Figure 3 Function relationship between q_k and v_k

The dotted line represents the first best result of the situation without asymmetric information and the black curve represents the second best in the situation of asymmetric information. Then the dash area represents the 'news quality decline space' and shows that the monopolistic media will drop its information quality to get the optimal solution (Figure 3(a)). In order to get optimal, the monopolist would like to use quality distorted on the high type. When $v_h < \underline{v}_h$, the quality value is higher than the first best, it is easy for monopolist to use quality distortions in order to get close to the first best level.

As v_h will increase then the preferences make the monopolist profitable to use quality distorted. When $v_h = \bar{v}_h$, the quality is the same as the first best which means there are no needs to use quality distorted. As the (b) of Figure 3, the competitive case is similar to monopoly case, when $v_h = \underline{v}'_h$, the quality value is highest, when $v_h \geq \bar{v}_h$, the quality is the same as the first best, which means there is no need to use quality distorted. Therefore, when $v_h \leq \bar{v}_h$, the competitive media still can use quality distorted in order to get the optimal solution. We can get the deteriorating curve under different v_h level as show in Figure 4.

There is a small distinction of the deteriorating pattern between the monopoly case and the competitive case. However, when the citizen's information-critical degree is below a certain level, there are probabilities for the media firm to use information quality distortions in order to maximize its profits, no matter if the firm is monopolistic or competitive.
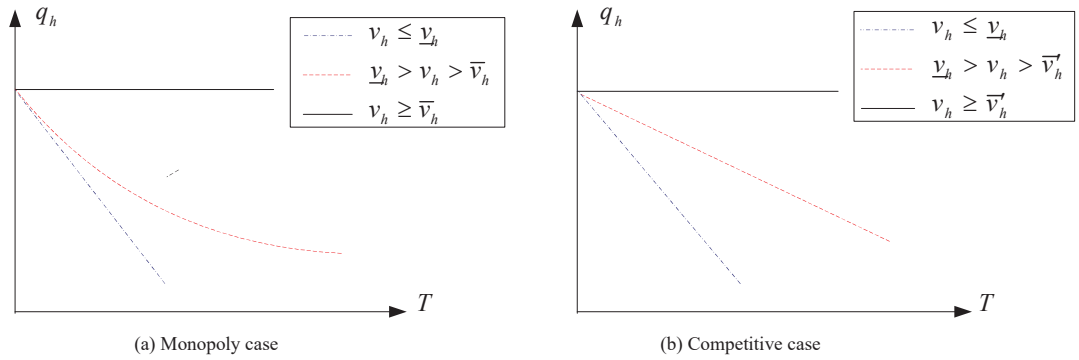
(a) Monopoly case   (b) Competitive case

Figure 4 Deteriorating rate under different v_k

4   Simulation by Agent-Based Model

In this section we present the simulation of the opinion dynamics. Providers and consumers of the news can be characterized by parameter defining. Consider the public crisis information dissemination as a market, there are N_M media and N_P netizenss who receive infromation. Generally, $N_P > N_M > 0$. For one public crisis event, the information quality is evenly distributed between 0 and 1, that is $q \in [0, 1]$. The information-critical level of the two type netizens will be $v_h \in [0, 1]$ and $v_l \in [0, 1]$, the usually $v_h > v_l$. The proportion of v_h is $\gamma \in (0, 1)$. We set the cognition level of the media I_M and the cognition level of netizens I_C, When crisis information is released, the media will evaluate its quality ($V_M = q \times I_M$), meanwhile, netizens will estimate its quality as well ($V_P = q \times I_c$). We can modify the parameter to simulate the dynamic evolution of netizens concerning the information. The results after100 times is shown in Figure 5.

There are different forms of news quality dropping independent from the monopoly case or competitive case. The competitive case, however, is decreasing much faster. As shown in subgraph (a) and (d), with the increase of proportion media to netizenss (scale from 1:20 to 1:10), the adverse selection slope will increase. That means in the case other conditions unchanged, the more proportion of media, the more serious the adverse selection will be. In Section 3, we drew the conclusion that the quality of news closely connect to v_h and γ. By using the model, we were able to test this outcome: We set three different levels of these two varibles. Let v_h=0.2, 0.4, 0.6 respectively, form the subgraph (b) and (e) we can see there are visible differences of the three evolution paths, the slop is in inverse proportion of v_h. This conclusion also applies to the relation between news quality and γ=0.2, 0.3, 0.4 in subgraph (c) and (f); this reconfirms our conclusion.
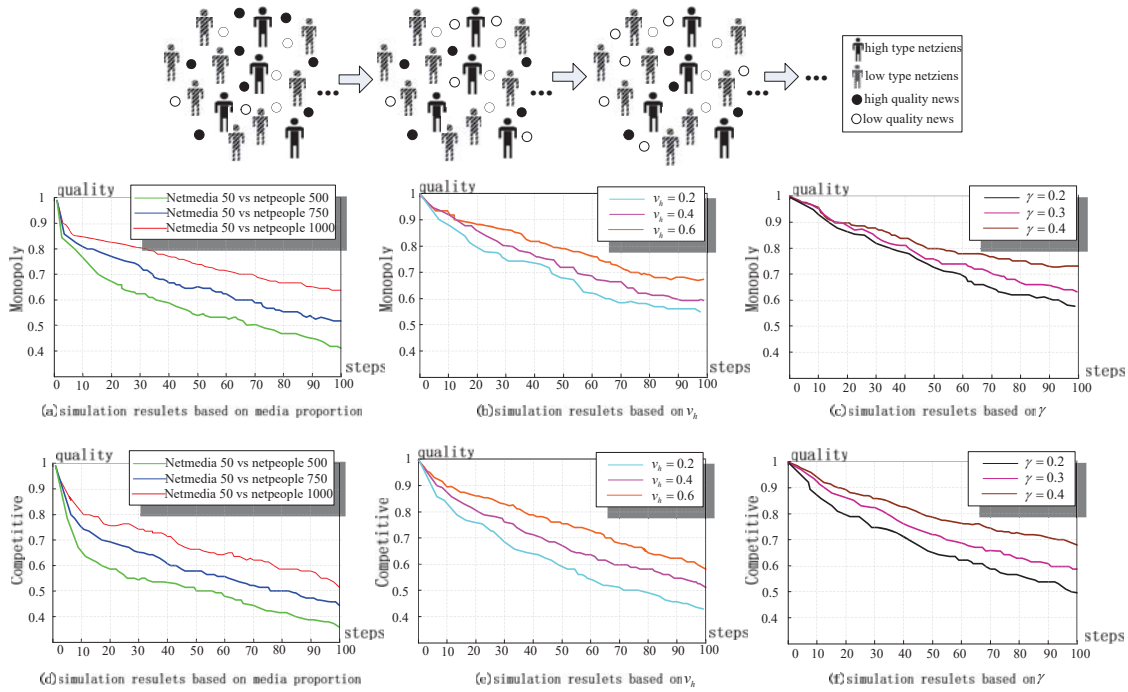
Figure 5 Simulation results

5 Discussion and Conclusion

Our research on the role of the formal and social media after the incident in the Binhai New Area of Tianjin indicates that both news channels provided a mix of trustworthy information and rumors. In the absence of reliable news by the formal authorities, however, social media started to function as a rumor mill shortly after the incident. It means that the inhabitants of Tianjin started to make sense of what happened in their city through posting information on Weibo. We found that Chinese netizens potentially play an important role in Chinese social and political life, but at the same time, the relative quality of the social media news must be considered in the analysis of crisis information in China. The echo-effect (i.e., the dissemination of previous posted unverified social media messages enabled by hyperlinks and re-posts) played a major role in the way rumors were disseminated on social media.

In more ideal typical terms, our simulation results show that the media propotion in the market plays a crucial role in the information evolution. The more social media exist in the market, the faster the speed of the information deterioration but also the capacity to 'discuss' rumors. We presented an agent-based model to analyze the news trading and found that regardless the crisis news spreading by monopolic single authority media or by competitive social medias on the free market: the news quality deteriorating will always exists as long as there are commercially viable for the medias. The crisis news, however, is different from traditional news, which can easily get profits from inject advertisings. So the news quality distortion stays under a certain level when it can extract more marginal income, which has been proved by our model.

In addition we found that, if there are more high quality type of news consumers — i.e., those who have a critical attitude towards the news — then the quality distortion will be less (Figure 5 (c), (f)). We can conclude that 1) in the monopoly case, the monopolist will try to get highest "profits" under the constraints of netizens getting non-negativity utility; 2) while in the competitive case, all the competitive media have to make sure netizens get highest utility under the constraints of making non-negativity profits. This results in different deteriorating evolution paths: generally the news quality will drop faster in the completely free market situation than the monopoly case. This resembles Alexander's study of two potential negative side effects of social media[23] and Mendoza's study on social media's broadcasting baseless rumors[24].

However, in line with Jong and Dückers[6], our analysis of social media data revealed self-correcting mechanisms of social media communities (i.e., verification of information). It means that — even in a more repressive news market, which is the case in China — low quality crisis information on social media first increases rapidly, but, because of self-correcting mechanism the amount of rumors start to decrease after some time. It might be true that many netizens do not care much about the authenticity and verification of the news. And as a result, non-verified information plays an important role in the 'consumer terminal', which infects the whole information market. But at the same time, we found that the information deterioration on the crisis is closely connect to the information-critical level of the higher type netizens willing to put energy in verifying the news, as well as to the proportion of these groups in the whole net community. The netizens' attitude and cognitive level on crisis news is an important factor that will restrict the media monopoly position. It is a concern, however, that both the critical level and the proportion of the high type netizens are unpredictable factors in developing countries like China in which the formal and social media is subject to state interference[25, 26].

5.1　Implications

Netizens habitually manage to piece together crisis information through "rumors", which makes the government, who is supposed to be the highest quality information provider, to lose its credibility. The spiral of silence law, proposed by the political scientist Elisabeth Noelle-Neumann[27] to explain how perceived public opinion can influence individual opinions or actions, accounts for the fact that opinion environment can, spontaneously, expand the "advantage opinions" and weaken the "weak opinions", making the advantage opinions becoming stronger, and the weaker forced out the information market. Like in the Tianjin Binhai explosion most netizens argued that the incident was the result of the government's default and make the official statement feeble.

In situations of distrust in the political system and the (local) authorities, such as in China, this is even more problematic. During previous incidents, the official news channels in China did not cover all of the aspects of the crisis, and the government did interfere repressively in the information market[1−3]. The society then falls into Tacitus trap: neither good nor bad policies would please people if they resent and distrust their government. In such a situation, the adverse selection problem is formed: netizens cannot identify the quality of the information, because they cannot hold it against a reliable resource. Instead they would get hold to the rumors rather than the official reports issued by the government. Eventually this leads to the deterioration of the public opinion, resulting in even more distrust of the formal crisis information. This

becomes a vicious cycle reinforced by information asymmetry: more people would not believe the official news.

We still believe there is a huge potential for the social medias to play a vital role in Chinese society at times of crisis, as we have shown in this article, but we need more empirical research on the role of the media in crisis situations to determine its relative value and to critically analyze the adverse selection problem.

5.2 Limitations

Our research attempts to study the information asymmetry problem in the crisis news dissemination after the Tianjin incident by setting up adverse selection model. It proposed possible causes for the information deterioration based on a classical economics theory. The present study has limitations that deserve further exploration. The model and simulation are ideal typical of nature and should be interpreted carefully. We drew conclusions by calculated the defined agent-based model, however, we did not consider other factors next to the economic ones, some of preconditions are based on ideal conditions, which are different in reality. In other words, our model and simulation open to extension and the possible influencing factors should be further explored.

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