Institute for Economic Studies, Keio University

Keio-IES Discussion Paper Series

Effect of Flaming on Stock Price: Case of Japan

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20 January, 2017
DP2017-003
http://ies.keio.ac.jp/en/publications/7403

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Version 1.0

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Key word: flaming, stock price, difference-in-difference, Internet
JEL code: G14, L15, L25, L86

I wish to give thanks to three students in my seminar regarding data collection procedure.

I Introduction

The goal of this paper is to examine the effect of flaming on a company's stock price using Japanese firms' data. Flaming appeared in the early stage of the internet, that is, during the 1980s-1990s, as a hostile and aggressive interaction in computer-mediated communications (O'Sullivan and Flanagin (2003)). The term "interaction" indicates that flaming at that time involved a communication problem among a few people typically on a mailing list or in newsgroups. Researchers described flaming as a malfunction of personal communication, such as, for example, disruptive communication in a computer-supported classroom discussion (Renig, Briggs and Nunamker (1998)) or an interpersonal hostile expression in newsgroups (Lee (2005)).

However, this decade, the characteristics of flaming have changed from personal trouble in communication to massive unilateral offenses owing to the prevalence of social network services (SNSs) and efficient search engines. Once flaming starts, offensive people come together from all over the internet through links in SNSs or search engines to join the flaming. A targeted person cannot respond to too many offensive comments and suffers from endless hostile messages, which typically leads to his or her closing his or her SNS account or blog. Harsh backlash sometimes even causes the targeted person to commit suicide, which was the case for Australian celebrity Charlotte Dawson.

Targets of this new type of flaming are not only individuals but also firms, which are the interest of this paper (Workman (2010)). For example, when an employee of a convenience chain store posted a photo of himself in the store's refrigerator box on his Facebook page, the photo was spread throughout Twitter and generated many criticizing messages because it looks polluting food, forcing the chain store to stop the operation and to close the store.[1] A hotel in Tokyo displayed an apology on its homepage after an employee revealed in a tweet that a popular athlete and actress privately stayed at the hotel.[2] A department store stopped a television (TV) commercial campaign supporting working women when it led to many harsh comments on Twitter claiming that the commercial was sexually harassing and politically incorrect.[3] A tweet showing a cockroach contaminating an instant cup of noodles led to a total recall of the product from the store and forced the firm to invest in new

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[1] This happened at convenience store chain LAWSON in July 2013.
[2] This happened at Westin Hotel in January 2011.
[3] This happened to department store LUMINE in March 2015.

production equipment.[4] All of these types of flaming incidences could damage the performance or reputation of a firm.

We should note that these flaming incidences originated from social networks on the internet, not from the reports of established journalistic publications, such as newspapers. Initially, these events were too tiny to become public news, but flaming on social networks magnified the problems. If there were no internet, the knowledge of these events would not have spread to people and would have never caused damage to the firms. In this sense, flaming is a phenomenon originating from the internet and is different from other events such as disasters (for example, the explosion of a chemical plant or a nuclear power accident) or scandals (financial fraud or environmental misconduct) that are reported in newspapers and damage firms' performance or reputations without necessarily involving the internet. [5] In this paper, we focus on flaming originating from the internet.

To cope with the risk of flaming, most large Japanese firms have created guidelines for their employees that forbid them to comment in social networks about the firms' services and products or any information about customers or clients. Also, some firms ask internet security companies to help them to manage flaming. These security companies monitor social networks to see if there are negative comments against firms, and if so, they try to lead the flow of the comments to a less harmful direction. They essentially strive to reduce damage when flaming occurs. The number of firms having contracts with these security firms has increased, reaching several hundred if we add all reported figures. This suggests that the risk of flaming has become a common concern among Japanese firms.

A seemingly minor event itself, such as a prank photo, an inadvertent tweet, a careless commercial, or a small accident, can impact a firm in a major way if magnified by massive offensive comments on the internet. Does flaming really cause true harm to a firm even if the event is tiny? Is a contract with a security company a rational choice? If there is harm, which kinds of firms should pay attention to what kind of flaming? This paper attempts to answer these questions by estimating the effect of flaming on a company's stock price because the stock price is supposed to summarize all of the future revenue of the firm.

Many research studies have been done on the effects of disasters or scandals on

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[4] This happened to the Maruka Foods Co. in December 2014.

[5] We should also note that flaming is different from cyber smearing and defamation, which attack a firm based on false statements. In the case of cyber smearing and defamation, firms can take counter legal actions because the offenders' claims are not true (Casarez (2002)). In the case of flaming, however, the event leading to the flaming is true no matter how tiny or defendable it is. Therefore, firms cannot take legal action against flaming offenders.

stock prices. For example, Capelle-Blancarda and Lagunab (2010) estimated the effect of an explosion of chemical plant on a company's stock price, and Bosch, Eckard, and Singal (1998) examined the effect of an airplane accident on the stock price. The effect of flaming on the stock price is, however, seldom seen. There is only one research on the effect of flaming, by Adachi and Takeda (2016). They exploited data on flaming during 2006-2013 from an internet security company in Japan and carried out an event study on the effect of flaming on the stock price. Their findings were that flaming originating on the internet had a very weak effect on the stock price. Overall, the effect of flaming on the stock price was statistically insignificant, although it had some effect 10 or 20 days later.

This research study exploited flaming data during 2012-2015 from different internet websites, including the proxy measure of the degree of the flaming. The degree of flaming is important because flaming has an influence owing to the large number of offensive comments generated. Flaming involving a small number of comments does not have influential power. By applying difference-in-difference analysis, we found that the flaming significantly decreased the stock price by 0.7%, which is almost equivalent with the reported effect of disasters such as a chemical explosion or an airplane crash. We also found that the effect was nonlinear with regard to the degree of the flaming, indicating there was a threshold level beyond which the stock price started to decrease. At the maximum level of the degree, the flaming could reduce the stock price by approximately 5%. Small firms suffered from flaming more than large firms did. From the view of economic welfare, flaming may be welfare enhancing because flaming might be a discipline that motivates firms to improve the quality of their core products and services.

The remainder of this paper is organized as follows. In Section II, we describe the data and model specification, and Section III shows the main result and robustness test. We discuss heterogeneity in Section IV, and we summarize the analysis in Section V.

II Data and model specification

Flaming on the internet typically takes three stages. First, it starts with a sudden increase in offensive comments on SNSs. Second, summary websites[6] summarize the

[6] A summary website is a kind of curation site that collects information about events on the internet. In the case of flaming, a summary website collects typical offensive comments on the SNS,

comments, enabling people to read them easily. Third, established newspapers report the relevant event to the general public. Of these three stages, the second stage is critically important for the flaming to become influential because the links to the summary websites are spread across the internet through SNSs, allowing many people to join in on discussion about the event. If no page on any summary website about the flaming exists, people cannot access the offensive comments easily, so most of the flaming fades away without appealing to the public. Therefore, we collected flaming cases using a summary website.

We collected flaming cases from the summary website of "NAVER," which is the largest summary website in Japan. [7] The merit of this site is that, in addition to its wide coverage of flaming, it records tweets, from which we could know the initial dates of the flaming, and it also shows view counts of the summary pages. The view count is the number of people who have visited the page of the flaming. The view count is very informative because it can be interpreted as a proxy of the degree of the flaming. As the flaming is larger, more people will visit the summary website to read the comments. Because the effect of flaming is supposed to depend on the degree of the flaming, we needed the measure of the degree of the flaming to estimate the effect on stock prices. We used the view counts of this summary website for each flaming as a proxy of the degree of the flaming.

There were 2778 flaming incidences during 2012-2015[8] on the NAVER summary website. Of these flaming incidences, we chose a sample according to the following criteria. 1) The target is a firm, not an individual. 2) The targeted firm is listed on the stock market. 3) The view count is over 10 thousand. The last criterion was to drop very small flaming incidences. The number of flaming incidences with view counts over 10 thousand were 1332, most of which involved attacking individuals or public organizations. The number of flaming cases involving attacking publicly listed firms was reduced to 99, from which double-counted ones were excluded, and we had 77 cases as the sample for our research. Table 1 shows descriptive statistics of the sample.

When we classify flaming by subject, 45% of flaming incidences are about a quality problem related to a core product or service, such as in the case of a contaminating cockroach in a food company's cup of noodles. A prank or the misconduct of an

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related articles and documents on the Web, and the reactions of the targeted firms or individuals. When people talk about flaming on their SNSs, they usually refer to links to summary sites.

[7] The Uniform Resource Locator (URL) is "http://matome.naver.jp/". According to a survey by VALUES, Inc., the number of visitors to NAVER is the largest and is eight times larger than that of the second-largest summary site.

[8] This is a fiscal-year term. More precisely, the sample period is April 2012 to April 2016.

employee, such as a photo in a refrigerator, makes up 34% of incidences, and the remaining 21% consist of other miscellaneous events, such as service trouble associated with temporary ceremonies or problems with non-core products and services. This classification by subject will be used in Section IV.

Table 1 Descriptive Statistics of the Flaming

		freq.	ratio
by subject			
Quality Problem of Core Product or Service		35	45%
Prank or Miscunduct of Employee		26	34%
Others		16	21%
	total	77	100%
by industry			
Food business		22	29%
Retail store		15	19%
Entertainment		12	16%
Other service to persons		18	23%
Manufacture		3	4%
Others		7	9%
	total	77	100%
by specific characetristics			
Caused by part time worker		19	25%
Caused by core workers		14	18%
Political Correctness		8	10%
TV commercial		3	4%

	freq.
by year	
2012	12
2013	26
2014	20
2015	19
total	77

descriptive statistics		
	view count	sales
(unit)	(#)	(billion yen)
mean	129,475	1,092
SD	222,281	3,371
min	10,188	2
max	1,137,503	28,400
n	77	77

The industries of targeted firms include food, retail, entertainment, and other personal services, whose combined share is 90%. Manufacture and business services are rarely the targets of flaming. More than 40% (=25+18) of the flaming is caused by an individual worker's conduct, and 10% is related to political correctness, such as discrimination or sexual harassment. When we divide the cases by year, there is no clear increasing nor decreasing trend. The mean of the view count is 130 thousand, and the mean of the sales of the targeted firm is one billion yen, with the standard errors being either two or three times larger than the mean.

Difference-in-difference analysis requires control firms for the comparison.[9] Control firms should have similar characteristics regarding the movement of their

[9] Although the event study is the most-used approach regarding the effect of external shocks on the stock price, we applied the difference-in-difference model to control for other common shocks to the stock price. Recently, some studies have analyzed the effects of shocks to stock prices using the difference-in-difference model, such as Gissler (2015) and Becchetti, Ferrari and Trenta (2014).

stock prices; thus, we chose five firms in the same industry. For example, if the targeted firm was a convenience store franchise, we chose another convenience store franchise as the control sample. We chose 343 control firms; thus, the total number of sample firms was 420.[10]

We used 60 days' worth of stock price data, in which the flaming started on the 31st day. In other words, the former 30 days were before the flaming, and the latter 30 days were after the flaming, including the day the flaming just started. The stock price was normalized by dividing the stock price on the 30th day and multiplying by 100. In other words, all stock prices were normalized to be 100 on the day just before the flaming started. In this situation, let S_{it} be the normalized stock price. The mean of the standard errors of the normalized 77 firms' stock prices, that is

$\sum_{i=1}^{77}(\sum_{t=1}^{60}\frac{(S_{it}-mean)^2}{60})/77$, is 4.9, meaning that approximately 60% variation occurs within a 5% range, and 95% variation occurs within a 10% range.

Let D_t be the dummy variable equal to zero during the first day to the 30th day, and equal to one from the 31st day to the end of the periods. T_i is equal to one when firm i is a target of the flaming, and zero for not target. The ordinary difference-in-difference equation is as follows.

$$S_{it} = c_i^0 + c_i^1 t + aD_t + b(D_t T_i) + u_{it}^1 \qquad (1)$$

Time trends $c_i^1 t$ depend on stock i. These trends are introduced to remove trends from the series because the difference-in-difference method assumes that trends are parallel or the same between the treatment and control.

Because time series variables sometimes have an autoregressive structure, a dynamic panel may describe the movement of the stock price well. Adding the lagged dependent variable to the right hand, we have

$$S_{it} = c_i^0 + c_i^1 t + dS_{i,t-1} + a^2 D_t + b(D_t T_i) + u_{it}^2 \qquad (2)$$

Unfortunately, the stock price is usually not stationary. In our sample, the Dickey Fuller test with a trend term indicates that 89% of the stock price is not stationary, suggesting that u_{it}~I(1). A non-stationary time series has a stochastic trend, which

[10] When we collected exactly five firms for all flaming cases, the total number of control firms was 77*5=385. However, in some flaming cases, we could find only three or four corresponding firms because there were not five similar firms in the industry, or they were not listed on the stock market.

misleads the difference-in-difference analysis. Therefore, we should take the difference to make the variable stationary.

$$\Delta S_{it} = c_i^1 + a\Delta D_t + b\Delta(D_t T_i) + e_{it}^1 \qquad (1)'$$

$$\Delta S_{it} = c_i^1 + d\Delta S_{i,t-1} + a\Delta D_t + b\Delta(D_t T_i) + e_{it}^2 \qquad (2)'$$

The Dickey Fuller test with the drift term showed that differentiated stock price ΔS_t is stationary. Thus, in the above regression, we can assume $e_{it}=u_{it}-u_{i,t-1} \sim I(0)$.

The model (1)' is a static panel, and model (2)' is the dynamic panel model. We estimated model (1)' by the fixed effect model with allowing the error term to be auto correlated, and model (2)' with the GMM estimator developed in Arellano-Bond (1991) and Arellano-Bover (1995). If the coefficient of the cross term, b, is significantly negative, we can say that the flaming reduces the stock price because the stock price declined after the flaming more than that of the control firms not under the flaming.

III Main result

When regression was applied to the 77 flaming cases separately, we obtained 77 results. Instead of reporting all cases, in this section, we will show the result of using all data combined as a summary of the research. In other words, 77 flaming firms and 343 control firms were merged to one panel dataset consisting of 420 (77+343) firms and 60 days in the time length. We applied model (1)' and (2)' to this merged data, and we obtained the result shown in Table 2

In both the static panel and the dynamic panel, the coefficients of the cross terms were significantly negative, indicating that the flaming reduced the stock prices. Flaming reduced the stock prices by 0.653% in the static panel model and 0.756% in the dynamic panel model because the stock price was normalized to 100 on the day before the flaming started. As a summary of these two regressions, we can say that the flaming reduced the stock price by approximately 0.7%.

The estimated coefficient, 0.7%, may seem to be small, but it is a considerable amount if compared with the case of other event studies. For example, Capelle-Blancarda and Lagunab (2010) estimated the effect of 64 chemical explosions during 1990-2005 on stock prices and reported that disasters reduced the stock price by 1.3% in the following two days after the accidents. Borenstein and Zimmerman (1988)

found an average decline of 1.35% in the day following an accident on the stock prices of airline companies. Bosch, Eckard, and Singal (1998) reported that the stock price of an airline company declined by 1.17% on the accident day and by 0.93% the next day compared with the price before the accident. Walker, Thiengtham, and Lin (2005) estimated that the accumulated stock price declined a week after the aviation crash by 3.88%, indicating an average decline of 0.55%(=3.88/7). We should note that the stock prices of the airplane firms recovered in a few days, whereas the effect of the flaming was 0.7% on average 30 days after the flaming. If we evaluate the effect as the average decline of the stock price 30 days after the event, the effect of flaming is almost equal to or larger than that of an airplane accident.

Because harm from flaming is real, it is rational for firms to take countermeasures against flaming, such as contracting with internet security companies.

Table 2 Main Result

	Static panel	Dynamic panel
VARIABLES	ΔS_{it}	ΔS_{it}
$\Delta S_{i,t-1}$		0.0175
		(0.0148)
$\Delta(D_t*T_i)$	-0.653**	-0.756***
	(0.274)	(0.274)
ΔD_t	0.193*	0.360***
	(0.117)	(0.127)
Constant	0.0357**	0.0312**
	(0.0141)	(0.0127)
Observations	23,820	23,767
Number of id	420	420

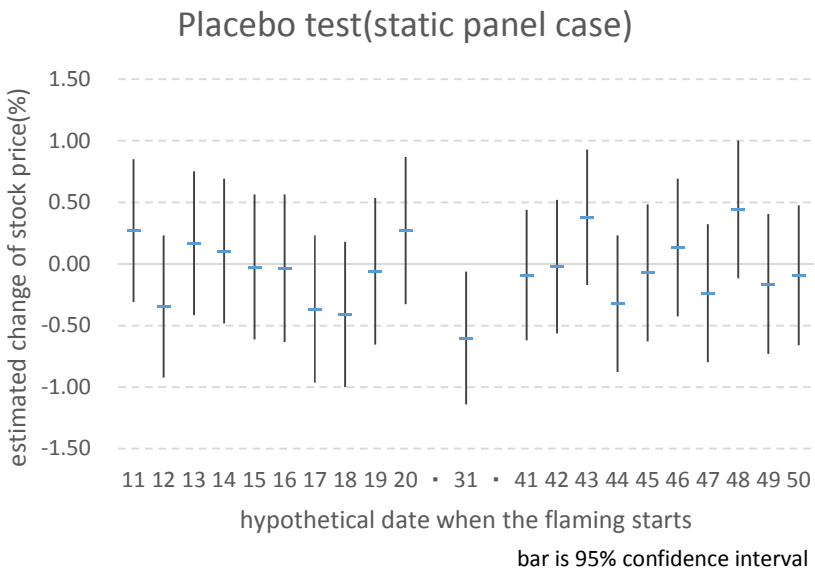
Standard errors in parentheses

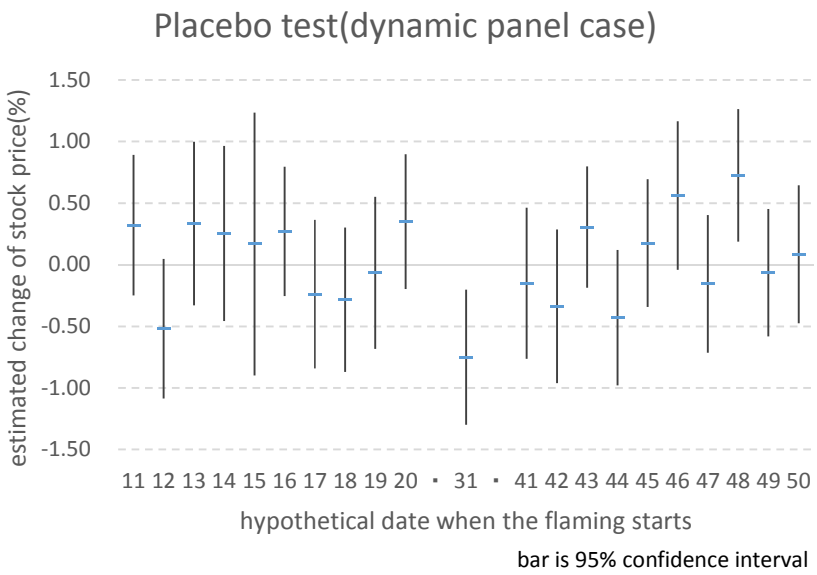
*** p<0.01, ** p<0.05, * p<0.1

To check the robustness, we carried out a placebo test. The same difference-in-difference models were applied for the limited data of 20 days without including the 31st day, assuming that the flaming occurred hypothetically in the middle of the limited data (10th day). The estimated coefficients of cross term D_tT_i are shown in Figure 1. The horizontal line is the day when the hypothetical flaming started in the placebo regressions, and the vertical line is the coefficient of D_tT_i, that is, the percentage decrease of the stock price, with vertical bars representing 95% confidence

intervals. As Figure 1 shows, in both the static panel and the dynamic panel, there is no significant decrease in the stock price in the placebo regressions. A significant decrease in the stock price is observed only when the flaming is assumed to start on the 31st day, the actual day the flaming really started. This placebo test indicates that our result of difference-in-difference analysis is robust regarding the selection of timing.

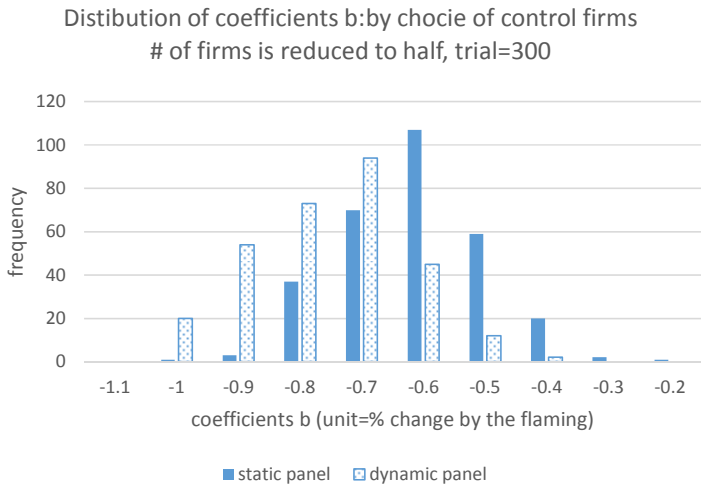
Figure 1 Placebo Test





As another robustness test, we changed the control firms randomly. We randomly reduced the control firms to a half and estimated the regression 300 times.[11] Figure 2 shows the distribution of 300 estimated coefficients. In both the static panel and the dynamic panel, all coefficients are negative, and 94% and 99% coefficients are significant at the 10% level in the static panels and dynamic panels, respectively. Therefore, the result of the negative effect of the flaming on the stock price does not depend on the choice of the control firms.

Figure 2



Stock price could decrease based on a newspaper report on the issue in question, not

[11] We can show a similar graph when we change the reduction ratio from a half to 30%.

by flaming on the internet. There are newspaper reports regarding 28 cases of our 77 samples. Therefore, the estimated decline of the stock price in Table 2 may be caused not by flaming on the internet but by a usual newspaper report.

To distinguish the effect of flaming from that of newspapers, we exploited the lag of the newspaper reports. Newspaper reports usually lag behind flaming on the internet. Figure 3 shows the distribution of the lags of the report on the Nikkei newspaper from the day when the flaming started on the internet.[12] Only in one case did the newspaper precede the flaming on the internet in our sample. In six cases, they started simultaneously, and in the remaining 21 cases, the flaming on the internet started before the newspaper report. Thus, by adding newspaper report dummy DN_t to the difference-in-difference regression, we can distinguish the effect of flaming on the internet from the newspaper effect. DN_t is equal to one after the newspaper reported the issue of the flaming.

Table 3 shows the result. In both the static panel and the dynamic panel, coefficients of the cross term of newspaper DN_t*T_i are negative but not significant, suggesting that the newspaper report may reduce the stock price to some extent but not in a certain-enough way to make it significant. On the other hand, the coefficients of cross term D_tT_i are significantly negative even if the newspaper variable is included in the regression. This result indicates that the flaming of the internet reduces the stock price even if there is no newspaper report. Note that the coefficients of -0.619 and -0.753 in Table 3 are very close to the main result of Table 2, -0.653 and -0.756, respectively. This means that flaming on the internet already reduces the stock price at almost a maximum degree before the newspaper report, suggesting that the effect of the newspaper is very limited.

Figure 3

[12] Nikkei is the largest Japanese newspaper regarding the economy and business, which most investors read. It is the Japanese version of the *Wall Street Journal* or *Financial Times*.

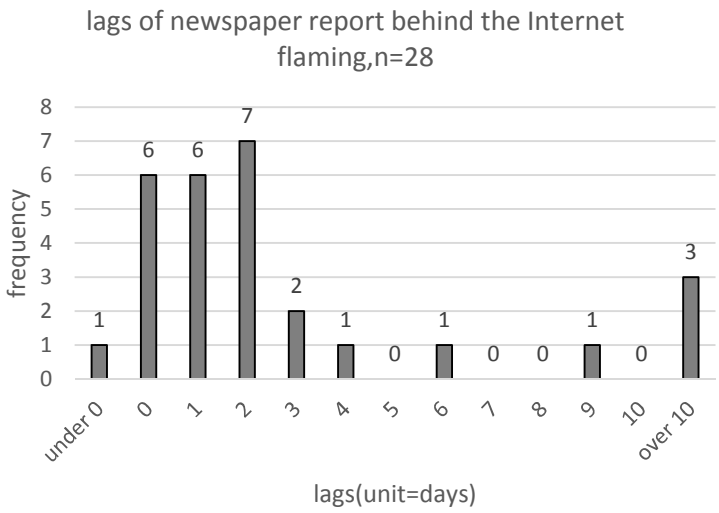


Table 3 Effect of Newspaper Report

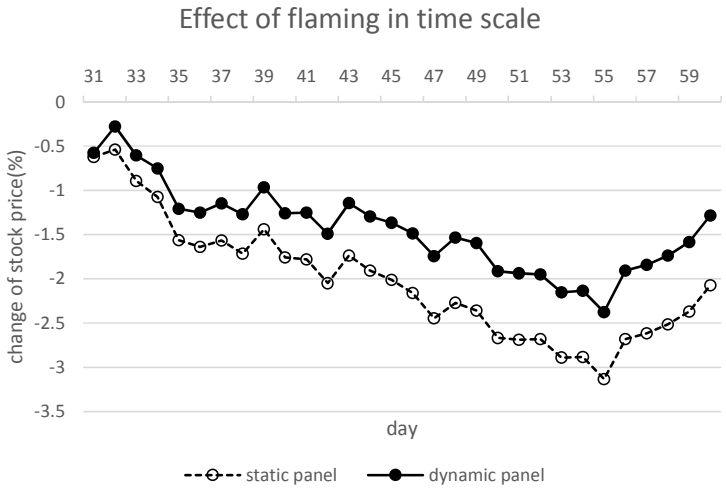
VARIABLES	Static panel ΔS_{it}	Dynamic panel ΔS_{it}
$\Delta S_{i,t-1}$		0.0177
		(0.0148)
$\Delta(D_t*T_i)$	-0.619**	-0.753***
	(0.275)	(0.271)
ΔD_t	0.200*	0.373***
	(0.118)	(0.125)
$\Delta(DN_t*T_i)$	-0.819	-0.532
	(0.553)	(0.776)
ΔDN_t	-0.154	-0.440
	(0.238)	(0.294)
Constant	0.0367***	0.0333***
	(0.0141)	(0.0129)
Observations	23,820	23,767
Number of id	420	420

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

How long does the effect of the flaming continue? Is duration time just temporal, like a few days or one week? To answer this question, we replaced dummy D_t of the cross term with impulse dummies D_{st}, which is equal to 1 if s=t, and zero otherwise. Then, coefficients b_s of the cross term, $\sum_{s=31}^{60} b_s \Delta(D_{st} T_i)$, represent the time distribution of the effect of the flaming, which is shown in Figure 4. The horizontal line is the day, and the vertical line is the change of the stock price. The stock price keeps decreasing until 55th day; thus, we can say that the flaming maintains its effect for at least three weeks (55-30=25). In other words, the duration time of the effect of the flaming is not a daily term but a weekly term. This result is consistent with Adachi and Takeda's (2016) reporting the effect of flaming 10 or 20 days later. The duration time of flaming's effect on the stock price is shorter than a month in a large recall case of the automobile industry, such as those of Firestone Tires and the Ford Explorer (Govindaraj, Jaggi,and Lin(2004)), but it is shorter than a day on average in airplane accident cases (Kaplanskia and Levyb (2010).

Figure 4



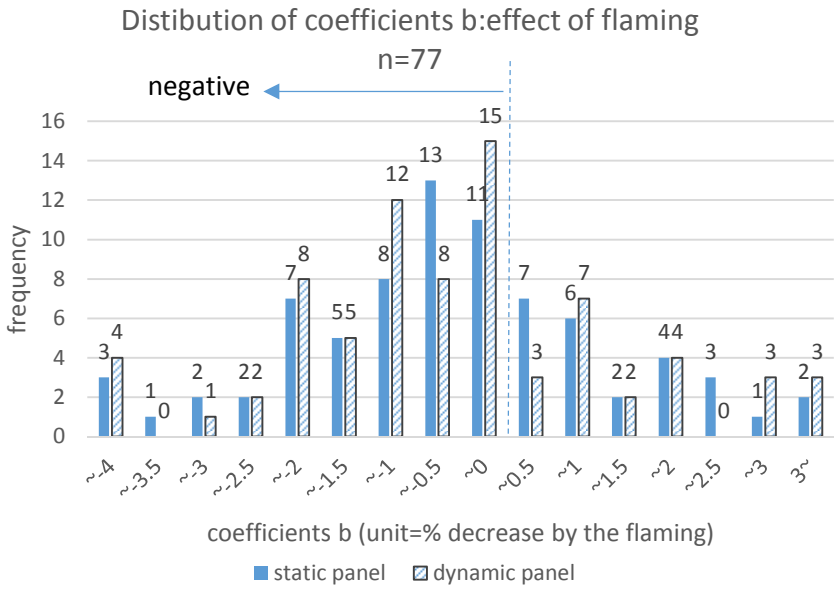
IV Heterogeneity

In the previous section, we combined all flaming cases into one set of panel data and applied single regression to all data. Another application of the difference-in-difference method is to apply the regression to each flaming case, respectively, that is, to regress using one flaming firm and five other control firms. This separate regression produced 77 results and coefficients showing the heterogeneity of the

flaming. In this section, we will see the heterogeneity of the flaming from various viewpoints.

The coefficients of 77 regressions are distributed as shown in Figure 5. This graph shows that two-thirds of coefficients are negative. The stock price decreased in 55 of the 77 flaming cases in the dynamic panel and in 52 of the 77 cases in the static panel, indicating that the decline of the stock price by flaming is a dominant phenomenon. Therefore, the conclusion of the previous section is confirmed in the separate regression. This graph also shows that the negative effect of the flaming is not caused by extreme exceptional cases; rather, it represents the overall tendency. At the same time, we should note that one-third of coefficients are positive. We need an explanation for this heterogeneity.

Figure 5



The most probable source of the heterogeneity is the difference of the degree of the flaming. In the flaming, many offensive comments were made against the targeted firm, but the number of comments against the firm varied greatly depending on the issue in

question. Actually, the view count of the flaming of the summary website ranged from several thousand to nearly a million as shown in Table 1. In other event studies, the seriousness of the event is an important factor determining the effect on the stock price, such as an airplane crash case where the stock price decreases more as the number of casualties increases (Borenstein and Zimmerman (1988), Walker, Thiengtham, and Lin (2005), Capelle-Blancarda and Lagunab (2010)). Therefore, it is a natural hypothesis that the effect of flaming on the stock price increases as the degree of the flaming becomes large.

We used the view count of the summary website as a proxy of the degree of the flaming. In this situation, V_i is denoted as the view count of the summary website of the flaming i (unit=10 thousand), and the cross term of V_i with D*T is added to the right side of the regression to measure the effect of the view count. To capture the nonlinear effect of the view count, at most, four degree polynomials of V are introduced, such as (D*T)*V, (D*T)*V^2, … and so on.

Table 4 shows the result the of static panel case. Models (1)~(4) correspond to the first- to the fourth-degree polynomial cases. Of these four cases, all coefficients are significant in the third-degree polynomials in Model (3). The dynamic panel also fits best with the data in the case of the third-degree polynomials. Therefore, in Figure 6, we draw a graph showing how the effect on the stock price changes as the view count increases using the coefficients of the third-degree polynomials. In other words, Figure 6 shows the function of $1.116+0.152V-0.00523V^2+3.64*10^{-5}V^3$.

Table 4 Effect of Flaming by View Count: Static Panel Model

VARIABLES	(1) ΔS_t	(2) ΔS_t	(3) ΔS_t	(4) ΔS_t
$\Delta(D_t*T_i)$	-0.673**	-0.536	-1.116***	-0.765
	(0.310)	(0.353)	(0.406)	(0.490)
$\Delta(D_t*T_i*V_i)$	0.00152	-0.0225	0.152**	-0.000124
	(0.0112)	(0.0315)	(0.0687)	(0.137)
$\Delta(D_t*T_i*V_i^2)$		0.000265	-0.00523***	0.00394
		(0.000325)	(0.00195)	(0.00741)
$\Delta(D_t*T_i*V_i^3)$			3.64e-05***	-0.000122
			(1.27e-05)	(0.000124)
$\Delta(D_t*T_i*V_i^4)$				7.94e-07
				(6.19e-07)
ΔD_t	0.193*	0.193*	0.193*	0.193*
	(0.117)	(0.117)	(0.117)	(0.117)
Constant	0.0357**	0.0357**	0.0357**	0.0357**
	(0.0141)	(0.0141)	(0.0141)	(0.0141)
Observations	23,820	23,820	23,820	23,820
Number of id	420	420	420	420

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 6

As easily seen, the effect of the flaming depends on the view count clearly in a nonlinear fashion. The effect of the flaming is almost zero under 200 thousand views, and it begins to decrease at more than 200 thousand views, finally reaching the bottom at minus 4~5% at 800 thousand views. Thus, flaming reduces the stock price only when the degree of the flaming becomes large enough to reach the certain threshold level. In terms of this summary website, the threshold is 200 thousand views. The number of the flaming incidences whose view count is over 200 thousand is 15 in our sample, which is 19% of the total number of samples. Therefore, we should say that flaming that "successfully" reduces the stock price is limited.[13] The number of flaming incidences that reduces the stock price is approximately four cases a year because there are 15 harmful flaming incidences in the four years of 2012-2015.

This graph also indicates that the decline of the stock price could reach at maximum about 4~5% when the view count reaches more than 800 thousand. A decline of 0.7% in Table 2 is an average figure. In case of the large flaming incident, we should expect the harm to the stock price to be a 5% decline at maximum.

Because the dependency on the view count is clear and large, hereafter, we will see the heterogeneity of the effect of the flaming as a shift of the curve of this Figure 6 to control for the difference of the degree of the flaming. Also, because the results of the static panel and the dynamic panel are almost the same, in the following figures, we will show only the static panel case to save space.

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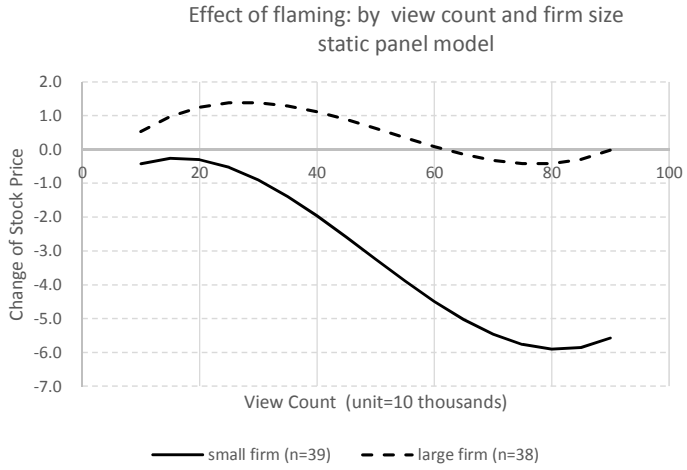
[13] This is the reason why Adachi and Takeda (2016) did not find a significant correlation between stock price and the flaming originating on the internet ("before the newspaper," in their words), whereas this paper did. They used data from internet security company, Eltes coop, which defined flaming as an increase of offensive comments that is three times more than usual. This definition includes a very small flaming incident whose view count would be less than 10 thousand or even that which has no summary site.

First, we will see the effect of firm size. Which firms suffer more from flaming, large firms or small firms? Large firms may be vulnerable to flaming because they are well known and thus have to care about their reputations more than small firms do.[14] On the contrary, large firms may be resistant against flaming because they produce lots of goods and services, and flaming usually attacks only one of the many products of large firms. To see which hypothesis is valid, we divided the sample firms into two groups at the median of the sales level and applied the same regression of Figure 6.

The result is shown in Figure 7. The dashed line is for large firms, and the solid line is for small firms. Clearly, the curve for large firms is almost flat; thus, they do not suffer from flaming. On the other hand, the curve for small firms decreases to minus 6%, indicating they experience more damage than average. Therefore, the latter hypothesis is supported. Because small firms produce fewer kinds of products than large firms do, damage to their stock prices becomes greater when flaming attacks their products.

Figure 7



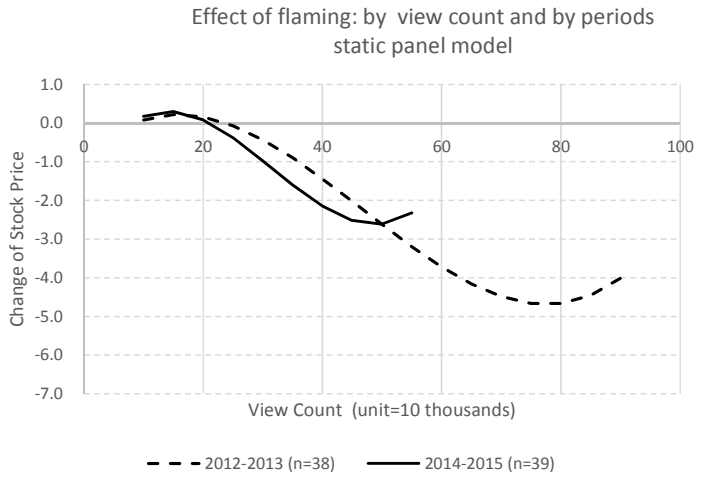
Second, we will see the chronological change of the effect of flaming. The degree of the flaming of a similar event could become smaller because people become accustomed to the event. For example, an employee's prank, such as a photo in the refrigerator box, has happened many times. Thus, now people do not take it seriously, and this type of flaming is becoming less common. On top of this, firms have deployed

[14] Tanimura and Okamoto (2013), based on the event study on stock price, reported that Japanese firms pay more attention to reputation than do United States firms.

countermeasures against flaming, such as SNS guidelines for employees and contracts with internet security companies managing flaming. In the literature, Scholtens and Boersen (2011) reported that 209 major energy accidents during 1907-2007 did not decrease the stock price because this type of accident is so common in the energy industry that the financial market sees it as being a "part of the game." As a result of all of these arguments, the effect of the flaming may have decreased recently. To see this, we divided the sample firms by periods, first half and second half, that is, the years of 2012-2013 and 2014-2015.

The result is shown in Figure 8. The dashed line is for the first half, and the solid line is for the second half. The solid line ends at around 500 thousand view counts because there is no flaming case over 500 thousand views for the second half (note that a nonlinear fitting is valid only within the range of the data). Two curves overlap until 500 thousand views, which means the structure of the flaming, that is, the relation between the flaming and the stock price, does not change. The change happened not to the structure but to the degree of the actual flaming. The degree of the flaming is reduced to almost half in the second period, suggesting that people may become accustomed to some flamed events or that firms may successfully decrease the degree of the flaming. However, once the flaming becomes large, it still has the same influence on the stock price as before because the structure does not change.

Figure 8



Last, we will examine the effect of flaming on economic welfare. Although flaming is costly to firms, it is just another problem, whether it is good or bad from the viewpoint of the economic welfare of society. Is flaming welfare enhancing or welfare

deteriorating?

Flaming would increase economic welfare if it motivated firms to improve the quality of their products and services. Flaming gives consumers the power to address products' or services' problems with the general public, which firms would not deal with if there was no internet. For example, the noodle maker with a contaminating cockroach renewed its equipment to prevent bugs from intruding into the product line. If firms become more eager to improve their products and services as a result of flaming, it can be welfare enhancing. To put this another way, in this case, flaming is a kind of *discipline* for firms.

On the other hand, flaming could decrease economic welfare if it leads to extra costs without improving the quality of products and services. For example, because an employee's personal misconduct does not change the quality of a product and service substantially, it is an unnecessary cost to shut down the store and require extra corporate training for all of the other honest employees. Or it might discourage the creative minds of commercial creators to pay great attention to the claims of people with extremely one-sided views. If flaming does not improve the quality of goods and services, it is just an extra cost to the economy.

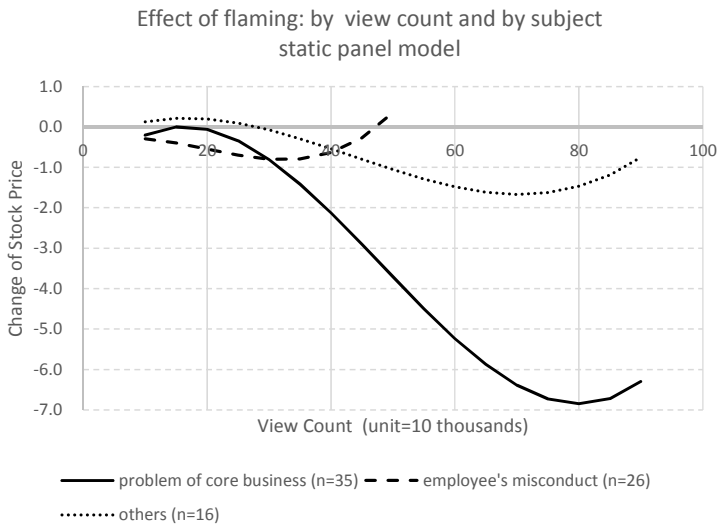
Is flaming a discipline for firms or just an extra cost? This is a difficult question that we cannot answer without much information about the consequences of the flaming. Instead, we will show suggestive conjecture using our data. Let us classify the flaming cases into three categories according to whether they have a relation to the quality of a product or service. The first category is flaming about a quality problem involving a core product or service, such as a food company's cup of noodles. Other examples include the security problem of the communication application software of an entertainment and communication company, or a chief executive officer's (CEO's) rude speech and behavior toward customers regarding a firm's core service. Second is the flaming caused by an employee's personal behavior, such as a prank photo in a retail shop that has little relation to the quality of a product or service. Third is other miscellaneous flaming, such as trouble with service involving a temporary advertising event, or a quality problem involving a non-core product or service, etc. As shown in Table 1, the ratios of these three categories are 45%, 34%, and 21%, respectively.

If their stock prices decline in the first category, firms have to improve the quality of their products to avoid flaming and to maintain their stock prices because the flamers criticize the quality of the firms' products, thus resulting in welfare enhancement. If the stock price declines in the latter two categories, firms have to make questionable efforts to avoid flaming, such as introducing a restrictive rule on an

employee's SNS usage or restricting creative or innovative activities. It is dubious whether these reactions improve the quality of a product. Therefore, we can obtain a suggestion about the welfare effect of flaming by estimating the effect by these three categories.

The result is shown in Figure 9. The solid line is for the first category, that is, the flaming about the core product or service. Clearly, the stock price decreases as the flaming becomes great. The dashed line and dotted line are for cases of employees' misconduct and others, showing almost no decline in the stock price. Therefore, if firms want to protect their stock prices amid the risk of flaming, they will try to improve the quality of their products and services, not try questionable efforts, such as restricting employees' behaviors. This result suggests that flaming might be welfare enhancing.

Figure 9



From another viewpoint, this result indicates that investors react rationally to flaming, as this result means that investors sell the firm's stock only when flaming attacks the quality of the firm's core products and services, which are a source of their revenue. If flaming does not have any relation with the firm's core business, investors will keep their stock in their hands. In other words, investors care about flaming when it has a direct link to the decrease of the firm's revenue, whereas they do not care about flaming whose link to revenue is questionable.

V. Conclusion

This paper examined the effect of flaming on the stock price. The findings are summarized as follows. We found that flaming reduces the stock price by 0.7%, which is almost equivalent to the effect of disasters such as airplane accidents or chemical explosions. The effect on the stock price depends on the degree of the flaming nonlinearly, indicating that there is a threshold level beyond which the decline of the stock price starts. Most of the flaming does not affect the stock price because the degree of the flaming is small. At the maximum degree of the flaming, the stock price decline reaches 5%. A small firm is more vulnerable to flaming than large firms are probably because the number of products of small firms is limited. As a conjecture, flaming might be welfare enhancing because a stock price decline occurs only when flaming attacks a problem with the quality of a core product or service, thus motivating firms to make an effort to improve the quality of their products and services.

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