The Role of Social Media in the Capital Market: Evidence from Consumer Product Recalls*

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May 2014

Abstract

We study the use of social media within the context of consumer product recalls to explore how social media affects the capital market consequences of firms' disclosures. Specifically, we examine how the short-window price reaction around recall announcements varies with the corporate use of social media. We identify and examine the effects of two distinguishing features of corporate social media platforms: The one-to-many *megaphone* feature, which accelerates the process of getting firms' intended messages out to a broad base of stakeholders and the multi-way *engagement* feature which facilitates a dialogue between firms and their online followers. We find that the megaphone feature of social media attenuates the negative capital market consequences of recall announcements, presumably because it facilitates getting the potentially hazardous products out of the hands of more consumers more quickly, thereby minimizing the associated legal liability and reducing the reputation damage. Interestingly, however, the multi-way *engagement* feature of the more interactive social media platforms, such as Facebook and Twitter, exacerbates the negative market reaction to recalls, presumably because the engagement feature facilitates viral distribution of negative sentiment. In addition to broadly comparing the capital market effects associated with these two different features of social media, we also perform a detailed analysis of Twitter activity, where we predict and find that the degree of control a firm has over the content appearing on its interactive social media platforms affects the market reaction to its product recall. The negative price reaction is attenuated by the frequency of tweets by the firm, while it is exacerbated by the frequency of tweets by other users.

*We are grateful to Phil Berger (the editor) and an anonymous referee for their helpful comments and suggestions. We thank workshop participants at Boston College, Boston University, Stanford University, University of Illinois-Chicago accounting research conference, and Beth Blankespoor, Jerry Kane, Paul Ma, Sam Ramsbotham and Sugata Roychowdhury for useful comments and suggestions. The paper has benefitted from insights from the 2013 CARE conference on *Impact of Emerging Information Technology on Capital Markets*. We also thank Andrew Bronzo, John DeLorenzo, Mollie Dillon, Daniel Kim, Sungwon Kim, Xiaohui Luo, and Jiada Tu, for their excellent research assistance.

1. Introduction

In the past decade, information technology has changed the disclosure landscape and the way firms communicate important information to stakeholders. Both regulators and companies are starting to embrace social media as a viable channel to disclose important information. In April 2013, the SEC announced that companies can use social media outlets to announce key information in compliance with Regulation Fair Disclosure so long as investors have been made aware of which social media will be used to disseminate such information.[1] Netflix filed an 8-K report soon after stating that it may use social media to disclose material information. Netflix specifically listed Twitter, the Netflix Facebook pages, as well as its own corporate blogs as possible outlets for disclosure (Bensinger 2013). Despite the increasing attention from regulators and companies, we know relatively little about how companies use social media to disseminate material information, especially nonfinancial information. In addition, there is little evidence on the consequences of corporate use of social media and even less on the differential impact of the various social media outlets.[2] In this study, we attempt to shed light on these issues.

The use of social media allows a firm to reach a large number of stakeholders on a timely basis with its intended message. To illustrate, users following a firm on its social media account(s) get instant notifications of the firm's news, and then users can share the news instantly or re-tweet the conversation to other interested parties. The ease of receiving and passing on information on social media amplifies the firm's reach to a wider network of people. Given the noted biases in press coverage (Miller 2006), social media provides overlooked firms a channel for direct, one-to-many communication that bypasses traditional third party information intermediaries (Blankespoor, Miller and White 2014). In addition to this megaphone feature of

[1] See http://www.sec.gov/News/PressRelease/Detail/PressRelease/1365171513574 .
[2] A noteworthy exception is Blankespoor, Miller and White (2014), who document that tech firms using Twitter to disseminate their earnings release experience lower information asymmetry.

social media, some social media outlets provide a platform for multi-directional *engagement*. For example, Facebook and Twitter allow users to have a "conversation" with the firm and with other users. The multi-way communication channel of these social media platforms stands in contrast to more traditional corporate disclosures, which typically are one-way communication.[3]

Interestingly, sophisticated investors have caught on to the wealth of information that social media provides, with social media content frequently updated and the actions of the firm as well as the reactions of the user community readily observable. Indeed, anecdotal evidence suggests that hedge funds recognize that tracking, aggregating and analyzing social media content can provide them with first-hand information about investor and consumer sentiment. Thus, hedge funds are beginning to dissect social media data in minute ways to gauge the public's view of corporate events in hopes of gaining insights regarding future firm performance.[4]

With an interest in exploring the power of social media in the context of corporate disclosure, we focus on product recalls under the 1972 Consumer Product Safety Act (CPSA).[5] A product recall constitutes a "crisis" in the recall firm's product market. While assessing quality concerns and the broader implications of a product recall, demand for information from consumers and investors likely increases. We expect social media to be a particularly effective channel of disclosure in this setting because of two distinguishing features of social media: *megaphone* (i.e., the ability to reach a large number of users quickly with the firm's intended

[3] Although there are several forums that enable multi-way communication between the firm and investors/financial intermediaries such as conference calls and investor/analyst conferences, these forums are different from social media platforms because (i) they are more formal and focused on financial results; (ii) they target investors and (iii) they occur on predetermined dates.

[4] Several social media aggregator services, such as Gnip, are providing hedge funds with real time data feed (from Twitter) to capture breaking news and the public's reaction to the news, which these funds are reportedly using to influence trading decisions (see Or 2011 and Conway 2012).

[5] The CPSA defined "consumer products" broadly, but excludes products regulated by other federal agencies. E.g., automobiles and related equipment (NHTSA), food, drugs, medical devices, cosmetics (FDA), firearms (ATF), airplanes (FAA), boats (Coast Guard) and pesticides (EPA).

message), and *engagement* (i.e., the ability to monitor and converse directly with users). Effective use of these features potentially changes the nature and the total costs, including product liability and reputation damage, associated with the recall.

Using a sample of 177 product recalls from 2008-2012, we examine whether and how corporate use of social media affects the total costs of recalls, as measured by the market reaction to the announcement of the recalls. We focus on the market reaction because it is an overall measure that captures both the direct and indirect costs of a recall (Jarrell and Peltzman 1985, Barber and Darrough 1996). Not surprising, prior research documents a significant, negative stock market reaction to consumer product recalls (e.g. Chen, Ganesan and Liu 2009). We hypothesize that corporate use of social media alters the total costs of a recall and thus the market reaction to the recall announcements through the two distinct features of social media, megaphone and engagement.

All four social media outlets we examine (corporate blogs, RSS feeds, Facebook and Twitter) have the megaphone feature, with the ability to spread the firm's intended message to a broad base of stakeholders quickly (Gallaugher and Ransbotham 2010). This feature can attenuate the negative market reaction to product recalls for two reasons.[6] First, with the megaphone feature firms get the potentially hazardous products out of the hands of more consumers more quickly, thereby minimizing the probability of an incident and the associated legal liability.[7] Second, with their intended messages sent directly to their online following, firms effectively augment the disclosure content provided in the standard CPSC recall announcements

[6]Another distinguishing feature of social media is the speed with which the information is disseminated. Our setting does not lend itself to examining the impact of speed per se. To examine the effect of speed, for example, we would need to hold the underlying information constant, as in Rogers, Skinner and Zachman (2013). This is impossible in our setting, as the use of social media most likely alters the total overall costs of a product recall.

[7] In fact, the *Consumer Product Safety Improvement Act* of 2008 holds firms liable not only for the problems that lead to the recall, but for the effectiveness of the recall itself. Thus, during our sample period 2008-2012, firms have strong incentives to adopt 'best practices' for their recall procedures to minimize the potential legal liabilities.

with additional clarifications, reassurances, and planned course of actions. This helps alleviate concerns about the firm's overall product quality and manage potential damage to the firm's reputation. It is also possible, however, that spreading the bad news to a wide network of users is to the recall firm's detriment: more consumers learn about the problems with the firm's product(s), leading to greater reputation damage and greater loss of future sales.

In addition to the megaphone feature, Facebook and Twitter also have an engagement feature that facilitates dialogue between the firm and its users as well as dialogue among users.[8] It is hard to predict *ex ante* how the engagement feature of these more interactive social media platforms affects the negative market reaction to product recalls. On the one hand, the open and interactive forum could attenuate the negative consequences if firms are able to use these platforms to monitor the concerns of their customers and respond to these concerns more effectively. In this case, higher quality customer care achieved with the engagement feature of social media is likely to minimize the damage to the firm's reputation and brand equity. On the other hand, the engagement feature could exacerbate the situation because the firms' interactive social media platforms can become *magnets* for inbound dialogue (i.e., customer feedback), giving disgruntled customers a platform upon which to share their negative views not only with the firm but with other customers and stakeholders. If these negative views gain traction with the company's online following, its interactive social media accounts can facilitate a "viral distribution" of negative sentiment. This can exacerbate the negative perceptions of the firm and its products among customers and investors.

To explore these issues we conduct two primary analyses. In the first, we examine the four-day market reaction to recall announcements and make two distinct comparisons designed

[8] While one can argue that corporate blogs also permits engagement to some extent (as users can leave comments), there is little doubt that Facebook and Twitter are much more engaging and interactive because of their built-in network effects – new postings are automatically forwarded in real time to "friends" and "followers".

to separately estimate the net effect of the megaphone and engagement features of social media. In the first comparison, we examine whether the negative price reaction to a recall is attenuated for firms with any of the four social media accounts (corporate blogs, RSS feeds, Facebook and Twitter), compared to firms without corporate social media accounts at the time of their recalls. Since all four social media platforms possess the megaphone feature, this comparison speaks to whether the megaphone feature in general mitigates the negative market reaction to recalls. The second comparison is made among the firms with corporate social media accounts, and estimates the incremental price reaction to recall announcements by firms with either Facebook or Twitter accounts. Since these two platforms support the engagement feature, this comparison speaks to whether the engagement feature attenuates or exacerbates the negative reaction to recalls.

Consistent with prior literature, we find that the negative market reaction to product recalls is larger for firms with larger recalls. However, the negative reaction is attenuated for firms with megaphone social media. In contrast, we find that the engagement feature of social media exacerbates the negative price reaction. We conjecture that this is so because the engagement feature of Facebook and Twitter invites conversations that could spiral into a "viral distribution of negative sentiment" following product recall announcements.

Comparing the different social media platforms enables us to draw broad inferences regarding the effects of the megaphone and engagement features of corporate social media. However, data limitations prevent us from exploring the actual activity level on corporate blogs, RSS feeds and Facebook. Without activity level data for these three platforms, we are prevented from examining how firm *control* over the flow of information on these platforms contributes to their effects. Fortunately, we are able to get data on tweeting activity. Specifically, we are able to

identify all Twitter activity that involves a recalling firm's username (or Twitter handle, e.g., @SummerInfant).

Thus, in our second primary analysis we examine how the price reaction to product recalls varies with the abnormal levels of firm versus non-firm tweets around the recall announcements. This analysis allows us to confirm our earlier interpretations of the larger negative price reaction to recalls by firms with Twitter and Facebook accounts, and to directly test our hypothesis that the net effects of the engagement feature of social media vary with the level of control a firm has over the flow of information appearing on its interactive platforms. If a firm uses the interactive platform to gain insight into stakeholders' concerns and provide clarifications and reassurances in a timely fashion, the monitor and reputational benefits associated with being responsive will dominate. In contrast, if the firm loses control of the conversation on its interactive platform to others, the negative herding among users will dominate. The findings are consistent with our predictions. Specifically, we demonstrate that the negative relation between abnormal returns and recall scale is attenuated with increased frequency of tweets by the firm and exacerbated by increased frequency of tweets by others.

One concern with our research design is a potential self-selection/endogeneity problem. In our first set of analysis, it is possible that the decision to initiate a corporate social media account is made in anticipation of a product recall, especially if it is expected to be a particularly challenging recall. We argue that this particular form of endogeneity is unlikely, because within our sample corporate social media accounts exist on average for 561 days prior to the recall announcements. Furthermore, setting up a social media account in anticipation of a product recall is unlikely to be effective because it takes time for a firm to develop an online following.[9]

[9] For example, customers and investors have to subscribe to the firm's RSS feed, follow the firm on Twitter or 'become a friend' of the firm on Facebook.

In our second analysis that analyzes Twitter data, the activities on the company's Twitter account could be driven by the "seriousness" of a recall that is beyond the recall characteristics observable to us at the time of the recall. In this case, it is the seriousness of the recall, as opposed to the amount of tweeting activity associated with the company's Twitter handle, that drives the market reaction. We address this potential endogeneity problem using a two stage model and find consistent results. These results are discussed below in detail in section 6.2.

Our work contributes to new research that examines the capital market consequences of using social media to disseminate corporate news (see Blankespoor et al. 2014).[10] We examine corporate use of social media to manage the dissemination of a negative corporate event, product recalls. We show that by reaching a large network of stakeholders with the firm's intended message, corporate use of social media mitigates the negative price reaction to the product recall because it likely lowers the overall costs of the recall. In addition, we demonstrate that the effect is more nuanced when the social media platform is interactive as the multi-way engagement feature can become a magnet for negative sentiment. To the best of our knowledge, this study is the first to document the differential capital market impact based on the megaphone and engagement features of social media platforms. These findings provide insights to managers and regulators on the use of social media in disclosing information to stakeholders.

Our study also contributes to the literature on the role of nonfinancial information in firm valuation. Previous studies have documented the importance of nonfinancial information such as market penetration, air pollution index and customer satisfaction scores in firm valuation (Amir and Lev 1996, Hughes 2000 and Ittner and Larcker 1998). Our paper highlights another source

[10] Blankespoor et al. (2014) document that using Twitter to disseminate earnings releases lowers information asymmetry, but they do not examine whether the use of Twitter affects the stock price reaction to the earnings news, because they do not expect it to affect how the information is perceived or interpreted by investors. In contrast, in our setting we expect corporate use of social media to have value implications because it has the potential to change the overall costs of the product recall.

of nonfinancial information that could be useful to investors, i.e., the wealth of information available in the social media space.[11]

The next section provides the needed background for our study and develops the hypotheses. Section 3 describes the sample and data. Section 4 presents the research design and results for the first analysis, which documents the net benefits of the megaphone and engagement features of corporate social media. Section 5 presents the research design and results for the second analysis, which uses detailed data on Twitter activity (tweets) to test whether the net benefits of the engagement feature of social media vary with the level of control a firm has over the flow of information. Section 6 provides additional tests, and section 7 concludes.

2. Background and Hypotheses Development

2.1 Social Media

Social media refers to web-based technologies that enable interactions among people to create, share and exchange information in virtual communities and networks. Social media are distinct from traditional media (i.e., newspapers, television and radio) as they are comparatively inexpensive and accessible enabling anyone to access and publish information. Importantly for corporate disclosure, many social media platforms provide an open arena where people are free to exchange ideas on companies, brands and products. They also provide an environment where firms can converse with stakeholders (including investors and customers) to promote their brand and improve their image.

Gallaugher and Ransbotham (2010) provide a useful framework and typology for thinking about the effects of corporate social media. Specifically, they refer to firm-initiated disclosures on social media as the *megaphone* because social media "operates like a giant word-

[11] Known as "social finance," hedge-funds are building models to track and trade on sentiment and trends dissected from social media data, e.g., Tweets. See Conway (2012).

of-mouth machine, catalyzing and accelerating the so-called viral distribution of information." This megaphone effect of corporate social media facilitates firm-directed, one-to-many communications that bypass the traditional media and permit the firm to broadcast its intended message. All four social media outlets examined in this study, corporate blogs, RSS feeds, Facebook and Twitter, have this megaphone feature**.**

In addition to this broadcasting feature, some corporate social media platforms facilitate direct *engagement* between the firms and its stakeholders. For instance, Facebook and Twitter facilitate multi-way (firm-to-user as well as user-to-user) dialogue and exchange of ideas and information. Gallaugher and Ransbotham (2010) point out that the engagement feature of these social media platforms facilitates and attracts inbound dialogue. On the one hand, the inbound feedback can help the firm *monitor* the concerns of its stakeholders and respond accordingly. On the other hand, such platforms can become a *magnet* for negativity as disgruntled customers are drawn to the site to voice their negative opinions. While the engagement feature of Facebook and Twitter permits firm intervention in the ongoing dialogues among users, it also comes at a cost as the firm loses complete control over the content appearing on its online sites.

Practitioners appear to recognize the pros and cons of the engagement feature of social media within the context of a product recall:

> *Thanks to the advent of social media, companies and consumers now have a direct line to each other to exchange information and voice opinions, whether positive or negative. While social media can be a great tool to manage a company's reputation and directly communicate with customers, it can also be a disaster waiting to happen when a recall notice is posted.*
>
> *But that doesn't have to be the case; companies are now using the power of social media to work in their favor during the recall process. Social media is a great tool to help reinforce regulatory compliance procedures during a recall, notify affected parties, control the conversation around the product and even boost public perception of a brand.*

Practitioners and researchers seem to agree that the key to crisis management and communication is to control the flow of information (Wigley and Zhang 2011, Gonzalez-Harrero and Smith 2008). However, the rise of internet-based technologies and social media networks has made it much more difficult to maintain control of the flow of information. Individuals are able to receive and transmit information, and share their views "at the touch of a button" making it more critical than ever for firms to control the flow of information during a crisis (Gonzalez-Harrero and Smith 2008). Gonzalez-Harrero and Smith also points out that since audiences can always find or create an online site where they can speak out, companies may wish to host an audience comment site.[13] Doing so gives the company the opportunity to identify, monitor, and influence the course of potentially conflictive issues as they arise.

2.2 Consumer Product Recalls

Consumer product recalls occur when a firm's consumer product (including toys, electronics, and household products) fails to meet a mandatory safety standard under the Consumer Product Safety Act 1972 (CPSA), contains a defect that could cause substantial harm to consumers, creates an unreasonable risk of serious injury or death, or fails to comply with certain voluntary standards adopted by its industry (Mullan 2004). The recall process begins when a consumer reports an incident to either the manufacturer or the Consumer Product Safety Commission (CPSC) or when the manufacturer itself reports a potential product hazard to the

[12] Stericycle, p 2. http://info.stericycleexpertsolutions.com/social-media-recall/
[13] Gonzalez-Harrero and Smith (2008) give the example of Dunkin' Donuts who sued and then bought from a dissatisfied customer the blogsite: http://www.dunkindonuts.org, only to have the same dissatisfied customer register a new site: http://www.dunkindonutssucks.com shortly afterwards.

CPSC.[14] The staff of the CPSC then conducts a 'risk analysis' to assess whether a recall is needed. Or if the firm chooses the "fast track" for rapid implementation, the staff's risk analysis is bypassed and the firm must initiate the recall within 20 days.

While the Commission has the power to mandate a product recall, "virtually all consumer product recalls and corrective actions in the U.S. are voluntary" with the majority of firms requesting the "fast track" for their product recalls (see Mullan 2004). Once a firm agrees to a product recall, it must file a *Correction Action Plan* detailing the remedy. When the plan is accepted by the CPSC, the CPSC and the firm jointly issue an official recall announcement in a standard format.

The CPSC's stated objectives of a recall are to locate and remove all defective products as quickly as possible from the distribution chain and from the possession of consumers, and to communicate accurate and understandable information in a timely manner to the public about the product defect, the hazard, and the corrective action. Companies are supposed to design all informational material to motivate retailers and media to get the word out and consumers to act on the recall.[15] To achieve these objectives, the Commission sends the joint news releases to major media outlets such as wire services, major newspapers, and television and radio networks. Given that the Commission explicitly discourages unilateral releases by companies (Ibid, p. 20), the joint press release issued by the CSPC and the recall firm is typically the first public announcement of the recall.[16]

[14] Section 15 of the CPSA requires firms to report immediately (within 24 hours) to the CPSC whenever a product "could" constitute a "substantial product hazard."
[15] See the CPSC Recall Handbook 2012, p.18.
[16] In February 2013 the Commission announced its intentions to standardize the use of several forms of social media when issuing its official recall announcements. http://www.cpsc.gov/en/Business--Manufacturing/Recall-Guidance/Social-Media-Guide-for-Recalling-Companies/ .

The Consumer Product Safety Improvement Act (CPSIA) enacted in 2008 not only holds companies liable for the problems that lead to a recall but also for the effectiveness of the recall itself. The enactment of the CPSIA and the rise of social media as an important outlet for recall information are not independent happenings:

> *Under the [new] law, strict penalties can be imposed if regulators sense that a company has fallen short of its responsibility to notify consumers and ensure that dangerous products are retrieved in a timely fashion. … It comes as little surprise that companies are increasingly turning to social media to limit legal risk and maintain consumer loyalty when a product liability crisis arises.*
>
> How Businesses Can Survive a Product Recall Using Social Media
> Patrick Kerley[17]

Lawyers often advise their client firms to adopt "best practices" as a way to defend the adequacy of their recall programs. The questions that can arise in the case of a lawsuit are whether the firm could and should have done more to recall the hazardous products and prevent an accident (see Ross 2012). While the legal process is highly unpredictable, it certainly seems that the more effective a recall is, the better a firm can defend itself in court.

2.3 Hypotheses Development

When recalling a consumer product, management's goal is to reach as many customers as quickly as possible with details regarding the product recall in a manner that best protects the firm's reputation. Given social media's megaphone feature, it is a highly effective way of "getting the word out" including the details needed for a successful product recall. By reaching more customers in a timely fashion, the firm can raise customer awareness regarding the product hazard and prevent the occurrence of future incidents. This will reduce the potential legal liability related to the product hazard. Furthermore, disseminating recall details to a wide

[17] Kerley 2011: http://mashable.com/2011/03/28/social-media-product-recalls/

network of customers can potentially reduce the administration costs associated with a recall by increasing the efficiency of communication.

In addition to facilitating more successful recalls, using the firm's own social media platforms provides the firm with an opportunity to deal with the potential fallout associated with the recall. According to the CMO (Chief Marketing Officer) surveys, "brand awareness and brand building" is the number one reason for corporate use of social media. [18] Hence, firms with social media are better positioned to rebuild the firms' brand and reputation following their product recalls. Specifically, they can augment the standardized details provided in the joint statement with the CPSC by providing additional information on how it is dealing with the recall and addressing any quality concerns. The augmented disclosure conveys the impression that the company is proactive in dealing with the recall. This in turn should mitigate the negative reputation effects related to the product recall.

While we argue that there are potential benefits of the megaphone feature, it is also possible, however, that spreading the bad news to a wider network of users can be damaging to the recall firm's reputation: more consumers will learn about the product problems, which can lead to greater loss of future sales.

Overall, the corporate use of social media can lower the recall firm's potential legal liability and administrative costs. It can also attenuate or exacerbate the damage to a recalling firm's reputation. All these benefits/costs ought to be impounded in the firm's stock price at the time of the recall announcement, leading to our first hypothesis, stated in its null form:

> *H1: The megaphone feature of corporate social media has no moderating effect on the negative price reaction to product recall announcements.*

[18] These surveys are conducted by Duke University, the American Marketing Association and McKinsey and Co., and companies surveyed are Fortune 1000, Forbes Top 200, among others. There are 531 respondents in the 2012 survey, with 86% of them at the VP-level or above.

As discussed above, interactive social media platforms, such as Facebook and Twitter, facilitate direct engagement between the firm and users (including its followers who are presumably its customers and investors) as well as among users. There are two competing effects that result from the engagement feature of corporate social media. The first is the *monitor* effect, as these platforms allow firms to monitor and mediate the once hidden dialogue among customers and other stakeholders. Beyond passive observation, the engagement permits firms to gain better insights into the concerns of a large group of stakeholders and respond accordingly. They can intervene to correct inaccuracies, encourage an activity, remedy a problem or even post an apology. With the ability to monitor and respond in a timely fashion, the company comes across as pro-active, willing to take responsibility for the recall, hence potentially mitigating the negative impact of the recall on its reputation, brand equity and ultimately future product sales.

The second effect of the engagement feature is the *magnet* effect. While many firms establish interactive social media accounts to attract inbound dialogue and capture customer feedback, this inbound dialogue is on display for all online users to view. Thus, the loss of complete control over the content posted and viewed on the firm's social media space likely adds new challenges for a recall firm as disgruntled customers are drawn to the site and voice their opinions for all to see. Such platforms can become "lightning rods" for negative sentiment. This is especially so if anger is a more influential emotion and spreads more quickly in social networks than other emotions (Fan, Zhao, Chen, and Xu 2013). With conflicting information and potentially "viral negative sentiment" facilitated by the engagement feature of Facebook and Twitter, firms with accounts on these social media networks potentially experience more negative capital market consequences when they announce their product recalls.

Overall, the net effect of the multi-way engagement feature of firms' interactive social media accounts on the capital market consequences of product recall announcements is an empirical question and we state our second, non-directional hypothesis in its null form:

> *H2: The engagement feature of corporate social media has no incremental moderating effect on the negative price reaction to product recall announcements.*

As discussed earlier, a key element of crisis management is the control over the flow of information. When a firm has an interactive social media account and it has to recall a product, the net benefits of the *engagement* feature depend on the amount of control a firm has over the content appearing on its social media platform. When a firm uses the *engagement* feature to gain insight into customers' and investors' concerns and provide timely clarifications and reassurances, the monitor and reputational benefits associated with being responsive will lead to improved market returns. In contrast, when angry customers usurp control of the site to vent their negative emotions, the negative sentiment can become magnified and the negative herding among users can exacerbate the negative market reaction to product recalls. This leads to our third hypothesis:

> *H3: The negative price reaction to product recalls is attenuated when the firm has greater control over the content on its interactive social media platforms and exacerbated when users take control of the content*.

3. Sample Selection and Data

3.1 Product Recalls Data

This study focuses on product recalls administered by the CPSC during the period 2008 to 2012. Our sample starts in 2008 due to the increasing popularity of social media in recent years and the enactment date of the CPSIA. Figure 1 shows the interest in "social media", as captured by Google searches (i.e., Google Trends) has intensified over time. With an upward

trend beginning in 2008, limiting the sample to 2008 and beyond enables us to get high quality data on the use of social media. Two recent papers that use social media data also begin their sample in 2008 (Blankespoor et al. 2014 and Chen, Hwang and Liu 2013).[19]

We obtain the initial product recall sample from the CPSC website (http://www.cpsc.gov/en/). During our sample period, 403 product recalls were issued by firms found on *Compustat*. We read the official recall announcements issued jointly by the recalling firm and the CPSC for these recalls, and retain only those recalls where the firm issuing the announcement is also responsible for the remedy. That is, we exclude 196 recalls issued by companies who are not the 'responsible' party.[20] We also exclude recalls with no stock return data on *CRSP* (n=2) and insufficient details in the recall announcement to estimate the scale of the recall (n=28), leaving us with a final sample of 177 product recalls. Panel A of Table 1 summarizes the sample selection procedure; Panel B presents the distribution of the recall announcements across the sample period. The recalls are fairly evenly distributed over the years in our sample period.

For the 177 recalls retained in our final sample, we hand collect from the official CPSC recall announcement details about the product recall including the number and the value of units affected (to estimate the scale of the recall), the number of incidents reported as of the date of the recall announcement, the product category, the hazard category, and whether the recalled product carries the company's brand name.

[19] Jung, Naughton, Tahoun, and Wang (2013) provide descriptive statistics on the adoption of social media by firms in the S&P1500. The earliest adopters of Facebook joined in November 2007; the earliest adopters of Twitter joined May 2008. Time trend data suggests that Twitter is becoming the perferred social media platform for companies.

[20] We identify the responsible party as the company whose name appears on the joint announcement with CPSC, and it is also responsible for providing a remedy. For example, if Columbia, Amazon, Bass Pro Outdoor World, and other major retailers recall Columbia jackets, we only include the recall by Columbia in our final sample. However, we include recalls by a major retailer, such as Macy's, when the product (e.g. children's clothing) is imported by Macy's, exclusively sold at their stores, and Macy's is responsible for the remedy.

Specifically, the recalls in our sample vary in scale, and we expect the total cost of a recall to vary with its scale. Thus, we estimate *Recall Scale* by multiplying the selling price listed in the recall announcement by the number of units being recalled.[21] In the event a selling price range is listed, we take the midpoint. In the event that a part (rather than a whole product) is being recalled and the value of that part is given in the release or can be estimated by us, we use the price of the part.[22]

For recalls of similar scale, total recall costs are still likely to vary with several additional recall characteristics. For instance, when comparing to recalls of the same scale, we expect the one with a Class A hazards (the highest level of product hazard) for a child-related product with a reported incident at the time of the recall announcement to have the higher expected litigation costs. Similarly, when comparing to recalls of the same scale, we expect the recall of a product that carries the company's brand name to result in greater loss of future sales because of the spillover effects to the company's other branded products. Thus, we construct a score variable (*Score*) that aggregates recall characteristics that are likely to accentuate the total costs of recall through higher expected litigation costs and greater loss of future sales. Specifically, *Score* takes on a value from 0 to 4 depending on whether the recall has the following four characteristics: (i) the recall involves a child-related product, (ii) the product defect is a Class A hazard (i.e. where the risk of death or grievous injury or illness is "very likely."), (iii) there is at least one incident

[21] Conceptually, it is unclear if the unit price used should be the selling price or the cost. Empirically, we use the selling price listed in the recall announcement because the cost price is not given.

[22] Because it is often difficult for consumers to separate a hazardous part from the whole product, more often than not, for consumer products the whole product rather than the particular component that causes the hazard is recalled. The same is true for products with parts made of materials that cause allergies or violate regulations (e.g., lead paint on a children's toy). However, there are several large ticket items (e.g., large appliances and gym equipment) in the initial recall sample for which only a part of the product is recalled. For these recalls, we took steps to obtain a reasonable estimate of the price of the part if it is not given in the details of the recall announcement. For example, we contacted companies for an estimate of the value of the part. Despite the steps taken, we were unable to obtain reasonable estimates of part values for several large ticket items such as all-terrain vehicles, snowmobiles and riding mowers which are akin to automobile recalls. Hence, we exclude these recalls from our sample (n=28). See Table 1.

reported at the time of the recall announcement, and (iv) the product carries the firm's brand name. Table 1 Panel C provides descriptive statistics for this *Score* variable. To separately identify those product recalls with characteristics that accentuate the total costs of recall through higher expected litigation costs and greater loss of future sales, we split the sample in two using an indicator variable *HighScore* equal to one for the 88 recalls with a *Score* of 2 or greater.

3.2 Social Media Data

We focus on corporate use of four social media channels – RSS feeds, corporate blogs, Facebook and Twitter. In its recent guidance on the use of social media for recalling companies, the CPSC suggests several social media outlets, including a blurb, Twitter, Facebook, Pinterest, Google+ and Instagram. We treat RSS feeds as a type of blurb, and include Twitter and Facebook. We exclude Pinterest and Instagram, because, while they are useful for sharing pictures and videos of recalled products, they are not useful for communicating the needed details of a product recall. We also exclude Google+ because it is in the early stage of adoption and not as widely used during our sample period.[23] To identify other social media channels, we look into the top 20 websites based on Internet traffic (http://www.alexa.com/topsites). In addition to Facebook and Twitter, other social media websites that are in the top 20 include LinkedIn, and blog publishing services - Blogspot and Wordpress. We exclude LinkedIn, which is primarily used for recruiting, but include corporate blogs as another social media channel because companies use their blogs to announce new products and important corporate events.

While recalling firms are able to make additional detailed disclosures about their product recalls on any of these four channels we examine, there are important differences across these four outlets. Specifically, Facebook, and Twitter are social *networking* platforms which facilitate

[23]Google+ was only opened to all adults (13 years or older) in the U.S. beginning January 2012. In two product recalls in our sample where Google+ is adopted, Twitter or Facebook was also adopted. Hence, our findings are not affected by the inclusion / exclusion of Google+.

more extensive interactions and group formations among users, resulting in less control by the company over the content.[24]

To determine whether the company has an existing social media account at the time of the product recall, we rely on different sources. For Facebook and Twitter, we obtain the company's official Facebook and/or Twitter account from the corporate website, and manually collect the start dates of these accounts. For RSS feeds and blogs, we first determine (from the company's corporate website) whether the company provides RSS feeds or has a blog as of January 2013. We then determine if the company had a blog or RSS feed at the time of the product recall by looking at the company's initial entry, contacting companies, and looking into archived web pages on the Wayback Machine.[25]

We define two indicator variables to capture the effects of social media. The first, *Megaphone*, is assigned a value of one if the company has a corporate blog, provides RSS feeds, or has a corporate Facebook or Twitter account at the time of the recall and zero otherwise. All four social media channels have the megaphone feature. The second indicator variable, *Engagement*, is assigned a value of one if the company has a Facebook or Twitter account at the time of the recall and zero otherwise. The *Engagement* variable is intended to capture the unique interactive effects of these social network sites. We note that the indicator variables, *Megaphone* and *Engagement*, are not mutually exclusive. Table 1 Panel D shows the distribution of social media channels by calendar year. There is an increase in the use of social media over the sample period, 2008 to 2012. The trend is largely driven by the corporate adoption of interactive social media – Facebook and Twitter, consistent with Jung et al. (2013).

[24] We looked into collecting data on # followers a firm has on Twitter and # friends on Facebook. However, we could only collect the data as of today's date (instead of on the date of the product recall announcement). Thus far we have opted not to collect this data.

[25] The Wayback Machine archives about 240 billion web pages beginning from as early as 1996. It does not hold a daily archive but displays archived web pages at various time intervals.

In order to draw inferences on *corporate use* of social media, we also need to control for the overall effects of traditional media and other general social media activity during the event window. *ATradMedia* is measured as the average daily number of articles in the event window (0, +3) minus the average daily number of articles in the pre-event period (-60, -1). Included in *ATradMedia* are all press articles found on *Factiva* with the company's name mentioned in the headline or the lead paragraph. To capture the unusual level of overall social media activity (*AGenSM*) around the recall announcement, we calculate the average daily number of times the company's name is mentioned on public blogs, Facebook and Twitter accounts in the event period (0,+3) minus the average daily number of times the company's name is mentioned on these outlets in the pre-event period (-60,-1).[26,27]

3.3 Descriptive Statistics

Studies of market reaction to product recalls have focused on a short window surrounding the announcement of the recalls. Jarrell and Peltzman (1985) show that the market reaction is complete in the period from 5 days before the announcement to 5 days after for a sample of drug recalls. Barber and Darrough (1996) examine the market reaction to automobile recalls using a 2-day window beginning on the announcement day. Chen et al. (2009) focus on the 1-day market reaction (i.e. the announcement day) for consumer product recalls. Unlike automobile and drug

[26] This is a summary measure of all social media activity based on the number of counts of the company's name in public Facebook posts, entire Twitter firehose and blogs hosted by service providers that are datamined by People Browsr such as Blogspot, Tumblr and Wordpress). We cannot isolate activity attributed to corporate social media accounts from this rather rudimentary frequency measure. The only exception is Twitter where we are able to separately identify activity using the company's Twitter handle (as opposed to the company's name) which we do in our Twitter analysis.

[27] Unlike the search for company name on Factiva where we can increase the confidence of obtaining important news articles on the company by limiting the search to the headline and lead paragraph, the search on social media space is more challenging. As an example, searching for the company name "Columbia" on the social media space will result in all mentions of the word "Columbia" regardless of whether they are referring to the sportswear company or not. A more refined search term such as "Columbia Sportswear" is also not ideal because social media posts tend to be informal. Hence, we rely on the difference between the number of mentions in the event period and the pre-event period.

recalls, Chen et al. (2009) argues that pre-event leakage is unlikely for consumer product recalls given that the recall firms are required to announce the recall jointly with the CPSC.

Following prior literature, we examine short-window cumulative abnormal returns beginning from the announcement date. Table 2 Panel A documents the mean and median CARs over the event window (0,+1), (0,+2), and (0+3). All are negative and statistically significant. Ranging from -0.2% to -0.9%, the magnitudes of these abnormal returns are comparable to those reported in Chen et al. (2009). The percentage of firms with negative CARs ranges from 54% to 56% and is not statistically different from 50%. We report the CARs in the (-3, -1) window and (+4, +10) window to account for the possibility that the recalls are anticipated and that there is a reversal after the event window. Neither of the non-event-period CARs is statistically significant.

Table 2 Panel B shows the difference in CARs for firms with and without corporate social media accounts. Compared to the firms with no corporate social media accounts at the time of their recall announcements (n=46), the market reaction is less negative for the recalls made by the firms with at least one corporate social media account (n=131). For the various event window, the mean CARs ranges from -1.9% to -2.4% for the no social media group versus from -0.03 to -0.02 for the social media group.[28] There is no difference in the CARs between the two groups of firms in the non-event periods. These univariate statistics indicate that the megaphone feature of corporate social media lowers overall total recall costs.

Next we split the sample of firms with at least one social media account based on whether their social media platforms provide the engagement feature. Table 2 Panel C shows the difference in CARs for firms with the megaphone feature only (n=24) versus firms with both the

[28] The magnitude of the mean CAR for the no social media group are comparable to those reported by Jarrell and Peltzman (1985), who report a mean CAR of -2.8% for their 5-day event window for their sample of 32 drug recalls. See their Table 2 on page 520.

megaphone and engagement feature (n=107). None of the mean or median CARs for the various event windows are significantly different across the sub-samples.

Table 3 Panel A reports the descriptive statistics for the variables used in our regression. See Appendix A for detailed variable definitions. The main variable that captures capital market consequences is CARs in the four day window (0, +3) around the recall announcements (*ARet*). There is substantial variation in the scale of the recall for firms in our sample. The mean dollar value of a recall is $14.95 million while the median is only $0.68 million. To have a more meaningful measure of the scale of the recall, we deflate the dollar value of recall scale by firm size measured as the market value of equity 15 days prior to the recall announcement date (Jarrell and Peltzman 1985). Similar to the dollar value of the recall scale, there is also substantial variation in the percentage measure (*RecallScale*). The mean is 4.4% while the median is only 0.2% of the market value of equity. This variation reflects the nature of product recalls, not all consumer product recalls are significant economic events for the recalling firms. The mean and median *ATradMedia* are 0.746 ($p<0.01$) and 0.450 ($p<0.01$) respectively, indicating that there are more news articles about the recalling firms during the event period (0,+3) than during the pre-event period (-60,-1). Additionally, there is some evidence that the abnormal level of overall general social media activity is higher for the recalling firms during the event window as indicated by a positive median for *AGenSM* (mean = 18.699; $p=0.15$ and median = 0.293; $p<0.01$).

Table 3 Panel B presents the descriptive statistics for key variables by social media features. The first three columns compare product recalls by firms with no social media with those by firms with social media. There are no significant differences between the two groups except for the announcement returns (*ARet*) and general social media (*GenSM*). While it is not

surprising that firms with corporate social media accounts have a higher level of general social media activity, the difference in their abnormal level of general social media activity (*AGenSM*) around the recall announcements is not significant. The next three columns condition on firms with at least one corporate social media account, and compare recalls by firms with social media with an engagement feature (accounts on Facebook and/or Twitter) to those by firms without. While the dollar value of recall scale is significantly smaller for firms without engagement social media, there is no difference in the recall scale deflated by firm size (*RecallScale*). There is also some evidence that firms with engagement social media are smaller and experience lower sales growth in the prior year. While they also experience higher level of general social media activity presumably due to the engagement feature, their abnormal level of general social media activity is not significantly different from those without engagement social media. These differences across the groups of firms with and without the megaphone and engagement features highlight the need to control for these key variables in our regressions.

4. Social Media and Investor Response to Product Recalls

4.1. Basic model

A product recall is a "product crisis" that is costly for the recalling firm. In addition to the out-of-pocket costs associated with the dissemination of the recall news and the remedy for the defective units, the firm also faces substantial indirect costs, including lost future sales as a result of reputation damage and potential legal costs associated with the product hazard. While these eventual costs associated with a recall, whether direct or indirect, cannot be exactly measured at the time of the recall, one would expect these costs to vary with the scale of a recall. Intuitively, recalls of a larger scale would cost the company more to manage the recall process, to remedy

the defective units, and would also translate into greater loss of future sales and higher potential legal costs. To formalize our intuition and to facilitate later discussion, we assume

$$Total\ Costs = \ \beta\ Recall\ Scale \tag{1}$$

This characterization is consistent with findings in the prior literature on recalls (e.g., Jarrell and Peltzman 1985, page 523).

When we deflate both sides of the equation by firm's pre-market value, we obtain the following:

$$Aret_{(event)} = \beta\ \frac{Recall\ Scale}{Market\ Value_{t-1}} \tag{2}$$

At the time of the recall investors assess the various costs related to the recall. Assuming the market is efficient and the recall is unexpected, investors' expectations of the full cost of the recall will be captured in the abnormal price reaction measured over the event window, $ARet_{(event)}$. The coefficient on deflated *Recall Scale*, β, indicates whether and how recall scale relates to investors' expectations of these overall costs of the product recall.

In this study we are interested in examining whether social media plays a role in how the market interprets and impounds the recall news. Specifically, we conjecture that β is a function of social media, as well as other potential control variables that affect the "mapping" from recall scale to loss in firm value.

$$\beta = \ \theta_0 + \ \theta_1 SM + \theta\ Controls \tag{3}$$

Substitute (3) into (2), we have the following equation:

$$\begin{aligned} ARet_{(event)} &= [\ \theta_0 + \ \theta_1 SM + \theta\ Controls\ ] \times\ RecallScale \\ &= \theta_0 RecallScale + \ \theta_1 SM \times RecallScale + \theta\ Controls \times RecallScale \end{aligned} \tag{4}$$

where *RecallScale* is now deflated by the pre-event market value of the firm.

To estimate Eq. (4) using OLS regression, we add the intercept, an error term, and the variables in Eq. (4) as main effects to ensure that the regression is properly specified.

$$Aret_{(event)} = \gamma_0 + \gamma_1 SM + \gamma Controls + \theta_0 RecallScale + \theta_1 SM \times RecallScale + +\theta\ Controls \times RecallScale + \epsilon \quad (5)$$

Our main variable of interest is θ_1, i.e., whether and how social media mediates the impact of *RecallScale* on firm value. If social media facilitates the dissemination of more detailed information to a broader customer base, the firm ought to be able to reduce the cost of administering the recall. In addition, timely dissemination of recall details to a broad base of customers ought to reduce a firm's product legal liability and mitigates reputation damage. However, the wider dissemination of the news of the product hazard can also lead to more returned units thereby increasing the cost of remedy, as well as increasing the reputational damage and the accompanying loss of future sales. Consequently, the directional prediction of θ_1 is ambiguous.

In the second primary analysis, we examine the relation between abnormal returns and abnormal Tweeting activity during the recall event window. We modify Eq. (5) above by replacing SM with the level of abnormal tweets by the firm and the level of abnormal tweets by others:

$$ARet_{(event)} = \gamma_0 + \gamma_1 SM + \gamma Controls + \theta_0 RecallScale + \theta_1 ATweets\ by\ Firm + \theta_2 ATweets\ by\ Others + \theta_3 ATweets\ by\ Firm \times RecallScale + \theta_4 ATweets\ by\ Others \times Recall\ Costs + \theta\ Controls \times RecallScale + \epsilon \quad (6)$$

4.2. Regression Results

The variables in the regression are defined in Appendix A. The control variables consist of firm characteristics, media activity and product recall characteristics. We control for firm size and sales growth because they are likely to affect both the market reaction to product recalls and corporate use of social media. For example, large firms are more likely to have the resources to actively manage social media accounts and the market reaction to product recalls by large firms might be less negative because larger firms are better positioned to "weather the storm." Firms

with higher sales growth might be more actively involved in branding the product on social media and thus, the effect of the product recall might be more damaging for these firms. Following the discussion in section 3, we also include *ATradMedia*, *AGenSM*, and *HighScore* as controls in the regression.

Table 4 presents the OLS regression results. We first estimate a baseline model that excludes the social media variables and all the interaction terms. Consistent with prior literature, the market reaction is more negative when the scale of product recall is larger; the coefficient on *RecallScale* is negative and significant. A one standard deviation increase in *RecallScale* results in a 1% decrease in stock price. In column (2), we estimate Eq. 5, with the control variables that capture various firm, recall and media characteristics. As expected, the market reactions to the product recall announcements vary cross-sectionally with several key variables of interest. To examine the effect of the megaphone feature on total recall costs (H1), we focus on the coefficient on *RecallScale*×*Megaphone.* The coefficient is positive and significant suggesting that the megaphone feature offered by all social media outlets mitigates the effects of product recalls on firm value. Even though social media can also spread the bad news more widely, the benefits from reduced legal liability and lower reputation damage appear to dominate. To examine the effect of the engagement feature on total recall costs, we focus on the coefficient on *RecallScale*×*Engagement.* In contrast to the megaphone feature, the coefficient on *RecallScale*×*Engagement* is negative and significant. Despite the benefits provided by the ability to monitor customers concerns and respond directly, the *magnet* effect of negative sentiment appears to dominate, reversing the positive effect of megaphone by about 70%. This result is consistent with the recent findings in Fan et al. (2013) that anger is the most influential emotion

on social media because compared to other emotions, anger spreads more quickly and broadly in social media networks.[29]

The above OLS analysis is potentially susceptible to a selection bias, as a "serious" recall might prompt a firm to take to social media to announce the recall, and serious recalls ought to have more negative price reactions. However, we argue this sort of a selection bias is less of a concern for the Table 4 regressions because we use the *existence* of a firm's social media account to proxy for its usage of social media. This decision is driven by data constraints – we do not have access to historical data on firms' actual use of their social media platforms (except for Twitter). So, we use the *existence* of various corporate social media accounts to proxy for corporate use of social media. While this approach undoubtedly leads to less powerful tests, the main variables of interest, *Megaphone* and *Engagement*, are also less susceptible (than the unavailable usage variable) to the endogeneity bias described above, especially since the adoption of social media precedes the recall announcements by well over a year. Nevertheless, to address the possibility that firms *adop*t social media in anticipation of a "serious" product recall, we perform a matched sample analysis and describe it in detail in section 6.

5. Twitter Activity and Market Reaction to Product Recalls

To further examine how corporate use of interactive social media affects the market reaction to product recalls, we focus on social media activity on Twitter, probably the most widely used social media platform. We are able to access the entire Twitter Firehose through the PeopleBrowsr API. This allows us to examine the intensity of social media activity around

[29] Here we are only interpreting the incremental effect of the engagement feature. If one is interested in understanding the full effect of Facebook / Twitter, we need to aggregate both the megaphone and the engagement effects as Facebook and Twitter facilitate both. In a separate analysis, we run a regression with firms that have either no social media (control firms) or only interactive social media (Twitter and Facebook). We define an indicator variable to denote Twitter and Facebook. We find that the coefficient on this indicator variable interacted with recall scale is positive and significant (coeff=0.1099, t-statistic=2.09), suggesting that the overall effect of Facebook and Twitter is to attenuate the negative market reaction to product recalls.

product recall announcements by counting the number of tweets containing the company's Twitter handle that are tweeted by the firm (*TweetFirm)* and tweeted by others (*TweetOther*) in the four-day event window, (0, +3). Table 5 presents descriptive statistics for the 97 product recalls announced by firms with Twitter accounts. There are more tweets by others (daily mean=44.585) than by the recalling firms (daily mean=7.807). To control for the "normal" level of Twitter activity, we calculate abnormal tweets, *ATweetOther* and *ATweetFirm*, by subtracting the average daily number of tweets in the pre-event window (-60, -1) from the average daily number of tweets in the event window (0, +3). There is evidence of unusually high Twitter activity surrounding product recalls: the mean abnormal number of tweets by others is 14.415 ($p<0.01$) and the mean abnormal number of tweets by the recall firms is 2.152 ($p<0.01$).

We run the following regression to examine how abnormal tweeting activities both by the firm and by other users affect the market reaction to recall scale:

$$\begin{aligned} ARet_{(0,+3)} = {} & \beta_0 + \beta_1 RecallScale + \beta_2 ATweetFirm + \beta_3 ATweetOther + \beta_4 RecallScale \times ATweetFirm \\ & + \beta_5 RecallScale \times ATweetOther + \beta_6 FirmSize + \beta_7 SalesGrowth + \beta_8 HighScore \\ & + \beta_9 AGenSM + \beta_{10} ATradMedia + \beta_{11} RecallScale \times FirmSize + \beta_{12} RecallScale \\ & \times SalesGrowth + \beta_{13} RecallScale \times HighScore + \beta_{14} RecallScale \times AGenSM \\ & + \beta_{15} RecallScale \times ATradMedia \end{aligned}$$

Table 6 Panel A presents the OLS regression results with abnormal stock returns as the dependent variable. Again, stock returns are more negative for recalls that are larger in scale. To assess whether the level of control a firm has over the content appearing on Twitter affects the market reaction to its recall, we focus on β_4 and β_5. We expect that greater control over the content mitigates the negative price reaction, thus β_4 is predicted to be positive. On the other hand, the loss of control over the content appearing on Twitter allows negative sentiment to take over and exacerbates the negative price reaction. Thus, β_5 is predicted to be negative.

Consistent with H3, we find that the coefficient on $RecallScale \times ATweetFirm$ is positive and significant, indicating that the relation between stock market returns and recall scale is attenuated by more tweets from the firm. In contrast, the coefficient on $RecallScale \times ATweetOther$ is negative and significant, suggesting that the negative relation between stock market returns and recall scale is exacerbated by more tweets from others. Based on this result, one abnormal tweet by the firm attenuates the market reaction to recalls by about 30% compared to a firm at its "normal" level of firm tweets. In addition, one abnormal tweet by a user accentuates the market reaction by about 2% compared to a firm that is receiving "normal" level of user tweets.[30]

While the OLS regression is intuitive, the specification is subject to a potential selection bias. Specifically, while we would like to interpret a significant coefficient, say, β_5 as evidence that Twitter use affects the market reactions to recalls, this association might be spurious. For example, a "serious" recall might prompt more users of the firm's Twitter account to express their opinions on this outlet, and the serious recall might also lead to more negative event day returns. In this case, the relation between social media and abnormal returns is spurious and driven by the unobservable "severity" of the recall.

Recognizing this problem, we include control variables such as media coverage and recall characteristics in the regression in the hope that they capture the "severity" of a recall. However, to the extent that they might not be entirely successful in doing so, we also perform a 2SLS analysis that "strips away" the endogeneity associated with the "seriousness" of a recall.

We first model Twitter usage as a function of predetermined variables. We then use the predicted values from the first stage as instruments, which replace the *actual* use of twitter by

[30] To calculate these, we use the coefficient estimates from the regression in Table 6 Panel A and the mean values of the variables in the regression.

firms and by users. For the two stage model to work properly, we need identification variables for the first stage, i.e., variables that are related to actual twitter usage during the event window but not directly related to the abnormal event day returns (e.g., via the "seriousness" of the recall). We include four variables for this purpose: (i) whether the firm is a Tech firm operating in SIC codes 3570-3579, 3610-3699, 7370-7379, 3810-3849, and 4800-4899; (ii) the percentage of the population under 45 in the Metropolitan Statistical Area (MSA) where the firm's HQ is located; (iii) a dummy variable if the age of the CEO is below the sample median, and (iv) pre-event levels of user tweets and firm tweets. As shown in the determinants regression in Table 6 Panel B, *PriorTweetFirm* and *PriorTweetOther* are the most important determinants of event-window tweeting frequencies by the recalling firms and by other users.

We then use the predicted usage of tweets as instruments. One complication is that there are actually four endogenous variables, *ATweetFirm*, *ATweetOther*, plus these two variables interacted with *RecallScale*. Thus, the correct specification involves four first stage regressions.[31] Panel C presents the second stage results of the 2SLS regressions. Our basic inferences from the OLS regression remain consistent. The coefficient on the instrument for *RecallScale*×*AtweetOther* is negative and significant, suggesting that user tweets exacerbate the negative price reactions to recalls. On the other hand, the coefficient on the instrument for *RecallScale*×*AtweetFirm* is positive and significant, suggesting that a firm's attempts to control the conservation on Twitter are likely beneficial.

6. Additional Analyses

6.1 Analyst Sales Forecasts Revision

We contend that the use of social media to manage product recalls affects firms' reputations and future sales, and consequently affects the market reaction to their recalls. We

[31] See, e,g. Wooldridge, pp. 267-268.

validate this conjecture by examining whether the expected loss in future sales following a product recall is indeed affected by corporate use of social media. The findings are presented in Table 7, with a regression specification based on Eq. (5). We use the revision in the consensus analyst sales forecasts as our dependent variable, (*SFRev*), measured around the recall announcement date and scaled by the market value of equity. Three observations have no sales forecasts, resulting in a sample of 174 firms for this analysis.

We find that the analysts' forecast revisions are negatively related to recall scale in the baseline regression presented in column (1). In the expanded regression with social media variables and other control variables added, we find that this relation is attenuated for firms with social media platforms with the megaphone feature, as indicated by the positive coefficient on *RecallScale*×*Megaphone*. In contrast, the coefficient on *RecallScale*×*Engagement* is negative and significant, suggesting the *engagement* feature exacerbates the negative market reaction to product recalls. On a side note, the regression also shows that the relation is exacerbated for recalls by firms with high sales growth, with brand name on the recalled product, and with more traditional media coverage, presumably because the loss in sales due to reputation damage is greater for these firms.

6.2 Endogeneity related to the adoption of Social Media platforms

As discussed earlier, management's decision to initiate a corporate social media account might be related to the anticipation of a product recall, leading to a potential selection bias. To mitigate this concern, we repeat the analysis in Table 4 using a matching procedure analogous to propensity score matching. We identify all 131 product recalls by firms with social media accounts during our sample period, 2008-2012 (i.e. treatment firms). Using the entire sample of 177 product recalls, we estimate a firm's propensity to adopt social media based on a number of

firm and recall characteristics such as recall scale, firm size, sales growth, high score, whether the firm had a prior recall, as well as the level of traditional media activity prior to the recall and a variable to capture time trend. Similar to the 2SLS approach in the Twitter analysis, we argue that tech firms, and firms with a younger work force and a younger CEO are more likely to adopt social media. Hence, we include these three additional variables in this model. The results of this regression are presented in Table 8, Panel A. We find that the percentage of young population is positively related to the adoption of social media, as is the year trend. The pseudo R^2 from the logistic regression estimating the probability of social media adoption is 21%.

We use the estimated coefficients from the logistic regression to generate propensity scores for all product recalls announced between 2000 and 2012 by firms *without* social media accounts (i.e. the control group). The product recall in the control group that has the closest propensity score is uniquely matched to a product recall in the treatment group. We end up with 131 matched pairs resulting in a total of 262 product recalls. The mean and the median differences in propensity scores of the matched pairs are 0.013 and 0.002, indicating that the product recalls are quite well-matched. The results from the "matched" analysis, presented in Panel B, confirm our primary findings in Table 4. Specifically, the coefficient on *RecallScale*×*Megaphone* is positive and significant, suggesting that the megaphone feature mitigates the negative market reaction to product recalls; the coefficient on *RecallScale*×*Engagement* is negative and significant, suggesting that the engagement feature exacerbates the negative market reaction.

6.3 Sentiment of Tweets by Firms versus Tweets by Others

Our analysis in section 5 implicitly assumes that tweets by the firm convey, on average, more positive sentiment than tweets by others and conversely that tweets by others convey, on

average, more negative sentiment than tweets by the firm. We validate this assumption empirically by documenting the sentiment of the tweets examined in section 5. PeopleBrowsr measures tweet sentiment and categorizes tweet sentiment as positive, negative and neutral/unclassified with most of the tweets falling into the last category.[32] We find that in the (0, +3) event window, 13.89% (0.86%) of tweets by the firm are positive (negative), while 6.31% (7.11%) of tweets by others are positive (negative). The differences in the proportion of positive and negative tweets are significant at the 1% level.

7. Conclusion

We study the corporate use of social media within the context of consumer product recalls as a way to explore how social media affects the capital market consequences of firms' disclosures. We report three main findings. First, we find that the megaphone feature of corporate social media, in general, attenuates the negative price reaction to product recall announcements. Second, the engagement feature of certain social media platforms, Twitter and Facebook, exacerbate the negative market reaction to product recalls. We interpret this finding as evidence that the engagement feature facilitates the viral spread of negative sentiment in the wake of a product recall. Finally, we conduct a detailed analysis of Twitter activity around recall announcements and document the importance of firm control over the flow of information during these product crises. Separating tweets by firms from tweets by others, we document that the degree of control a firm has over its interactive social media content affects the market reaction to its product recalls: the negative reaction is attenuated by the frequency of firm tweets, while it is exacerbated by the frequency of tweets by others.

[32] The underlying dictionary and algorithm used by PeopleBrowsr to measure sentiment are undisclosed. Thus, we do not use their sentiment measures in our primary tests.

Overall these findings highlight the benefits and the costs of social media within the context of corporate disclosure. Our findings suggest that due to its tremendous reach, the megaphone feature of social media platforms accelerates the dissemination of news from the firm to a broader set of stakeholders. In the context of product recalls, this feature enables firms with social media accounts to effectively "get the word out," which potentially reduces product liability and lowers reputational damage. However, the effect of the engagement feature of social media is more nuanced. While the engagement feature allows firms to monitor and directly respond to the concerns voiced by its customers, it also has the potential disadvantage of permitting disgruntled users to take control of the online discussions, making the firm's own social media site a lightning rod for negative sentiment. Thus, the engagement feature can potentially facilitate the "viral distribution of negative sentiment" following negative corporate events.

Future research can explore whether our findings generalize to other important corporate announcements, such as earnings warnings, restatements, stock offerings, stock repurchases, or announcements of mergers and acquisitions. Each of these corporate announcements is likely to generate significant social media activity. Does corporate use of interactive social media facilitate larger price reactions only for negative corporate events or for positive events as well?

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TABLE 1
Sample Selection and Distribution

Panel A: Sample Selection

	No. of Firm Years
Compustat Firms with CPSC product recalls for the period 2008-2012	403
Less:	
Firm is not the 'responsible' party involved in the recall making the joint announcement with CPSC and providing the remedy for the recall	196
No stock returns data on CRSP	2
Insufficient recall data available in the product recall announcement to estimate the scale of the recall (total units affected multiplied by estimated value of unit/part)	28
FINAL	177

Panel B: Number of Product Recalls by Calendar Year

Year	No. of Product Recalls
2008	37
2009	39
2010	36
2011	36
2012	29

Panel C: Distribution of Product Recalls by Score and Recall Characteristics

		Product Recall Characteristics Indicators (0 or 1 for each category)			
Score (N out of (1) to (4))	**Number of Product Recall with Score N**	**(1) Child**	**(2) Hazard**	**(3) Incidents**	**(4) Brand on Product**
N = 0	16	0	0	0	0
N = 1	73	14	0	38	21
N = 2	81	23	1	70	68
N = 3	7	7	0	7	7
N = 4	0	0	0	0	0

Notes to Table 1 Panel C:
The second column reports the number of product recalls with Score N. Each product recall has a Score where Score is the summation of four indicator variables: (1) whether the recalled product is categorized as a child-related product, (2) whether the defective product is classified as a Class A hazard, (3) whether there has been an incident reported at the time of the recall, and (4) whether the company's brand is on the product. Columns (1) to (4) are not mutually exclusive.

TABLE 1 (continued)
Sample Selection and Distribution

Panel D: Distribution of Corporate Social Media Channels by Calendar Year

Year	(1) RSS	(2) Blog	(3) Twitter	(4) Facebook	**Megaphone Feature (Megaphone)** (At least one out of 1 to 4)	**Engagement Feature (Engagement)** (At least one between 3 and 4)
2008	1	19	2	3	20	3
2009	2	9	16	13	24	20
2010	2	8	23	20	27	25
2011	3	6	29	20	32	31
2012	4	7	27	16	28	28
Total	12	49	97	72	131	107

Notes to Table 1 Panel D:
Columns (1) to (4) are not mutually exclusive. The next column reports the number of product recalls by firms with Megaphone social media (at least one out of (1) to (4)) and the last column reports the number of product recalls by firms with Engagement social media (at least one between (3) and (4)). Note megaphone feature and engagement feature are not mutually exclusive.

TABLE 2
Cumulative Abnormal Returns Around Product Recall Announcements

Panel A: Descriptive statistics of CARs over different windows

Cumulative Abnormal Returns (CARs) over Different Windows	Mean (N=177)	p-value	Median (N=177)	p-value	Percentage of Negative CARs (N=177)	p-value
0, +1	-0.006	0.047	-0.004	0.006	56%	0.115
0, +2	-0.008	0.015	-0.002	0.026	54%	0.260
0, +3	-0.009	0.009	-0.003	0.015	56%	0.115
-3, -1	0.003	0.270	0.003	0.436	46%	0.260
+4, +10	0.004	0.359	0.000	0.289	49%	0.707

Panel B: Descriptive statistics of CARs splitting on the Megaphone feature

CARs over Different Windows	Mean			Median			Percentage of Negative CARs		
	No Megaphone (N=46)	Megaphone (N=131)	Diff (p-value)	No Megaphone (N=46)	Megaphone (N=131)	Diff (p-value)	No Megaphone (N=46)	Megaphone (N=131)	Diff (p-value)
0, +1	-0.019	-0.002	0.014	-0.008	-0.001	0.099	61%	54%	0.433
0, +2	-0.023	-0.002	0.015	-0.008	-0.002	0.079	60%	52%	0.294
0, +3	-0.024	-0.003	0.017	-0.011	-0.002	0.096	61%	54%	0.433
-3, -1	0.010	0.001	0.628	0.004	0.002	0.506	43%	47%	0.718
+4, +10	0.004	0.004	0.960	-0.002	0.001	0.644	54%	47%	0.364

Notes to Table 2 Panel B:
CAR is the cumulative abnormal returns adjusted using the value-weighted index for the event windows where day 0 is the announcement date. We report the p-values based on two-tailed tests for test of difference in means, signed rank test for differences in medians, and chi-square test for differences in proportions.

TABLE 2 (continued)

Panel C: Descriptive statistics of CARs splitting on the Engagement feature

CARs over Different Windows	Mean			Median			Percentage of Negative CARs		
	No Engagement (N=24)	Engagement (N=107)	Diff (p-value)	No Engagement (N=24)	Engagement (N=107)	Diff (p-value)	No Engagement (N=24)	Engagement (N=107)	Diff (p-value)
0, +1	0.005	-0.003	0.259	0.003	-0.004	0.335	42%	57%	0.173
0, +2	0.006	-0.004	0.196	0.004	-0.002	0.164	38%	55%	0.118
0, +3	0.005	-0.005	0.259	0.000	-0.003	0.264	50%	55%	0.648
-3, -1	-0.008	0.003	0.142	-0.003	0.003	0.233	54%	45%	0.409
+4, +10	0.007	0.003	0.601	0.001	0.001	0.715	46%	47%	0.937

Notes to Table 2 Panel C:
CAR is the cumulative abnormal returns adjusted using the value-weighted index for the event windows where day 0 is the announcement date. We report the p-values based on two-tailed tests for test of difference in means, signed rank test for differences in medians, and chi-square test for differences in proportions.

TABLE 3
Descriptive Statistics

Panel A: Descriptive statistics for the entire sample

Variable	Mean	Std dev	25%	Median	75%
ARet $_{(0, +3)}$	-0.009	0.043	-0.022	-0.003	0.011
Recall Scale (in $millions)	14.947	64.599	0.135	0.684	5.760
RecallScale	0.044	0.221	0.000	0.002	0.006
FirmSize	7.722	2.443	5.739	7.762	9.321
SalesGrowth	0.028	0.124	-0.054	0.033	0.121
HighScore	0.497	0.501	0	0	1
GenSM	376.96	1135	1.50	53.25	225.25
AGenSM	18.699	172.168	-0.005	0.293	5.315
TradMedia	3.476	5.315	0.750	1.750	3.250
ATradMedia	0.746	2.932	-0.317	0.450	1.633
N	177	177	177	177	177

Panel B: Descriptive statistics for sample splitting on Megaphone

	All Firms (N=177)			Firms with Megaphone (N=131)		
	Megaphone Feature			Engagement Feature		
Variable	(1) No	(2) Yes	p-value (1) - (2)	(3) No	(4) Yes	p-value (3) - (4)
ARet $_{(0, +3)}$	-0.024	-0.003	0.017	0.004	-0.005	0.259
Recall Scale (in millions)	15.674	14.692	0.907	2.748	17.371	0.062
RecallScale	0.089	0.029	0.291	0.012	0.033	0.223
FirmSize	7.301	7.869	0.175	8.843	7.651	0.034
SalesGrowth	0.019	0.031	0.586	0.072	0.021	0.073
HighScore	0.587	0.466	0.157	0.458	0.467	0.937
GenSM	63.495	487.081	0.001	55.408	583.904	0.001
AGenSM	-1.092	25.648	0.131	-3.123	32.102	0.107
TradMedia	2.592	3.786	0.103	4.178	3.699	0.716
ATradMedia	0.471	0.842	0.369	0.548	0.908	0.701
N	46	131		24	107	

Notes to Table 3:
All variables are defined in Appendix A. is We report the p-values based on two-tailed tests for test of difference in means for the continuous variables and test of difference in proportions for the indicator variables.

TABLE 4

Regressions Examining the Effect of Social Media on Stock Returns Surrounding Announcement of Consumer Product Recalls

$$ARet_{(0,+3)} = \beta_0 + \beta_1 RecallScale + \beta_2 Megaphone + \beta_3 Engagement + \beta_4 RecallScale \times Megaphone + \beta_5 RecallScale \times Engagement + \beta_6 FirmSize + \beta_7 SalesGrowth + \beta_8 Score + \beta_9 AGenSM + \beta_{10} ATradMedia + \beta_{11} RecallScale \times FirmSize + \beta_{12} RecallScale \times SalesGrowth + \beta_{13} RecallScale \times HighScore + \beta_{14} RecallScale \times AGenSM + \beta_{15} RecallScale \times ATradMedia$$

Variable	(1)			(2)		
	E[Sign]	Coeff	t-statistic	E[Sign]	Coeff	t-statistic
Intercept		-0.0245*	-1.78		-0.0339	-2.10
RecallScale	-	-0.0451**	-2.44	-	-0.8273**	-2.40
Megaphone					0.0153	1.35
Engagement					-0.0073	-0.65
RecallScale×Megaphone				+/-	0.3616***	3.01
RecallScale×Engagement				+/-	-0.2585**	-1.97
FirmSize		0.0033**	2.08		0.0031**	1.99
SalesGrowth		-0.0062	-0.22		-0.0056	-0.20
HighScore		-0.0069	-1.38		-0.0043	-0.85
AGenSM		-0.0001**	-2.52		0.0000	0.23
ATradMedia		0.0005	0.60		0.0010	1.10
RecallScale×FirmSize					0.1465**	2.07
RecallScale×SalesGrowth					0.0235	0.32
RecallScale×HighScore					0.0768	1.19
RecallScale×AGenSM					-0.0073	-1.48
RecallScale×ATradMedia					-0.0747***	-2.71
Year Fixed Effects		Included			Included	
N		177			177	
Adj R^2		0.055			0.090	

Notes to Table 4:
All variables are defined in Appendix A. *, ** and *** represent significance at 10%, 5% and 1% (2-tailed). All continuous variables are winsorized at the extreme 1%. t-statistics are calculated based on firm-clustered standard errors.

TABLE 5
Descriptive Statistics on Sample of Firms with Twitter Accounts

Variable	Mean	Std dev	25%	Median	75%
ARet (0, +3)	-0.006	0.037	-0.021	-0.004	0.007
Recall Scale ($ millions)	16.028	81.285	0.117	0.710	4.913
RecallScale	0.024	0.105	0.0003	0.002	0.005
FirmSize	7.638	2.517	5.604	7.762	9.300
SalesGrowth	0.020	0.117	-0.050	0.018	0.121
HighScore	0.433	0.498	0.000	0.000	1.000
GenSM	625.22	1479	55.25	151.50	554.75
AGenSM	34.492	231.375	-0.315	2.232	9.655
TradMedia	3.507	5.128	1.000	2.000	3.500
ATradMedia	0.699	2.493	-0.333	0.467	1.800
TweetOther	44.585	71.280	11.500	14.250	27.250
TweetFirm	7.807	22.294	3.000	3.750	5.500
ATweetOther	14.415	50.876	8.217	9.017	11.133
ATweetFirm	2.152	22.904	0.600	1.000	1.383
N	97	97	97	97	97

Notes to Table 5:
All variables are defined in Appendix A.

TABLE 6
Regressions Examining the Effect of Tweeting Activity on Stock Returns Surrounding Announcement of Consumer Product Recalls for Sample of Firms with Twitter Accounts

Panel A: OLS regression

$$ARet_{(0,+3)} = \beta_0 + \beta_1 RecallScale + \beta_2 ATweetFirm + \beta_3 ATweetOther + \beta_4 RecallScale \times ATweetFirm + \beta_5 RecallScale \times ATweetOther + \beta_6 FirmSize + \beta_7 SalesGrowth + \beta_8 HighScore + \beta_9 AGenSM + \beta_{10} ATradMedia + \beta_{11} RecallScale \times FirmSize + \beta_{12} RecallScale \times SalesGrowth + \beta_{13} RecallScale \times HighScore + \beta_{14} RecallScale \times AGenSM + \beta_{15} RecallScale \times ATradMedia$$

Variable	E[Sign]	Coeff	t-statistic
Intercept		-0.0325	-1.63
RecallScale	-	-1.5505*	-1.93
ATweetFirm		-0.0001	-0.89
ATweetOther		-0.0001	-0.68
RecallScale×ATweetFirm	+/-	0.5826**	2.00
RecallScale×ATweetOther	+/-	-0.0073**	-2.30
FirmSize		0.0050*	1.95
SalesGrowth		0.0140	0.31
HighScore		-0.0154*	-1.77
AGenSM		0.0001*	1.80
ATradMedia		-0.0001	-0.12
RecallScale×FirmSize		0.2535*	1.87
RecallScale×SalesGrowth		0.8471**	2.55
RecallScale×HighScore		0.0345	0.54
RecallScale×AGenSM		-0.0619**	-2.14
RecallScale×ATradMedia		0.0175	0.35
Year Fixed Effects		Included	
N		97	
Adj R^2		0.092	

Notes to Table 6:
All variables are defined in Appendix A. *, ** and *** represent significance at 10%, 5% and 1% (2-tailed). All continuous variables are winsorized at the extreme 1%. t-statistics are calculated based on firm-clustered standard errors.

TABLE 6 (continued)

Panel B: Determinants models of levels of tweeting activities

$$Tweet_{(0,+3)} = \beta_0 + \beta_1 Tweet + \beta_2 PctYoungPop + \beta_3 Tech + \beta_4 YoungCEO + \beta_5 RecallScale + \beta_6 FirmSize + \beta_7 SalesGrowth + \beta_8 HighScore + \beta_9 PriorGenSM + \beta_{10} PriorTradMedia$$

Variable	Dep = TweetFirm			Dep=TweetOther		
	E[Sign]	Coeff	t-stat	E[Sign]	Coeff	t-stat
Intercept		4.735	-0.03		29.984	0.82
PriorTweetFirm		0.202***	33.94	+		
PriorTweetOther	+				0.344***	8.62
PctYoungPop	+	-0.005	-0.04	+	-0.333	-0.32
Tech	+	-1.123	-0.75	+	17.824	1.35
YoungCEO	+	-0.358	-0.39	+	-11.989	-1.49
RecallScale		-0.415	-0.24		2.323	0.15
FirmSize		-0.160	-0.82		1.735	1.00
SalesGrowth		4.975	1.38		-26.561	-0.83
HighScore		1.044	1.21		1.813	0.24
PriorGenSM		0.001***	10.22		0.000	0.36
PriorTradMedia		-0.160**	-2.36		0.007	0.01
N		97			97	
Adj R^2		0.971			0.617	

Notes to Table 6 Panel B:
The regressions model the determinants of the level of average daily tweeting activity by other users (TweetOther) and the firm (TweetFirm) in the event window (0,+3). PriorTweetOther and PriorTweetFirm are the levels of average daily tweeting activity by other users and the firm respectively in the pre-event period (-60,-1). PctYoungPop is the percentage of the population that are under 45 in the Metropolitan Statistical Area (MSA) where the firm's HQ is located. Tech is an indicator set to 1 if the firm is in the SIC codes 3570-3579 (computer manufacturing), 3610-3699 (electronic equipment), 7370-7379 (computer and data processing), 3810-3849 (optical, medical and scientific equipment), and 4800-4899 (communications). YoungCEO is an indicator set to 1 if the CEO is below 54, the median age of the CEO in our sample. PriorGenSM is the average daily count of the company name on social media channels (consisting of all public Facebook posts, entire Twitter firehose and blogs hosted by service providers datamined byPeopleBrowsr such as Blogspot, Tumblr and Wordpress) in the pre-event period (-60, -1). PriorTradMedia is the daily number of news articles in the pre-event period (-60,-1). All other variables are defined in Appendix A. All continuous variables are winsorized at the extreme 1%. *, ** and *** represent significance at 10%, 5% and 1% (2-tailed). t-statistics are calculated based on firm-clustered standard errors.

TABLE 6 (continued)

Panel C: 2SLS regression

$$ARet_{(0,+3)} = \beta_0 + \beta_1 RecallScale + \beta_2 IATweetFirm + \beta_3 IATweetOther + \beta_4 I(RecallScale \times ATweetFirm) + \beta_5 I(RecallScale \times ATweetOther) + \beta_6 FirmSize + \beta_7 SalesGrowth + \beta_8 HighScore + \beta_9 AGenSM + \beta_{10} ATradMedia + \beta_{11} RecallScale \times FirmSize + \beta_{12} RecallScale \times SalesGrowth + \beta_{13} RecallScale \times HighScore + \beta_{14} RecallScale \times AGenSM + \beta_{15} RecallScale \times ATradMedia$$

Variable	E[Sign]	Coeff	t-statistic
Intercept		-0.0331*	-1.76
RecallScale	-	-1.465**	-1.98
IATweetFirm		-0.0008	-1.29
IATweetOther		0.0001	0.25
I(RecallScale×ATweetFirm)	+/-	0.8966*	1.83
I(RecallScale×ATweetOther)	+/-	-0.0168*	-1.95
FirmSize		0.0040	1.53
SalesGrowth		0.0176	0.40
HighScore		-0.0166**	-2.06
GenSM		0.0002	1.34
TradMedia		-0.0007	-0.43
RecallScale×FirmSize		0.2220	1.41
RecallScale×SalesGrowth		0.6526	1.54
RecallScale×HighScore		-0.0951	-0.44
RecallScale×AGenSM		-0.0829**	-2.01
RecallScale×ATradMedia		0.1500	0.76
Year Fixed Effects		Included	
N		97	
Adj R^2		0.092	

Notes to Table 6 Panel C:
The "I" that precedes ATweetOther, ATweetFirm, RecallScale×ATweetFirm,and RecallScale×ATweetOther denotes that the four variables are instrumented. All variables are defined in Appendix A. *, ** and *** represent significance at 10%, 5% and 1% (2-tailed). All continuous variables are winsorized at the extreme 1%. t-statistics are calculated based on firm-clustered standard errors.

TABLE 7
Regressions Examining the Effect of Social Media on Analyst Forecast Revisions of Future Sales after Product Recall Announcements

$$SFRev = \beta_0 + \beta_1 RecallScale + \beta_2 Megaphone + \beta_3 Engagement + \beta_4 RecallScale \times Megaphone + \beta_5 RecallScale \times Engagement + \beta_6 FirmSize + \beta_7 SalesGrowth + \beta_8 BrandOnProduct + \beta_9 AGenSM + \beta_{10} ATradMed + \beta_{11} RecallScale \times FirmSize + \beta_{12} RecallScale \times SalesGrowth + \beta_{13} RecallScale \times BrandOnProduct + \beta_{14} RecallScale \times AGenSM + \beta_{15} RecallScale \times ATradMed$$

Variable	(1)			(2)		
	E[Sign]	Coeff	t-statistic	E[Sign]	Coeff	t-statistic
Intercept		0.0109	0.30		-0.0103	-0.31
RecallScale	-	-0.1289***	-3.00	-	-0.3439	-0.54
Megaphone					0.0075	0.62
Engagement					0.0131	1.04
RecallScale×Megaphone				+/-	0.6390**	2.35
RecallScale×Engagement				+/-	-0.6287*	-1.84
FirmSize		-0.0008	-0.20		-0.0006	-0.14
SalesGrowth		0.1888***	2.73		0.1035***	2.69
BrandOnProduct		-0.0253**	-2.19		-0.0148	-1.48
AGenSM		0.0000	0.55		0.0000	0.37
ATradMedia		-0.0004	-0.19		0.0020	1.29
RecallScale×FirmSize					0.0385	0.29
RecallScale×SalesGrowth					-0.3635***	-2.98
RecallScale×BrandOnProduct					-0.3152***	-3.45
RecallScale×AGenSM					-0.0033	-0.89
RecallScale×ATradMedia					-0.2466***	-3.89
Year Fixed Effects		Included			Included	
N		177			177	
Adj R^2		0.099			0.196	

Notes to Table 7:
The dependent variable in the regression, SFRev, is the analysts' sales forecast revision measured as the consensus analysts' sales forecast after the product recall announcement minus the consensus analysts' sales forecasts before the announcement, scaled by market value of equity. All variables are defined in Appendix A. *, ** and *** represent significance at 10%, 5% and 1% (2-tailed). All continuous variables are winsorized at the extreme 1%. t-statistics are calculated based on firm-clustered standard errors.

TABLE 8
Propensity Matched Sample Analysis

Panel A: Logistic regression modeling adoption of social media

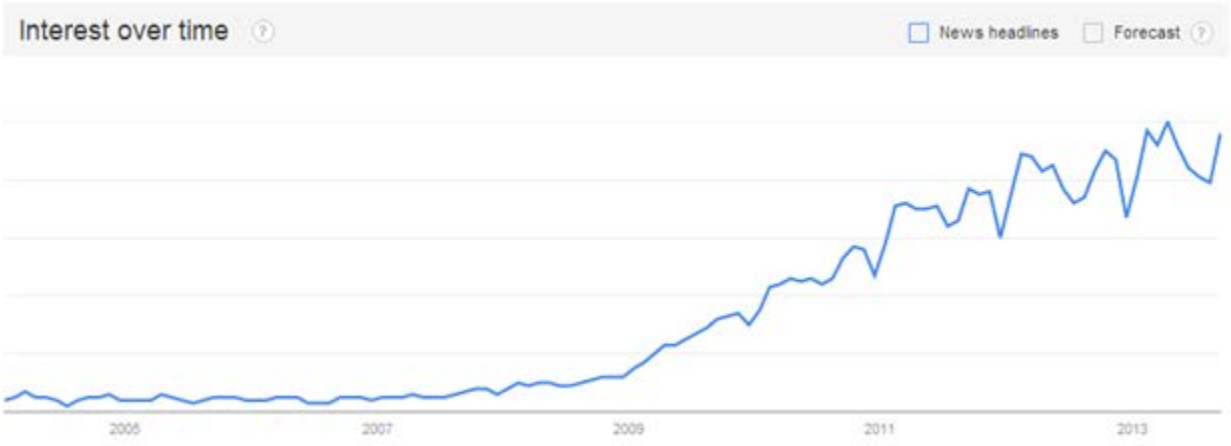
	Coefficient	p-value
Intercept	-1755***	0.00
RecallScale	-1.110	0.15
FirmSize	0.062	0.54
SalesGrowth	0.387	0.81
HighScore	-0.247	0.54
PriorTradMedia	-0.006	0.90
PctYoungPop	0.252***	0.01
Tech	-0.649	0.35
YoungCEO	0.753*	0.08
PriorRecall	0.277	0.56
Year	0.870***	0.00
N	177	
Pseudo R^2	0.214	

Panel B: OLS regression Using Propensity Matched Samples

Variable	E[Sign]	Coeff	t-statistic
Intercept		-0.0463***	-2.67
RecallScale	-	-0.2470***	-3.27
Megaphone		0.0288**	2.23
Engagement		-0.0027	-0.24
RecallScale×Megaphone	+/-	0.1556**	2.20
RecallScale×Engagement	+/-	-0.1367*	-1.71
FirmSize		0.0019	1.56
SalesGrowth		-0.0019	-0.15
HighScore		-0.0069*	-1.76
ATradMedia		0.0014	1.52
RecallScale×FirmSize		0.0426***	2.93
RecallScale×SalesGrowth		-0.0887**	-2.17
RecallScale×HighScore		-0.0320	-1.37
RecallScale×ATradMedia		-0.0571***	-2.88
Year Fixed Effects		Included	
N		262	
Adj R^2		0.091	

Notes to Table 8
The regression in Panel A models the probability of adopting social media using the sample of product recalls from 2008 to 2012. PctYoungPop is the percentage of the population that are under 45 in the Metropolitan Statistical Area (MSA) where the firm's HQ is located. Tech is an indicator set to 1 if the firm is in the SIC codes 3570-3579 (computer manufacturing), 3610-3699 (electronic equipment), 7370-7379 (computer and data processing), 3810-3849 (optical, medical and scientific equipment), and 4800-4899 (communications). YoungCEO is an indicator set to 1 if the CEO is below 54, the median age of the CEO in our sample. PriorRecall is an indicator set to 1 if the firm has a prior product recall before the current recall. PriorTradMedia is the average daily number of news articles in the 60-day period prior to the product recall announcement. The regression in Panel B is based on a sample of firms with social media in the period 2008 to 2012 (n=131) and another 131 firms without social media which are matched to the sample firms using the model in Table 4 Panel B, resulting in a total of 262 product recalls. All variables are defined in Appendix A*, ** and *** represent significance at 10%, 5% and 1% (2-tailed). . All continuous variables are winsorized at the extreme 1%. t-statistics are calculated based on firm-clustered standard errors.

Figure 1
Interest in Social Media Over Time on Google Trends



APPENDIX A
Variable Definitions

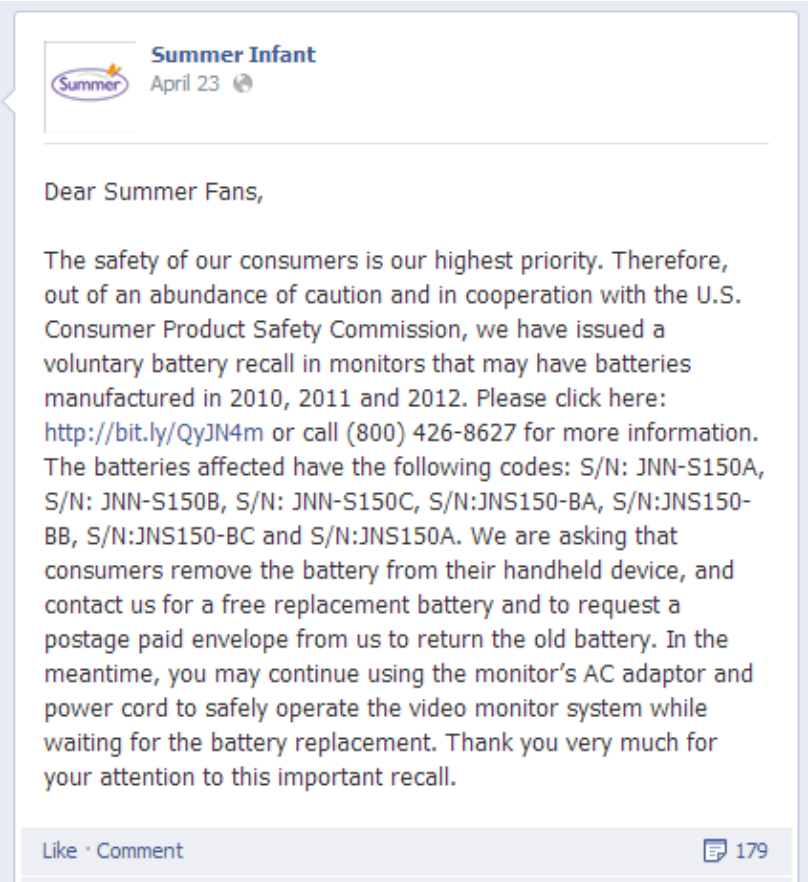
Variable		Definition
ARet (0,+3)	=	Value-weighted market-adjusted cumulative returns for the four-day event window (0,+3) beginning from the day of the product recall announcement.
Recall Scale ($Millions)	=	Unit price of the recalled product multiplied by the number of units affected. Unit price of the product is the selling price of the product or estimated value of a product part.
RecallScale	=	Recall Scale ($Millions) divided by the market value of equity 15 days before the recall.
Megaphone	=	Indicator variable equal to 1 if the company has one of the following at the time of the product recall: blog, RSS, Twitter or Facebook, and equal to zero otherwise.
Engagement	=	Indicator variable equal to 1 if the company has Twitter or Facebook at the time of the product recall, and equal to zero otherwise.
FirmSize	=	Log of market value of equity (prcc_f*csho), measured at the end of the prior fiscal year.
SalesGrowth	=	Sales (sale) at the end of the prior fiscal year (t-1) minus sales at the end of year t-2, divided by sales at the end of year t-2.
HighScore	=	Indicator variable equal to 1 for product recalls with a Score of 2 or higher where Score is the summation of four indicator variables: (i) whether recalled product is categorized as a child-related product, (ii) whether the defective product is classified as a Class A hazard, (iii) whether there has been an incident reported at the time of the recall, and (iv) whether the company's brand is on the product. We follow the CPSC guideline for categorizing hazard: A Class A hazard exists when a risk of death or grievous injury or illness is very likely, or serious injury or illness is very likely. A Class B hazard exists when a risk of death or grievous injury or illness is not likely to occur, but is possible, or when serious injury or illness is likely, or moderate injury or illness is very likely. A Class C hazard exists when a serious injury or illness is not likely, but is possible, or when moderate injury or illness is not necessarily likely, but is possible.
GenSM	=	Average daily count of the company name on social media channels (consisting of all public Facebook posts, entire Twitter firehose and blogs hosted by service providers datamined byPeopleBrowsr such as Blogspot, Tumblr and Wordpress) in the event period (0, +3).
AGenSM	=	Abnormal Gen SM measured as GenSM minus the average daily count in the pre-event period (-60, -1).
TradMedia	=	Average daily number of news articles in event period (0, +3).
ATradMedia	=	Abnormal TradMedia measured as TradMedia minus the average daily number of news articles in the pre-event period (-60, -1).

APPENDIX A (CONTINUED)
Variable Definitions

Variable		Definition
TweetOther	=	Average daily number of tweets associated with the company's Twitter handle tweeted by others in the event period (0, +3).
TweetFirm	=	Average daily number of tweets associated with the company's Twitter handle tweeted by the company in the event period (0, +3).
ATweetOther	=	Abnormal daily tweets by others measured as TweetOther minus average daily number of tweets associated with the company's Twitter handle tweeted by others in the pre-event period (-60, -1).
ATweetFirm	=	Abnormal daily tweets by the firm measured as TweetFirm minus average daily number of tweets associated with the company's Twitter handle tweeted by the firm in the pre-event period (-60, -1).

APPENDIX B
Examples of Social Media Posts

Examples of Megaphone



The post stresses that the safety of consumers is a priority. It contains a link to the company's website which has the official CPSC announcement, an online form to complete to order the free replacement, and a detailed FAQ.

The tweet contains the same link.

Examples of Engagement

Yes..I have had many issues and was told no complaints were filed..now a recall?

My Connect Plus overheats constantly and has to be turned off to cool down, but isn't included in the recall- how can I get a new battery for this issue?

Totay explains why my monitor keeps going out and doesn't work properly! I have two of the cameras as well and they don't always work either. Sometimes the screen gets all multi-colored and greenish! Have to turn it off for a while and usually it comes back on. Both of them do this it's very strange. The other day my monitor showed my sleeping daughter as she walks into the living room I'm confused because it still shows her sleeping! Very weird and crazy!

Disgusting that customers with the summer infant baby monitor affected by the recall have to wait 4 weeks for a new & safe battery!!! In the mean time, using a plug to view our baby while he sleeps is not only inconvenient but an unsatisfactory option given we spent almost $300.00 on this monitor in the first place to not have to be married to a wall plug in! Not happy with Summer Infant products as a result, more should be done regarding the recall~if batteries aren't available immediately then the entire unit should be taken back from the original store purchased or your company & a new comparable replacement should be immediate to the consumer...will be the last Summer Infant product I ever buy! ~Mom of a 9 month old...with another on the way!

Like · Comment · 19 hours ago near Norwalk, CT

likes this. Top Comments

The customer service with this company is atrocious. Worst I've ever seen.

Like · Reply · 1 · about an hour ago

Summer Infant Hello We received your private message and our Consumer Relations Manager will call you directly. Thank you.

6h

Appreciate that @summerinfant decided to voluntarily make this recall! Will feel safer if the battery is cooler. Mine's rather hot now.

Expand Reply Retweet Favorite More

Summer Infant, Inc. @summerinfant · 4h

@ Thank you very much. We appreciate your note as the safety of our consumers is our highest priority.

Hide conversation Reply Retweet Favorite More

I haven't purchased my monitor yet but I will now be demanding one from your company because of the awesome customer service you are showing on Facebook of all places. Thank you for proving it's not hard to respond to your customers respectfully and promptly!