

Peer Effect in Spreading Network of Fake Information in Public Crisis¹

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Abstract

Identifying social influence in networks is critical to understanding how behaviors spread and controlling information spread in public crisis. To identify the most influential members in public crisis among peers, this paper constructs a single factor and a binary relation model between individuals and their peers in spreading network of fake information by using Cox risk proportion model through field investigation and visiting. Then it shows that, from the point of age, 23 to 30 individual are the most susceptible while 31-45 individuals having most influential to individual of 23 to 30; From the point of gender, men have more influence than women, and the influence of the opposite sex than homosexual influence; From the point of social relations, married people has the strongest influence while people in love in the most susceptible; In addition, more importantly, the public media information has significant influence for people to take action, and influence increases as the increasing of the age. In order to controlling the spread of fake information, the government's leading policy should be through public media information targeted to those strong influence individuals to release.

Keywords: *public crisis, fake information, social network, peer effect*

1. Introduction

Peer effects are elusive in the social science. Recently, there are many experimental researches trying to measure the cause and effect of online society influence [1-4]. Meanwhile, more and more people show their great interests in studying behaviors which affect the real world by social network [5-7]. Scholars from all fields exhibit their interests in issues, such as if colleagues of the staff affect their productivity, if peers affect the personal adoption for new products and service, if teenagers' partners affect their learning ability, if sense of happiness, fat and smoking may become "Contagious" through peer effects spreading. Actually, the research on peer effects is very crucial to the policy making.

Throughout the break-out and development of public crises, we can find out that they are almost along with cases in which non-objective and unreal information, such as rumors, gossips, hearsay spreads and propagates or the information became twisted and mutated. For instance, the panic buying craze of Radix Isatidis when SARS broke out; the "Guizhou Weng'an incident" happened in 2008; the panic salt buying storm triggered by Japan nuclear leak in 2012, the Diaoyu Islands event and other cases like these cause panic in crowd, bring about chaos, affect people's normal life. Moreover, the pervasion of fake information plays a more and more important role in public crisis development,

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which adds to the complexity and uncertainty of public crisis, aggravates the destruction of public crisis, sets up obstacles for the crisis recovery, and even endangers the social and political stability.

It is critical for controlling fake information pervasion in public crisis to make sure that how fake information which created by individuals' panic spreads quickly in the public through peer effects, and then bring about social amplification effect, identify the social influence of social members in information pervasion network.

2. Questionnaire Design and Data Collect

In order to achieve the purpose of this text, we choose the "panic buying salt storm which is brought about by nuclear leak crisis after Japan earthquake" as a case for fake information pervasion research. We have designed a questionnaire (start from the end of 2012) to measure the influence and susceptibility of the representative sample in fake information spreading. This survey involves people from cities, countryside, and all other fields. In this survey, the subjects were asked to recall their memory if their peers called them, sent messages to them or told them from mouth to mouth to inform them of the panic salt buying, and if they joined in buying salt and then delivered the message to other peers.

In this process, we choose respondents (we get the information from pedestrians on the street or ask students to enquire their relatives) randomly to insure the balance of the subjects. The evaluation for network members' influence and susceptibility was achieved by if members adopt the information which their peers deliver to them. This research continued almost half a year, and we investigated more than 500 people. But there are many missing data in some questionnaires because we chose retrospective investigation as the main way. We finally got 276 valid questionnaires. Descriptive statistics of the relevant variables is shown in Table 1.

Table 1. Descriptive Statistics of the Relevant Variables in Questionnaires

variables	Mean	Standard deviation
dependent variables		
Do they have salt buying intention or behaviors or not (yes=1; no=2)	1.68	.489
The attributes of members who receive the information		
age (0-22=1; 23-30=2; 31-45=3; more than 45=4; unknown=5)	2.21	1.058
gender (male=1; female=2; unknown=3)	1.57	.535
Social relations (single=1; in love =2; married=3; unknown=4)	1.95	.919
location (city=1; town=2; unknown=3)	1.41	.531
Is there public media information or not (yes=1; no=2; unknown=3)	1.37	.522
the attributes of peers who spread information		
age (0-22=1; 23-30=2; 31-45=3; more than 45=4; unknown=5)	3.04	1.136
gender (male=1; female=2; unknown=3)	1.80	.408
Social relations (single=1; in love=2; married=3; unknown=4)	2.64	.700

location (city=1; town=2; ; unknown=3)	1.36	.489
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3. A Single Factor Model for Peer Effect

The evaluation for members' influence and susceptibility in information spreading network is achieved by if peers adopt the influential information and then take action. In order to evaluate the moderate effect which attributes of the social member i have by external influence in whether j takes action to buy salt or not and the sensitivity of j itself, we use Cox risk proportion model. Cox risk proportion model is a Multivariate survival analysis method which allows existence of "censored data" in datum and can analyze many factors' influence on survival time. It is a semi parametric method which is widely used in medical science and biology.

In this research, whether members in social network take actions to buy salt finally was considered as the fake information' survival condition. For the condition in which the survival time is not continuous, we can extend the function to the discrete case by logistic transformation. In this research, we use single-failure proportional hazards model to estimate how the peers respond quickly to information received (rather simply respond or not), as shown in formula (1)

$$\lambda_j(t, X_i, X_j, N_j) = \lambda_0(t) \exp[\beta_{susc}^j X_j + \beta_{inf}^i X_i + \beta_N N_j] \quad (1)$$

λ_j represents the risk of node member j who receives information in social network and then decides to buy salt. $\lambda_0(t)$ represents baseline risk. X_i represents attributes of the member i who spread information in the network. X_j represents attributes of the member j who gets the information. N_j represents public media information that j received in the fake information spreading process (for example TV news report the salt event), β_{susc}^j estimates the tendency that members with attribute X_j spontaneously adopt in the absence of influence ($N_j = 0$), β_{inf}^i estimates the impact of user i's attributes on i's ability to influence peer j to adopt the application above and beyond j's propensity to adopt spontaneously, β_N estimates the possibility of which members who received public media information take action (keep attributes of information receiver and underlying information sender unchanged). (Alternative specifications, robustness and goodness of fit, see table S8, figure S5 to S12)

SPSS19 is used for model fitting. All Categorical covariates which affect information spreading are labeled indicators, and finally choose the last covariate in each category as a reference object. For example, covariate "social relations", the investigation process will be divided into four categories in which 1 means "single", 2 means "deep in love", 3 means "married", 4 means "very complex, unknown.", then the operation will last during a 4 "complex, unknown" as a reference object. Assume that the social relations "complex, unknown" is 0, compare coefficients of the rest categories with it, and so on.

Robustness, goodness of fit and individual susceptibility and the influence coefficient are shown in Table 2-4.

Table 2. Integrated Test Model Coefficients

-2 times the value of the log likelihood	The whole (score)			Start to change from last step			Start to change from last section		
	Chi square	df	Sig.	Chi square	df	Sig.	Chi square	df	Sig.
251.609	48.998	21	.001	46.244	21	.001	46.244	21	.001

a. numbers of the starting part means= input

Table 3. Evaluation of Coefficient β_{sus}^j of Individuals Susceptibility in Fake Information Spreading Process

Categorical covariates	β	SE	Sig.	Exp(β)	95.0% CI	
					lower part	upper part
x1 age						
0-22	-.256	.609	.675	.774	.235	2.557
23-30	.513	.986	.602	1.671	.242	11.536
31-45	-.165	.817	.840	.848	.171	4.201
over 45	-.005	.942	.996	.995	.157	6.307
x2 gender						
male	-.394	.436	.366	.674	.287	1.585
female	.044	1.086	.968	1.045	.124	8.785
x3 social relations						
single	-.062	.788	.937	.940	.201	4.401
in love	1.204	1.170	.303	3.335	.337	33.038
married	-.476	.779	.541	.621	.135	2.860
x4 location						
cities	-.025	1.101	.982	.976	.113	8.449
towns	-.187	.410	.648	.829	.371	1.852
x5 Do they acquire public media information or not?						
yes	-.024	.710	.973	1.976	1.243	3.923
no	-.186	.405	.646	.830	.376	1.835

Table 4. Evaluation of Coefficient β_{inf}^j of Individuals Influence in Fake Information Spreading

Categorical covariates	β	SE	Sig.	Exp(β)	95.0% CI	
					lower part	upper part
Y 1age						
0-22	-.541	1.074	.615	.582	.071	2.778
23-30	-.500	1.081	.644	.606	.073	6.046
31-45	.682	1.205	.571	1.977	2.187	20.958
Over 45	-.121	1.113	.913	.886	.100	7.849
y2 gender						
male	.088	.460	.848	1.092	.443	2.691
female	-.021	1.041	.984	.979	.127	7.535
y3 social relations						
single	-1.700	.488	.000	.183	.070	.475
in love	-.710	.607	.242	.492	.150	1.614
married	-.528	.680	.437	.590	.156	2.234
y4 location						
cities	.340	.395	.390	1.405	1.647	3.050
towns	-9.167	355.626	.979	.000	.000	5.347E29

According the results in Table 3 and Table 4, people in 23-30 age are the most susceptible, and there are 67.1% risk rate more than people with no age information in taking actions to buy salt, 97.1% risk rate more than 31-45 –year old people, 67.9% more than people over 45. In terms of cases chosen in this paper, maybe because this group of

people just entered the society and lack social and life experience, they are easier to be affected in diet-related issues. People in 0-22 are the most insusceptible, and there are 22.6% risk rate less than people with no age information in salt buying. They are not easy to be affected because most of them are in campus and don't pay attention to daily necessities. However, people in 31-45 age are the most influential. Compared with the 0-22 year olds, their influence is obviously significant. The 31-45 –year old people have the risk rate of over 239% to use their influence to urge their peer to take action.

Furthermore, the susceptibility of city groups is 17.7% more than town groups while their influence is absolutely stronger than town groups. Table4 shows that the influence of town groups is almost zero.

What worth attention is that the possibility of individuals who received the public media information taking actions is 138% higher than those who did not receive these information. Then we can learn that public media ,especially TV, always report something happened in somewhere with the intention to report this incident in objective perspective, but actually that may promote the spread of the fake information of this incident or something relevant.

Meantime, the male's influence is 11.5% more than the female, but susceptibility of female is 55% more than male. People who are in love are the most susceptible while married people are the most influential. According to the data from questionnaires, married people are more than twice the single's influence.

4. Models of Dyadic Relationships of Peer Effects of Fake Information in Public Crisis

We find that 31-45-year old group has the strongest influence in single factor functioning process. But it is not clear that they will affect which group most and which is greater: male' influence on female or female 's influence on female. In order to further estimate the binary relationship between covariates, this paper constructs binary relationship model between the influence of peer effects and susceptibility, as is shown in Formula (2)

$$\lambda_j(t, X_i, X_j, N_j) = \lambda_0(t) \exp[\beta_{susc}^i X_j + \beta_{inf}^{i \rightarrow j} S(X_i, X_j) + \beta_N N_j] \quad (2)$$

X_i represents a set of the individual attributes of the sender. X_j represents features of information receiver j. $S(X_i, X_j)$ represents a set of dyadic covariates that characterize the joint attributes of the sender-recipient pair, for example, which has greater influence and susceptibility: the information sender and receiver are in the same age or not. $\beta_{inf}^{i \rightarrow j}$ represents the influence degree of partner i's and j's binary attributes on j over j taking actions spontaneously. We got the results through SPSS, as is shown in table 5(part of the data was shown because there are too many binary relations).

Table 5. Binary Effect Between Peers in Fake Information Spreading

Binary Covariant	β	SE	Sig.	Exp(β)	95.0% CI	
					lower part	upper part
x1age*y1age (choose part of it for too much data there)						
0-22 *31-45	.461	1.986	.817	1.585	.032	77.763
23-30*31-45	.933	2.535	.713	2.543	.018	366.047
31-45*31-45	.719	1.378	.602	2.053	.138	30.572
Over 45*31-45	.323	2.916	.912	1.381	.005	418.753

x2gender* y2gender						
male*male	-1.644	1.581	.298	.193	.009	4.281
female*male	.543	1.204	.652	1.721	.163	18.218
male*female	-.255	2.064	.902	.775	.014	44.312
female*female	.135	1.116	.903	1.145	.129	10.203
x3social relations* y3social relations (only part of the data)						
single*single	-2.082	1.780	.242	.185	.004	4.079
in love*single	-6.032	31.293	.847	.002	.000	1.040E 24
single*in love	8.131	125.75	.948	3396.9	.000	3.725E 110
in love * in love	-1.614	3.228	.617	.199	.000	111.26 0
in love *married	-.933	2.104	.657	.393	.006	24.319
married * married	-1.629	3.231	.614	.196	.000	110.38 4
x5Do they acquire the public media information or not?						
0-22*yes	-5.735	31.377	.855	.003	.000	1.648E 24
23-30*yes	.685	74.106	.993	1.984	.000	2.382E 63
31-45*yes	.934	1.486	.529	2.545	.138	46.801
Over 45*yes	7.313	76.672	.924	1499.5	.000	2.749E 68
male *yes	-1.239	1.560	.427	.290	.014	6.159
female*yes	-.223	.522	.669	.800	.288	2.226
single*yes	-1.150	74.117	.988	.317	.000	3.886E 62
in love*yes	-5.774	76.781	.940	.003	.000	7.054E 62
married*yes	.718	.650	.269	2.051	.574	7.332
cities*yes	-1.054	1.430	.461	.348	.021	5.743
towns*yes	.974	1.664	.558	2.648	.102	69.008

From the results we can see, from the point of age, 0-22 individuals have little effect on people of all ages while 31-45 individuals are the most influential and have the greatest influence on 23-30 individuals. In turn, 23-30 individuals are more susceptible to 31-45 individuals' influence.

From the point of gender, the influence of male to female is 50.3% more than female to female while the influence of female to male is 301.6% more than male to male. So people in the same gender repel each other while opposite attract.

Moreover, from the point of social relations, supposing that relations strength is ranking as follows: single<in love<married, the influence of high strength relations to low is greater than the influence between the same strength. (for example, the influence of people married to people in love almost have twice influence as great as people in love to people in love). The influence of people in the same strength is about the same, and the influence of the single to the single is almost equal to people in love to people in love.

In nondyadic relationship model, we find that obtaining public media information has significant effect on people's taking action. We can see that public media information has more influence on people in older people and has significant influence on married women. In addition, people in towns have obviously greater influence than people in cities.

5. Result Analysis and Conclusion

We found that different individuals play different roles in information spreading process through the analysis of the single-factor model of fake information spreading and the peer effects of a binary relation model. For example, in the fake information spreading case that iodized salt is resistant to radiation, 23-30 individuals are susceptible to information from the outside while 31-45 individuals are the most willing to spread information and the most influential. The public media information has significant promoting effect on people's taking actions to buy salt, which indicates that public media does play a part in making the public know about that but it doesn't play a positive role in controlling the public crisis.

In order to interpose and control the spread of information, we can make news or videos mainly for 31-45 individuals and influence other people by their influences. Furthermore, the female is not efficient candidates for public media to spread government information. In information spreading process, from the analysis of this paper, we can see that the influence of male is greater than female, especially those who are already married. Although female is susceptible, their influence on spreading government information is not enough. These results are of great help for the government to design and develop the relevant policy for controlling false information in the public crisis

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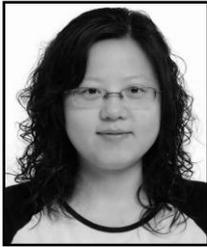
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