Haibing Gao, Jinhong Xie, Qi Wang, & Kenneth C. Wilbur

Should Ad Spending Increase or Decrease Before a Recall Announcement? The Marketing–Finance Interface in Product-Harm Crisis Management

Product recalls tend to damage the stock price of the recalling firm. This article proposes and empirically demonstrates that adjustments to prerecall advertising spending can be used as a tool to moderate this financial damage. Using data on automobile recalls and detailed advertising expenditures from 2005 to 2012, the authors show that adjustments to a firm's prerecall advertising expenditure can either mitigate or amplify the negative effect of the recall on stock market value, depending on the direction of advertising adjustment and the recall characteristics. Boosting ad spending before a recall announcement softens the stock price loss when the recall involves a newly introduced product with a minor hazard but sharpens the loss when the recalled product is an established model with a major hazard. Cutting prerecall advertising worsens the stock price loss when the recall involves a new product, regardless of the hazard. This research also reveals that in product-harm crisis management, profit maximization and shareholder value maximization can conflict with each other, underscoring the importance of developing an integrated crisis management strategy.

Keywords: prerecall advertising, product recall, product-harm crisis management, event study, marketing–finance interface

Product recalls have been increasing. A recent study by the ACE Group, one of the world's largest property and casualty insurers, reported that 2,363 consumer products, pharmaceuticals, and medical devices were recalled in the United States in 2011, representing a 14% increase from the previous year and a 62% increase from 2007 (Advisen Insurance Intelligence 2012). Similarly, the National Highway Traffic Safety Administration (NHTSA 2015) reported that the average number of annual automotive recalls rose 76% (from 339 to 599) between two ten-year periods (1994–2003 and 2004–2013). This upward trend in product recalls has been driven by the increasing globalization of production, growing product complexity, and more stringent product-safety laws (Chen, Ganesan, and Liu 2009; Dawar and Pillutla 2000). As these trends continue, firms are expected to face an even higher risk of product recalls (Chen and Nguyen 2013).

Product recalls can cause severe financial damage. A firm's share price usually falls immediately after a recall announcement. Consider several notable examples in recent years: Boston Scientific's stock price fell 13% after announcing a recall of its implantable defibrillators in 2010 (Rockoff 2010); Cochlear's share price promptly dropped 20% after a voluntary recall of its Nucleus 5 implant product in 2011 (Q Continuum 2011); Toyota's shares fell 22% in two weeks in 2010 after its recall of 2.3 million vehicles in the United States due to accelerator pedal problems (BBC News 2010); and most recently, a *USA Today* headline reported that "GM Stock Below IPO Price as Recall Talk Swirls" (Healy 2014).

Although only the most severe recalls make headlines, the harmful financial consequences of product recalls are not merely "bad luck" that only occurs occasionally. The economics and finance literature has repeatedly shown that, in general, product recall announcements reduce the recalling firm's stock price. This negative effect has been empirically confirmed across a wide range of industries, including automobiles, pharmaceuticals, food, toys, electronics, cosmetics, and outdoor products (e.g., Barber and Darrough 1996; Chen and Nguyen 2013; Chu, Lin, and Prather 2005;

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Davidson and Worrell 1992; Hoffer, Pruitt, and Reilly 1987; Jarrell and Peltzman 1985; Pruitt and Peterson 1986; Thomsen and McKenzie 2001). Together, the increasing frequency of product recalls and their severe financial consequences have motivated us to identify effective *preventive* marketing strategies (which can be executed before a recall announcement) to mitigate such financial damage. Specifically, we investigate the potential of using prerecall advertising spending as a strategic tool to weaken the postrecall stock price drop.

In this article, we propose a theoretical framework that conceptualizes the link between prerecall advertising and postrecall stock market response. We argue that prerecall advertising can either reduce the harm of a recall by signaling firms' future financial capability or intensify the injury of a recall by increasing unfulfilled expectations. We identify specific recall characteristics that determine the direction and strength of the impact of prerecall advertising on the stock market. We design our empirical study to test the proposed effects and to provide answers to three questions: (1) Should a firm increase or decrease prerecall advertising to protect its postrecall share value? (2) When is the best time for such an adjustment (i.e., how long before the recall announcement)? and (3) What specific characteristics of product recalls may determine the direction/effectiveness of the moderating effect of prerecall advertising adjustments? Our findings provide useful insights for firms to plan a preventive advertising strategy when anticipating a product recall.

The strategic use of prerecall advertising in crisis management is feasible in practice. Firms often anticipate a product recall months or years before announcing it publicly. Consider the automobile industry, in which product safety recalls fall into two categories: firm initiated and government (i.e., NHTSA) initiated.[1] In firm-initiated recalls, the manufacturer determines whether a safety defect exists through its own inspection procedures and decides if and/or when to issue a recall. Firms typically have enough time to implement marketing strategies before the announcement of self-initiated recalls. Even for recalls initiated by the NHTSA, the investigation procedure is lengthy, consisting of a preliminary investigation that lasts an average of 120 days and an engineering analysis that takes approximately one year to complete. During this process, manufacturers provide required information (e.g., data on complaints, crashes, injuries, warranty claims, modifications, part sales) to the NHTSA and have the opportunity to present their own analysis and views regarding the alleged defect.[2] In both types of recalls, manufacturers often have ample time to adjust marketing strategies before the recall is formally announced. Thus, it is feasible to use prerecall advertising as a strategic variable for managing a product-harm crisis. To the best of our knowledge, we offer the first prescriptive guidance about the conditions under which an automobile manufacturer might want to increase prerecall advertising to influence its share price.

Using automobile safety recalls and detailed advertising expenditures from 2005 to 2012, our empirical analysis demonstrates that the recalling firm's prerecall advertising indeed moderates the postrecall fall in stock prices. This moderating effect differs depending on the direction of advertising adjustment and the recall characteristics. Specifically, increasing prerecall advertising spending lessens firms' postrecall loss in stock price when the recall involves newly introduced products with a minor hazard. However, for recalls of older products with a major hazard, the opposite holds: increasing prerecall advertising spending worsens the negative impact of the recall on firm value. Our results also reveal that decreasing the prerecall advertising worsens the negative impacts of the recall on stock price as long as the recall involves new products, regardless of the degree of recall hazard. However, a downward adjustment does not affect postrecall firm value for recalls of older products.

Our article makes contributions to five related research streams, as Table 1 summarizes. First, our research adds to the literature on the stock market impacts of product recalls. Many studies in this literature have found that, on average, product recalls cause negative impacts on stock returns (e.g., Barber and Darrough 1996; Chen and Nguyen 2013; Chu, Lin, and Prather 2005; Davidson and Worrell 1992; Hoffer, Pruitt, and Reilly 1987; Jarrell and Peltzman 1985; Pruitt and Peterson 1986; Thomsen and McKenzie 2001). Our research is motivated by the damage of product recalls to the stock market found in this literature and contributes a preventive marketing strategy that can moderate such damage in some circumstances. Our research findings provide specific insights into *when* and *how* to adjust prerecall advertising for the benefit of stock prices under a product recall.

Second, our article contributes to the literature on the impact of product recalls on consumers and marketing metrics. For example, several prior studies have found that product recalls affect consumers and identify some factors that influence such impacts, such as consumer expectations (Dawar and Pillutla 2000), consumer loyalty and familiarity (Cleeren, Dekimpe, and Helsen 2008), and recall type (Souiden and Pons 2009). In addition, Van Heerde, Helsen, and Dekimpe (2007) find that a severe recall hurts baseline sales as well as advertising effectiveness after the recall. Our article examines product-harm crisis management from a different perspective: the marketing–finance interface.

Third, our study contributes to the literature on marketing strategies that protect firm value during a product recall. Despite the financial damage of product recalls, there is limited research on how marketing strategy may help. One exception is Chen, Ganesan, and Liu (2009), who propose and empirically demonstrate that the recall strategy (proactive vs. passive) moderates the relationship between product recalls and abnormal stock returns. Whereas Chen, Ganesan, and Liu focus on the recalling firms' choice in cooperation strategy (i.e., whether and when to cooperate

[1]For example, our data set consists of recalls for the six largest automakers (Toyota, Honda, Nissan, General Motors, Ford, and Chrysler) from 2005 to 2012. Among them, 61.8% are firm-initiated recalls.

[2]For more detailed discussion about the recall procedure, see http://www.nhtsa.gov/Vehicle+Safety/Recalls+&+Defects/Motor+Vehicle+Safety+Defects+and+Recalls+Campaigns.

TABLE 1
Related Literature and the Incremental Contributions of Our Study

Key Issue and Main Finding	Publications	Our Incremental Contribution
The Impact of Product Recalls on Stock Prices		
Key Issue: Whether and how the stock market responds to product recall announcements *Main Finding*: Product recalls, on average, hurt the recalling firms' stock prices by generating negative abnormal returns. This finding is consistent across different industries and time periods.	•Jarrell and Peltzman (1985) (auto, drugs) •Pruitt and Peterson (1986) (nonauto) •Hoffer, Pruitt, and Reilly (1987) (auto) •Davidson and Worrell (1992) (nonauto) •Barber and Darrough (1996) (auto) •Thomsen and McKenzie (2001) (meat and poultry) •Chu, Lin, and Prather (2005) (nonauto) •Chen and Nguyen (2013) (auto, nonauto)	Our article contributes to this literature by identifying a preventive marketing strategy, prerecall advertising, which can reduce the damage of product recalls on stock prices.
The Impact of Product Recalls on Consumers and Marketing Metrics		
Key Issue: Whether and how product recalls damage consumer market performance and marketing effectiveness *Main Findings*: (1) The negative impacts of product recalls on consumers may be affected by other factors such as consumer expectation, consumer familiarity, and recall type. (2) A severe recall hurts baseline sales as well as advertising effectiveness after the recall.	•Dawar and Pillutla (2000) (brand equity) •Souiden and Pons (2009) (consumer loyalty) •Cleeren, Dekimpe, and Helsen (2008) (purchase) •Van Heerde, Helsen, and Dekimpe (2007) (sales, postrecall advertising effectiveness)	Our article examines product-harm crisis management from a different perspective: the marketing–finance interface.
Marketing Strategies to Protect Firm Value Under a Product Recall		
Key Issue: The effect of a firm's recall strategy (proactive vs. passive) on the stock market response to a recall announcement *Main Finding*: The proactive recall strategy can intensify the damage of product recalls on the stock market.	•Chen, Ganesan, and Liu (2009)	Our article proposes and demonstrates a different strategic variable that can help firms reduce the harm of recalls on firm value (i.e., prerecall advertising).
Optimal Advertising Strategies to Protect Consumer Market Performance Under a Product Recall		
Key Issue: Pre-/postrecall optimal advertising strategies for the benefit of consumer market performance under a product recall *Main Findings*: (1) Postrecall optimal advertising to overcome product-harm crises is affected by negative publicity of the recall crisis and whether the affected brand acknowledges blame. (2) Optimal precrisis advertising decreases, but optimal postcrisis advertising increases, as the crisis likelihood (or damage rate) increases.	•Cleeren, Van Heerde, and Dekimpe (2013) (postrecall advertising and price adjustment) •Rubel, Naik, and Srinivasan (2011) (pre- and postrecall optimal advertising strategy)	We contribute to this literature by exploring the optimal advertising strategy to protect firms' financial market performance. Our study, together with Rubel, Naik, and Srinivasan (2011), raises a question regarding the potential conflict between profit maximization and shareholder value maximization in product-harm crisis management.
Advertising as a Moderator in the Marketing–Finance Interface		
Key Issue: Whether and how advertising may moderate the stock market response to some specific events *Main Finding*: Stock market responses to specific events (movie releases, IPOs, third-party reviews, and firm news) are influenced by firms' advertising strategies.	•Joshi and Hanssens (2009) (movie release) •Luo (2008) (IPO) •Chen, Liu, and Zhang (2012) (third-party review) •Xiong and Bharadwaj (2013) (firm news)	Our article contributes to this literature by demonstrating the role of advertising as a strategic moderator in a different type of event: a product-harm crisis, often known to the firm far in advance. We propose and demonstrate that prerecall advertising can be used as a strategic variable to weaken the negative impact of a recall event on stock prices.

with the regulatory agency to issue a recall), our research focuses on firms' choice of advertising strategy (i.e., when and how to adjust prerecall advertising spending). Our research complements Chen, Ganesan, and Liu by offering firms another tool to protect their financial value when facing a product-harm crisis.

Fourth, our article extends the literature on optimal advertising strategies to protect consumer market perfor-

mance during a product recall. For example, Cleeren, Van Heerde, and Dekimpe (2013) examine how postrecall advertising and price adjustments affect the changes in consumers' brand share and category purchases. In contrast, we examine how prerecall advertising can be used as a strategic variable to protect firms' financial market performance. Our research also reveals a new trade-off during a product-harm crisis: although advertising less may reduce profit losses, it may simultaneously worsen the damage to stock price. Specifically, Rubel, Naik, and Srinivasan (2011) demonstrate that when envisioning a severe recall, the profit-maximizing strategy is to reduce prerecall advertising. However, our results reveal that doing so intensifies the firm's loss in stock value if the recall involves newly introduced products. In this situation, the firm should make trade-offs between marketing and financial objectives (i.e., profit vs. stock value). Our study, along with Rubel, Naik, and Srinivasan's research, raises a question regarding the potential conflict between profit maximization and shareholder value maximization in product-harm crisis management. We also discover that such trade-offs are not required for recalls of older products, suggesting that the firm can protect its marketing interest without sacrificing its financial interest. Our findings also bring attention to the opposite (and as yet unexplored) strategic move in crisis management (i.e., increasing prerecall advertising spending). We demonstrate that for a recall of new products with a minor hazard, the firm can protect its financial value by strategically boosting prerecall advertising spending. These findings both advance the theoretical understanding of effective crisis management and help firms develop integrated product-harm crisis management strategies.

Finally, our article is relevant to the literature on advertising as a strategic moderator in the marketing–finance interface. In recent years, marketing scholars have paid increasing attention to the impact of marketing actions/metrics (e.g., customer satisfaction, new product introduction, advertising, research-and-development spending) on firms' stock prices (for a review, see Srinivasan and Hanssens 2009). Some recent studies have investigated how advertising may moderate stock market responses to specific events, such as a movie's release (Joshi and Hanssens 2009), an initial public offering (IPO) announcement (Luo 2008), third-party product review publications (Chen, Liu, and Zhang 2012), and news reports (Xiong and Bharadwaj 2013).[3] Our article contributes to this literature by demonstrating the role of advertising as a strategic moderator in a different type of event: a product-harm crisis. We propose and demonstrate that prerecall advertising can be used as a strategic variable to weaken the negative impact of a recall announcement on stock prices.

We organize the remainder of this article as follows: First, we present our conceptual framework and develop hypotheses. Next, we introduce the modeling methodology (an event study and a cross-sectional regression model). We then introduce our data and present the empirical results. Finally, we conclude the article with managerial implications and suggest several directions for further research.

Theoretical Framework and Hypotheses

In this article, we examine whether prerecall advertising can be used as a preventive strategy for firms to manage a product-harm crisis. In this section, we provide a theoretical framework that links prerecall advertising adjustments with postrecall stock market response.

According to the efficient market hypothesis, an unexpected change in prerecall advertising should be immediately reflected in stock price at the time the advertising adjustment is made. However, when a recall is announced, investors may reinterpret such an adjustment because of the information asymmetry between the recalling firm and the stock market with respect to the consequences of the recall for future cash flows. Specifically, we argue that an advertising adjustment before a recall announcement can impose two possible effects on investors' postrecall responses: (1) a signaling effect caused by information asymmetry between firms and investors and (2) an expectation effect due to the unfulfilled high expectations raised by the advertising increase before the recall announcement. We identify specific recall characteristics that determine the strength of each effect and develop theoretical predictions regarding the direction of adjusting prerecall advertising under some specific conditions.

Prerecall Advertising: Signaling Effect and Expectation Effect

Signaling effect. We propose that prerecall advertising can impose a signaling effect on the stock market under a recall crisis. In the consumer market, the signaling effects of the marketing mix on consumers' perceptions of product quality have been well documented in the economics and marketing literature (e.g., Byzalov and Shachar 2004; Erdem and Keane 1996; Milgrom and Roberts 1986; Nelson 1974; Wernerfelt 1988; Zhao, Zhao, and Helsen 2011). The fundamental mechanism under which marketing actions can signal product quality to consumers is the information asymmetry between sellers and consumers. Sellers know more about the quality of their products than consumers do, and thus, consumers may infer product quality on the basis of observable firm-initiated actions. Advertising expenditure can credibly signal quality because it is economically optimal only for high-quality firms to spend large amounts on advertising (Kihlstrom and Riordan 1984;

[3]Although product recalls can be considered one specific type of negative firm news, our research differs from Xiong and Bharadwaj (2013) in both its research questions and findings. Xiong and Bharadwaj are interested in unanticipated news stories and investigate how current advertising moderates the relationship between news and stock prices, whereas we are interested in product recall announcements that firms can anticipate and we investigate how prerecall advertising moderates the financial damage of recall announcements. Xiong and Bharadwaj find that a firm's current advertising does not moderate the effect of negative news, whereas our research reveals that adjustments to prerecall advertising do moderate the effect of product recall announcements in some circumstances.

Milgrom and Roberts 1986). Specifically, if a firm spends heavily on advertising, its claim about high quality is likely true because the real quality would be revealed to early adopters and communicated to followers through word of mouth; firms producing low-quality goods would not be able to recover the cost of advertising (Kirmani and Rao 2000).

In the stock market, information asymmetry also exists between firms and investors; that is, firms have private information about their financial value that investors do not know (Myers and Majluf 1984). Because of this information asymmetry, investors may actively use firm-initiated actions as disclosed signals to interpret the firm's expected future cash flows (Bhattacharya 1979; Ross 1977). In recent years, marketing scholars have examined the signaling effect of advertising on the stock market. For example, Joshi and Hanssens (2010) suggest that advertising can signal a firm's financial well-being or competitive viability to investors. Kim and McAlister (2011) propose that because advertising expenditure affects consumers, it is reasonable to assume that the stock market is also aware of such effects and interprets advertising expenditure as a signal of the firm's future earnings.

In this article, we argue that prerecall advertising can create a signaling effect in the stock market when a product recall is announced because a recall announcement creates new uncertainty about the implicated firm's future earnings and intensifies the information asymmetry between the firm and its investors. Firms typically possess private information about the nature of the product hazard and its potential consequences, which is not available to investors (Chen, Ganesan, and Liu 2009). In the face of intensified information asymmetry, investors have a stronger incentive to use firm-initiated activities before a recall announcement as signals of internal information about the potential consequences of a recall on the firm's future cash flows.

If the firm increases its advertising expenditure before a recall, investors may interpret such a proactive adjustment as a positive signal that the recalled products do not have a severe quality defect and that the anticipated recall may not seriously affect the firm's future sales and earnings. An advertising increase can also signal the firm's confidence to consumers that the recall would not seriously affect the recalled firm's product quality and services, which can reduce the perceived risk of new customers buying the firm's product and the likelihood of current customers switching. As a result, increasing prerecall advertising can mitigate the adverse impact of the recall on the firm's future sales and cash flows. This enhances investors' confidence in the implicated firm's prospects and creates a positive signaling effect, which in turn lessens the damage of the product recall on its stock market valuation. In contrast, a decrease in prerecall advertising can deliver a negative signal with regard to the severity of product defects and their potential harmful impact on future cash flows and earnings. As a result, cutting advertising spending before a recall announcement can create a negative signaling effect and worsen the damage of product recalls on the firm's stock market value.

Expectation effect. In addition to the signaling effect, we propose that adjusting advertising near a recall can affect investors' expectations regarding product quality at the time of the recall. Researchers have long investigated the expectation effects of marketing metrics on consumer behavior (e.g., Cardozo 1965; Kopalle and Lehmann 2006). The marketing literature (e.g., Dutta, Narasimhan, and Rajiv 1999; Rao and Monroe 1989; Wallace, Giese, and Johnson 2004) has demonstrated that various marketing metrics, including advertising, play an important role in influencing consumer expectations. Specifically, a high advertising expenditure can lead to high expectation about product quality (Kopalle and Lehmann 2006). Consequently, when the product does not live up to customers' expectations (e.g., on its perceived quality), customer satisfaction is lower (Cardozo 1965), which further lowers customers' willingness to pay and decreases the likelihood of future purchases (Fornell, Rust, and Dekimpe 2010; Homburg, Koschate, and Hoyer 2005).

Now consider the expectation effect of prerecall advertising on the stock market. A recall may result in a discrepancy between investors' prerecall expectations of product quality and the actual quality defect revealed by the recall. The finance literature has suggested that unfulfilled high expectations can lead to investor disappointment (Hirshleifer 2001). According to the theory of investor disappointment (Bonomo et al. 2011; Gul 1991; Routledge and Zin 2010), investors would overdiscount the utility of a stock with lower-than-expected outcomes and sell that stock to avoid a high risk, exhibiting risk-averse behavior in response to disappointment.

In the context of a product recall, we expect that an increase in prerecall advertising can create a negative expectation effect on the stock market under a product recall. Such an increased investment in advertising can generate high prerecall expectations about product quality from both consumers and investors, who are often not aware of a forthcoming recall due to information asymmetry. When the recall announcement is made, the discrepancy between prior expectations of high quality and the actual quality problem indicated by the recall can lead to dissatisfaction and disappointment from both consumers and investors (Anderson 1973; Routledge and Zin 2010). This, in turn, increases the likelihood of existing consumers to switch and decreases the likelihood of new consumers to buy the recalled products, which exacerbates the damage of a product recall on the firm's future sales and cash flows. Such an increase of prerecall advertising also hurts investors' confidence in the recalling firm's future cash flows and worsens the negative impact of a product recall on the stock market.

Overall, an adjustment in prerecall advertising may create both a signaling effect and an expectation effect. The net impact of an advertising adjustment near a recall is dependent on the relative strength of these two effects, the direction of the advertising adjustment (i.e., increase vs. decrease), and the specific recall characteristics. In the following sections, we discuss how increasing or decreasing prerecall advertising affects firm value under a recall crisis

with specific characteristics and then derive our theoretical predictions.

Increasing Prerecall Advertising

As we discussed previously, an increase in prerecall advertising for recalled products may create a positive signaling effect and a negative expectation effect, both of which moderate the detrimental impact of product recalls on the recalling firm's stock market value. With these two opposite effects in place, we propose that the overall impact of increasing prerecall advertising depends on specific characteristics of the recall. We identify two recall characteristics, (1) the degree of product newness and (2) the degree of recall hazard. Specifically, the former affects the degree of information asymmetry between the implicated firms and investors and, thus, the strength of the signaling effect, whereas the latter affects the degree of investor disappointment and, thus, the strength of the expectation effect. We therefore propose hypotheses pertaining to the overall impact of increasing prerecall advertising under different recall situations.

The degree of product newness and the signaling effect. We expect that the strength of the positive signaling effect varies with the degree of product newness. Specifically, we expect the positive signaling effect to be stronger when the recall involves a newly introduced product. Previously, we discussed that the signaling effect of prerecall advertising on the stock market occurs because of information asymmetry between firms and stakeholders (i.e., consumers and investors). When a newly introduced product is recalled, information asymmetry is larger. Compared with firms that possess unique internal information about the severity of a quality defect and its potential damage to future cash flows, investors have less information because the new product has neither fully penetrated the market nor been completely tested by experts or consumers. For example, at Edmunds.com, a popular website of consumer reviews for cars, the newly launched Toyota Sequoia 2014 received only two reviews through March 2014, compared with 115 for the Sequoia 2008. Thus, it is difficult for investors (and consumers) to develop any sound estimate of the potential impact of the new model's recall on the basis of such limited information. With such a high degree of information asymmetry, we expect the signaling effect of increasing prerecall advertising to be stronger for recalls of new products because investors (and consumers) would make greater use of such information to evaluate the recall in the absence of extensive information from other sources.

When a product has been on the market for a longer period of time, more public information is available to investors (e.g., from news releases, expert analyses, and consumer reviews), and the information asymmetry between firms and stakeholders (i.e., consumers and firms) is reduced. Thus, when older products are recalled, investors (and consumers) can use multiple sources of available information to form their estimates of the severity of the product defect and the consequence of the recall. As a result, we expect the signaling effect of increasing prerecall advertising to be weaker in recalls of older products.

The degree of recall hazard and the expectation effect. We expect the strength of the negative expectation effect of increasing prerecall advertising to be dependent on the degree of recall hazard. Specifically, we expect the negative expectation effect to be stronger when the recall is due to a major hazard but weaker when the recall is due to a minor hazard. The level of safety hazard is critical information about different categories of product recalls regulated by different government agencies (e.g., the Food and Drug Administration for product safety relevant to public health, the Consumer Product Safety Commission for non-auto-related product safety, the NHTSA for automobile safety). In particular, product recalls can be classified into major or minor hazard categories according to the severity of quality defects. According to the NHTSA, major hazard recalls are caused by severe quality defects (e.g., fuel leakage, steering problems, acceleration problems, braking failure, repeated stalling, visibility issues) that may lead to fire or a car crash. For example, Toyota's recall announcement on September 29, 2009, clearly indicated that "a stuck open accelerator pedal may result in very high vehicle speeds and make it difficult to stop the vehicle, which could cause a crash, serious injury or death" (NBCNews.com 2009). Auto recalls that do not fall into the category of major hazard are regarded as minor hazard recalls.

Sensational hazards such as fire, crash, and death strengthen the message of product failure and enlarge the discrepancy between the higher expectations of quality developed by increased prerecall advertising and the actual poor quality indicated by the major hazard. When such recalls are announced, investors (and consumers) may experience a stronger sense of unfulfilled expectations, which amplifies their dissatisfaction and disappointment, thus leading to a stronger negative expectation effect as a result of increased prerecall advertising. In contrast, when recalls are due to a minor hazard, the sense of unfulfilled expectation is relatively low. Thus, investors (and consumers) may experience relatively weaker feelings of disappointment about such recalls, which corresponds to a relatively weaker negative effect.

Considering the joint influence of these two recall characteristics, product newness and recall hazard, we make predictions about the overall impact of increasing prerecall advertising under three scenarios:

Scenario 1: Recalls of newly introduced products with a minor hazard. Under this scenario, because an increase in prerecall advertising generates a stronger positive signaling effect (for new product recalls) and a weaker negative expectation effect (because of a minor hazard), we expect the stronger positive signaling effect to dominate the weaker negative expectation effect; therefore, the net impact of increasing prerecall advertising is positive (i.e., the positive signaling effect will diminish the negative impact of product recalls on the recalling firms' stock returns).

Scenario 2: Recalls of older products due to a major hazard. Under this scenario, we expect the net impact of increasing prerecall advertising to be reversed from Scenario 1. Specifi-

cally, an increasing adjustment generates a weaker positive signaling effect (for recalls of older products) and a stronger negative expectation effect (due to a major hazard). We predict that the stronger negative expectation effect dominates the weaker positive signaling effect; therefore, the net impact of increasing prerecall advertising is negative (i.e., the negative expectation effect will worsen the negative impact of products recalls on stock returns).

Scenario 3: Recalls of new products with a major hazard. Under this scenario, an increasing adjustment simultaneously causes a stronger positive signaling effect and a stronger negative expectation effect. The net impact of increasing prerecall advertising under this scenario can be positive or negative, depending on the relative strength of the two effects. Thus, we consider competing predictions. Note that we do not expect a significant impact of prerecall advertising increases for recalls of older products with a minor hazard, for which both the positive signaling and the negative expectation effects are weak.

Formally, we propose the following specific hypotheses for the overall impact of increasing prerecall advertising:

H_1: For recalls of newly introduced products with a minor hazard, increasing the recalled products' prerecall advertising diminishes the negative impact of product recalls on firms' stock returns.

H_2: For recalls of older products with a major hazard, increasing the recalled products' prerecall advertising worsens the negative impact of product recalls on firms' stock returns.

H_3: For recalls of newly introduced products with a major hazard, increasing the recalled products' prerecall advertising (a) diminishes or (b) worsens the negative impact of product recalls on firms' stock returns.

Decreasing Prerecall Advertising

Following the same arguments for the positive signaling effect created by increasing prerecall advertising, we expect that a reduction of advertising before a recall can create a negative signaling effect. Such a negative signaling effect is stronger for new product recalls (because of greater information asymmetry) but weaker for recalls of older products (less information asymmetry).

Similarly, we expect that a decrease in advertising spending creates a positive expectation effect. Relative to no adjustment of prerecall advertising, a decrease in prerecall advertising lowers investors' expectations of product quality, which reduces their disappointment toward product recalls. Because investors have a stronger disappointment reaction to a major hazard than to a minor hazard, we expect the positive expectation effect of a decreasing adjustment to be stronger for the former than for the latter.

The overall impact of decreasing prerecall advertising will be jointly determined by the two recall characteristics, product newness and recall hazard. Specifically, we expect that the net impact of decreasing prerecall advertising will be negative for recalls of newly introduced products with a minor hazard because of a strong negative signaling effect and a weak positive expectation effect. However, the impact will be positive for recalls of established products with a major hazard because of a weak negative signaling effect and a strong positive expectation effect. For recalls of new products with a major hazard, cutting prerecall advertising causes both a strong negative signaling effect and a strong positive expectation effect. Because the overall impact of decreasing prerecall advertising can be positive or negative, we consider two competing hypotheses. Formally, we propose the following specific hypotheses for the overall impact of decreasing prerecall advertising:

H_4: For recalls of newly introduced products with a minor hazard, decreasing the recalled products' prerecall advertising worsens the negative impacts of product recalls on firms' stock returns.

H_5: For recalls of older products with a major hazard, decreasing the recalled products' prerecall advertising diminishes the negative impact of product recalls on firms' stock returns.

H_6: For recalls of newly introduced products with a major hazard, decreasing the recalled products' prerecall advertising (a) diminishes or (b) worsens the negative impact of product recalls on firms' stock returns.

Model

We first use the event study framework to calculate the abnormal returns to the events of auto recall announcements. Then, we examine the impact of prerecall advertising adjustments on those abnormal returns.

Event Study

We adopt an event study analysis to examine the stock market impact of product recalls. In recent years, the event study methodology has been widely used in the marketing literature to investigate the stock market impacts of marketing initiatives, such as new product development alliances (Kalaignanam, Shankar, and Varadarajan 2007), innovation (Sood and Tellis 2009), product placement (Wiles and Danielova 2009), new distribution channels (Geyskens, Gielens, and Dekimpe 2002), and product quality (Tellis and Johnson 2007). This method relies on the efficient market hypothesis (Fama 1970), which suggests that the price of a stock should immediately reflect all publicly available information and that any abnormal stock return reflects the impact of *newly available* public information. In this study, a publicly reported auto recall is defined as an event that delivers new information to the stock market.

The abnormal return of an auto recall is the difference between the actual stock return and the expected normal return. Following the literature (MacKinlay 1997), we estimate the expected normal return using a market model:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it},$$

where R_{it} is the stock return of firm i on day t and R_{mt} is the base return of a value-weighted market index on day t. Following prior studies (e.g., Chen, Ganesan, and Liu 2009; MacKinlay 1997), we chose an estimation period of 250 prior trading days (i.e., day –271 to day –22) to estimate the normal component of stock returns. We then applied the estimated $\hat{\alpha}_i$ and $\hat{\beta}_i$ to calculate firm i's expected normal returns. We calculate the abnormal return as the difference between the actual return and the expected return during the

event window: $AR_{i(\tau)} = R_{i(\tau)} - E[R_{i(\tau)}] = R_{i(\tau)} - [\hat{\alpha}_i + \hat{\beta}_i R_{m\tau}]$, where $\tau \in [\tau_1, \tau_2]$. Finally, the cumulative abnormal return (CAR) is aggregated over the event window $[\tau_1, \tau_2]$; that is, $CAR_{i(\tau_1, \tau_2)} = \Sigma_{\tau=\tau_1}^{\tau_2} AR_{i(\tau)}$.

Cross-Sectional Analysis

To examine the impact of prerecall advertising on the abnormal returns of product recalls, we conduct a cross-sectional analysis by regressing the CARs on prerecall advertising adjustments, the interaction terms between prerecall advertising adjustments and the two recall factors of product newness and recall hazard, and the control variables. Equation 1 presents the cross-sectional model:

$$\begin{aligned}(1)\ CAR_{ij} = {} & b_0 + b_{inc}inc_{ij} + b_{dec}dec_{ij} + b_{new}new_{ij} + b_{hazard}hazard_{ij} \\ & + b_{inc \times new}inc_{ij} \times new_{ij} + b_{dec \times new}dec_{ij} \times new_{ij} \\ & + b_{inc \times hazard}inc_{ij} \times hazard_{ij} + b_{dec \times hazard}dec_{ij} \times hazard_{ij} \\ & + b_{control}control_{ij} + \varepsilon_{ij},\end{aligned}$$

where the dummy variables inc_{ij} and dec_{ij} refer to an increase and a decrease in prerecall advertising for recalled products, respectively. Specifically, if firm i increases its advertising for recalled products before the recall j, inc_{ij} is equal to 1 and dec_{ij} is equal to 0. In contrast, if firm i decreases its advertising before the recall j, inc_{ij} is 0 and dec_{ij} is 1. When there is no adjustment in prerecall advertising, both inc_{ij} and dec_{ij} are equal to 0. We also incorporate two dummy variables, product newness (new_{ij}) and major hazard ($hazard_{ij}$), and their interactions with prerecall advertising adjustments to examine the moderating effects of these two recall factors on the impact of prerecall advertising. The dummy variable new_{ij} is equal to 1 if the recall involves new products, and the dummy variable $hazard_{ij}$ is 1 if the recall is due to a major safety hazard. A vector of control variables, such as other recall factors and characteristics of the recalling firm, is also incorporated into the model. We introduce definitions and measurements of these control variables in the next section. To derive the overall impact of increasing and decreasing prerecall advertising under certain recall scenarios, we sum all coefficients related to the advertising adjustment and its interaction with the specific recall scenario. In the cases of increasing adjustments of prerecall advertising, to test H_1, we sum the two coefficients of inc and inc × new (i.e., $b_{inc} + b_{inc \times new}$) for recalls of new products with minor hazards and test its significance. To test H_2, we sum the two coefficients of inc and inc × hazard (i.e., $b_{inc} + b_{inc \times hazard}$) for recalls of older products with major hazards. To verify H_3, we sum the three coefficients of inc, inc × new, and inc × hazard (i.e., $b_{inc} + b_{inc \times new} + b_{inc \times hazard}$) for recalls of new products with major hazards. Regarding the decreasing adjustments of prerecall advertising, to test H_4, we sum the two coefficients of dec and dec × new (i.e., $b_{dec} + b_{dec \times new}$). To test H_5, we sum the two coefficients of dec and dec × hazard (i.e., $b_{dec} + b_{dec \times hazard}$). To verify H_6, we sum the three coefficients of dec, dec × new, and dec × hazard (i.e., $b_{dec} + b_{dec \times new} + b_{dec \times hazard}$).

Empirical Analysis

Data

This study examines the impact of prerecall advertising on firms' abnormal stock returns resulting from safety recalls in the automotive industry. We collected recall data from the NHTSA. Our sample consists of vehicle safety recalls by the six largest automakers (Toyota, Honda, Nissan, General Motors, Ford, and Chrysler) from 2005 to 2012 because these six automakers account for about 90% of the U.S. motor vehicle market for cars and light trucks. Following prior studies (Barber and Darrough 1996; Hoffer, Pruitt, and Reilly 1988; Jarrell and Peltzman 1985), we included a vehicle safety recall in the sample if it was reported by the *Wall Street Journal* (*WSJ*) or if it was large in proportion to firm size (following Jarrell and Peltzman 1985), that is, 50,000 vehicles affected for Toyota; 40,000 vehicles affected for General Motors, Ford, and Chrysler; 30,000 for Honda; or 20,000 for Nissan. One hundred fifty-seven vehicle recalls met these criteria.

We identified the recall announcement date on the basis of the recall information provided by the NHTSA and reports by third-party media such as *WSJ*. Six recalls were not reported by the media, meaning no exact date could be identified, so we dropped them. If a recall was reported on multiple dates by multiple sources, we used the earliest one as the recall announcement date. To prevent information leakage before the event date, we followed previous literature (e.g., Chen, Ganesan, and Liu 2009; Davidson and Worrell 1992) and excluded 15 recalls for which there were news reports about related accidents and safety issues in *WSJ* before the recall announcement. Finally, following Chen, Ganesan, and Liu (2009) and Chen, Liu, and Zhang (2012), to rule out potential confounding effects, we also excluded 26 recalls whose event windows overlapped with confounding major events (i.e., earnings surprises, earnings warnings, new plants, new products, mergers and acquisitions, joint ventures, bankruptcy, layoffs, and changes in top management) that received high levels of publicity (defined as coverage in *WSJ*) because these events are capable of contaminating the effect of a product recall.

Our final sample consists of 110 automobile safety recalls, similar to some previous studies. Jarrell and Peltzman (1985) studied 116 auto recalls from 1967–1981. Chen, Ganesan, and Liu (2009) studied 153 (nonauto) consumer product recalls from 1996 to 2007. We collected stock price and market index data from the Center for Research in Security Prices at the University of Chicago. We obtained data on firm characteristics such as firm size and firm debt from Compustat, firm reputation scores from annual surveys by *Fortune* magazine, and data on recall characteristics from the NHTSA database. In addition, we collected recalled product quality data from *Consumer Reports Buying Guide* and advertising data from Kantar Media.

Variables

Prerecall advertising adjustment. To identify whether a firm adjusts its advertising spending before an anticipated

recall, we specify an adjustment period and a benchmark period. Conceptually, the adjustment period is the prerecall period when the stock market perceives an unexpected change in advertising spending, whereas the benchmark period is the period when the stock market develops expectations about advertising spending for the adjustment period. In other words, we use the advertising spending in the benchmark period to predict the expected advertising spending in the adjustment period. We then compare the expected and the actual advertising spending in the adjustment period to determine whether there is an unexpected change in advertising when approaching the recall.[4] Figure 1 illustrates these two periods in relation to the event window of a product recall, where $\tau_0 = 0$ denotes the recall announcement date; $[\tau_1, \tau_2]$ denotes the event window; and ν_1, ν_2 denote two cutoff dates for the adjustment and benchmark periods, respectively. Accordingly, l_a in Figure 1 denotes the length of the adjustment period between τ_1 and ν_1, while l_b denotes the length of the benchmark period between ν_1 and ν_2.

Specifically, to derive the expected advertising spending in the adjustment period, we first estimate an autoregressive model of A_t as a function of previous advertising spending:

$$(2) \qquad A_t = \lambda_0 + \sum_{i=1}^{l_b} \lambda_i A_{t-i} + \eta_t,$$

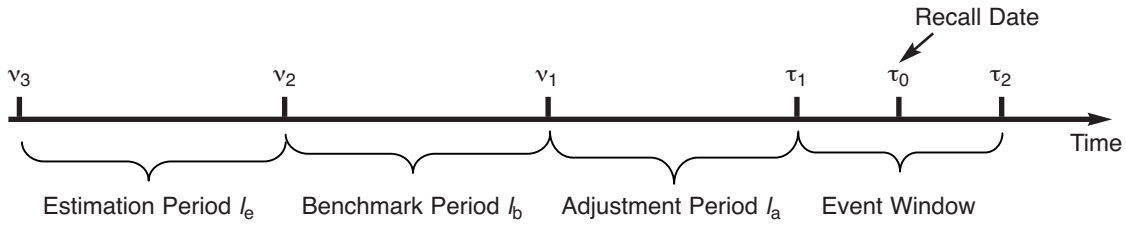
where the order of the autoregressive model is equal to the length of the benchmark period, l_b (i.e., the number of weeks in the benchmark period). For example, if the benchmark period is set to be four weeks, we use four series of weekly advertising spending in the benchmark period to estimate the expected advertising in the adjustment period. To derive parameters λ_0 and λ_i, we estimate Equation 2 by using the advertising spending in an estimation period (in this study, 52 weeks before the benchmark period). Figure 1 illustrates the estimation period in relation to benchmark and adjustment periods. With the estimates of λ_0 and λ_i, we can predict the expected advertising spending in the adjustment period using the observed advertising spending in the benchmark period—that is, $\hat{A} = \hat{\lambda}_0 + \Sigma_{i=1}^{l_b} \hat{\lambda}_i A_{t-i}$. Finally, we calculate the unexpected change in advertising spending as the difference between the average of actual advertising spending and the expected spending in the adjustment period, $\Delta A = [(1/l_a)\Sigma_{t=1}^{l_a} A_t] - \hat{A}$, where A_t ($t = 1, \ldots, l_a$) denotes the actual weekly advertising spending in the adjustment period, and l_a denotes the length of the adjustment period (i.e., the number of weeks in the adjustment period). Accordingly, if the unexpected change in advertising spending, ΔA, is above (below) the threshold of two standard deviations of the predicted spending in the adjustment period, we define the advertising adjustment as an increase (decrease); otherwise, we define it as no adjustment.

To determine the appropriate lengths of the benchmark and adjustment periods, we considered adjustment periods lasting from one to three weeks before the recall announcement and benchmark periods lasting from three to six weeks before the adjustment period. Then, we experimented with eight sets of adjustment and benchmark periods. For example, one choice of adjustment and benchmark periods $[l_a, l_b]$ can be [1, 4], indicating an adjustment period of one week and a benchmark period of four weeks. We applied our cross-sectional model to numerous sets of benchmark and adjustment periods and found consistent results (see the "Robustness and Validity of Results" subsection). Among them, the model with the adjustment and benchmark periods of [1, 4] provides the best model fit. Thus, our discussions of the empirical analyses focus on the estimation results based on the adjustment and benchmark periods of [1, 4].

The content of prerecall advertising could be closely related to the mechanisms of its signaling and expectation effects. The literature has found that informative advertising is effective in signaling product quality and in forming expectations of product quality (e.g., Anderson and Renault 2009; Zhao 2000). Accordingly, brand-oriented advertising that aims to inform potential purchasers about product attributes could demonstrate a stronger signaling effect than promotion-oriented advertising aimed to persuade

[4]Advertising adjustments could also be measured in levels or share of voice. We use discrete changes because a large weekly variation in ad spending is typical, so investors would be unable to distinguish small signals from regular variation in advertising. In addition, discretizing advertising adjustments to be increased or decreased enables us to capture asymmetric impacts of prerecall advertising adjustments, as our study found. Share-of-voice measures are even noisier because they include competitors' intertemporal advertising variation, which is less relevant to the recall event because competitors are not able to anticipate the occurrence or timing of recall events.

FIGURE 1
The Time Frame of Advertising Adjustments Near a Product Recall



purchase.[5] Similarly, investors' expectations of product quality can be formed from repeated prior marketing information (Haruvy, Lahav, and Noussair 2007), which, in this study, is the exposure to increased frequency of informative advertising near a recall. Motivated by these arguments, we focused on brand-oriented advertising to specify prerecall advertising adjustments. We define advertising as expenditures on national television networks because Xu et al.'s (2014) content analysis indicates that local automotive advertising is primarily price oriented. Among the brand-oriented advertising, we further excluded ads labeled as "sales event," "sponsored event," "general promotion," "corporate promotion," and so on.

Two recall characteristics. The first recall characteristic involves the newness of the recalled products. We classify an auto recall as a new product recall when the recall involves vehicles introduced within two years (24 months) before the recall announcement date. This definition specifies a constant novelty period relative to the recall point and thus a relatively consistent level of information asymmetry about the recalled new vehicles.[6] The second recall characteristic is the severity of the safety hazard. Following the literature (Rupp 2004; Rupp and Taylor 2002), we classify a recall as a major hazard recall if severe quality defects (e.g., fuel leakage, steering problems, acceleration problems, brake failure, repeated stalling, visibility, which may cause fire or car crash) were involved. We collected both variables from the NHTSA recall database.

Summarizing the prerecall advertising adjustments data, Table 2 shows that there are 35 cases of increase, 36 cases of decrease, and 39 cases of no adjustment. Sixty-five recalls involved new products, and 56 were due to major hazards. Similar numbers of increasing and decreasing adjustments of prerecall advertising occurred, regardless of whether the recalled product was new or old or whether the recall hazard was major or minor.

Control variables. Our empirical analysis incorporates two types of controls: (1) recall factors and (2) characteristics of the recalling firm. In line with the extant literature on auto recalls (Rupp 2004, 2005; Rupp and Taylor 2002), we included recall initiator, recall size, airbag recall, and publicity of a recall as control variables. The dummy variable NHTSA denotes whether the recall was initiated by the NHTSA (rather than by the firm). Recall size, rcsize, is measured as the logarithm of the total number of vehicles affected by the recall. The dummy variable airbag denotes whether a recall is due to an airbag defect. The information on these recall factors was also collected from the NHTSA. We also incorporated a dummy control t2009, indicating whether a recall occurred after Toyota's 2009 unexpected acceleration recall crisis, which enables us to control for whether the stock market impact of an auto recall is influenced by reactions to Toyota's recall crisis. Another control variable we used in this study is the quality of the recalled products. We measured the quality of the recalled vehicles as the logarithm of their average road-test scores, which we collected from the *Consumer Reports Buying Guide*.

We define the final recall control variable, publicity, in two steps. First, we sum the circulations of all newspapers reporting the recall. Then, we classify total publicity into four categories: negligible (0), local (1), national (2), and supranational (3). We define publicity as supranational if it exceeded 1.073 million (i.e., circulation equivalent to coverage in at least two of the top five newspapers[7]), national if it exceeded 522,874 (i.e., circulation equivalent to coverage in the smallest of the top five newspapers), local if it exceeded 104,053 (equivalent to Chicago's *Daily Herald*, a relatively small newspaper), or negligible otherwise.[8]

The control variables representing characteristics of the recalling firms include firm size, firm debt, firm reputation, and past recall frequency. We measure firm size, fsize, as the logarithm of the firm's sales revenue, and firm debt, fdebt, is calculated as the logarithm of the firm's long-term liability. We collected data on sales revenue and long-term liability from Compustat. We measured firm reputation, frep, as the logarithm of the firm's reputation score from the most recent issue of *Fortune* magazine's annual survey of "America's Most Admired Companies." Furthermore, we measured past recall frequency as the logarithm of the number of recalls from the same firm in the preceding year (i.e.,

[5]We thank an anonymous reviewer for providing this insight.

[6]We thank an anonymous reviewer for suggesting this point.

[7]According to *Factiva*, the top five newspapers by circulation are *WSJ* (2,117,796), *USA Today* (1,829,099), *The New York Times* (916,911), *The Washington Post* (550,821), and *New York Post* (522,874).

[8]The results are unchanged if we measure publicity by total circulation directly or if we separate publicity into local, national, and supranational fixed effects.

TABLE 2
The Distribution of Prerecall Advertising Adjustments

	Advertising Adjustment			
	Increase	**Decrease**	**No Adjustment**	**Total**
Overall	35	36	39	110
New product recall	25	27	13	65
Older product recall	10	9	26	45
Major hazard	19	22	15	56
Minor hazard	16	14	24	54

Notes: The three categories of advertising adjustments are classified on the basis of the adjustment period of one week and the benchmark period of four weeks.

within 365 days preceding the focal recall). We obtained the data on recall frequency from the NHTSA monthly reports on vehicle safety recalls. Incorporating past recall frequency enables us to control for its possible influence on abnormal returns of the focal recall because a large number of prior recalls may build a reputation among investors, thereby potentially reducing information asymmetry about the focal recall.[9] Finally, we incorporate two dummy variables, inc_u and dec_u, to control for the potential effect of adjustments (i.e., increase or decrease) in prerecall advertising for products of the same firm that are unaffected by the recall. The variable definitions and the specifications of prerecall advertising adjustments for unaffected products are similar to those for recalled products. Table 3 summarizes variable definitions, data sources, and descriptive statistics.

Results

Abnormal returns to product recalls. We use an event study to calculate the abnormal returns to the events of auto recall announcements. To minimize the contaminating effects of potential confounding events (McWilliams and Siegel 1997), we focus on four relatively short event windows: (1) the day before the event date (i.e., the day –1), (2) the event date (i.e., the day 0), (3) the day after the event date (i.e., the day +1), and (4) both the event day and its following day (i.e., [0, 1]). Table 4 reports the abnormal returns over these four event windows.

As Table 4 shows, the abnormal return on day –1 is not significant, indicating no evidence of information leakage before the recall announcement. In our sample, an auto recall was typically reported by the digital media (e.g., Internet news, television news) first on the event date 0 and then appeared in print media (e.g., newspapers, magazines) on day +1 following the event date. The abnormal returns on both days of publicity are significantly negative. Table 4 shows that on event day 0, the average abnormal return of the recalling firms is $CAR_{[0, 0]} = –.54\%$ ($t = –4.91$, $p < .01$); on day +1 after the event date, the average abnormal return is $CAR_{[1, 1]} = –.36\%$ ($t = –3.59$, $p < .01$). Together, the CAR over these two days is $CAR_{[0, 1]} = –.89\%$ ($t = –6.85$, $p < .01$). These results are consistent with prior findings on the detrimental impacts of product recalls on firms' stock returns (Barber and Darrough 1996; Davidson and Worrell 1992; Jarrell and Peltzman 1985; Thomsen and McKenzie 2001). Because this analysis indicates that abnormal returns accrue on the day of the recall announcement and the day after, we chose [0, 1] as the event window for the following analyses. Barber and Darrough (1996) also adopted this

[9]We thank an anonymous reviewer for providing this insight.

TABLE 3
Variable Definitions and Data Statistics

Variable	Definition/Operationalization	Source	M	SD
Advertising Adjustments				
inc	Whether prerecall advertising for recalled products increases (1) or not (0)	Kantar Media	.318	.468
dec	Whether prerecall advertising for recalled products decreases (1) or not (0)		.327	.471
Recall Characteristics				
new	Whether the recall involves new products (1) or not (0)	NHTSA	.591	.493
hazard	Whether the recall is due to a major safety hazard (1) or not (0)	NHTSA	.509	.502
NHTSA	Whether the recall is initiated by the NHTSA (1) or not (0)	NHTSA	.382	.488
rcsize	The logarithm of the total number of products affected by the recall	NHTSA	5.305	.530
airbag	Whether the recall is due to an airbag problem (1) or not (0)	NHTSA	.064	.245
t2009	Whether the recall is after Toyota's 2009 recall crisis (1) or not (0)	NHTSA	.427	.497
quality	The logarithm of the average quality of the recalled products	*Consumer Reports*	1.836	.085
frequency	The logarithm of the number of recalls from the same firm in the preceding year	NHTSA	.649	.217
publicity	The level of publicity of a product recall with four possible categories: 0 = negligible, 1 = local, 2 = national, and 3 = supranational	Factiva news database	1.509	.983
Firm Characteristics				
fsize	Firm size, measured as the logarithm of the firm's sales revenue	Compustat	5.218	.155
fdeb	Firm debt, measured as the logarithm of the firm's long-term liability	Compustat	4.597	.346
frep	Firm reputation, measured as the logarithm of the firm's reputation score	*Fortune* magazine	.744	.076
inc_u	Whether prerecall advertising for unaffected products increases (1) or not (0)	Kantar Media	.282	.452
dec_u	Whether prerecall advertising for unaffected products decreases (1) or not (0)		.318	.468

TABLE 4
Abnormal Returns of Auto Recalls over Different Event Windows

Event Window	Abnormal Return	SE	T-Statistics	*p*-Value
[–1, –1]	.0003	.0019	.16	>.10
[0, 0]	–.0054	.0011	–4.91	<.01
[1, 1]	–.0036	.0010	–3.59	<.01
[0, 1]	–.0089	.0013	–6.85	<.01

two-day event window in a similar event study of auto recalls.

The impact of prerecall advertising adjustments. Table 5 presents the results of a simple univariate analysis, which directly tests whether the postrecall abnormal returns differ across prerecall advertising adjustments. To underscore the significance of the two recall factors identified herein (i.e., product newness and recall hazard), we present the results ignoring these recall factors in Table 5, Panel A, and provide the results considering them in Panel B.

Without considering specific recall characteristics, Table 5, Panel A, demonstrates the effects of two advertising adjustments (increasing prerecall advertising vs. no adjustment, and decreasing prerecall advertising vs. no adjustment). As Panel A shows, the average abnormal return with increasing prerecall advertising does not significantly differ from that with no adjustment ($\Delta CAR = -.0016$, $p > .10$), indicating that the positive signaling effect and the negative expectation effect of the increasing adjustments cancel each other out, on average, for an increase in prerecall advertising. However, the average abnormal return with decreasing prerecall advertising is significantly lower than that with no adjustment ($\Delta CAR = -.0089$, $p < .05$), indicating that the negative signaling effect of the decreasing adjustment dominates, on average, when prerecall advertising falls. Table 5, Panel B, which incorporates the specific recall factors, shows the effects of advertising adjustments for six cases (four for increasing prerecall advertising vs. no adjustment and two for decreasing prerecall advertising vs. no adjustment). Panel B reveals significant results in four cases: (1) When a recall involves new products with a minor hazard, the average abnormal return is significantly higher for increasing adjustments in prerecall advertising than for no adjustment of prerecall advertising ($\Delta CAR = .0079$, $p < .10$), which is consistent with H_1. (2) When the recalled products are older with a major hazard, the average abnormal return is significantly lower for increasing adjustments than for no adjustment ($\Delta CAR = -.0126$, $p < .05$), consistent with H_2. (3) When a recall involves new products with a minor hazard, the average abnormal return is significantly lower for decreasing adjustments than for no adjustment ($\Delta CAR = -.0108$, $p < .05$), consistent with H_4. (4) When a recall involves new products with a major hazard, the average abnormal return is lower for decreasing adjustments than for no adjustment ($\Delta CAR = -.0103$, $p < .05$), which supports H_{6b}. These results suggest that when ignoring specific recall factors (Panel A), one may mistakenly conclude that increasing prerecall advertising does not affect firm value under a recall crisis, but decreasing it always harms firm value.

To further examine the impact of prerecall advertising on the abnormal returns to product recalls, we also estimated the cross-sectional model of Equation 1. We conducted the Lagrange multiplier test (Breusch and Pagan 1980) for potential heterogeneity among different recalling firms, and it does not indicate unobserved heterogeneity ($\chi^2 = 1.06$, $p > .10$). Next, we checked for multicollinearity. The variance inflation factor of the full interaction Model 1 ranges from 1.193 to 8.467, with the largest variance inflation factor being less than 10, suggesting that multicollinearity is not a severe problem. Therefore, we estimated Equation 1 using pooled ordinary least squares with heteroskedasticity-consistent standard errors.

We present two versions of estimation results of cross-sectional regression in Table 6. The first version reports the estimation results of a partial cross-sectional model without

TABLE 5
Abnormal Returns Under Different Adjustments of Prerecall Advertising and Types of Product Recalls

A: Prerecall Advertising Adjustments[a] and Abnormal Returns to Product Recalls

	"Increasing Prerecall Advertising" Versus "No Adjustment"[b]	"Decreasing Prerecall Advertising" Versus "No Adjustment"
All	–.0016	–.0089**

B: Prerecall Advertising Adjustments and Abnormal Returns to Different Types of Product Recalls

	"Increasing Prerecall Advertising" Versus "No Adjustment"[b]		"Decreasing Prerecall Advertising" Versus "No Adjustment"	
	Major Hazard	Minor Hazard	Major Hazard	Minor Hazard
New products	.0009	.0079*	–.0103**	–.0108**
Old products	–.0126**	.0017	.0019	.0006

*$p < .10$.
**$p < .05$.
[a]The advertising adjustments are classified on the basis of the adjustment period of one week and the benchmark period of four weeks.
[b]The abnormal return reported here is $\Delta CAR_{inc\text{-}no,[0,\ 1]}$—that is, it is the average abnormal return to product recalls of those firms that increased prerecall advertising, minus the average abnormal return of those firms that made no prerecall advertising adjustment. Similarly, all the abnormal returns reported in this table are relative to those under no adjustment of prerecall advertising.

incorporating the interaction terms between prerecall advertising adjustments and the two recall factors, while the full version reports the estimation results of Equation 1 including the interaction effects. Consistent with the univariate analysis results in Panel A of Table 5, without considering the interaction terms, the coefficient of increasing prerecall advertising is not significant. For an increasing adjustment, the positive signaling effect and the negative expectation effect may cancel each other out. The coefficient of decreasing prerecall advertising is significantly negative, indicating that the negative signaling effect of a decreasing adjustment dominates.

When incorporating the interaction terms (i.e., the full cross-sectional regression in Equation 1), we identified conditions under which increasing/decreasing prerecall advertising can lessen or worsen the harmful impact of product recalls on stock returns. For an increasing adjustment of prerecall advertising, the coefficient of inc × new is significantly positive ($b_{inc \times new} = .0108$, $p < .05$), whereas the coefficient of inc × hazard is significantly negative ($b_{inc \times hazard} = -.0135$, $p < .05$). Thus, when a recall involves new products with a minor hazard (i.e., new = 1 and hazard = 0), the overall impact of increasing prerecall advertising, measured as the sum of the coefficients of inc and inc × new, is significantly positive ($b_{inc} + b_{inc \times new} = .0111$, $p < .05$). This result, consistent with the univariate analysis in the Table 5, Panel B, provides further empirical evidence for support H_1.

For recalls of older products with a major hazard (i.e., hazard = 1 and new = 0), the overall impact of increasing prerecall advertising, calculated as the sum of the coefficients of inc and inc × hazard, is significantly negative ($b_{inc} + b_{inc \times hazard} = -.0132$, $p < .05$). Consistent with Table 5, Panel B, this result further supports H_2.

For recalls of new products with a major hazard (i.e., new = 1 and hazard = 1), the net effect of increasing prerecall advertising, represented by the sum of three coefficients of inc, inc × new, and inc × hazard, is not significant ($b_{inc} + b_{inc \times new} + b_{inc \times hazard} = -.0024$, $p > .10$). So neither H_{3a} nor H_{3b} is supported. This result indicates that the stronger positive signaling effect (strengthened by the larger information asymmetry for new product recalls) and the stronger negative expectation effect (intensified by the stronger investor disappointment toward major hazard recalls) may cancel each other out.

With regard to the decreasing adjustments in prerecall advertising, the coefficient of dec × new is significantly negative ($b_{dec \times new} = -.0127$, $p < .05$). When a recall involves new products with a minor hazard, the overall impact of decreasing prerecall advertising, measured as the sum of the coefficients of dec and dec × new, is significantly negative ($b_{dec} + b_{dec \times new} = -.0132$, $p < .05$). This result further supports H_4.

For recalls of older products with a major hazard, the impact of decreasing prerecall advertising is the sum of the coefficients of dec and dec × hazard ($b_{dec} + b_{dec \times hazard} = .0016$, $p > .10$), indicating that H_5 is not supported. According to the estimation result, the coefficient of dec × hazard is not significant ($b_{dec \times hazard} = .0021$, $p > .10$), suggesting

TABLE 6
Estimation Results of Cross-Sectional Regressions

	Cross-Sectional Regression: Main Effects Only		Cross-Sectional Regression: Full Model	
	Estimate	**SE**	**Estimate**	**SE**
Intercept	−.0211	.0532	−.0259	.0511
inc × new			.0108**	.0045
dec × new			−.0127**	.0044
inc × hazard			−.0135**	.0049
dec × hazard			.0021	.0046
inc	−.0005	.0028	.0003	.0038
dec	−.0095**	.0028	−.0005	.0046
new	−.0059**	.0027	−.0056*	.0030
hazard	−.0049**	.0022	−.0007	.0028
NHTSA	−.0064**	.0026	−.0048*	.0025
rcsize	−.0005	.0024	−.0012	.0020
airbag	−.0078**	.0036	−.0075**	.0027
t2009	.0014	.0026	.0021	.0024
quality	.0063	.0126	.0056	.0123
frequency	−.0056	.0057	−.0033	.0052
publicity	−.0030**	.0013	−.0042**	.0011
fsize	.0031	.0110	.0038	.0103
fdeb	−.0008	.0040	−.0015	.0037
frep	−.0138	.0202	−.0107	.0185
inc_u	.0018	.0029	.0026	.0025
dec_u	−.0084**	.0025	−.0078**	.0021
Observations	110		110	
R-square	.38		.50	

*$p < .10$.
**$p < .05$.
Notes: The advertising adjustments are classified on the basis of the adjustment period of one week and the benchmark period of four weeks.

that a significant expectation effect may not exist for a decreasing adjustment in prerecall advertising. This inconsistency with H_5 implies that the expectation effects of increasing and decreasing prerecall advertising may not be symmetric (i.e., although an increasing adjustment can develop investors' high expectations, a decreasing adjustment fails to lower their expectations).

For recalls of new products with a major hazard, the net impact of decreasing prerecall advertising is the sum of the coefficients of dec, dec × new, and dec × hazard, which is significantly negative ($b_{dec} + b_{dec \times new} + b_{dec \times hazard} = -.0111$, $p < .05$). Thus, H_{6b} is supported. This result shows that, for a decreasing adjustment under this scenario, the negative signaling effect dominates the positive expectation effect ($b_{dec \times new} = -.0127, p < .05$ vs. $b_{dec \times hazard} = .0021, p > .10$).

These results demonstrate how adjustments of prerecall advertising for recalled products moderates the financial damage of product recalls. In addition, our results reveal a noteworthy finding regarding the moderating impact of prerecall advertising for unaffected products sold by the implicated firm. Specifically, an increase in prerecall advertising for unaffected products shows no significant impact on the firm's abnormal returns ($b_{inc\_u} = .0026, p > .10$), while a decrease imposes a negative impact ($b_{dec\_u} = -.0078, p < .05$). These results suggest that investors may interpret a downward adjustment of prerecall advertising for unaffected products as private information that the recall may affect consumers' perceptions of nonrecalled models. However, increasing prerecall advertising for unaffected products does not seem to increase abnormal returns at the time of the recall announcement.

Robustness and Validity of Results

We conducted several additional analyses to examine the robustness and validity of our estimation results. First, as stated previously, we experimented with eight sets of benchmark and adjustment periods. For ease of discussion, we refer to these estimation results using different lengths of the adjustment and benchmark periods as Estimation [l_a, l_b]. For example, Estimation [1, 4] refers to the estimation results using the adjustment period of one week and the benchmark period of four weeks. Table 7 presents the cross-sectional regression results when the adjustment and benchmark periods of [1, 3], [1, 4], [1, 5], and [1, 6] are used, and Table 8 presents the regression results when the adjustment and benchmark periods of [2, 4], [3, 4], [2, 5], and [3, 5] are used. As Tables 7 and 8 show, the regression results for the interactions between prerecall advertising and the two recall factors are generally consistent throughout these different combinations of adjustment and benchmark periods.

Second, we explored different thresholds in determining the adjustment of prerecall advertising.[10] Specifically, we consider three thresholds from one to three standard devia-

[10]We thank an anonymous reviewer for suggesting this robustness check.

TABLE 7
Estimation Results of Different Benchmark Periods

	Estimation [1, 3]		Estimation [1, 4]		Estimation [1, 5]		Estimation [1, 6]	
Variable	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
Intercept	−.0293	.0526	−.0259	.0511	−.0167	.0489	−.0278	.0493
inc × new	.0102**	.0047	.0108**	.0045	.0095*	.0050	.0099*	.0052
dec × new	−.0110**	.0045	−.0127**	.0044	−.0130**	.0041	−.0093**	.0046
inc × hazard	−.0117**	.0056	−.0135**	.0049	−.0141**	.0048	−.0153**	.0052
dec × hazard	.0026	.0049	.0021	.0046	.0015	.0052	.0009	.0053
inc	.0018	.0040	.0003	.0038	.0016	.0033	.0025	.0032
dec	−.0011	.0048	−.0005	.0046	−.0012	.0044	.0003	.0049
new	−.0066*	.0035	−.0056*	.0030	−.0050	.0035	−.0068**	.0034
hazard	−.0029	.0024	−.0007	.0028	−.0015	.0026	−.0003	.0028
NHTSA	−.0042	.0030	−.0048*	.0025	−.0049*	.0027	−.0040	.0029
rcsize	−.0023	.0023	−.0012	.0020	−.0011	.0024	−.0015	.0026
airbag	−.0076**	.0032	−.0075**	.0027	−.0080**	.0030	−.0072**	.0033
t2009	.0031	.0026	.0021	.0024	.0023	.0022	.0017	.0025
quality	.0048	.0131	.0056	.0123	.0041	.0137	.0035	.0146
frequency	−.0019	.0061	−.0033	.0052	−.0012	.0065	−.0021	.0059
publicity	−.0037**	.0014	−.0042**	.0011	−.0040**	.0012	−.0038**	.0014
fsize	.0010	.0119	.0038	.0103	.0022	.0115	.0015	.0126
fdeb	−.0014	.0040	−.0015	.0037	−.0020	.0036	−.0012	.0038
frep	−.0125	.0197	−.0107	.0185	−.0118	.0209	−.0122	.0193
inc_u	.0032	.0031	.0026	.0025	.0028	.0027	.0030	.0031
dec_u	−.0053*	.0029	−.0078**	.0021	−.0070**	.0025	−.0067**	.0026
Observations	110		110		110		110	
R-square	.41		.50		.45		.42	

*$p < .10$.
**$p < .05$.
Notes: The first number in brackets refers to the number of weeks in the adjustment period, and the second number refers to the number of weeks used for benchmark period (e.g., Estimation [1, 3] refers to the estimation results using the adjustment period of one week before the recall announcement date and the benchmark period of three weeks).

tions above or below the predicted advertising spending to specify increasing or decreasing adjustments. The combination of these three possible thresholds for increasing/decreasing adjustments generates nine possible sets of thresholds. For example, a set of thresholds [1 SD, 3 SD] implies that the increasing adjustment is determined as one standard deviation above the expected advertising spending in the adjustment period and the decreasing adjustment is specified as three standard deviations below the expected spending. This classification allows asymmetric thresholds to determine increasing and decreasing adjustments. As Table 9, Panels A and B, show, the estimation results using each of the nine sets of thresholds generated consistent results, among which the symmetric combination of moderate thresholds [2 SD, 2 SD] provides the best model fit.

Third, we estimated the cross-sectional Equation 1 to control for possible endogeneity. There are two primary endogeneity concerns. It may be that firm-level factors (e.g., the quality of the firm's managers) correlate with both prerecall advertising adjustments and postrecall stock market reactions. If true, these omitted factors could lead to a spurious correlation between prerecall advertising and postrecall CAR. To check for this possibility, we reestimated Equation 1 with firm fixed effects so that the correlation between firm-level factors and prerecall advertising adjustments would exist among observed variables and therefore would not bias the estimates of prerecall advertising adjustments. As Table 10 shows, the main results persist when we include firm fixed effects in the regression.

The other endogeneity concern pertains to unobserved recall characteristics. It is possible that some unobserved recall characteristics known to both firms and investors may drive both prerecall advertising adjustments and postrecall CAR. To address this concern, we found an instrument and reestimated Equation 1 using two-stage least squares (2SLS). We use within-category advertising by competitors during the prerecall adjustment window as an instrumental variable for the firm's prerecall advertising. Competing firms' advertising expenditures are often correlated with each other because they are commonly driven by time-varying factors that influence category profitability, such as interest rates, gasoline prices, or unobserved trends in consumer preferences. The first-stage estimation results reported in Table 11 show that competitors' advertising expenditures are good predictors of the recalling firm's advertising spending.

The instrument meets the standard exclusion restriction for two reasons. Competitors have no way to anticipate whether or when a recall will be announced, so they are not able to adjust their advertising to affect the recalling firm's postrecall abnormal returns. Furthermore, competitor advertising during the adjustment window has been observed by the market at the time of the recall and therefore should be reflected in the recalling firm's baseline stock price; thus, by definition, it should not be related to postrecall abnormal

TABLE 8
Estimation Results of Different Adjustment Periods

	Estimation [2, 4]		Estimation [3, 4]		Estimation [2, 5]		Estimation [3, 5]	
Variable	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
Intercept	−.0119	.0535	−.0301	.0492	−.0268	.0517	−.0312	.0467
inc × new	.0087	.0051	.0081	.0053	.0064	.0055	.0049	.0056
dec × new	−.0152**	.0041	−.0124**	.0048	−.0135**	.0043	−.0161**	.0045
inc × hazard	−.0136**	.0052	−.0127**	.0054	−.0150**	.0049	−.0147**	.0048
dec × hazard	.0012	.0053	.0025	.0048	.0017	.0051	.0020	.0055
inc	.0069*	.0037	.0059	.0042	.0051	.0041	.0065	.0040
dec	.0026	.0046	.0011	.0047	.0008	.0050	.0037	.0042
new	−.0041	.0035	−.0046	.0038	−.0042	.0034	−.0049	.0033
hazard	−.0021	.0029	−.0028	.0033	−.0019	.0035	−.0014	.0031
NHTSA	−.0035	.0027	−.0053*	.0028	−.0049*	.0026	−.0044*	.0024
rcsize	−.0017	.0023	−.0019	.0026	−.0023	.0026	−.0031	.0028
airbag	−.0065**	.0031	−.0057	.0036	−.0062*	.0034	−.0059*	.0032
t2009	.0012	.0025	.0009	.0030	.0003	.0031	.0025	.0027
quality	.0052	.0129	.0040	.0135	.0038	.0139	.0027	.0145
frequency	−.0026	.0053	−.0017	.0054	−.0018	.0055	−.0012	.0056
publicity	−.0032**	.0012	−.0029**	.0012	−.0030**	.0012	−.0028**	.0012
fsize	−.0008	.0103	.0021	.0107	−.0016	.0098	.0017	.0105
fdeb	.0010	.0038	−.0005	.0037	−.0003	.0041	−.0023	.0039
frep	−.0113	.0191	−.0129	.0195	−.0118	.0189	−.0112	.0187
inc_u	.0021	.0026	−.0003	.0028	.0007	.0026	.0019	.0026
dec_u	−.0069**	.0025	−.0075**	.0026	−.0073**	.0027	−.0067**	.0029
Observations	110		110		110		110	
R-square	.44		.40		.44		.41	

*$p < .10$.
**$p < .05$.
Notes: The first number in brackets refers to the number of weeks in the adjustment period, and the second number refers to the number of weeks used for benchmark period (e.g., Estimation [2, 4] refers to the estimation results using the adjustment period of two weeks before the recall announcement date and the benchmark period of four weeks).

TABLE 9
Estimation Results of Different Adjustment Thresholds

A: Thresholds [1 SD, 1 SD], [1 SD, 2 SD], [2 SD, 1 SD], and [1 SD, 3 SD]

	[1 SD, 1 SD]		[1 SD, 2 SD]		[2 SD, 1 SD]		[1 SD, 3 SD]	
Variable	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
Intercept	−.0164	.0541	−.0217	.0523	−.0145	.0509	−.0253	.0501
inc × new	.0067	.0056	.0052	.0059	.0112**	.0047	.0070	.0055
dec × new	−.0095*	.0049	−.0142**	.0043	−.0093*	.0048	−.0095*	.0050
inc × hazard	−.0103*	.0058	−.0107*	.0058	−.0141**	.0052	−.0109*	.0059
dec × hazard	−.0012	.0048	.0011	.0046	−.0015	.0049	.0030	.0042
inc	.0050	.0039	.0063	.0040	.0005	.0045	.0055	.0040
dec	−.0035	.0047	−.0017	.0049	−.0046	.0042	−.0040	.0044
new	−.0059**	.0029	−.0054	.0032	−.0052	.0033	−.0061**	.0030
hazard	−.0057*	.0030	−.0045	.0028	−.0039	.0027	−.0057*	.0031
NHTSA	−.0044*	.0024	−.0046**	.0023	−.0045*	.0024	−.0046*	.0026
rcsize	−.0023	.0022	−.0014	.0026	−.0021	.0022	−.0019	.0025
airbag	−.0056	.0036	−.0064*	.0035	−.0062*	.0034	−.0051	.0038
t2009	.0015	.0028	.0024	.0025	.0019	.0026	.0003	.0030
quality	.0035	.0131	.0041	.0127	.0048	.0124	.0032	.0133
frequency	−.0023	.0055	−.0012	.0059	−.0022	.0055	−.0017	.0057
publicity	−.0029**	.0012	−.0032**	.0011	−.0035**	.0011	−.0028**	.0012
fsize	.0012	.0110	.0019	.0106	−.0007	.0115	.0021	.0105
fdeb	−.0012	.0041	−.0023	.0038	−.0026	.0036	−.0015	.0040
frep	−.0118	.0190	−.0127	.0185	−.0124	.0183	−.0119	.0188
inc_u	.0039	.0028	.0033	.0025	.0025	.0026	.0047	.0029
dec_u	−.0061**	.0028	−.0063**	.0026	−.0058**	.0029	−.0056**	.0027
Observations	110		110		110		110	
R-square	.39		.42		.45		.40	

B: Thresholds [3 SD, 3 SD], [3 SD, 1 SD], [3 SD, 2 SD], and [2 SD, 3 SD]

	[3 SD, 3 SD]		[3 SD, 1 SD]		[3 SD, 2 SD]		[2 SD, 3 SD]	
Variable	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
Intercept	−.0163	.0505	−.0112	.0523	.0159	.0519	−.0187	.0496
inc × new	.0079	.0052	.0095*	.0049	.0066	.0056	.0110**	.0047
dec × new	−.0095**	.0046	−.0088**	.0044	−.0135**	.0042	−.0096**	.0047
inc × hazard	−.0108*	.0056	−.0115*	.0053	−.0099*	.0055	−.0132**	.0051
dec × hazard	−.0015	.0046	.0016	.0047	.0021	.0044	−.0011	.0049
inc	.0044	.0042	.0034	.0041	.0053	.0039	−.0019	.0045
dec	−.0040	.0047	−.0047	.0042	−.0012	.0049	−.0041	.0047
new	−.0062*	.0033	−.0060*	.0033	−.0053	.0035	−.0048	.0035
hazard	−.0055**	.0027	−.0050*	.0028	−.0061**	.0029	−.0046	.0031
NHTSA	−.0045*	.0025	−.0047*	.0026	−.0051**	.0023	−.0044*	.0025
rcsize	−.0018	.0023	−.0016	.0022	−.0031	.0019	−.0015	.0024
airbag	−.0050	.0033	−.0055	.0032	−.0065*	.0036	−.0069*	.0037
t2009	.0015	.0029	.0012	.0030	.0021	.0026	.0025	.0024
quality	.0038	.0119	.0031	.0112	.0026	.0127	.0029	.0125
frequency	−.0044	.0055	−.0039	.0055	−.0033	.0059	−.0030	.0058
publicity	−.0030**	.0012	−.0032**	.0012	−.0036**	.0011	−.0039**	.0011
fsize	.0020	.0117	.0027	.0109	.0032	.0105	.0030	.0106
fdeb	−.0030	.0040	−.0025	.0039	−.0026	.0041	−.0029	.0040
frep	−.0129	.0191	−.0127	.0196	−.0116	.0187	−.0119	.0189
inc_u	.0023	.0028	.0025	.0028	.0035	.0026	.0033	.0025
dec_u	−.0059**	.0027	−.0056**	.0027	−.0072**	.0028	−.0061**	.0028
Observations	110		110		110		110	
R-square	.40		.42		.43		.45	

*$p < .10$.
**$p < .05$.
Notes: The first (second) number in brackets refers to the standard deviation to specify increasing (decreasing) adjustments (e.g., Threshold [1 SD, 1 SD] refers to the estimation results using the threshold of one standard deviation to specify both increasing and decreasing adjustments).

TABLE 10
Estimation Results Including Automaker Fixed Effects

	Cross-Sectional Regression: Main Effects Only		Cross-Sectional Regression: Full Model	
Variable	**Estimate**	**SE**	**Estimate**	**SE**
inc × new			.0112**	.0052
dec × new			−.0130**	.0048
inc × hazard			−.0132**	.0052
dec × hazard			.0016	.0051
inc	−.0006	.0031	−.0007	.0042
dec	−.0099**	.0031	.0003	.0051
new	−.0053*	.0029	−.0050	.0036
hazard	−.0061**	.0024	−.0006	.0031
NHTSA	−.0064**	.0028	−.0039	.0027
rcsize	−.0003	.0027	−.0015	.0023
airbag	−.0069**	.0031	−.0063**	.0026
t2009	.0023	.0028	.0027	.0025
quality	.0056	.0131	.0048	.0119
frequency	−.0040	.0059	−.0026	.0057
publicity	−.0028**	.0014	−.0042**	.0013
fsize	.0043	.0161	.0028	.0142
fdeb	−.0039	.0048	−.0022	.0045
frep	−.0143	.0208	−.0101	.0197
inc_u	.0009	.0030	.0026	.0026
dec_u	−.0080**	.0028	−.0075**	.0025
DCX	−.1881	.1328	−.1166	.1264
Ford	−.1818	.1306	−.1094	.1241
GM	−.1896	.1325	−.1145	.1258
Honda	−.1775	.1274	−.1037	.1209
Nissan	−.1762	.1259	−.1067	.1195
Toyota	−.1919	.1349	−.1126	.1283
Observations	110		110	
R-square	.40		.52	

*$p < .10$.
**$p < .05$.

returns. Table 11 reports the 2SLS estimation results. The primary conclusions of the exercise do not change.[11]

Finally, to further validate our empirical results, we constructed a control sample to examine whether the moderating effects of prerecall advertising presented previously are strictly due to the event of product recalls. Specifically, we used the same sample of firms and products but randomly selected a two-day, event-free window for each firm and recall (i.e., no auto recalls and no news reported by *WSJ*). We calculated the abnormal returns in each event-free window and, in a similar way, specified advertising adjustments one week before this window. We then estimated the cross-sectional model of Equation 1, excluding recall factors, to test whether the advertising adjustments demonstrate similar moderating impacts in the event-free scenario. The results in Table 12 indicate no significant impact of advertising adjustments one week before the event-free window on the firms' abnormal returns over that window, verifying that the moderating effects of prerecall advertising identified in this study are specific to the recall events.

[11]The primary conclusions also remain unchanged with automaker fixed effects in the 2SLS regression.

Conclusion

Despite the increasing number of product recalls in recent years and the severe consequences of product-harm crises, the knowledge of product-harm crisis management remains limited in both theory and practice (Smith, Thomas, and Quelch 1996). This article develops a theoretical framework of whether and how prerecall advertising adjustments affect a firm's stock market valuation after a product recall. Our theoretical framework and empirical findings contribute to the crisis management literature and to the marketing–finance literature. The key findings also provide guidance for firm management during product-harm crises.

Managerial Implications

Suppose a product-harm crisis is about to be announced. What should a firm do with its advertising before the recall announcement—should it spend more, spend less, or maintain the current plan? Recent research (Rubel, Naik, and Srinivasan 2011) has argued that advertising should decrease before a recall is announced because the product harm will reduce the short-term benefits of advertising, thereby reducing profitability. However, a product-harm crisis not only reduces consumer market profit but may also damage stock market value. Although a retreat in prerecall advertising avoids inefficient marketing spending on the recalled product, will investors interpret it as a signal of deeper problems? More generally, when and how does prerecall advertising affect postrecall stock price?

Our research findings demonstrate that prerecall advertising is a tool that a firm can use to strategically soften the negative impact of a product recall on stock market value. Firms are typically aware of a pending recall (whether firm or government initiated) before it is announced and can therefore act before the announcement. However, the optimal reaction requires an understanding of the type of hazard and the novelty of the recalled product. The data indicate that automakers may not fully understand the existence of these effects because there have been many cases in which firms have increased prerecall ad spending for older models with major hazards. In these cases, the firm could have benefited by forgoing an advertising increase for the model in question. Overall, firms anticipating a recall announcement should consider the seriousness of the defect and the novelty of the product. Our findings offer specific guidance as to how and when firms should adjust their prerecall advertising.

When to increase precrisis advertising? Our findings suggest that when a recall involves a new product with a minor hazard, increasing prerecall advertising can lessen the negative impact of the product recall on postrecall stock returns. Doing so can send a positive signal to the stock market about the recalling firm's continuing confidence in the quality of its recalled product. Thus, to protect stock market value, the firm may consider increasing its advertising spending for new product recalls associated with a minor hazard.

When to decrease precrisis advertising? We have uncovered no situations in which there are positive stock market benefits of increasing prerecall advertising for older products. In such situations, it is probably advantageous for firms to decrease their prerecall advertising expenditure to

TABLE 11
2SLS Estimation Results

Variable	Choice of Advertising Adjustments: Increase		Choice of Advertising Adjustments: Decrease		Cross-Sectional Regression (Main Effects)		Cross-Sectional Regression (Full Model)	
inc × new							.0098**	(.0047)
dec × new							–.0111**	(.0049)
inc × hazard							–.0123**	(.0045)
dec × hazard							.0037	(.0053)
inc					–.0018	(.0033)	.0021	(.0044)
dec					–.0076**	(.0035)	–.0019	(.0050)
new	1.315*	(.6873)	1.224*	(.6417)	–.0052*	(.0029)	–.0069**	(.0034)
hazard	.8105	(.5691)	1.129*	(.5907)	–.0049**	(.0024)	–.0028	(.0031)
NHTSA	.1867	(.6531)	–.5574	(.6068)	–.0055**	(.0027)	–.0046*	(.0025)
rcsize	1.149*	(.6278)	.3814	(.6153)	–.0014	(.0028)	–.0023	(.0026)
airbag	–.4159	(1.167)	–.9571	(1.397)	–.0083**	(.0039)	–.0071**	(.0031)
t2009	1.635	(1.249)	1.209	(1.183)	.0025	(.0031)	.0036	(.0028)
quality	.9136	(3.793)	–5.892*	(3.246)	.0073	(.0147)	.0045	(.0131)
fsize	–6.712**	(3.151)	–2.125	(2.370)	.0018	(.0127)	.0051	(.0108)
fdeb	.4313	(1.269)	–.3227	(1.152)	–.0026	(.0045)	–.0019	(.0036)
frep	5.381	(4.932)	6.172	(4.585)	–.0138	(.0193)	–.0103	(.0185)
frequency	–1.959	(1.526)	–.7687	(1.498)	–.0071	(.0059)	–.0026	(.0051)
inc_comp	1.067*	(.5732)	–.9521*	(.5248)				
dec_comp	–.6159	(.5665)	.9346*	(.5073)				
publicity					–.0028**	(.0013)	–.0039**	(.0012)
inc_u					.0024	(.0035)	.0042	(.0031)
dec_u					–.0078**	(.0026)	–.0071**	(.0023)
Likelihood ratio	205.70							
R-square					.33		.44	
Observations	110				110		110	

TABLE 12
Estimation Results Using the Event-Free Sample

	Estimate	SE
Intercept	.0183	.0467
inc	.0006	.0032
dec	–.0015	.0029
fsize	.0052	.0117
fdeb	–.0021	.0046
frep	–.0093	.0221
inc_u	.0005	.0032
dec_u	–.0011	.0028
Observations	110	
R-square	.08	

reduce marketing costs because doing so would not hurt the firm's stock market valuation.

When to use integrated crisis management? When anticipating a new product recall due to a major hazard, we advise managers to use an integrated crisis management strategy. Specifically, decreasing ad spending during the prerecall window is likely to improve the firm's marketing profits while simultaneously harming the firm's financial value in the short run by signaling the severity of the recall crisis to investors, and these conflicting incentives must be traded off in determining a course of action.

How should advertising adjustments be timed? The timing of a prerecall advertising adjustment is also of strategic importance to managers. Tables 7 and 8 show that the stock market responds most actively to advertising adjustments made one week before recall announcements. Thus, to maximize the strategic impact of advertising adjustments on the financial market during a product-harm crisis, managers should not make the adjustment too early, because the stock market may not interpret an overly early adjustment as a signal related to the recall crisis.

Further Research

Our research can be extended in several directions. First, although our study uses safety recall data from the automobile industry, our conceptual framework applies to product recalls in general. Further research can extend our study to other contexts (e.g., consumer products, food and drugs) to examine the generalizability of our findings (i.e., whether the same pattern of prerecall advertising as a product-harm crisis management strategy can also be observed in other industries).

Second, it would be valuable to explore whether prerecall advertising influences future cash flows. Specifically, how does prerecall advertising predict postrecall cash flows? Are there any differential impacts of prerecall advertising on abnormal returns and cash flows? To answer these research questions, high-frequency data on future cash flows are required to minimize the effects of confounding factors. Although it is challenging to identify such a data source (e.g., weekly cash flows of recalled products), the potential empirical findings on this issue can provide more insight into the moderating impacts of prerecall advertising on cash flows.

Third, our study uses spending as the metric of advertising. Further research can consider other advertising dimensions such as type of advertising media (e.g., sponsored search advertising, Internet advertising, social media adver-

tising) and advertising creativity (Smith et al. 2007; Yang and Smith 2009). The former is related to the audience for the advertising, while the latter is related to its communication effectiveness. Investors may react to adjustments of these advertising metrics differently in a crisis environment than in a normal environment.

Finally, further research might also extend our study to investigate how other prerecall marketing variables affect stock markets during a recall crisis. For example, how does the stock market interpret a sales promotion deployed shortly before a recall announcement, and how does that interpretation depend on product and recall characteristics? In particular, when a large sales drop is inevitable after the recall, would a sales promotion before the recall improve or harm the recalling firm's financial value?

In conclusion, it is important for both researchers and practitioners to understand how investors interpret the adjustments of firms' marketing strategies before a product recall. We are confident that further research will lead to a comprehensive understanding of how firms can optimally predict and manage their marketing and financial objectives during a product-harm crisis.

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