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

Abstract

We examine how corporate social media affects the capital market consequences of firms' disclosure in the context of consumer product recalls. Product recalls constitute a "product crisis" exposing the firm to reputational damage, loss of future sales and legal liability. During such a crisis it is crucial for the firm to quickly and directly communicate its intended message to a wide network of stakeholders, which in turn, renders corporate social media a potentially useful channel of disclosure. While we document that corporate social media, on average, attenuates the negative price reaction to recall announcements, the attenuation benefits of corporate social media vary with the level of control the firm has over its social media content. In particular, with the arrival of Facebook and Twitter, firms relinquished complete control over their social media content, and the attenuation benefits of corporate social media, while still significant, lessened. Detailed Twitter analysis confirms that the moderating effect of social media varies with the level of firm involvement and with the amount of control exerted by other users: the negative price reaction to recall is attenuated by the frequency of tweets by the firm, while exacerbated by the frequency of tweets by other users.

Keywords: Social Media, Disclosure, Product Recalls

JEL classification: M40, M41, G14, M15

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 disclosure channel for important information. In April 2013, the SEC announced that companies may use social media outlets to announce key information in compliance with Regulation Fair Disclosure.[1] Despite the increasing attention from regulators and companies, there is limited evidence on the consequences of corporate use of social media and even less on the differential impact of various social media platforms.[2] In this study, we attempt to shed light on these issues.

Compared to traditional disclosure channels, social media allows a firm to directly and quickly reach a large network of stakeholders with its intended message. To illustrate, followers of a firm's social media account(s) get instant notifications of corporate news; they can share the news immediately with their friends and followers, cascading into widespread reach of the firm's intended message. Through the use of corporate social media, the firm can bypasses information intermediaries and disseminate their intended message, unfiltered by traditional media, to a large network of users. In addition, social media outlets such as Facebook and Twitter facilitate multi-directional interactions that allow users to have an online "conversation" with the firm and with other users, which changes the dynamics and nature of the corporate disclosure.[3]

[1] See http://www.sec.gov/News/PressRelease/Detail/PressRelease/1365171513574. Netflix announced soon after the SEC announcement that it may use social media channels such as Twitter, Facebook, and its own corporate blogs as outlets for disclosing material information (Bensinger 2013).

[2] A noteworthy exception is Blankespoor, Miller and White (2014), who document that tech firms using Twitter to disseminate links to firm-initiated press releases experience lower information asymmetry.

[3] Sophisticated investors have caught on to the wealth of information on social media. Anecdotal evidence suggests that hedge funds are beginning to track and dissect social media content to gain insights into investor and consumer sentiment, aided by social media aggregator services such as Gnip (see Or 2011 and Conway 2012).

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). A product recall constitutes a "crisis" in the firm's product market. As is the case with most corporate crisis, the primary goal of a recalling firm is to contain the harm and limit and repair damage to the firm's reputation. Social media is likely to be a useful disclosure channel within the crisis context. As previously mentioned, a firm's social media platform (hereafter referred to as corporate social media) facilitates quick, direct broadcasting of the firm's intended message to a broad base of stakeholders. Timely disclosure of the recall to a large network of users is an effective way to contain the damage. It gets more consumers to stop using the potentially hazardous product sooner, thereby reducing the number of incidents, which in turn minimizes the negative publicity surrounding the recall as well as the associated legal liability.

In addition, firms can use their social media posts to augment the disclosure content provided in the official Consumer Product Safety Commission (CPSC) recall announcements with additional clarifications, reassurances, and planned course of actions. A product recall increases uncertainty about the firm and its products, and leads to a greater demand for information from customers and investors alike. Social media use enables the firm to quickly fill the information vacuum with its own message, before misinformation, rumors and speculation intensify the crisis. Through consistent and continual communication, the firm can demonstrate its competence in handling the crisis and show concern and empathy for those affected by the product hazard, thereby lessening stakeholders' negative perceptions of the firm in the wake of the recall. This ultimately helps the firm regain credibility and repair its reputation.

While corporate social media is likely to be useful in managing a product crisis, there is one potentially important downside to its use: the bad news is spread to a wider audience. This

can be detrimental to a firm's reputation and its future sales as more consumers learn about the problems with the firm's product. In the end, it is an empirical question whether corporate social media provides net benefits during a product recall.

Using a sample of 405 consumer product recalls between 2000 and 2012, we examine whether corporate social media affects the market reaction to product recall announcements.[4] We focus on the market reaction because it is an overall measure of the costs of a recall (Jarrell and Peltzman 1985, Barber and Darrough 1996, Davidson and Worrell 1992). Not surprising, prior research documents a significant, negative market reaction to consumer product recalls (Pruitt and Peterson 1986, Chen, Ganesan and Liu 2009). Our evidence demonstrates that recalling firms with any of the four social media platforms we examine (corporate blogs, RSS, Facebook and Twitter) experience a less pronounced negative price reaction to their recall announcements than firms with no social media accounts.

We initially treat the four social media platforms as homogenous. However, we recognize that social media platforms differ in their features, and the available technology and norms of social media evolved over our sample period. In the early 2000s firms were largely limited to non-interactive social media platforms, specifically corporate blogs and RSS feeds as channels of direct online communication with a broad set of stakeholders. After 2008, however, Facebook and Twitter, two interactive networking platforms, become the dominant choice for corporate use of social media (Jung, Naughton, Tahoun, and Wang 2013).

When a firm establishes a corporate account on Facebook or Twitter, the online community (including customers and investors) can converse among themselves as well as with

[4]The CPSA defines "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).

the firm in a multi-way dialogue viewable by all on this central platform. With these relatively open, interactive social media platforms, a recalling firm relinquishes full control over the content appearing on its corporate social media.[5] Other users now have the opportunity to broadcast their messages on the firm's social media channel, potentially diluting or even distorting the firm's intended message, interjecting rumors and speculation, or voicing negative sentiment. This is in sharp contrast to non-interactive social media platforms where the firm tends not to share control over the content with other users.

In the context of a recall, it is unclear whether the interactive feature of corporate social media provides net benefits or costs. On the one hand, interactivity gives disgruntled customers a forum to air their negative views not only with the firm but with other stakeholders.[6] If these negative views gain traction with the firm's online following, its interactive social media accounts can facilitate a "viral distribution" of negative sentiment, exacerbating the negative perceptions of the firm and its products. On the other hand, interactive social media enables the firm to monitor user concerns (including otherwise hidden user-to-user dialogue) and respond accordingly. Through dialogue with its online following, the firm has the ability to direct and influence conversations, and to demonstrate its sensitivity to customer needs and concerns. If effective, this can help the firm appease angry customers and rebuild its reputation. Thus, it is unclear *ex ante* whether the potential costs from losing control of the online dialogue outweigh the possible benefits of being able to monitor and influence the direction of the online dialogue.

[5] Communications literature suggests that during a crisis, control over the information flow is crucial, with the loss of control leading to greater negative consequences (Coombs 2007, Gonzalez-Harrero and Smith 2008, Wigley and Zhang 2011).

[6] While disgruntled customers could air their negative views on any interactive social media site, we expect them to seek a relevant, sympathetic audience and thus migrate to the firm's corporate site as it provides a common forum.

Once again, it is an empirical question whether there are net benefits to using interactive corporate social media in the context of product recall.

With the exogenous shift in the available technology from the early to the latter part of our sample period, we have a relatively clean empirical setting within which to explore whether the evolution to more interactive social media changed the effects of social media. Empirically, we document two findings: First, within the context of product recalls the overall effect of corporate accounts on Facebook and Twitter is still positive. That is, compared to firms with no social media, the negative stock price reaction to product recall announcements is less pronounced for firms with interactive corporate social media. Second, we find that the attenuation benefits of interactive social media are significantly lower than those provided by corporate blogs and RSS feeds. We interpret this latter finding as suggestive that the loss in control over social media content diminishes the overall benefits of corporate social media.

To strengthen our interpretation of the findings related to interactive social media, next we directly examine user and firm Twitter activity during a product recall. We focus on Twitter, an interactive social media platform where we can obtain activity data (tweets).[7] In this analysis, we identify all Twitter activity that involves a recalling firm's Twitter handle (e.g. @SummerInfant). We then examine how the price reaction to product recalls varies with the abnormal levels of firm and user tweets around the recall. Our results show that the negative market reaction to a recall is exacerbated by the number of tweets by other users, but attenuated by the number of tweets by the firm. These findings suggest that when other users have control of the corporate social media content, they can dilute or distort the firm's message and lower the

[7] Data limitations prevent us from exploring actual activities on corporate blogs, RSS feeds and Facebook.

benefits of corporate social media. In contrast, recalling firms actively engaged in the online dialogue appear to be able to influence stakeholders' perceptions and lessen the damage.

Our work contributes to new research that examines the capital market consequences of using social media to disseminate corporate news (Blankespoor et al. 2014).[8] We show that disclosure through corporate social media in the context of a product recall has a real effect on firm value, i.e., it alters the nature and total costs of a product recall via direct messaging to a wide network of users. This study also extends the literature by exploring the effects of the interactive feature of newer social media platforms and the role of control over corporate social media content during a negative event.[9] These findings provide insights to managers and regulators on the likely effects of using corporate social media as a disclose channel.

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

The next section provides the background and develops the hypotheses. Section 3 describes the research design and sample selection. Section 4 presents the results using all four

[8] Blankespoor et al. (2014) document that using Twitter to disseminate links to firm-initiated press releases lowers information asymmetry. However, they do not examine whether the use of Twitter affects the stock price reaction.
[9] We note that Mayew (2008) suggests that managers attempt to control the flow of information even in non-crisis settings, specifically earnings conference calls. Mayew demonstrates that favorable analysts are about two and one-half times more likely to ask a conference call question than unfavorable analysts. He interprets this as evidence that managers use their discretion to discriminate among analysts granting more participation to more favorable analysts.

social media platforms. Section 5 presents the results using detailed Twitter activity. 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 people to create, share and exchange information in virtual communities and networks. Social media are distinct from traditional media (newspapers, television and radio) as they are comparatively accessible enabling anyone to publish information. From a corporate disclosure perspective, corporate social media facilitates firm-directed, one-to-many communications that bypass the traditional media and permits a firm to broadcast its intended message to a large network of stakeholders.

For firms that desire to utilize social media as a disclosure channel, the technology and norms of social media have evolved over time. Blogs and RSS were the early forms of social media that enabled users to directly broadcast their thoughts to others. Blogs became increasingly widely adopted from around 2000 with the launching of several popular blogging platforms (LiveJournal, Blogger). The first version of RSS came out in 1999 and its adoption grew alongside blogs as it was an efficient way for users to keep track of updates across diverse blogs. Twitter and Facebook were the next evolution of social media. These network-based platforms provide one-click ways for users to share updates with one another. Both gained popularity in the late 2000s, with their popularity exploding by 2010.[10] In addition to broadcasting, Facebook and Twitter provide an open arena where people are free to exchange ideas on companies and products. These interactive platforms facilitate direct, multi-way

[10]Twitter was founded in 2006 but only gained popularity in 2009 and exploded in popularity in 2010 with 105 million registered users. Facebook was open to everyone in late 2006 and by 2010 had 608 million active users.

engagement between firms and stakeholders, permitting firm-to-user and user-to-firm as well as user-to-user exchanges with the various exchanges readily observable to all.

2.2 Consumer Product Recalls

Consumer product recalls occur when a firm's consumer product (toys, electronics, and household products) fails to meet a safety standard under the 1972 Consumer Product Safety Act, contains a defect that could cause substantial harm, 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 CPSC.[11] The staff of the CPSC then conducts a 'risk analysis' to assess whether a recall is needed. While the Commission has the power to mandate a product recall, "virtually all consumer product recalls in the U.S. are voluntary" (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(s). 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 (CPSC Recall Handbook 2012 p.18). To achieve these objectives, the Commission

[11]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."

sends the joint news releases to all major media outlets. 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.

2.3 Hypotheses Development

A product recall constitutes a "product crisis", where the primary goals of the firm are to minimize the "product harm" and to limit and repair damage to the firm's reputation and its brand equity.[12] The use of corporate social media during a product recall is likely to help the firm achieve its primary goals in several ways.

First, social media allows the firm to reach a larger network of users quickly with the details of the product hazard, which helps the firm achieve the "one universal goal of crisis communication: to reduce and contain harm" (Seeger 2006, p. 234). By increasing consumer awareness of the product harm in a timely manner and getting them to stop using or return the hazardous product, the firm can limit the negative publicity surrounding the recall and reduce the firm's legal liability associated with the product hazard.[13]

Second, social media enables a firm to provide quick, consistent and continual disclosure to its customers and stakeholders. As in most crisis situations, product recalls create uncertainty and increase demand for information by customers and investors alike. Amid this information vacuum, it is important for the firm to get its intended message out first, ahead of misinformation, rumors and unfounded speculations that could otherwise worsen the situation. If the firm is not forthcoming, the public will get information from other sources, and the firm will

[12] In the event of a product recall, evidence in the marketing literature suggests that a "firm's response to a product harm crisis has a profound impact on customer-based brand equity" (Dawar and Pillutla 2000, p. 216).
[13] Product liability litigation can be costly for the firm due to damage payments, legal fees and reputation loss associated with the negative publicity surrounding a lawsuit (Prince and Rubin 2002).

lose the ability to manage the crisis message (Seeger 2006). Recalling firms with social media platforms can augment the information provided in the official CPSC recall announcement and provide additional details on how the firm is dealing with the recall and addressing related quality concerns. Through consistent and continual communication, the firm can demonstrate its competence in handling the crisis, show concern and empathy for those affected by the product hazard, and lessen stakeholders' negative beliefs about the firm. All these actions can help the firm regain its credibility and begin the process of rebuilding its reputation and brand equity.

While the ability to reach a large network of user quickly and directly can help the firm manage the product crisis, the potential cost is also obvious. It is possible that spreading the bad news to a wider network of users can be damaging to the recall firm's reputation: more people will learn about the product problems and regard the firm and its products negatively.

Overall, we expect corporate use of social media to influence the consequences of a product recall by affecting a firm's reputation loss and its product liability. The totality of these effects will 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: Corporate social media has no moderating effect on the negative price reaction to product recall announcements.*

While all social media platforms facilitate direct messaging to a large network of users, the more interactive corporate social media platforms, such as Facebook and Twitter, also permit direct engagement between the firm and other users (including its customers and investors) as well as among the users. There are likely benefits and costs associated with this interactivity.

The likely benefit is that with interactive social media the firm is able to observe and directly respond to customers' inquiries with accurate information, empathy and even regret.

Firms can use the interactivity to monitor customer concerns and ensure that customers understand the instructional information provided in the official press release, for example, how to remedy the product hazard. They can use the platform to mediate and direct the online conversation and correct any inaccuracies. These actions can help the firm regain its credibility and lessen the public's negative view of the firm and its products.

However, because these platforms encourage multi-directional dialogue, the firm relinquishes full control over its social media content. During a product recall, these more open, interactive forums can become "lightning rods" for negative sentiment, as disgruntled customers are drawn to these sites to voice their negative opinions. This is especially so since anger spreads faster and further online than other emotions (Berger and Milkman 2012, Fan, Zhao, Chen, and Xu 2013). With conflicting information and negative opinions posted by online users, as well as the potential for "viral distribution" of misinformation or negative sentiment, interactive social media can exacerbate the negative market reaction to product recalls.[14]

To summarize, interactive social media provides firms with the ability to monitor and mediate the online conversation. However, with interactivity firms also relinquish some control over the content on their corporate social media, creating a magnet for negative sentiment that easily spreads. Given the pros and cons of interactive social media, it is an empirical question which effect, the monitoring or the loss of control, dominates in the context of a product harm crisis. We state our second hypothesis in its null form:

> *H2: Compared to non-interactive corporate social media, interactive corporate social media has no moderating effect on the negative price reaction to product recall announcements.*

[14]Practitioners and researchers agree that the key to effective crisis management is to control the flow of information during the crisis. They note that the rise of social media networks has added new challenges for firms attempting to maintain control of the conversation during a product crisis. (See Wigley and Zhang 2011, Gonzalez-Harrero and Smith 2008.)

To shed light on the particular mechanisms through which interactivity affects the market reaction to product recalls, next we use detailed Twitter data to directly measure the level of intervention by the firm and the amount of control exerted by other users. During the product crisis, angry customers can usurp control of a firm's Twitter account to vent their negative emotions. The negative sentiment can become magnified and spread virally through these tweets, thereby exacerbating the negative market reaction to product recalls. On the other hand, firms can tweet with clarifications, remedies or even apologies, potentially attenuating the negative impact of the recall on its stock price. This leads to our third hypotheses:

> *H3: The negative price reaction to product recalls is exacerbated when other users take control and attenuated when the firm exercises control over the firm's interactive corporate social media.*

3. Research Design and Sample Selection

3.1 Basic Regression Model

A product recall is a crisis in a firm's product market that is likely to be costly. The costs include those directly associated with the recall process itself (e.g., outlays for recall notices, product replacements and refunds) as well as indirect costs of reputational damage and loss of future sales. These costs likely vary with the scale of the recall. Intuitively, recalls of a larger scale lead to greater costs to remedy the defective units. Larger scale recalls are also likely to generate more negative publicity and result in greater loss of future sales.

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 Peltzman1985).

Deflating both sides of the equation by a firm's pre-event market value leads to

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

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 β indicates whether and how recall scale relates to investors' expectations of these overall costs of the product recall.

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

$$\beta = \theta_0 + \theta_1 SocialMedia + \theta\ Controls \quad (3)$$

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

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

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

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

$$\begin{aligned} ARet_{(event)} = \gamma_0 + \gamma_1 SocialMedia + \gamma Controls + \theta_0 RecallScale + \theta_1 RecallScale \times SocialMedia + \\ +\theta\ RecallScale \times Controls + \epsilon \end{aligned} \quad (5)$$

Our main variable of interest, θ_1, measures whether social media mediates the impact of *RecallScale* on firm value. We mean-adjust all continuous control variables to allow for the interpretation of the coefficient on the main variable of interest (i.e., RecallScale x Social Media) when these covariates are evaluated at their means.

3.2 Sample of Product Recalls

We focus on product recalls administered by the CPSC between 2000 and 2012. From the CPSC website (http://www.cpsc.gov/en/), we obtain 816 product recalls by firms on *Compustat*. We exclude 291 recalls where the firm issuing the announcement is not the 'responsible' party.[15] We also exclude 19 recalls with no stock return data on *CRSP* and 101 recalls with insufficient details in the recall announcement to estimate the scale of the recall.[16] The final sample consists of 405 product recalls between 2000 and 2012. Table 1 Panel A summarizes the sample selection procedure. We also construct a subsample of 177 recalls between 2008 and 2012. For this time period we are able to obtain the data needed to measure activities in general social media space (not just corporate social media).[17] Hence, we use this subsample to ensure that the main findings are robust after controlling for other general social media activity.

We hand collect from the official CPSC recall announcements details about the 405 product recalls. As discussed in Section 3.1, we expect the total cost of a recall to vary with the scale of the recall. Based on prior research (Jarrell and Peltzman 1985, Pruitt and Peterson 1986), we estimate the scale of the recall as the number of recalled units multiplied by its price, where the unit price is the retail price of the product or a part depending on what is being recalled.[18]

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[15] We identify the responsible party as the firm whose name appears on the joint announcement with CPSC, and who is responsible for providing a remedy. For example, if Columbia, Amazon, Bass Pro Outdoor World all recall Columbia jackets, we only include the recall by Columbia.

[16] These include large ticket items (e.g., all-terrain vehicles) with a particular part being recalled and the value of the part is not estimable. See footnote 18 for more details.

[17] Additionally, the Consumer Product Safety Improvement Act of 2008 not only holds companies liable for the problems that lead to a recall but also for the effectiveness of the recall itself. Practitioners argue that this act contributed to the observed shift towards best practice, i.e., the adoption of social media (Kerley 2011: http://mashable.com/2011/03/28/social-media-product-recalls/).

[18] In the event a retail price range is listed, we take the midpoint. If 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, we use the price of the part. Because it is often difficult for consumers to separate a hazardous part from the whole product, frequently whole products are recalled. However, there are some large ticket items (e.g., large appliances and gym equipment) for which only a part is recalled. For these recalls, we obtain a reasonable estimate of the price of the part if it is not given in the recall announcement by emailing or calling the firms for an estimate of the value. Despite the steps taken, we were

Consistent with Eq. (2), we deflate the dollar value of recall scale by the market value of equity 15 days prior to the recall announcement date (*RecallScale*).

3.3 Measuring Corporate Social Media

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, Google+, Pinterest, and Instagram.[19] We treat RSS feeds and corporate blogs as forms of blurb, and include Twitter and Facebook. We exclude Google+, Pinterest and Instagram because these platforms were in the early stages of adoption during our sample period.[20]

To determine whether the firm has an existing social media account at the time of the recall, we rely on various sources. For Facebook and Twitter, we obtain the firm'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 corporate website whether the firm provides RSS feeds or has a blog as of January 2013. We then determine if the firm had a blog or RSS feed *at the time of the product recall* by looking at the firm's initial entry, contacting companies, and looking into archived web pages on the Wayback Machine.[21]

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unable to obtain reasonable estimates for several large ticket items such as all-terrain vehicles. Hence, we exclude these recalls from our sample as detailed in Table 1.

[19] http://www.cpsc.gov/en/Business--Manufacturing/Recall-Guidance/Social-Media-Guide-for-Recalling-Companies/

[20] Google+ was opened to individuals 13 years or older in the U.S. in January 2012. In the two product recalls in our sample where Google+ is adopted, Twitter and/or Facebook were also adopted. Similarly, Pinterest only began to gain traction at the beginning of 2011. In the 10 product recalls in our sample where Pinterest was adopted, the firm also had another corporate social media channel. Hence, our findings are not affected by the inclusion / exclusion of Google + or Pinterest. Finally, firms tend to use Instagram within their Twitter or Facebook accounts.

[21] The Wayback Machine archives about 240 billion web pages beginning from as early as 1996. It does not hold daily archives but displays archived web pages at various random intervals. In the earlier period, 2000-2007, the information is more sparse making it a less reliable source of data. For recalls in the earlier sample period, it is in general more difficult to determine whether the firm had a corporate blog or RSS feed *at the time of the product recall*. In addition to more limited archives of web pages, department personnel contacted by us also had less

We define an indicator variable, *SocialMedia*, as one if the firm has any of the four social media platforms (corporate blog, RSS feeds, Facebook or Twitter) at the time of the recall and zero otherwise. Table 1 Panel B shows the distribution of product recalls by *SocialMedia* and social media channels. Out of the four social media channels, Facebook and Twitter facilitate more extensive interactions with group formations and networking effects among users.[22] A second indicator variable, *Interactive*, is one for firms with Facebook or Twitter accounts at the time of their recall announcements and zero otherwise.

Table 1 Panel C shows that there is an increase in the use of social media over the sample period, 2000 to 2012. In the early part of the sample, pre 2007, about a third of the recalls had social media. Early adopters used non-interactive social media platforms, because Facebook and Twitter were not yet available. Post 2008, over 50% of the recalls used social media and over 80% of the social media firms used Facebook or Twitter. By 2012, the last year in our sample, 97% of the recalls use social media and all of them used Facebook or Twitter. The adoption pattern of social media platforms documented in Table 1 Panel C suggests that firms tend to gravitate towards the "best" available technology, moving towards adoption of interactive platforms when they became available, post 2008.[23]

3.4 Control Variables

accurate information about the start dates. While it is possible that we misclassified the start date of a firm's blog or RSS feed, it is unlikely that the measurement error is systematic. When we re-ran our main analyses excluding observations for which we are unable to verify whether the firm had a corporate blog or RSS feed as of its recall announcement (18% of the sample), the tenor of the findings is unchanged. Specifically, in tests of H1 (Table 4), the coefficient on *RecallScale*×*SocialMedia* is 0.1009 ($p<0.01$).

[22]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 the current date (instead of on the date of the product recall announcement). Thus, we opted not to collect this data.

[23] These adoption trends are largely consistent with findings reported in Jung et al. (2013).

We have three categories of control variables: 1) controls for media other than corporate social media, 2) controls for recall characteristics and 3) controls for firm characteristics.

To draw inferences on *corporate use* of social media, our analysis needs to control for the overall effects of traditional media and other general social media activity during the event window. We measure traditional media activity (*ATradMedia*) as the average daily number of press articles found on *Factiva* with the firm's name mentioned in the headline or the lead paragraph in the event window (0, +3), minus the average daily number of articles in the pre-event period (-60, -1). Similarly, we measure general social media activity (*AGenSM*) as the average daily number of times the firm's name is mentioned on public blogs, Facebook or Twitter in the event window (0,+3), minus the average daily number of times it is mentioned on these outlets in the pre-event period (-60,-1). [24]

Ceteris paribus, the market reaction to a recall announcement is likely to vary with several recall characteristics. Specifically, a recall of a child-related product is likely to generate more negative publicity, leading to a larger negative price reaction, as are recalls following reported incidents, injuries or deaths resulting from the product hazard. Recalls of products classified as having a higher hazard level are also likely to involve greater overall costs. Lastly, a recalled product that carries the firm's brand name is likely to generate negative spillover effects to the firm's other branded products, thereby increasing the total overall costs of the recall. We construct a single score variable (*Score*) to aggregate and summarize the recall characteristics that likely result in higher overall recall costs due to their effects on reputation loss, future sales

[24] *GenSM* is a summary measure based on the number of counts of the firm's name on several public social media channels that are datamined by PeopleBrowsr. We cannot, however, separate activity attributed to corporate social media sites versus general social media sites within this rather rudimentary frequency measure. This measure is only available from 2008 onwards.

and higher expected litigation costs. Specifically, *Score* takes on a value from 0 to 4 based on whether the recall has the following four characteristics: (i) a child-related product, (ii) at least one incident reported at the time of the recall announcement, (iii) a Class A hazard (where the risk of death or grievous injury or illness is "very likely"), and (iv) the firm's brand name on the recalled product. Table 1 Panel D provides descriptive statistics for this *Score* variable. For ease of interpretation, we split the sample using an indicator variable *HighScore*, equal to one for the 233 recalls with a *Score* of 2 or greater.[25]

Finally, we control for firm characteristics, *FirmSize* and *SalesGrowth*. In addition, we examine all CPSC recall announcements available on their website to determine whether a firm has had a prior recall, and create an indicator variable, *PriorRecall*.

3.5 Descriptive Statistics

Following prior literature, we examine several short-window cumulative abnormal returns.[26] We begin our event window from the official CPSC announcement date (day 0) on the premise that pre-event leakage is unlikely for consumer product recalls since a recall firm is required to announce the recall jointly with the CPSC. Table 2 Panel A presents the mean and median CARs over the event windows (0,+1), (0,+2), and (0,+3). The event window CARs all are negative and statistically significant.[27] Ranging from −0.6% to −0.9%, the magnitudes of the

[25]In the online appendix, we present additional analyses to demonstrate that our findings are robust to using *Score* instead of *HighScore* and disaggregating *Score* into its components.

[26]Prior studies of the market reaction to product recalls rely on market efficiency and tend to focus on short windows surrounding the recall announcements. Jarrell and Peltzman (1985) show that the market reaction to drug recalls is complete from 5 days before the announcement to 5 days after. Barber and Darrough (1996) document a negative market reaction to automobile recalls using a 2-day (0, +1) window. Both Pruitt and Peterson (1986) and Davidson and Worrell (1992) find that the negative market reaction to non-automobile recalls is confined primarily to the 3-day window (-1, +1). Finally, Chen et al (2009) use a single-day event window, the official CPSC announcement date (day 0), to examine the market reaction to announcements of consumer product recalls.

[27] Product recall announcements are prompted by the discovery of product hazards, and therefore are unlikely to be clustered in time. Thus as expected, when we examine our data for evidence of event-day clustering, we find that

mean CARs are comparable to those reported in Chen et al. (2009). The percentage of firms with negative CARs is around 55% to 56% and is statistically different from 50%.

To examine whether the market reaction to recalls is largely confined to the event windows discussed above, we also report the CARs for the (-3, -1) and (+4, +10) windows. Examining these two additional windows allows us to note whether the recalls were anticipated and whether the market over or under reacted to the initial recall news. The results indicate that neither the pre-event nor the post-event CARs is statistically significant, providing support for the maintained assumptions that the market is fairly efficient and that the product recalls are in general unanticipated. In Panel B of Table 2 we split the sample by whether the recalling firm has corporate social media at the time of its product recall announcement. There are no significant differences in the event and non-event window CARs for the two sub-samples.

While the mean and median event window CARs reported in Panel A are negative and statistically significantly, the magnitudes are fairly modest ranging from −0.3% to −0.9%. However, we expect the magnitude of the market reaction to vary with the scale of the recall, with larger recalls eliciting significantly greater negative reactions. To demonstrate this relation, we sort the sample into low, medium and high terciles based on recall scale (*RecallScale*) and report the mean and median four day event window CAR(0,+3) for each tercile. Consistent with our expectation, Table 2 Panel C reports that the mean (median) CAR monotonically decreases from 0.1% (0.2%) in the low tercile to −1.9% (−1.1%) in the high tercile.[28]

less than 5% (22 out of 405) of the recalls overlap, and deleting the 22 observations leaves the inference from Table 2 unaffected (e.g., mean CAR (0,+3) =-0.083, p=0.002).

[28]The Pearson correlation between $CAR_{0,+3}$ and *RecallScale* is −0.152 (p<0.01) and the Spearman correlation is −0.128 (p=0.01). Thus, there appears to be a consistently negative relation between $CAR_{0,+3}$ and *RecallScale*.

Table 3 Panel A reports the descriptive statistics for the variables used in our regression analyses. See Appendix A for detailed variable definitions. The main variable used to capture the market reaction to the recalls is $CAR_{0,+3}$. We include three additional days following the announcement to allow social media activities to be fully impounded by the market. There is substantial variation in the scale of the product recalls in our sample, and the distribution is positively skewed, as indicated by the fact that the mean dollar value of the recalls is $18.228 million while the 75th percentile is $6.695 million, and the median is only $852 thousand. Similarly, the deflated variable, *RecallScale*, has a mean of 4.8% while the 75th percentile is 0.8%, and the median is only 0.2%. This variation reflects the nature of product recalls; not all consumer product recalls are significant economic events, yet some are quite sizeable.[29] It is interesting to note that the mean and median of *ATradMedia* are 0.885 ($p<0.01$) and 0.583 ($p<0.01$) respectively, indicating that there are more news articles about recalling firms during the event period (0,+3) relative to the pre-event period (-60,-1). There is also evidence that the abnormal level of overall social media activity increases for the recalling firms during the event window, as indicated by a positive median for *AGenSM* (median=0.293; $p<0.01$).

In Table 3 Panel B, we compare recalling firms with and without corporate social media and present difference in means tests for the continuous variables and difference in proportions tests for the discrete variables. The first three columns present these tests for the full sample; the last three columns for the subsample between 2008 and 2012. Within the full sample, compared to firms without social media, social media firms are larger, experience lower sales growth, attract more traditional media activity on days surrounding the product recall announcement, and

[29]Additional analyses using approaches that exclude influential outliers and robust regressions demonstrate that our results are not driven by influential outliers. We discuss these robustness tests in Section 6.4 and in the online appendix.

are more likely to have had a prior recall. The proportion of product recalls with *HighScore* is lower for firms with social media than for those without social media. Within the sub-sample, again there are several significant differences between firms with and without corporate social media. Specifically, firms with interactive social media are larger, experience less negative event window returns, and have a higher level of general social media activity around the recall announcement. These significant differences highlight the need for our control variables in the regression analyses that follow.

4. Regression Results

To examine whether the negative market reaction to product recall announcements is moderated by corporate social media we estimate Eq. 5 in Section 3.1 and present the results in Table 4 for both the full sample 2000-2012 and the subsample 2008-2012.[30] For the full sample, we are not able to control for activity on social media channels beyond the firm's corporate channels, i.e., social media content not controlled by the firm. In particular, there could be systematic differences in the level of general social media activity between firms with and without social media (as indicated in Table 3 Panel B). Thus, to demonstrate that the use of corporate social media has a unique and important impact on product recalls beyond the effects of general social media activity, we repeat the analysis using the subsample, where we are able to obtain measures of general social media activity. The sample size drops to 177 recalls. Since the

[30]To demonstrate that the market reaction is more negative for recalls of larger scale, we also estimate a baseline model that ignores the effect of social media, and document a negative and significant coefficient on *RecallScale*. For the full sample in the baseline model the coefficient on *RecallScale* is −0.0267 and the t-stat −1.66; for the subsample the coefficient on *RecallScale* is −0.0502 and the t-stat −2.84.

main inferences are consistent across the two samples, we focus our discussion on this latter sample which controls for general social media activity.[31]

As shown in Table 4, the coefficient on *RecallScale* is negative and significant (coefficient=-0.5648), indicating that, for firms without social media, the market reaction is more negative for recalls of larger scale. The coefficient on *RecallScale*×*SocialMedia* is positive and significant (coefficient =0.1695), suggesting that corporate social media attenuates the negative relation. As noted previously, for ease of interpretation, we have mean-adjusted all continuous control variables. As a result, the attenuation effect of social media can be calculated as the ratio of the coefficient on *RecallScale*×*SocialMedia* and the coefficient on *RecallScale* for any increase in recall scale. In terms of economic significance, for a hypothetical "mean" firm in the sample, the attenuation effect of corporate social media is roughly 30% (0.1695/0.5648). Overall, the results suggest that the reputational benefits of using corporate social media outweigh the costs of spreading the bad news more broadly.

While the analysis presented in Table 4 treats all four social media platforms as homogenous, available social media platforms and their features evolved during our sample period. We next examine whether the benefits of social media within the context of a product recall have changed as interactive platforms (Facebook and Twitter) became the norm. To shed

[31]Note that we use the *existence* of a firm's social media account to proxy for its usage. This decision is driven by data constraints as we do not have access to historical data on firms' actual activity on their corporate social media (except for Twitter). While this approach undoubtedly leads to less powerful tests, the main variables of interest, *SocialMedia*, is also less susceptible to a selection bias, i.e., a "serious" recall (which causes a more negative market reaction) prompting a firm to use social media to announce the recall.

light on this, we run a regression comparing the moderating effects of interactive and non-interactive social media on the price reaction to product recalls.[32]

In Table 5 the main variable of interest is *RecallScale*×*SocialMedia*×*Interactive*. The coefficient on this variable is negative and significant, suggesting that compared to non-interactive social media, the attenuation benefits of interactive corporate social media are significantly less (50 to 70 percent less), presumably because the firm relinquishes some control of its corporate social media content.[33] However, relative to no corporate social media, there are still attenuation benefits to interactive social media. An F-tests indicates that the sum of the coefficients on *RecallScale*×*SocialMedia* and *RecallScale*×*SocialMedia*×*Interactive* is positive and significant (Full Sample $p<0.001$; Subsample $p=0.06$).[34]

5. Twitter Activity and Market Reaction to Product Recalls

Our findings suggest that compared to non-interactive social media, interactive social media attenuates the negative consequences of product recalls to a lesser degree, presumably because the costs of losing control of the social media content outweigh the monitoring benefits.

[32] Note that the time series shift of available social media platforms, with the earlier time period dominated by non-interactive social media and the latter period dominated by interactive social media, means that the type of social media that a firm adopts is not a conscious choice but driven by exogenous factors (e.g. due to prevailing technology). Thus, our sample period, 2000-2012, presents a relatively clean empirical setting to explore the effects of the different social media platforms.

[33] As discussed earlier and shown in Table 1 Panel C, interactive social media is available only in the later part of our sample period, and was used by essentially all firms (94%) that had social media post 2008. Thus, an alternative way to view these findings is that the attenuation effects of social media lessened in the later years of our sample because of the existence of interactive social media. Consistent with this view, when we re-run the Full Sample regression in Table 5 replacing the variable *Interactive* with a *Post-2008* dummy equal to 1 when the recall is announced post year 2008 and 0 otherwise, we find that the coefficients on *RecallScale*×*SocialMedia* and *RecallScale*×*SocialMedia*×*Post-2008* are 0.1602 ($p<0.001$) and −0.0806 ($p=0.064$), respectively.

[34] Since firms with Facebook and Twitter (*Interactive* = 1) are a subset of firms with corporate social media (*Social Media* = 1), the term *RecallScale*×*SocialMedia*×*Interactive* is not a typical triple interactive term, but rather an incremental variable identifying the effect of interactive social media over and above the general effect of corporate social media. Thus, to assess the total effect of interactive social media, one must sum the coefficients on *RecallScale*×*SocialMedia* and *RecallScale*×*SocialMedia*×*Interactive*.

To examine more directly the benefits of firm involvement and the costs of users usurping control of social media content, we focus on corporate social media activity on Twitter.

We are able to access the entire Twitter Firehose through the PeopleBrowsr API. This allows us to examine social media activities around product recall announcements by counting the number of tweets containing the firm's Twitter handle that are tweeted by the firm (*TweetFirm)* and tweeted by other users (*TweetOther*) in the event window (0, +3). Each tweet by a Twitter user can be viewed by not only all of his/her followers and the firm's followers, but also the followers of the followers, thereby facilitating the transmission of a particular message throughout the network. The greater the number of tweets, the more extensive is the reach. To capture abnormal tweeting activity around a recall, we subtract the event window tweets, measured as the average daily number of tweets in the event window (0, +3), by the average daily number of tweets in the pre-event window (-60, -1).

Table 6 presents descriptive statistics for the 97 product recalls announced by firms with Twitter accounts. There are more tweets by other users (daily mean=44.585) than by the recalling firms (daily mean=7.807). There appears to be unusually high Twitter activity around a product recall: the mean abnormal tweets by others is 14.415 ($p<0.01$) and the mean abnormal tweets by the firm 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:

$$CAR_{(0,+3)} = \beta_0 + \beta_1 RecallScale + \beta_2 ATweetFirm + \beta_3 ATweetOther + \beta_4 RecallScale \times ATweetFirm + \beta_5 RecallScale \times ATweetOther + \gamma Controls + \theta RecallScale \times Controls \quad (6)$$

Table 7 presents the OLS regression results with abnormal stock returns as the dependent variable. Consistent with earlier results, we expect stock returns to be more negative for recalls

of larger scale, i.e., $\beta_1 < 0$. To assess how Twitter activities by the firm and by other users affect this relation, we focus on β_4 and β_5. When a firm is more proactive, for example by intervening to clarify a message, correct a misconception, or direct an online conversation, it potentially mitigates the negative price reaction, leading to a positive β_4. However, if other users take control of the content on the firm's corporate Twitter account allowing negative sentiment to snowball, this will exacerbate the negative price reaction, leading to a negative β_5.

As in earlier regressions, all control variables are included stand alone as well as interacted with *RecallScale.* In addition to firm characteristics, we also control for recall characteristics. Specifically, a serious recall likely prompts more users of the firm's Twitter account to express their opinions on this outlet, and it also leads to more negative event day returns, potentially causing a spurious association between tweets and abnormal returns. We use *HighScore, ATradMedia* (abnormal traditional media), and *AGenSM* (abnormal general social media) to capture the seriousness of a recall. To the extent that more serious recalls get greater traditional media and general social media coverage, controlling for these activities enables us to draw inferences regarding the incremental effects of firm tweets and user tweets.

Consistent with H3, we find that the coefficient on $RecallScale \times ATweetFirm$ is positive and significant. This indicates that all else equal, the negative relation between stock market returns and recall scale is attenuated by more tweets from the firm. In terms of economic significance, increasing abnormal tweets by the firm from the 25th to 75th percentile attenuates the negative market reaction by about 30%. In contrast, the coefficient on $RecallScale \times ATweetOther$ is negative and significant. This suggests that the negative relation between stock

market returns and recall scale is exacerbated by more tweets from other users.[35] Specifically, increasing abnormal tweets by other users from the 25th to 75th percentile exacerbates the negative market reaction by about 2%. Interestingly, the coefficient on *Recall Scale ×ATradMedia* is negative, suggesting that market reaction to recalls is exacerbated for recalls with abnormal traditional media coverage, consistent with traditional media's bias towards covering more "sensational" stories.

6. Additional Analyses and Robustness Checks

6.1 Social media and loss of future sales

We contend that corporate social media attenuates the negative market reaction to product recalls, in part because social media mitigates the damage to firm reputation. We validate this conjecture by examining whether the expected loss in future sales following a recall is indeed affected by corporate social media. The findings are presented in Table 8. We use the revision in the consensus analyst sales revenue forecasts as our dependent variable, (*SFRev*), measured around the recall announcement date and scaled by the market value of equity. There are 28 recall observations with no analyst forecasts available, resulting in a sample of 377 recalls for this analysis. Consistent with the negative relation between stock returns and recall scale, analysts' forecast revisions are negatively related to *RecallScale*. Importantly, this negative relation is attenuated for firms with social media. These findings help validate our conjecture that social media helps mitigate reputation damage, as captured by loss of future sales.

[35]Our analysis implicitly assumes that tweets by other users convey more negative sentiment than firm tweets. We validate this assumption empirically. PeopleBrowsr measures tweet sentiment and categorizes tweet sentiment as positive, negative and neutral/unclassified, with most of the tweets falling into the last category. 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. The underlying dictionary and algorithm used by PeopleBrowsr to measure sentiment are undisclosed. In addition, many tweets, such as those sarcastic in tone, are likely to be misclassified. Thus, we do not use their sentiment measures in our primary tests.

6.2 Endogeneity related to Twitter analysis

In the OLS regression in Table 7, we control for the seriousness of a recall by including a number of control variables. However, it is possible that these controls are not entirely successful. Thus, we also perform a 2SLS analysis to "strip away" the endogenous level of social media activity driven by the seriousness of the recall.[36] Since the main variables of interest involve interactions with the potentially endogenous variables, our estimation procedure consists of three steps (Wooldridge 2010, pages 268, 937-944; Chang, Dasgupta and Hilary 2009). In the first step, we regress event-window firm tweets and user tweets on all exogenous variables. From these two models we obtain the predicted event-window firm tweets and predicted event-window user tweets. In steps 2 and 3, we use a standard instrumental variables approach, with the predicted values from step 1 as the basis to construct the instruments.

For brevity detailed results of the 2SLS analysis are presented in the online appendix. We use pre-event levels of firm tweets and user tweets, *PriorTweetFirm* and *PriorTweetOther*, as excluded instruments, i.e., variables that are related to the event window firm and user tweets (instrument relevance) but not directly related to the abnormal event window returns (other than through the hypothesized channel –exclusion restriction). Firms with high level of pre-event user tweets are likely to be those that attract intense interest from the Twitter community, meaning they are prone to viral sentiment on the recall day. Similarly, *PriorTweetFirm* captures the firm's general tendency to be active and responsive on its Twitter account, and is likely highly correlated with the number of firm tweets during the event window. Indeed, in both the firm-

[36]We note that while we conduct 2SLS to rule out the "seriousness" of a recall as an explanation for our results, it also addresses other unobserved correlated omitted variables. Specifically, inferences from our 2SLS on the main variables of interest are unaffected by any remaining correlated omitted variables because the instruments by construction are uncorrelated with the errors terms (and any omitted variables embedded in the error terms).

tweet prediction model and the user-tweet prediction model, the coefficients on the excluded instruments, *PriorTweetFirm,* and *PriorTweetOther,* are positive and highly significant (t-stat = 33.25 and 11.02, respectively). At the same time, there is no reason to believe a priori that these two variables, measured prior to the event window, would affect the event window abnormal returns, other than through the hypothesized channels.

From these two models, we construct *PredATweetFirm* and *PredATweetOther,* as well as the interaction variables, *PredATweetFirm*×*RecallScale*, and *PredATweetOther*×*RecallScale*. These are now used as instruments in a standard 2SLS. Angrist and Pischke (2009) F-statistics for weak identification indicate that the instruments adequately identify the model.[37] 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. In contrast, the coefficient on the instrument for *RecallScale*×*ATweetFirm* is positive and significant, suggesting that a firm's proactivity on Twitter is likely beneficial.

6.3 Endogeneity related to the adoption of corporate social media

Our findings on the relation between social media and abnormal returns to product recall announcements (Table 4) will be affected if the decision to initiate a corporate social media account is made in anticipation of a product recall. We argue this is unlikely for our sample because corporate social media accounts generally exist well in advance of the recall

[37]Specifically the F-statistics for our main variables of interest, *RecallScale*×*ATweetOther* and *RecallScale*×*ATweetFirm*, are 47.87 and 16.52, respectively; both significant at conventional levels (Stock and Yogo 2005)

announcements.[38] 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.

Nevertheless, to address the possibility that firms *adopt* social media in anticipation of a "serious" product recall, we perform a matched sample analysis using propensity score matching. Using the entire sample of 405 product recalls, we estimate a firm's propensity to adopt social media based on a number of firm and recall characteristics such as *RecallScale, FirmSize, SalesGrowth, HighScore, PriorRecall,* as well as the level of traditional media activity prior to the recall. We also include four additional variables that are likely to affect the firm's tendency to adopt social media: (i) whether the firm is a Tech firm (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 is headquartered; (iii) a dummy variable for a young CEO (below sample median age), and (iv) time trend. Tech firms and firms with a younger work force or a younger CEO are more likely to be at the forefront of changes in technology and thus, more likely to adopt social media. In addition, although the time trend variable is unlikely to capture cross-sectional variation in the adoption of social media, we expect it to capture changes in technology and adoption of social media over time. The logistic regression is presented in Table 9 Panel A. We find that firms are more likely to adopt social media over time and that larger firms as well as firms with younger CEOs are more likely to adopt social media. The pseudo R^2 from the logistic regression estimating the probability of social media adoption is about 22%.

[38]For the sample of firms where we can obtain the actual start dates of their corporate social media accounts, the social media accounts exist on average for about 561 days prior to the recall announcements.

We generate scores on the propensity to adopt social media (*PScore*) as well as the scores interacted with recall scale (*PScore*×*RecallScale*) for the 206 product recalls by firms with social media accounts (treatment group) and the 199 product recalls by firms with no social media accounts (control group).[39] The results from the matched analysis, presented in Panel B, are consistent with our primary inference from Table 4 that social media mitigates the negative market reaction to product recalls.

6.4 Effect of influential outliers

We note in Section 3 that the distribution of *RecallScale* is positively skewed. Although skewness of independent variables in itself does not violate assumptions in the OLS estimation, one concern is that outliers could have a significant influence on the fitted model. To ensure that the results are robust to influential outliers, we first re-ran the analyses on a subsample excluding influential outliers as identified by Cook's D (n=374). Our results indicate that (1) the coefficient on *RecallScale*×*SocialMedia* remains positive (0.089, p=0.02) in the regression examining social media (H1); (2) the coefficients on *RecallScale*×*SocialMedia* and *RecallScale*×*SocialMedia* ×*Interactive* are positive (0.136, p=0.02) and negative (-0.093, p=0.03), respectively, in the regressions examining the interactivity of social media (H2); and (3) the coefficients on *RecallScale*×*ATweetFirm* and on *RecallScale*×*ATweetOther* are positive (0.449, p=0.01) and negative (-0.008, p=0.04), respectively, in the regressions examining tweeting activity (H3).[40]

[39]Specifically, a product recall from the treatment group is first matched, with replacement, to all product recalls from the control group with a *PScore* within 0.05 of the treatment firm. From this subset of firms, we select a firm that has the closest *PScore*×*RecallScale*. This results in199 matched pairs (398 product recalls). The mean (median) differences in *PScore* and *PScore*×*RecallScale* of the matched pairs are 0.024 (0.023) and 0.010 (0.001) respectively, indicating that the product recalls are quite well-matched. We also repeat the analysis using a tighter interval of ±0.01 (rather than ±0.05) which resulted in a smaller sample of 316 product recalls. The results, though weaker, continue to be consistent (coefficient on *RecallScale*×*SocialMedia* = 0.0842, p=0.09).

[40]The findings are robust to alternative methods for excluding influential observations: studentized residuals, DFFits and DFBeta. All analyses using method for dealing with influential outliers are available in the online appendix.

Second, instead of excluding outliers, we also re-ran the analyses using robust regressions, which give less weight to outliers but do not discard them, and our inferences remain unchanged.[41]

6.5 Correlated omitted variables

It is possible that the existence of a corporate social media account can proxy for a firm "type" such as the propensity to be more forthcoming or to be more in-touch with stakeholders. We conduct two additional analyses to address this concern. First, we develop a proxy for a firm's propensity to be more forthcoming: whether the firm issues management guidance (Guide = 1) in the 90 days prior to the recall announcement. Using IBES guidance data, which begins in October 2001, we repeat our main analysis for a subsample (371 recalls occurring between 2002-2012) where we include *Guide* and *RecallScale*×*Guide* in the main regression, and find that our results (reported in the online appendix) are robust to including these variables. Second, we control for a firm's customer awareness using advertising expense (*Advertise*). We include *Advertise* and *RecallScale*×*Advertise* in the main regression, and again, the results (reported in the online appendix) are similar.

6.6 Alternative notification channels: Direct contact with customers

We argue in developing H1 that corporate use of social media is beneficial to recalling firms because it helps to minimize the product harm by reaching a larger audience more quickly with the details of the product recall. For some items, recalling firms may have customer lists, which they can use to contact customers directly. Reviewing the official CPSC recall

[41]Specifically, using M-estimation the coefficient *on RecallScale*×*SocialMedia* remains positive (0.092, p=0.00) in the regression examining social media (H1); the coefficients on *RecallScale*×*SocialMedia* and *RecallScale*×*SocialMedia*×*Interactive* are positive (0.147, p=0.00) and negative (-0.076, p=0.08) respectively in the regressions examining interactivity of social media (H2); the coefficients on *RecallScale*×*ATweetFirm* and on *RecallScale*×*ATweetOther* are positive (0.763, p=0.01) and negative (-0.012, p=0.01) respectively in the regressions examining tweeting activity (H3).

announcements for any mention that the firm will directly contact its customers, we identify 53 recalls (13% of the sample) by firms with customer lists. Next, we examine whether the existence of a customer list is related to firm use of corporate social media. Splitting the sample into firms with and without social media, 14% of firms with no social media use direct contact, versus 12% of firms with social media. A chi-square test indicates that the existence of corporate social media and direct contact are not significantly related (p=0.564). Nevertheless, to ensure that our findings are robust, we repeat our main regression excluding the 53 product recalls. The results (available in the online appendix) continue to indicate that social media attenuates the negative market reaction to product recalls.

7. Conclusion

Social media has become an increasingly important way for firms to directly disseminate material information to a large network of stakeholders on a timely basis. Using product recalls as a setting, we examine how corporate social media affects the capital market consequences of firms' disclosures. Product recalls constitute a product crisis exposing the firm to potential legal liability and reputational damage. Such a crisis makes it crucial for the firm to quickly and directly reach a wide network of stakeholders with its intended messages. This renders corporate social media a potentially useful channel of disclosure. Thus, in this paper we examine whether the use of corporate social media moderates the negative market reaction to product recalls.

First, we find that corporate social media, in general, attenuates the negative price reaction to product recall announcements. This finding is consistent with social media increasing the effectiveness of the recall process itself including limiting harm, as well as mitigating the repercussions of the recall for the firm's brand equity and reputation.

Second, as social media evolved from less to more interactive channels, firms lost complete control over the content appearing on their corporate social media. The attenuation benefits of social media lessened, but were not fully lost. Compared to firms with no social media, interactive social media still attenuates the negative market reaction to product recalls.

Finally, using detailed Twitter activity, we find that increased frequency of tweets by other users exacerbates the negative market reaction as disgruntled users interject negative sentiment into the online dialogue. In contrast, increased frequency of tweets by the firm attenuates the negative market reaction, suggesting that firms actively engaged in the online dialogue are able to direct and influence stakeholders' perceptions and actions to minimize the damage caused by the recall crisis.

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, social media accelerates the delivery of intended messages from the firm to a broader set of stakeholders. However, the effect of interactive social media is more nuanced. When the firm shares control of its corporate social media, other users now have the opportunity to broadcast their messages as well, making it critical for a firm to exercise control, particularly following negative corporate events.

Our study is subject to the following caveats. First, the economic magnitudes of the results are relatively modest, likely due to two facts: 1) our measure of recall scale is noisy and 2) we include all consumer product recalls with sufficient data; some of these recalls are insignificant economic events. Nevertheless, this paper is an interesting first step to further our understanding of social media as a form of corporate disclosure. Second, our corporate disclosure setting is unique, a product crisis with potentially significant negative implications for

the firm's reputation and brand equity. While this offers a powerful setting to study the role of social media, our findings may not generalize. It is an open question whether and how corporate use of social media affects the market reaction to positive corporate disclosures. 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, as these corporate announcements are likely to generate significant social media activity.

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TABLE 1
Sample Selection and Corporate Use of Social Media

Panel A: Sample Selection

	No. of Product Recalls
Compustat Firms with CPSC product recalls for the period 2000-2012	816
Less:	
Firm is not the primary party involved in the recall making the joint announcement with CPSC and providing the remedy for the recall	291
No stock returns data on CRSP	19
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)	101
Full Sample	**405**
Product recalls for the period 2000-2007	228
Subsample for 2008-2012	**177**

Panel B: Number of Product Recalls by Corporate Social Media Channels

	Total	**No Social Media**	**Social Media**	**Social Media Channels**			
				(1) RSS	(2) Blog	(3) Facebook	(4) Twitter
No. of Product Recalls	405	199	206	56	95	74	97

Notes to Table 1 Panel B:
The tables shows the total number of product recalls, and the number of product recalls by firms with no social media and firms with social media. Firms are considered to have social media if they have at least one social media account on the following channels – RSS, Blogs, Facebook and Twitter. The next four columns report the number of product recalls by social media channels. The four columns (columns (1) to (4)) are not mutually exclusive.

TABLE 1 (continued)

Panel C: Number of Product Recalls and Corporate Use of Social Media by Calendar Year

Year	No. of Product Recalls			
	Total	**No Social Media**	**Any Social Media** (At least one social media channel)	**Interactive Social Media** (Facebook or Twitter)
2000	16	14	2	0
2001	18	12	6	0
2002	25	17	8	0
2003	25	16	9	0
2004	35	22	13	0
2005	41	29	12	0
2006	27	20	7	0
2007	41	23	18	2
2008	37	17	20	3
2009	39	15	24	20
2010	36	9	27	25
2011	36	4	32	31
2012	29	1	28	28

Notes to Table 1 Panel C:
The total number of product recalls in each year is the sum of the number of product recalls by firms with no social media and firms with social media. Firms are considered to have social media if they have at least one social media account on the following channels – RSS, Blogs, Facebook and Twitter. The last column reports the number of product recalls by firms with either Facebook or Twitter accounts, and is a subset of the column to its left.

Panel D: 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	27	0	0	0	0
N = 1	145	29	0	73	43
N = 2	202	53	1	174	176
N = 3	31	31	0	31	31
N = 4	0	0	0	0	0

Notes to Table 1 Panel D:
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 at least one incident reported at the time of the recall, and (4) whether the firm's brand is on the product. Columns (1) to (4) 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=405)	p-value	Median (N=405)	p-value	Standard Deviation	Percentage of Negative CARs (N=405)	p-value
0, +1	-0.006	0.007	-0.005	0.001	0.046	56%	0.011
0, +2	-0.009	0.001	-0.003	0.002	0.050	55%	0.066
0, +3	-0.008	0.000	-0.004	0.001	0.044	56%	0.015
-3, -1	-0.002	0.344	-0.002	0.303	0.039	52%	0.398
+4, +10	0.001	0.582	-0.001	0.956	0.054	51%	0.804

Panel B: Difference in means, medians and percentage of negative CARs across recalling firms with and without social media

CARs over Different Windows	Mean			Median			Percentage of Negative CARs		
	No Social Media (N=199)	Social Media (N=206)	Diff (p-value)	No Social Media (N=199)	Social Media (N=206)	Diff (p-value)	No Social Media (N=199)	Social Media (N=206)	Diff (p-value)
0, +1	-0.008	-0.004	0.432	-0.006	-0.004	0.443	57%	55%	0.693
0, +2	-0.011	-0.006	0.286	-0.005	-0.003	0.291	56%	53%	0.496
0, +3	-0.011	-0.005	0.138	-0.006	-0.002	0.190	58%	54%	0.372
-3, -1	-0.001	-0.003	0.611	-0.002	-0.002	0.622	51%	53%	0.739
+4, +10	0.005	-0.002	0.241	0.001	-0.002	0.292	49%	52%	0.459

Notes to Table 2 Panels A and B:
CAR is the cumulative abnormal returns adjusted using the value-weighted index for the event windows where day 0 is the announcement date. All p-values are based on two-tailed tests. Panel B reports 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 CAR(0,+3) and RecallScale partitioned on RecallScale

Partitioning Variable: ***RecallScale***		**CARs**	**p-value**	**RecallScale**
Low	Mean	0.001	0.918	0.001
N=135	Median	0.002	0.731	0.001
	% Neg.	48%	0.667	
Medium	Mean	-0.005	0.108	0.003
N=135	Median	-0.004	0.058	0.003
	% Neg.	59%	0.048	
High	Mean	-0.019	0.000	0.140
N=135	Median	-0.011	0.009	0.021
	% Neg.	61%	0.008	

Notes to Table 2 Panel C:
CAR(0,+3) is the cumulative abnormal returns adjusted using the value-weighted index for the four day event window, where day 0 is the announcement date. The sample of product recalls is sorted into terciles based on recall scale. The mean, median and percentage of negative CAR(0,+3), as well as the mean and median *RecallScale* are reported for each tercile. All p-values are based on two-tailed tests.

TABLE 3
Descriptive Statistics

Panel A: Descriptive statistics for key variables

Variable	N	Mean	Std dev	25%	Median	75%
CAR $_{(0, +3)}$	405	-0.008	0.044	-0.025	-0.004	0.013
Recall Scale (in $millions)	405	18.228	71.039	0.158	0.852	6.695
RecallScale	405	0.048	0.211	0.001	0.002	0.008
FirmSize	405	8.101	1.817	6.769	8.253	9.150
SalesGrowth	405	0.062	0.232	-0.021	0.049	0.115
HighScore	405	0.575	0.495	0.000	1.000	1.000
TradMedia	405	3.057	4.815	0.750	1.750	3.250
ATradMedia	405	0.885	2.579	-0.167	0.583	1.550
PriorRecall	405	0.723	0.448	0.000	1.000	1.000
GenSM	177	376.96	1135	1.50	53.25	225.25
AGenSM	177	18.699	172.168	-0.005	0.293	5.315

Panel B: Difference in means tests for recalling firms with and without corporate social media

	Full Sample (N=405)			Subsample (N=177)		
	Social Media			Social Media		
Variable	(1) No	(2) Yes	p-value (1) - (2)	(3) No	(4) Yes	p-value (3) - (4)
CAR $_{(0, +3)}$	-0.011	-0.005	0.131	-0.024	-0.003	0.017
Recall Scale (in millions)	15.259	21.097	0.405	15.674	14.692	0.907
RecallScale	0.065	0.031	0.102	0.089	0.029	0.291
FirmSize	7.756	8.434	0.000	7.971	8.535	0.088
SalesGrowth	0.083	0.042	0.079	0.019	0.031	0.586
HighScore	0.653	0.500	0.001	0.587	0.466	0.157
TradMedia	2.294	3.795	0.002	2.592	3.786	0.103
ATradMedia	0.718	1.046	0.201	0.471	0.842	0.369
PriorRecall	0.668	0.777	0.015	0.739	0.840	0.173
GenSM				63.495	487.081	0.001
AGenSM				-1.092	25.648	0.131
N	199	206		46	131	

Notes to Table 3:
All variables are defined in Appendix A. GenSM and AGenSM are only reported for the subsample because data is only available for the time period 2008-2012. In panel B, p-values are reported 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
Effect of Corporate Social Media on Stock Returns Surrounding Announcement of Consumer Product Recalls

$$CAR_{(0,+3)} = \beta_0 + \beta_1 RecallScale + \beta_2 SocialMedia + \beta_3 RecallScale \times SocialMedia + \gamma Controls + \theta RecallScale \times Controls$$

Variables		**Full Sample: 2000-2012**		**Subsample: 2008-2012**	
	E[Sign]	**Coeff**	**t-statistic**	**Coeff**	**t-statistic**
Intercept		0.0005	0.03	-0.0231*	-1.71
RecallScale	−	-0.1453***	-3.18	-0.5648*	-1.78
SocialMedia		0.0014	0.30	0.0113	1.41
RecallScale×SocialMedia	+/-	0.1045**	2.13	0.1695**	2.23
FirmSize		0.0025**	2.32	0.0025	1.27
SalesGrowth		-0.0045	-0.34	-0.0012	-0.04
HighScore		-0.0052	-1.21	-0.0047	-0.88
AGenSM				-0.0003	-1.41
ATradMedia		-0.0012*	-1.87	-0.0009	-0.93
PriorRecall		0.0015	0.27	0.0029	0.34
RecallScale×FirmSize		0.0261**	2.15	0.1004	1.47
RecallScale×SalesGrowth		0.0617***	3.23	0.2015	1.15
RecallScale×HighScore		-0.0059	-0.33	0.1892	1.26
RecallScale×AGenSM				-0.0065	-1.36
RecallScale×ATradMedia		-0.0071	-0.64	0.0337	0.99
RecallScale×PriorRecall		0.0700**	2.34	0.1485	0.93
Year Fixed Effects		Included		Included	
N		405		177	
Adj R^2		0.067		0.077	

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%. All continuous control variables are mean-adjusted. t-statistics are calculated based on firm-clustered standard errors.

TABLE 5
Exploring the Incremental Effect of Interactive Social Media on Stock Returns Surrounding Announcement of Consumer Product Recalls

$$CAR_{(0,+3)} = \beta_0 + \beta_1 RecallScale + \beta_2 SocialMedia + \beta_3 Interactive + \beta_4 RecallScale \times SocialMedia + \beta_5 RecallScale \times SocialMedia \times Interactive + \gamma Controls + \theta RecallScale \times Controls$$

Variables		**Full Sample: 2000-2012**		**Subsample: 2008-2012**	
	E[Sign]	**Coeff**	**t-statistic**	**Coeff**	**t-statistic**
Intercept		0.0075	-0.49	-0.0172**	-1.23
RecallScale	−	-0.1709***	-3.83	-0.7958**	-2.28
SocialMedia		-0.0002	-0.03	0.0179	1.58
Interactive		0.0021	0.25	-0.0117	-0.97
RecallScale×SocialMedia	+/-	0.1665***	3.68	0.5133***	3.15
RecallScale×SocialMedia×Interactive	+/-	-0.0897**	-1.96	-0.3545***	-2.70
FirmSize		0.0023**	2.33	0.0020	1.00
SalesGrowth		-0.0058	-0.42	-0.0138	-0.43
HighScore		-0.0049	-1.16	-0.0041	-0.77
AGenSM				-0.0003	-1.54
ATradMedia		-0.0012*	-1.92	-0.0008	-0.85
PriorRecall		0.0006	0.11	0.0037	0.41
RecallScale×FirmSize		0.0299**	2.37	0.1513*	1.76
RecallScale×SalesGrowth		0.0754***	4.21	0.3196*	1.67
RecallScale×HighScore		-0.0138	-0.71	0.2405	1.46
RecallScale×AGenSM				-0.0069	-1.49
RecallScale×ATradMedia		-0.0059	-0.48	0.0366	0.92
RecallScale×PriorRecall		0.0978***	3.94	0.3134*	1.74
Year Fixed Effects		Included		Included	
N		405		177	
Adj R^2		0.069		0.081	

Notes to Table 5:
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%. All continuous control variables are mean-adjusted. t-statistics are calculated based on firm-clustered standard errors. Since firms with Facebook and Twitter (*Interactive* = 1) are a subset of firms with corporate social media (*Social Media* = 1), the term *RecallScale×SocialMedia×Interactive* is not a triple interactive term, but rather an incremental variable identifying the effect of interactive social media over and above the effect of corporate social media in general.

TABLE 6
Descriptive Statistics on Sample of Firms with Twitter Accounts, 2008-2012

Variable	Mean	Std dev	25%	Median	75%
$CAR_{(0, +3)}$	-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	8.399	1.867	6.970	8.444	9.585
SalesGrowth	0.020	0.117	-0.050	0.018	0.121
HighScore	0.433	0.498	0.000	0.000	1.000
TradMedia	3.507	5.128	1.000	2.000	3.500
ATradMedia	0.699	2.493	-0.333	0.467	1.800
PriorRecall	0.866	0.342	1.000	1.000	1.000
GenSM	625.22	1479	55.25	151.50	554.75
AGenSM	34.492	231.375	-0.315	2.232	9.655
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 6:
All variables are defined in Appendix A.

TABLE 7
Effect of Tweeting Activity on Stock Returns Surrounding Announcement of Consumer Product Recalls for Sample of Firms with Twitter Accounts, 2008-2012

$$CAR_{(0,+3)} = \beta_0 + \beta_1 RecallScale + \beta_2 ATweetFirm + \beta_3 ATweetOther + \beta_4 RecallScale \times ATweetFirm + \beta_5 RecallScale \times ATweetOther + \gamma Controls + \theta RecallScale \times Controls$$

Variable	E[Sign]	Coeff	t-statistic
Intercept		-0.0020	-0.10
RecallScale	-	-1.0321**	-2.27
ATweetFirm		-0.0001	-0.33
ATweetOther		0.0000	-0.25
RecallScale×ATweetFirm	+	0.4003**	2.24
RecallScale×ATweetOther	-	-0.0057**	-2.29
FirmSize		0.0003	0.19
SalesGrowth		-0.0176	-0.39
HighScore		-0.0074	-1.28
AGenSM		0.0000	0.63
ATradMedia		0.0011	1.02
PriorRecall		0.0005	0.03
RecallScale×FirmSize		0.3001**	2.43
RecallScale×SalesGrowth		-0.3165	-0.76
RecallScale×HighScore		-0.1358	-0.63
RecallScale×AGenSM		-0.0021	-0.29
RecallScale×ATradMedia		-0.9050***	-4.75
RecallScale×PriorRecall		0.2331	0.42
Year Fixed Effects		Included	
N		97	
Adj R^2		0.074	

Notes to Table 7:
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%. All continuous control variables are mean-adjusted. t-statistics are calculated based on firm-clustered standard errors.

TABLE 8
Regressions Examining the Effect of Social Media on Analyst Forecast Revisions of Future Sales after Product Recall Announcements

$$SFRev = \beta_0 + \beta_1 RecallScale + \beta_2 SocialMedia + \beta_3 RecallScale \times SocialMedia + \gamma Controls + \theta RecallScale \times Controls$$

Variable	E[Sign]	Coeff	t-statistic
Intercept		0.0084	0.45
RecallScale	-	-0.2273**	-2.33
SocialMedia		0.0076	1.06
RecallScale×SocialMedia	+/-	0.1678**	2.35
FirmSize		-0.0003	-0.14
SalesGrowth		0.0198*	1.67
HighScore		-0.0060	-0.84
ATradMedia		0.0011	1.21
PriorRecall		0.0131	1.53
RecallScale×FirmSize		0.0491	1.06
RecallScale×SalesGrowth		0.0667**	2.33
RecallScale×HighScore		-0.0252	-0.22
RecallScale×ATradMedia		-0.0675*	-1.86
RecallScale×PriorRecall		-0.1202	-0.60
Year Fixed Effects		Included	
N		377	
Adj R^2		0.111	

Notes to Table 8:
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. We calculate our own mean consensus sales forecasts as the average of all analysts' forecasts issued in the 30 days window before and after the recall announcement. However, if there are fewer than three forecasts issued, we use the prevailing IBES consensus analyst forecast. 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. All continuous control variables are mean-adjusted.

TABLE 9
Propensity Matched Sample Analysis

Panel A: Logistic regression modeling adoption of social media

	Coefficient	p-value
Intercept	-6.1443***	0.00
RecallScale	-0.2016	0.74
FirmSize	0.1429*	0.06
SalesGrowth	-0.8080	0.28
HighScore	-0.4069	0.18
PriorTradMedia	0.0241	0.53
PriorRecall	-0.0850	0.75
Tech	0.1620	0.35
PctYoungPop	0.0510	0.17
YoungCEO	0.3911*	0.09
Year	0.2940***	0.00
N	405	
Pseudo R^2	0.218	

Panel B: OLS regression Using Propensity Matched Samples

Variable	E[Sign]	Coeff	t-statistic
Intercept		0.0101	0.53
RecallScale	-	-0.3972***	-3.84
SocialMedia		-0.0005	-0.09
RecallScale×SocialMedia	+/-	0.3352**	2.31
FirmSize		0.0038***	2.92
SalesGrowth		-0.0051	-0.15
HighScore		-0.0017	-0.36
ATradMedia		-0.0012	-1.52
PriorRecall		0.0021	0.37
RecallScale×FirmSize		0.0308	1.57
RecallScale×SalesGrowth		-0.2143	-1.57
RecallScale×HighScore		0.0499	1.32
RecallScale×ATradMedia		0.0013	0.04
RecallScale×PriorRecall		0.0586	1.03
Year Fixed Effects		Included	
N		398	
Adj R^2		0.099	

Notes to Table 9:

The regression in Panel A models the probability of adopting social media using the sample of product recalls from 2000 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. PriorTradMedia is the average daily number of news articles in the 60-day period prior to the product recall announcement. All continuous variables are winsorized at the extreme 1%. p-values are calculated based on firm-clustered standard errors.

The regression in Panel B is based on 199 matched pairs. We first match each product recall by firms with social media to all product recalls by firms without social media, using a propensity score interval of ±0.05. We then select, with replacement, the product recall by a firm without social media with the closest propensity score multiplied by *RecallScale*. 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. All continuous control variables are mean-adjusted.

APPENDIX A
Variable Definitions

Variable		Definition
$CAR_{(0,+3)}$	=	Value-weighted market-adjusted abnormal returns for the four-day event window (0,+3) where Day 0 is the date of the official CPSC product recall announcement.
Recall Scale ($Millions)	=	Unit price of the recalled product multiplied by the number of units affected where the unit price is the retail price of the product or a part depending on what is being recalled. In the event a retail price range is listed, we take the midpoint. If a part (rather than a whole product) is being recalled and the value of that part is given in the recall announcement or can be estimated, we use the price of the part.
RecallScale	=	Recall Scale ($Millions) divided by the market value of equity 15 days before the recall.
SocialMedia	=	Indicator variable equal to 1 if the firm has one of the following social media platforms at the time of the product recall: blog, RSS, Twitter or Facebook, and equal to zero otherwise.
FirmSize	=	Log of sales revenue (sale), 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. Score is the summation of four indicator variables: (i) whether the recalled product is categorized as a child-related product, (ii) whether the recalled 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 firm'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.
GenSM	=	Average daily number of times a firm's name is mentioned on social media channels (including all public Facebook posts, entire Twitter firehose and blogs hosted by service providers covered by PeopleBrowsr such as Blogspot, Tumblr and Wordpress) in the event period (0, +3).
AGenSM	=	Abnormal GenSM measured as GenSM minus the average daily number of times the firm's name is mentioned on social media channels (defined above) in the pre-event period (-60, -1).
TradMedia	=	Average daily number of press articles found on *Factiva* with the firm's name mentioned in the headline or the lead paragraph in the event period (0, +3).
ATradMedia	=	Abnormal TradMedia measured as TradMedia minus the average daily number of press articles found on *Factiva* with the firm's name mentioned in the headline or the lead paragraph in the pre-event period (-60, -1).
PriorRecall	=	Indicator variable equal to 1 if the firm has had a prior product recall, at least one recall before the current recall, and equal to zero otherwise.

APPENDIX A (CONTINUED)
Variable Definitions

Variable		Definition
Interactive	=	Indicator variable equal to 1 if the firm has Twitter or Facebook at the time of the product recall, and equal to zero otherwise.
TweetOther	=	Average daily number of tweets associated with the firm's Twitter handle tweeted by other users in the event period (0, +3).
TweetFirm	=	Average daily number of tweets associated with the firm's Twitter handle tweeted by the firm in the event period (0, +3).
ATweetOther	=	Abnormal daily tweets by other users measured as TweetOther minus average daily number of tweets associated with the firm's Twitter handle tweeted by other users 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 firm's Twitter handle tweeted by the firm in the pre-event period (-60, -1).