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ORIGINAL EMPIRICAL RESEARCH

Service crisis recovery and firm performance: insights from information breach announcements

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Abstract The extant literature has studied the effects of a firm's service recovery efforts on the reactions of customers and employees following an individual service failure. However, the impact of recovery efforts on a firm's performance after a public and large service failure—such as a large-scale information breach—has received scant attention. To address this gap, this current research develops a framework and finds support for the impact of *service crisis recoveries* on a firm's performance, as measured by firm-idiosyncratic risk. Using a unique dataset of service crisis recoveries, the authors find that firms offering compensation (i.e., tangible redresses) or process improvement (i.e., improvements in organizational processes) show more stable performance (less idiosyncratic risk), from two quarters to two calendar years after the announcement of their recovery plan. In line with the documented dual effect of apologies, firms that offer apology-based recoveries display more volatile performance (higher idiosyncratic risk). Of note, this volatility increases with the number of affected individuals, and it remains unaffected even when the apology is expressed with high intensity.

Keywords Service crisis · Service crisis recovery · Firm risk · Shareholder value · Marketing–finance interface · Information breach

How should a firm respond to a service crisis that affects a large group of stakeholders (customers or employees) so that its financial performance does not suffer? The literature on service recovery and organizational justice typically focuses on small-scale failures and private responses (e.g., Cohen-Charash and Spector 2001; Smith et al. 1999). Little attention has been given to the effectiveness of recovery efforts after a *service crisis*—that is, a public service failure affecting a large number of individuals (e.g., public transport deficiencies, information breaches, internet service or electricity outages). Despite the inevitable occurrence of service crises (Gijsenberg et al. 2015), we still have limited insights on the impacts of recovery efforts on shareholder value and financial performance after such crises. In light of these gaps, this current research emphasizes three principal contributions: (1) defining service crisis recoveries, (2) understanding the effects of these recoveries using investors' responses, and (3) adopting firm-idiosyncratic risk to capture firm investors' reactions and firm performance.

As its first contribution, this research pays special attention to positioning the concept of service crises, compared to other related concepts such as private service failures and product-harm crises. The marketing literature has devoted considerable attention to *product-harm crises*—defined as well-publicized events involving defective or dangerous products (e.g., Laufer and Coombs 2006). This literature, surprisingly,

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has overlooked crises that derive from service failures. Although the literature counts hundreds of articles on private service failures (e.g., see Gelbrich and Roschk [2011] for a meta-analysis), there are only a few studies on service crises (see Gijsenberg et al. [2015] and Malhotra and Malhotra [2011] for exceptions).

Specifically, this research defines a *service crisis* as *a service performance that fails to reach the expectations of a large group of stakeholders, and that becomes publicized in the media* (Gijsenberg et al. 2015). The inability of TJX to protect the private information of 45.7 million customers against hackers (Kawamoto 2007), and the problems in Amazon's cloud infrastructure that caused serious disruptions to Netflix customers (Darrow 2015) are examples of such crises. We expand this literature and propose the concept of *service crisis recovery,* which we define as *a firm's public attempts to redress and repair inconveniences to all stakeholders who are affected by such crises*. Our general purpose is to examine the effects of such recoveries on firm performance.

The present research selects information breach—i.e., the malpractice of unauthorized access to personal information of a group of individuals (Culnan and Williams 2009)—as the service crisis of interest. Data security is one of the most basic expectations of any stakeholder (Ball 2001; Carroll 1991) and a key component of service quality (Lewis and Mitchell 1990; Yang and Fang 2004). Violation of this expectation would represent a "service quality" failure for both customers and employees that could degenerate into a service crisis.

As our second contribution, we examine the effects of three commonly used service crisis recovery efforts—compensation, process improvement, and apology (Fang et al. 2013; Gelbrich and Roschk 2011)—on investor responses, as an indicator of a firm's future financial performance. Given their very nature, service crises differ from product-harm crises in terms of recovery strategies. Product-harm crises mainly rely on the implementation of a "product recall strategy" (e.g., Dawar and Pillutla 2000), which is not applicable in a service context because of the intangible and inseparable nature of services (Gijsenberg et al. 2015). Because of these key differences, firms need to rely on other recovery strategies for service crises, and the current research examines the differentiated effects of these recoveries on investors' responses.

We argue that investors could react differently from other stakeholders in response to service crisis recoveries. Investors are loss averse and pursue long-term returns which are influenced by firms' decisions (Barberis and Huang 2001; Fama 1998), whereas customers and employees are mainly concerned about event-specific satisfaction (Saad Andaleeb and Conway 2006). For instance, investors should respond favorably to compensation and process improvement; these actions respectively improve a firm's relational capital and its operational efficiency in the long term (Johnston and Michel 2008; Smith et al. 1999). However, investors tend to react unfavorably to a public apology because this action is interpreted as a firm's "admission of blame," which could lead to lawsuits (Cohen 1999a; Robbennolt 2003) and customer or employee churn (Zechmeister et al. 2004).

As our third contribution, we adopt *firm-idiosyncratic risk* as the evaluation criterion to measure investors' responses to different service crisis recoveries (e.g., Dechow 1994; Luo et al. 2014). To the best of our knowledge, the current research is the first to use this metric in a service crisis context. Firm-idiosyncratic risk (or stock return volatility) is a critical indicator of a firm's financial stability and performance, which is influenced by the firm's actions and resources (Dechow 1994; Goyal et al. 2003; Srinivasan and Hanssens 2009). Since investors evaluate a firm's decisions in the long term, this metric is a solid indicator of the strategic consequences of a firm's decisions (Luo and Bhattacharya 2009; Rust et al. 2004).

By using this metric, our analyses of a dataset of 212 information breaches show that offering compensation or process improvement decreases firm-idiosyncratic risk, while offering apology increases this same risk. These impacts start two calendar quarters and persist for up to two calendar years after the announcement of recovery plans. Importantly, the type of victimized stakeholders (customers vs. employees), the cause of the crisis and its severity do not change the general impact of the three recovery actions.

In the remaining sections, we review the literature on our foundational constructs (i.e., service crisis, information breach, and firm-idiosyncratic risk). Then, we present a theoretical framework explaining the impact of service crisis recoveries on firm-idiosyncratic risk. Afterwards, we describe our research and discuss the implications of our results.

Research background

Defining service crisis and service crisis recovery

Service crisis Our focus goes beyond private- and individual-based service failures that have been widely studied in the last 20 years (e.g., Smith et al., 1999; Tax et al., 1998). Building on the crisis literature (Keown-McMullan 1997; Pearson and Clair 1998), we focus on *service crisis*—that is, when a service performance fails to reach the expectation of a large group of stakeholders, and when this crisis is publicized in the media. We further explain the differences between service crisis and other related concepts by using a "two by two" matrix (see Table 1). The first dimension makes a distinction between the contexts involving defective products vs. service failures, whereas the second dimension relates to the number of affected individuals (i.e., private vs. mass). This matrix provides key definitions and a summary for each quadrant.

The two quadrants that relate to *private* responses have received abundant attention in the literature. The earliest

Table 1 The differences between service crisis and other related constructs

Number of affected individuals	Type of offering	
	Product	Service
Private (one or a few individuals)	Private product failure: A product that fails to match the average quality of similar devices. • Earliest research efforts in this area (Traynor 1964); • Examination of the attributional antecedents leading to different customers' responses (Folkes 1984).	Private service failure: A service performance that falls below the expectation of a given individual. • The richest quadrant with hundreds of articles; • The variables belonging to the "cognitions – emotions – behaviors" process are well studied; • See meta-analyses on justice theory (Gelbrich and Roschk 2011; Orsingher et al. 2010) and attribution theory (Van Vaerenbergh et al. 2014).
Mass (a large group of individuals)	Product-harm crisis: A well-publicized event wherein products are found to be defective or dangerous. • A rich quadrant in which the responses to product recalls are well studied (see Laufer [2015] for a special issue); • Product recall is the recovery strategy of choice (e.g., Dawar and Pillutla 2000); • For instance, research has documented customer responses toward product recall (e.g., Cleeren et al. 2008), and the effectiveness of post marketing actions (Cleeren et al. 2013).	Service crisis: When a service performance fails to reach the expectations of a large group of stakeholders, and is intensively publicized in diverse media. • The less studied quadrant (see Gijsenberg et al. [2015] and Malhotra and Malhotra [2011] for exceptions); • This context differs from private service failure because managers need to publicly recover for other entities (such as the investors); • Because of the intangibility of services, a "recall" strategy is not possible; the problem cannot be easily isolated and repaired; • The service failure cannot be "separated" from a broader service, and a small event can affect a whole network of individuals. **General purpose of the current research:** Understanding the effectiveness of recovery efforts on investors' responses after service crises

Inspired by Gijsenberg et al. (2015)

efforts in this whole area were devoted to studying private product failures—that is, a product that fails to match the average quality of similar devices (Traynor 1964; Folkes 1984). In turn, the quadrant on private service failures is probably the richest of all (see Gelbrich and Roschk [2011] and Orsingher et al. [2010] for meta-analyses of this stream).

At a mass level, most research focuses on product-harm crisis rather than on service crisis, as witnessed by a recent special issue on product-harm crisis (Laufer 2015). A product-harm crisis typically happens when a firm's product fails to meet safety standards or contains a defect that could cause substantial inconvenience, harm, or even death (Chen et al. 2009). Firms' responses to product-harm crises mainly consist of implementing a product recall strategy and offering apologies (Dawar and Pillutla 2000). Research has also discussed the effectiveness of post-crisis actions, such as advertising and offering price discount (Cleeren et al. 2013).

We argue that service crises deserve special attention because they possess different characteristics, which affect managers' recovery plans. In contrast to private service failures, managers need to recover *both* privately and publicly from these events. Indeed, managers need to redress the inconvenience to all the participants involved in the incident (i.e., customers, employees, investors, suppliers or the community). Our current research focuses on investors' reactions due to their influence on a firm's value.

Compared to product-harm crises, the recovery approach used for service crises is not as straightforward as implementing a product recall. Because of the intangibility of services, the cause of a crisis may be difficult to identify, isolate and repair (Gijsenberg et al. 2015; Rushton and Carson 1985). For example, it takes some time to understand the nature of an information breach; and once the information is disclosed, there is no clear solution for restoring the loss in "privacy" to the state in which it was before the crisis (Malhotra and Malhotra 2011). The inseparability of services also becomes an issue in a time of crisis. A service crisis typically affects all individuals who are simultaneously using that service, while in the case of a product-harm crisis, a smaller fraction of customers can usually be affected (Gijsenberg et al. 2015). For example, a disruption in delivering Internet service affects all the users of that service at the same time, and the population size may be remarkable. Given the difficulties associated with recovering from service crises, this current research focuses on this issue.

Service crisis recovery efforts For private service failures, a service recovery can be broadly defined as a firm's attempts to

redress the inconvenience to a given individual (Smith et al. 1999). We extend this concept to our crisis context and define *service crisis recovery* as a firm's *public* attempts to repair inconvenience to *all* stakeholders affected by a service crisis. Building on prior work (Fang et al. 2013; Gelbrich and Roschk 2011), we study the effects of three recovery efforts, which can be viewed as the most commonly made by managers, and also the most studied by researchers—that is, compensation (i.e., tangible redresses), process improvement (i.e., improvements made to deficient procedures), and apologies (i.e., acknowledgement of a firm's blameworthiness).

Information breach as a service crisis

An information breach is defined as an event signaling the potential or actual malpractice of unauthorized access to personal information belonging to a group of stakeholders (Culnan and Williams 2009), and we use such breaches as our service crisis context of interest. Due to firms' massive collection of customers' personal data, the security of such information is a necessary condition for the development of strong customer relationships (Martin and Murphy 2016). Prior research provides evidence indicating that information privacy and confidentiality are important attributes forming service quality (e.g., Lewis and Mitchell 1990; Yang and Fang 2004). Accordingly, customers should view any violation of their confidentiality and privacy as a serious lack of service quality, and as a major service failure. Consistent with this view, Malhotra and Malhotra (2011) urge marketing managers to view information breaches as service failures—rather than information systems failures.

From the employees' standpoint, firms must respect their right to safety, privacy, and fair treatment (Carroll 1991). Here, employees can be viewed as "customers inside the firm," and managers are responsible for providing their employees with services that satisfy their needs (Berry 1981). The growth in "Human Resources Management" systems has produced an increased demand for employees' personal information. In this context, an implicit social contract is established between employees and employers; firms need to carefully protect this information to maintain harmonious relationships with their employees (Ball 2001). Any violation of this "contract" would be viewed as an important "internal" service failure.

On the basis of these explanations, we argue that information breaches are major service failures for both customers and employees. The information breach context provides a good fit with our service crisis research in three ways. First, information breaches may inconvenience a large group of stakeholders, and they may receive substantial media attention; these two characteristics correspond to our definition of service crisis. Second, information breaches are becoming more prevalent, calling for managers to find effective ways to redress them. From 2006 to 2015, the DatalossDB.org database showed that the number of breaches increased from 643 to over 1500 annually ("Statistics | DataLossDB" 2016). Third, information breaches possess sufficient magnitude to influence the responses of investors (K. Campbell et al. 2003).

Firm-idiosyncratic risk as a way to capture investors' responses

In finance, a firm's stock risk—as reflected in stock price volatility—is a key metric that reflects the future vulnerabilities and uncertainties of its cash flows. Accordingly, this metric is an indicator of a firm's long-term valuation. Total firm risk has two components: systematic and unsystematic risk. In particular, systematic risk—defined as the sensitivity of a firm's stock return to variation in the entire stock market return—stems from macroeconomic factors (such as inflation and interest rates), which are beyond the control of management. Unsystematic or idiosyncratic risk—defined as firm-specific volatility of stock return—is driven by micro firm-level factors (such as marketing strategies) that are controllable by management (Goyal et al., 2003; Srinivasan and Hanssens 2009). In general, idiosyncratic risk accounts for the largest component of total firm risk (around 80%) (Goyal et al. 2003).

In light of this definition, this research focuses on idiosyncratic risk as the main evaluation criterion. By capturing investors' reactions to firms' decisions and news, this measure can represent the advantages or disadvantages associated with a firm's strategies (Srinivasan and Hanssens 2009). The logic behind this metric is that a firm's strategies influence its earnings and cash flow fluctuations, and that investors carefully predict these changes and react to them in order to secure their investments. In other words, firm-idiosyncratic risk reflects market beliefs and is a valuable criterion for evaluating the effectiveness of marketing strategies (Rust et al. 2004). The marketing literature has used this metric to understand the effectiveness of several marketing strategies, such as corporate social responsibility (Luo and Bhattacharya 2009), brand management (Rego et al. 2009), and service transition (Josephson et al. 2016). We apply a similar logic in this research by examining the effects of recovery efforts on this metric.

From an investment point of view, investors prefer stable earnings over volatile ones (J. Y. Campbell et al. 2001; Goyal et al. 2003). Therefore, understanding the financial impact of service crisis recoveries through idiosyncratic risk could benefit investors in managing their investment portfolios. From a managerial standpoint, managers carefully manage firm-idiosyncratic risks (Brown and Kapadia 2007) because their compensation plans are significantly influenced by this metric (Core et al. 1999; Dechow 1994). As a result, having more insights into the financial consequences of their crisis recovery plans could assist them in enhancing their firm's performance and their own earnings.

Hypotheses: Linking service crisis recoveries to firm-idiosyncratic risk

A growing body of literature supports the view that a firm's value corresponds to its resource-based potential (e.g., Tuli and Bharadwaj 2009; Luo and Bhattacharya 2009). The resource-based theory of the firm claims that valuable, rare, and inimitable firm resources contribute to a sustainable competitive advantage, leading to superior performance (Barney 1991; Kozlenkova et al. 2014; Srivastava et al. 2001). Building on this theory, we argue that effective crisis recoveries enhance a firm's key resources (i.e., its relationships with its stakeholders) and/or capabilities (i.e., processes to protect data confidentiality). In turn, these stronger resources and capabilities stabilize the firm's future performance and cash flow. Then, this stability is predicted by investors, and the judgment of these individuals is reflected in a firm-idiosyncratic risk (Srinivasan and Hanssens 2009).

Consistent with prior research (e.g., Rego et al. 2009), our three hypotheses are based on this logic: namely, investors predict the effects of recovery efforts on a firm's resources with a special focus on its relationships with stakeholders. In other words, the current research predicts and tests the effects of different recoveries on investors' predictions about a firm's performance. However, it should be noted that we do not directly test the effects of recovery efforts on customers' and employees' perceptions; we make inferences about these effects on the basis of the literature. As a result, in the formulation of our hypotheses, we try to be explicit about the evidence for stakeholders that is derived from the literature (which is not tested) and the predictions involving investors, which are directly tested with our dataset.

The effect of compensation

Compensation is a tangible benefit that a firm offers to its stakeholders to restore their loss (Davidow 2003). Compensation can be offered as a correction, discount or replacement (Gelbrich et al. 2015). Justice theory states that offering compensation to stakeholders increases their satisfaction through their perception of distributive justice (Gelbrich and Roschk 2011). Here, distributive justice is defined as the appropriateness of the outcomes received by stakeholders after a service crisis (Smith et al. 1999).[1]

In line with this view, several studies and meta-analyses find that compensation leads to positive customer reactions, such as satisfaction, loyalty, and positive word-of-mouth (Davidow 2003; Gelbrich and Roschk 2011; Orsingher et al. 2010), through distributive justice. In their meta-analysis, Cohen-Charash and Spector (2001) also report that distributive justice advances employee performance, organizational commitment, and trust. Overall, this literature posits that providing compensation to customers and employees enhances their perceptions of distributive justice and helps restore their relationships with firms.

We make a natural link between the noted positive effects of compensation on stakeholder relationships and a firm's market value. Indeed, the literature has consistently found a positive linkage between stakeholders' strong relationships (based on satisfaction) and shareholder value (e.g., Edmans 2011; Tuli and Bharadwaj 2009). In addition, there is evidence that a substantial portion of a firm's market value relies more on its intangible assets—such as its relationships with stakeholders—than on its tangible assets (Srivastava et al. 1998). For instance, Pruitt and Peterson (1986) find that the loss of reputation and business relationships (i.e., intangible assets) due to a product-harm crisis is more impactful than the short-term loss of financial (and tangible) assets due to a product recall. These arguments suggest that the long-term value of offering compensation—in terms of relationship building—outweighs its short-term implementation costs.

Building on this literature, we expect that investors will foresee and predict these comparative effects (between intangible and tangible assets) in a service crisis context. Investors should understand that offering compensation has the ability to restore the relationships between a firm and its stakeholders, and that the long-term effect of this important resource on a firm's performance largely offsets the short-term costs of compensation. When a firm offers compensation, investors will interpret it as the firm's having solidified an important resource (i.e., its relationships with stakeholders) that should lead to future cash flow stability—that is, reduced firm-idiosyncratic risk. Formally,

H1: Offering compensation is negatively associated with firm-idiosyncratic risk.

The effect of process improvement

We define process improvement as a firm's actions that aim to improve its deficient procedures in order to prevent future failures (Johnston and Michel 2008). This recovery effort focuses on minimizing the reoccurrence of a failure as well as on enhancing stakeholder relationships (Davidow 2000; Johnston and Michel 2008). Building on the available literature, we argue this recovery effort improves a firm's performance in three ways.

[1] We highlight that compensation does not *only* have an effect on distributive justice; this recovery effort also influences the other justice dimensions (i.e., procedural and interactional), but to a lesser extent. Gelbrich and Roschk (2011) in their meta-analysis found the greatest effect size between compensation and distributive justice. Consistently, researchers generally assume that compensation operates mainly through its effects on distributive justice (Gelbrich et al. 2015).

First, the development of processes to protect stakeholders' information should naturally lead to a competitive advantage, which results in superior performance. Here, organizational processes have been defined as important intangible resources that carry a great deal of value for firms (Srivastava et al. 1998). Second, process improvement indicates a firm's willingness to invest in relationships with its stakeholders, which is another important intangible resource (see our explanations for H1). Third, this recovery effort should have a positive impact on perceived procedural justice[2] (Johnston and Michel 2008; Martin and Murphy 2016), which is defined as the appropriateness of the policies and practices that a firm puts in place to serve its stakeholders (Tax et al. 1998). This heightened sense of procedural justice should enhance stakeholders' perceptions of trust and relationship quality (Cohen-Charash and Spector 2001; Tax et al. 1998; Van Vaerenbergh et al. 2012). In accordance with these reasons, the extant literature provides evidence that process improvement increases customers' satisfaction and repurchase intention (Palmatier et al. 2006; Van Vaerenbergh et al. 2012) and also increases employees' citizenship behavior and organizational commitment (Daileyl and Kirk 1992; Tsui et al. 1997).

In turn, investors should recognize the advantages resulting from any process improvement measure, and the favorable effects of this recovery effort on a firm's two core resources: its relationships with stakeholders and its improved capability of protecting data. Because these resources (and capabilities) are intangible and strong precursors of a sustainable competitive advantage, investors should naturally conclude that firms using such recoveries would experience greater performance and steadier cash flows. Similar to the argument made in H1, the long-term intangible benefits associated with process improvement should appear larger than the short-term financial costs (Srivastava et al. 1998). Formally,

H2: Offering process improvement is negatively associated with firm-idiosyncratic risk.

The effect of an apology

Broadly defined, apologies refer to messages containing the acknowledgement of blameworthiness for a negative event; they can include expressions of remorse, sorrow, or regret (Cohen 1999a, 1999b; Davidow 2003; Robbennolt 2003; Roschk and Kaiser 2013). By making an apology, a firm accepts its responsibility for the failure and shows regret for what happened.

The ability of an apology to attenuate the negative responses of stakeholders and investors is not as straightforward as the other two recoveries. Indeed, an apology is associated with a well-documented dual effect that includes both positive and negative effects (e.g., Roschk and Kaiser 2013; ten Brinke and Adams 2015). This recovery involves the expression of a firm's concern for its stakeholders (i.e., a positive effect), *but also* perceptions of being an insufficient measure and a form of guilt admission for the failure (i.e., negative effects) (Davidow 2000; Patel and Reinsch 2003).

In terms of the positive effects of an apology, most studies in the context of private service failure and personal offense find that stakeholders respond favorably to apologies; see the meta-analysis of Gelbrich and Roschk (2011) that finds a general positive link between an apology and customer satisfaction.[3] At an interpersonal level, the expression of an apology has favorable effects. It demonstrates a firm's empathy and concern for its stakeholders, and such a gesture helps restore the broken relationship (Roschk and Kaiser 2013).

An apology has also been associated with negative responses and serious backlashes—especially in a public context—for two key reasons (Boshoff 1997; Davidow 2000; Goodwin and Ross 1990). First, if apologies are not appropriately delivered, they could enhance public anger (Goodwin and Ross 1990; Zechmeister et al. 2004). There is evidence showing that perfunctory, cold, and distant apologies do not relieve public anger, especially for large-scale crises, because these actions are perceived as insincere and somewhat fraudulent (Goodwin and Ross 1990; Zechmeister et al. 2004). Apologies made in a public context can be viewed as "cheap" because they do not involve the firms investing any tangible resources. Second, apology-based recovery could also make the firm a potential target for lawsuits. Building on the rich law literature (Cohen 1999a, 1999b; Patel and Reinsch 2003; Robbennolt 2003; Tyler 1997), plaintiffs may use a firm's apology as an admission of liability, which could increase their chance of winning their case. Juries regularly construe a firm's apology as being the equivalent of a firm taking responsibility for the alleged wrongdoing. It then becomes strong evidence helping juries to convict the firms.

To the best of our knowledge, such a dual effect has not been argued for compensation and process improvement. Indeed, providing compensation and improving processes do not involve the same level of blame attribution as an apology does (Davidow 2000). For instance, a firm could provide compensation because they want to help their stakeholders in a moment of need; it could also improve its processes to enhance the quality of its services. In addition, these two

[2] Similar to the effects of compensation, process improvement efforts influence the two other justice dimensions (i.e., distributive and interactional), but to a lesser extent (Gelbrich and Roschk 2011).

[3] Gelbrich and Roschk's (2011) meta-analysis incorporates tangible compensation and an apology in the same broad category called "compensation." We contacted the authors about the specific effects of an apology. Their results confirmed that an apology typically had a positive effect on satisfaction and the other variables of their model.

recoveries are more likely to be considered as "sincere" because firms need to allocate tangible resources to implement them (Goodwin and Ross 1990).

On the evidence of this literature—and considering that investors are loss averse and mainly concerned with protecting their long-term investments—these last individuals should respond negatively to apology-based recovery for two main reasons. First, because of the absence of a tangible measure, apologies could be viewed as being insufficient to restore the broken relationships between a firm and its stakeholders. In this context, investors are concerned that these poor relationships lead to massive stakeholder churn, which would plunge a firm's performance. Second, since some stakeholders could interpret public apology as an admission of guilt, investors could fear the risk of lawsuits and expensive class actions against the firm. Here, service crises are an ideal condition for class actions because they involve a large number of individuals. In summary, in the investors' eyes, the likelihood of stakeholder churn and the risk of litigation could threaten a firm's performance and the stability of its cash flows. Formally,

H3: Offering an apology is positively associated with firm-idiosyncratic risk.

In addition to the above hypotheses, we examine the interactions among these three service crisis recoveries so that we can identify the "optimal" combination of recoveries to reduce a firm's idiosyncratic risk (e.g., Blodgett et al. 1997). These interactions will also help us understand the effects of concurrently offering two or three service crisis recoveries. We do not offer a formal hypothesis for these interactions because recovery efforts have not consistently been found to interact with each other (Davidow 2003). Moreover, little is known about these effects from the investor's perspective.

Research design

Data and sample

We constructed our dataset using records and announcements from several sources (i.e., Privacy Rights Clearinghouse, Factiva and web search engines, and Standard & Poor's COMPUSTAT database). We started by collecting the announcements of information breach events from the Privacy Rights Clearinghouse (PRC) database.[4] This source contains data about information breach events and relevant consumer rights in North America. From 2001 to 2013, this database reported 4486 events, 1639 of which did not involve public corporations, so we excluded them from our data collection. The remaining 2847 events involved private and publicly traded firms in various industry sectors.

Given the large number of events, a subsample was drawn from the event population. For subsampling, we could not apply simple random sampling of events since the list of events involving publicly traded firms was not available. To address this issue, we employed the cluster sampling technique, which is appropriate when the size of a database is large, and when the list of relevant observations is not available (Hansen and Hurwitz 1943; Henry 1990). Cluster sampling divides the population into clusters of observations according to one of the characteristics of the observations. Thereafter, clusters are selected by simple random sampling and all observations within those selected clusters are processed, and if appropriate (e.g., involve publicly traded firms), are added to the final dataset. We clustered the information breach events in the PRC database according to their calendar week of announcement.

We targeted a final sample size of at least 200 observations for our research according to the suggested rules of thumb ($N > 104 +$ number of IVs or 10 observations per IV) (Maxwell 2000). Our initial inspection of the database revealed that each week, on average, included two to three events involving publicly traded firms. Hence, to achieve our targeted sample size and to have enough observations, after attrition, in further stages of data collection (for confounding events, missing data, etc.) (McWilliams and Siegel 1997), we decided to randomly select 160 weeks from 2001 to 2013 and collected events that happened during those weeks. Selecting 160 weeks (out of 676 weeks) was appropriate to represent the diversity of the database. This sample size is subject to a margin of error of approximately 3%.

By considering 160 weeks, we collected 345 observations involving publicly traded firms or their subsidiaries. Next, we cross-checked these observations through the Factiva database and web search engines to obtain details of the events, precise dates of announcements, and all subsequent recovery offerings from publicly available news websites and governmental databases. We removed 44 observations at this stage because we did not find any evidence of the occurrence of these events in other sources. In addition, we removed 41 cases because the available documents about the events were governmental documents that were not available to the public, or because the available information was incomplete and did not allow coding our variables. Following standard practice (e.g., Dewan and Ren 2007), we dropped 37 cases with confounding announcements within one week before and after the event, to make sure that the announcements about each particular case were not affected by other events. We considered various types of news to be confounding announcements: earnings announcements, mergers and acquisitions, and large profit announcements. We removed two observations due to missing

[4] Privacy Rights Clearinghouse. *Chronology of Data Breaches*. Retrieved January 10, 2014 from https://www.privacyrights.org/data-breach.

data in Standard & Poor's COMPUSTAT database, which was used to compute financial control variables. Finally, in order to be able to control for the type of victimized stakeholder (i.e., customers or employees) as an important control variable, we removed nine cases in which both groups were affected. Following these steps, we were left with 212 cases, including 171 different publicly traded companies.

Relevant announcements about each case usually extend over a one-week period (see Web Appendix B for an example). According to the Efficient Markets Hypothesis (EMH) in finance, investors fully and immediately react to any new information that has value relevance (Srinivasan and Hanssens 2009). Hence, in our context, the stock value of the involved firms is expected to start changing from the first announcement about the service crisis recovery. However, to make sure that investors have considered all the relevant information, we chose as our event dates five trading days (one calendar week) after the initial announcements about the recovery plans. Exclusion of these five days removes bias from our analysis that could be caused by abnormal returns surrounding the first announcement (Bansal and Clelland 2004). Table 2 provides the industry composition of our sample of firms in addition to examples; the industries are identified by the two-digit North American Industry Classification System (NAICS) code.

In our dataset, information breach events had several causes, including hacker attack (39 cases), theft of equipment by an outsider (40 cases), misplaced data source (20 cases), employees' intentional breach (67 cases), employees' accidental mistake (35 cases), and technical errors (11 cases). Firm-level accounting data to compute the financial control variables were obtained from Standard & Poor's COMPUSTAT database.

Coding of service crisis recoveries

For the content analysis of our public announcements, and on the basis of our conceptual definitions, we defined *compensation* as offering any tangible redress to restore the loss of victimized groups (e.g., Smith et al. 1999). *Process improvement* was defined as any promise or indication to improve or develop the organizational processes that led to the information breach (e.g., Davidow 2000). *Apology* was defined as the presence of the terms "apology," "regret," "sorry," "remorse," or their synonyms by the responsible firm in their public communications (e.g., Cohen 1999a). Web Appendix A presents these definitions and representative examples taken from our dataset. In addition, Web Appendix B gives an example of the announcements of a specific case and shows how we coded the service crisis recoveries for this specific case.

Following Kassarjian (1977), we trained two independent coders to recognize the three service crisis recoveries of interest. A few warm-up sessions were necessary to adjust the coding scheme and help the coders become familiar with the instructions. After these sessions, the level of agreement between coders was high. Applying Perreault and Leigh's (1989) reliability,[5] this index indicated high levels of agreement with scores of .921 for compensation, .852 for process improvement, and .932 for apology. The coders used discussion to resolve disagreements.

Out of 212 cases, 57 cases did not offer any recovery in their communication, and the rest of the cases offered one or a combination of recoveries. Specifically, 108 cases offered compensation, 93 cases provided process improvement, and 96 cases expressed an apology after the information breach.[6] Overall, 71 failures affected employees and 141 affected customers.

Measurement of firm-idiosyncratic risk

We calculated idiosyncratic risk by using daily return data for each firm within the year following the recovery announcement. Our measure of idiosyncratic risk is based on a regression projection of stock returns of each firm on the returns of the market index and other relevant factors. We applied a widely accepted approach: the Fama-French four-factor model (e.g., Luo and Bhattacharya 2009). We also checked our results through the Market Model specification.

The Fama-French four-factor model proposes that a firm's daily stock return ($r_{i,d}$) is a function of market return (r_d^{MKT}), the difference of returns between small and big stocks (r_d^{SMB}), the difference of returns between high and low book-to-market stocks (r_d^{HML}), and return momentum (r_d^{UMD}), along with a residual ($u_{i,d}$):

$$r_{i,d} = \alpha_i + \beta_i^{MKT} r_d^{MKT} + \beta_i^{SMB} r_d^{SMB} + \beta_i^{HML} r_d^{HML} + \beta_i^{UMD} r_d^{UMD} + u_{i,d} \quad (1)$$

where α_i is the intercept term and $u_{i,d} = \rho u_{i,d-1} + \delta_{i,d}$. $\delta_{i,d}$ is assumed to be a normal random variable with a mean of "0" and variance of σ^2_δ, which allows Eq. (1) to control for serial correlation in the residual term. Our measure of firm-idiosyncratic risk is the variance of residuals $[1/n \times (\Sigma^n_{d=1} u^2_{i,d})]$ of the regression of Eq. (1), where n denotes 252 trading days (one calendar year) starting five trading days after the first service crisis recovery announcement.

[5] $I_r = \{[(F/N) - (1/k)][k/(k-1)]\}^{0.5}$, for $F/N > 1/k$; where F is the frequency of agreement between coders, N is the total number of judgments and k is the number of categories.

[6] The fact that 57 observations did not offer any recovery action shows that our sample is not biased by the inclusion of only firms that offered recoveries. In the current context, we minimize the potential bias that would result from selecting only firms that made a recovery decision—this bias would be based on the assumption that these firms would have different characteristics compared to firms that did not provide any recovery action (Certo et al. 2016).

Table 2 Industry composition of dataset

Two-digit NAICS code	Industry name	Frequency		Example
		N	%	
11	Agriculture, forestry, fishing and hunting	1	.5	Monsanto Co.
21	Mining and oil and gas extraction	2	1	Murphy Oil Corp.
22	Utilities	4	2	Xcel Energy Inc.
23	Construction	1	.5	MasTec Inc.
31–33	Manufacturing	40	19	Sony Corp.
42	Wholesale trade	6	3	PSS World Medical Inc.
44	Retail trade	15	7	Best Buy Inc.
48–49	Transportation and warehousing	4	2	Alaska Air Group Inc.
51	Information	42	20	Oracle Corp.
52	Finance and Insurance	67	31	Bank of America
53	Real estate and rental and leasing	4	2	Wyndham Worldwide Corp.
54	Professional, scientific and technical services	9	4	Ceridian Corp.
56	Administrative and support	6	3	Equifax Inc.
62	Health care and social assistance	1	.5	DaVita HealthCare Inc.
72	Accommodation and food services	10	4.5	McDonald's Corp.

Following Ferreira and Laux (2007) and Luo and Bhattacharya (2009), our dependent variable is relative idiosyncratic risk, which is the ratio of idiosyncratic risk to total firm risk and is equal to $1\text{-}R^2_i$, where R^2_i is the coefficient of determination for Eq. (1). Because of the bounded nature of R^2_i, we use a logit transformation of $1\text{-}R^2_i$ as the measure of idiosyncratic risk:

$$V_i = \mathrm{Ln}\left(\frac{1-R^2 i}{R^2 i}\right) \tag{2}$$

Ferreira and Laux (2007) argue that scaling idiosyncratic risk by total risk distinguishes firm-specific return volatility from market-related and industry-related returns volatility; and consequently, the results will be comparable across industries and years. It should be noted that some business activities are subject to economy-wide and industry-wide shocks that make the absolute idiosyncratic risk (variance of residuals) more volatile, with this volatility stemming from environmental factors (Durnev et al. 2003). Hence, this scaling helps us make our results comparable across the wide range of industries and years in our dataset. The required daily stock price data was obtained from the CRSP database, and the daily data for the Fama-French factors from the Kenneth R. French database.

Control variables

Following similar studies (Ferreira and Laux 2007; Luo and Bhattacharya 2009), we controlled for multiple firm, industry, and event level covariates in our analysis to capture the extent to which service recovery offerings can truly explain firm-idiosyncratic risk.

Profitability We measured profitability as return on assets. Firms with high profitability show future financial health and are more favorable to investors (J. Y. Campbell et al. 2008).

Profit volatility This variable was measured as the standard deviation of the prior five years' return on assets. High variations in profitability reveal future cash flow uncertainty (J. Y. Campbell et al. 2008).

Leverage The ratio of long-term debt to total assets was computed to control for leverage. Greater leverage indicates higher risk of default, which affects a firm's future cash flow (Ben-Zion and Shalit 1975).

Market capitalization We computed this variable by taking the logarithm of the product of the number of shares outstanding multiplied by the market price. Firms with higher market capitalization show less volatile stock returns (Brandt et al. 2010).

Firm age The age of the firm was measured as the logarithm of the number of months that have elapsed since the stock's inclusion in the CRSP database. Older firms exhibit creditworthiness, less risk of disappearance, and more cash flow stability (Ben-Zion and Shalit 1975).

Firm size We measured firm size as the logarithm of total asset value. All else being equal, larger firms exhibit more return stability (Ben-Zion and Shalit 1975).

Industry concentration According to J. Y. Campbell et al. (2001), industry-level variables are key variables in explaining the volatility of stock returns. Hence, we measured a series of variables to control for industry-level variables. First, we computed industry concentration by the Herfindahl-Hirschman Index (HHI). HHI is measured as the sum of the squared market share of the individual firms in the industry based on the three-digit SIC code. Market shares are calculated by sales data. The HHI industry concentration ratio controls for the industry's competitive intensity. Firms in highly concentrated industries are less risky because they engage in less competition and practice less innovation (Hou and Robinson 2006).

Type of industry Two-digit NAICS codes were used as dummies to control the industry-level risk. Natural risk varies in different industry sectors (J. Y. Campbell et al. 2001). We grouped firms with close NAICS codes together to have at least 10 observations for each sector.

Year This refers to the year when the recoveries were offered. We used year dummies to operationalize this variable. This market-level variable calibrates for yearly macroeconomic fluctuations (J. Y. Campbell et al. 2008).

Breach cause As a key event control variable**,** we controlled for the cause of the information breach to calibrate the type of failure, since different types of failures present different levels of loss (Smith et al. 1999; Weun et al. 2004), and these failures may signal different categories of a firm's weaknesses to investors. Causes of information breaches include: hacker attack, theft of equipment by an outsider, misplaced data source, employees' intentional breach, employees' accidental mistake, and technical errors.

Customers victimized As a second event control variable, we controlled for the group of victimized stakeholders (customers or employees) to examine if the type of victimized stakeholders affects the reaction of investors.

Results

Descriptive statistics

Table 3 presents descriptive statistics and the correlations among the variables used in the study. This table shows that there is a low risk of collinearity among variables, with all correlations being below .5. In addition, the correlations between service crisis recovery efforts (as the focal variables of our study) are all below .39, which indicates that they are distinct constructs. For further assurance of the low linear dependence among variables, we computed their variance inflation factors (VIF). All variance inflation factors were below 4, indicating low collinearity among variables (O'brien 2007).

Tests of hypotheses

Model specification We tested our hypotheses through two simple linear regression models. We employed levels regression models (i.e., cross-sectional regressions), as opposed to changes models, since our events of interest are new discrete events that carry limited prior information[7] (Srinivasan and Hanssens 2009). Model 1 assesses the effect of three service crisis recoveries (compensation, process improvement and apology) on firm-idiosyncratic risk. Model 2 examines the interactions among these three recovery strategies.

The Durbin-Watson test does not show a potential issue of autocorrelation among the errors of our observations (DW = 1.74). According to the established "rule of thumb," there is a limited problem of autocorrelation when the DW parameter is close to 2.

An initial outlier diagnostic test, through the minimum covariance determinant (MCD) method, illustrates the existence of 10 outliers in our dataset, one of which is a bad leverage point (i.e., observations with outlying x and y that do not follow the pattern of the majority of observations) (Rousseeuw and Driessen 1999). The MCD method detects outliers by finding a subsample of observations whose covariance matrix has the lowest determinant. Then, using Eq. (3), the robust distance of each observation from this subsample is computed:

$$\mathrm{RD}(x_i) = \left[(x_i - \mathrm{T}(X))^{\mathrm{T}} \mathrm{C}(X)^{-1} (x_i - \mathrm{T}(X))\right]^{1/2} \quad (3)$$

where T(X) is the average of observations of the subsample and C(X) is their covariance matrix. The observations whose robust distance is higher than the cutoff value are detected as outliers. Cutoff value is equal to the square root of the 97.5% quantile of the chi-square distribution with degrees of freedom equal to the number of variables.

[7] When independent variables are not discrete new actions of firms, but changes in existing strategies of firms (e.g., changes in the marketing alliance strategy), changes models (first-differenced regression) are especially appropriate to test the hypotheses. Changes models examine the impact of changes in independent variables on changes in a dependent variable. The rationale for changes models is that an event announcement may carry relevant information from the past, and this "prior" information can affect the reaction of investors to the announcement of a target event. By using changes models through time series datasets, researchers can ensure that they focus only on the impact of new information. Since announcements of recovery strategies are discrete decisions that carry little prior information, our analyses rely on levels models rather than changes models.

Table 3 Descriptive statistics and correlation matrix ($N = 212$)

Variables	M	SD	1	2	3	4	5	6	7	8	9	10	11
1. Firm-idiosyncratic risk	.60	.98											
2. Compensation	.51	.50	−.14 **										
3. Process improvement	.46	.50	.02	.33 ***									
4. Apology	.45	.50	−.01	.21 ***	.39 ***								
5. Customers victimized	.67	.47	.10	−.24 ***	−.20 ***	−.19 ***							
6. Profitability	.04	.09	−.17 **	.02	.05	−.01	−.15 **						
7. Profit volatility	.04	.09	.19 ***	−.06	−.02	.03	−.16 **	.06					
8. Leverage	.19	.19	.12 *	−.03	.05	.09	.01	.11 *	−.02				
9. Market capitalization	9.11	2.12	−.46 ***	−.10	−.12 *	−.15 **	.09	.25 ***	−.21 ***	−.09			
10. Firm age	5.24	.99	−.11	−.10	.06	−.03	.03	.15 **	−.01	−.02	.15 **		
11. Firm size	9.89	2.46	−.45 ***	−.04	−.16 **	−.24 ***	.21 ***	−.07	−.32 ***	−.15 **	.38 ***	.06	
12. Industry concentration	1743.64	1593.94	.13 *	.00	.11	.18 **	−.10	.00	.04	−.06	−.19 ***	.09	−.32 ***

*$p < .10$; **$p < .05$; ***$p < .01$.

Outliers and leverage points are sources of multicollinearity that can cause a bias in the estimate of coefficients (Kamruzzaman and Imon 2002). To address this issue, we applied the M-estimator robust regression, which bounds the influence of outliers, to examine our hypotheses. This method is not robust to bad leverage data points but is useful when vertical outliers and good leverage points are a concern (Rousseeuw and Leroy 1987), as is the case in the current study. Also, this method can reduce the concern about heteroscedasticity (Maronna et al. 2006).

In contrast to ordinary least square estimation that minimizes the sum of squares of the residuals, the M-estimator method minimizes the influence of outliers on the parameter estimation:

$$\min \sum_i \rho(r_i(x)) \tag{4}$$

where r is the residual vector (r = y – Ax) and ρ is the Huber loss function defined by:

$$\rho(t) = \begin{cases} \frac{t^2}{2} & , |t| \le c \\ c|t| - \frac{c^2}{2} & , \text{otherwise} \end{cases} \tag{5}$$

where c is an estimate of σ (Huber 1973).

Cross-sectional regression results The main results are presented in Table 4. The results of our first regression (i.e., Model 1) show that compensation (β = −.241, SE = .103, chi-square = 5.46, $p < .05$), process improvement (β = −.298, SE = .098, chi-square = 9.21, $p < .01$), and apology (β = .299, SE = .102, chi-square = 8.62, $p < .01$) significantly influence firm-idiosyncratic risk. These results support H1, H2, and H3, respectively. Specifically, Model 1 indicates that compensation and process improvement are associated with .241 and .298 decreases, respectively, in a firm's idiosyncratic risk for one year after the announcement of these recovery initiatives. As we predicted, the results demonstrate that apology raises a firm's idiosyncratic risk for the same period. Model 2 shows that the interactions among the different recovery efforts are not significant—these results indicate that the effects of the recovery efforts are independent of each other in this context.

Along with the three identified main effects, we find that the control variables firm profitability and market capitalization are negatively associated with firm-idiosyncratic risk. Moreover, profit volatility is positively associated with firm-idiosyncratic risk (e.g., J. Y. Campbell et al. 2008; Ben-Zion and Shalit 1975).

Robustness check

To verify the robustness of our results, first, we measured firm-idiosyncratic risk using the Market Model approach and repeated the estimation of Models 1 and 2. The Market Model approach relates a firm's daily stock return only to the market return. This single-factor model imposes fewer restrictions on returns compared to the Fama-French four-factor model; thus, it alleviates the concern about biases arising from restrictions (MacKinlay 1997):

$$r_{i,d} = \alpha_i + \beta_i\, r_{md} + u_{i,d} \tag{6}$$

where, $r_{i,d}$ is the firm's daily stock return, r_{md} is the market return, α_i is the intercept and $u_{i,d}$ is the residual. As reported in Web Appendix C, Section A, the results remained mostly unchanged.

Second, we excluded low-priced stocks and small-cap firms from our dataset and repeated Model 1. In this way, we can verify whether the obtained results are not driven by firms with low-priced stocks or small-cap, as these types of firms have relatively higher volatile stock returns (Brandt et al. 2010). We excluded firms with average annual stock prices below $5. Eight observations (4%) were deleted. The new results mirrored the previous results: compensation (β = −.173, SE = .103, chi-square = 2.85, $p < .1$), process improvement (β = −.263, SE = .095, chi-square = 7.67, $p < .01$), and apology (β = .221, SE = .101, chi-square = 4.80, $p < .05$).

Table 4 Results of the impact of service crisis recoveries on firm-idiosyncratic risk (Fama-French four-factor approach)

Variables	Hypothesis	Model 1 (Main model)		Model 2 (Interactions)	
		B	S.E.	B	S.E.
Effects					
Compensation (C)	H1(−)	−.241 **	.103	−.288 *	.147
Process improvement (P)	H2(−)	−.298 ***	.098	−.298 *	.172
Apology (A)	H3(+)	.299 ***	.102	.340 *	.195
C × P				.088	.262
C × A				−.060	.264
A × P				−.223	.293
C × P × A				.205	.394
Event controls[a]					
Customers victimized		.066	.111	.048	.110
Hacker attack		.057	.219	.104	.217
Theft of equipment		.173	.214	.222	.211
Misplaced data source		.256	.235	.279	.232
Employee intentional breach		.176	.212	.204	.209
Employee accidental mistake		−.049	.221	.003	.219
Technical error		0[b]	.	0[b]	.
Firm Controls					
Profitability		−1.046 *	.629	.345	.766
Profit volatility		1.300 **	.535	1.019 *	.536
Leverage		.024	.266	.080	.263
Market capitalization		−.117 **	.045	−.148 ***	.046
Firm age		−.064	.045	−.072	.045
Firm size		−.064	.043	−.030	.044
Industry and market controls					
Industry concentration		−.001	.001	−.001	.001
Type of industry dummies			Yes		Yes
Year dummies			Yes		Yes

*$p < .10$; **$p < .05$; ***$p < .01$

[a] The reference category for the cause of the information breach is: technical error

[b] This parameter is set to zero because it is redundant

Finally, we excluded firms with market capitalizations that place them in the smallest NYSE/AMEX size decile of 10. The size deciles were obtained from the CRSP Cap-based portfolio. Overall, 43 observations (20%) were omitted. Again, results were statistically similar: compensation ($\beta = -.241$, SE = .103, chi-square = 5.50, $p < .05$), process improvement ($\beta = -.225$, SE = .097, chi-square = 5.45, $p < .05$), and apology ($\beta = .286$, SE = .104, chi-square = 7.60, $p < .01$). In sum, we conclude that our findings are robust according to several stringent tests.

Additional analyses

To further test the robustness of our results, we conducted seven post-hoc analyses. We summarize four of them below, and the remaining three are presented in Web Appendix C. The analyses provided in the Web Appendix C show that: (1) the strength of the coefficient for compensation versus that for process improvement is equivalent; (2) the intensity of an apology does not change its negative effect on idiosyncratic risk; and (3) there is no significant interaction between types of victimized stakeholders and recovery actions and between causes of information breaches and recovery actions. We present below the other analyses.

Durational persistence of impacts of service crisis recoveries The impact of a firm's decisions and strategies on its stock value prevails during a finite time horizon because its stock value will capture other news and information over time. For our main analyses, we chose a one calendar year time horizon, since this time horizon is long enough to capture the reaction

of investors and to depict the gravity of the recovery strategies (e.g., Luo and Bhattacharya 2009).

To better understand the durational persistence of the impacts of service crisis recoveries, we computed the idiosyncratic risk for different time horizons (calendar quarters) and repeated Model 1 for each window. For the sake of parsimony, Table 5 presents only the parameters associated with our three focal recovery actions for several time windows. These results reveal that the impact of service crisis recoveries on firm-idiosyncratic risk starts two quarters after their announcement and lasts for up to two calendar years (eight calendar quarters) after their announcement. After two years, the significance of compensation weakens, while the significance of other plans tends to persist.

The interaction effect between number of affected individuals and an apology Per H3, our explanation for the positive effect of an apology on idiosyncratic risk relies on investors perceiving threats of stakeholder churn and/or potential class-action lawsuits. To provide more evidence for this reasoning, we used the number of affected individuals as a proxy for these threats. Our logic is that the larger the number of affected individuals, the greater the potential for massive stakeholder churn and/or expensive lawsuits. To make this point, we examined the interaction between the number of affected individuals and offering an apology. The positive effect of an apology on idiosyncratic risk should be higher for a large number of individuals (versus a low number of individuals) because of greater threats of churn and lawsuits.

We conducted this analysis on a base of 114 observations; many firms in our sample did not disclose the number of affected individuals. As expected, the interaction effect of interest (i.e., number of affected individuals x apology) was positive and significant ($\beta = .199$, SE = .103, chi-square = 3.75, $p < .05$). We conducted a spotlight analysis at one standard deviation above and below the mean level of the number of affected individuals (i.e., 1,323,500 individuals). Our results show that, in the low liability risk situation (i.e., less than 150 individuals), the impact of offering an apology on firm-idiosyncratic risk is negative but not significant ($\beta = -2.13$, SE = .128, chi-square = 2.76, $p > .05$). However, in the high liability risk situation (i.e., more than 2,646,850 individuals), offering an apology keeps its positive and significant impact on idiosyncratic risk ($\beta = 2.72$, SE = 1.23, chi-square = 4.85, $p < .05$). Overall, this result is consistent with the rationale underlying H3. These results are also in line with the service failure literature (Gelbrich and Roschk 2011) which suggests that an apology tends to have a favorable effect when a small group of stakeholders are affected.

The role of crisis severity Crisis severity is a key variable that could affect stakeholders' reactions (Weun et al. 2004), and it could influence risk variations for firms. Crisis severity is defined as the extent to which a service crisis has caused inconvenience to a firm's stakeholders (Grégoire and Fisher 2008). Hence, it is important to understand its role in our analyses.

To this end, we measured the severity of different causes of information breaches—by using primary data and a basic experiment—and then added these values as a control variable in our analyses. Because we did not have a variable to measure crisis severity in our original dataset, we designed a scenario-based experiment in which we asked participants to evaluate different service crises scenarios. Web Appendix C presents the details of this experiment.

As shown in Web Appendix C, Section B, we reran our model while controlling for the new "crisis severity" variable. The new results reveal that the severity of the information breach does not influence our previous results. When taking into account crisis severity, the three recovery strategies keep their significance on firm-idiosyncratic risk, while crisis severity is not significant ($\beta = .139$, SE = .161, chi-square = .740, $p = .390$). These findings illustrate that idiosyncratic risk is mainly affected by service crisis recovery strategies, but not crisis severity.

Impacts of combinations of recovery plans As mentioned earlier, some firms in our dataset offered no recovery plan, while others offered one or more recovery plans. To determine if there is a pattern associated with concurrent recovery strategies, we tested the interaction effects between the three variables. As presented in Table 4, the interactions between these recovery plans were not significant. Model 2, Table 4, shows that both three-way and two-way interactions were not significant (all $ps > .10$). Further analyses, in which we excluded the three-way interaction, also yielded non-significant parameters for the two-way interactions. Overall, this suggests that investors do not see any "synergy effect" among the recovery efforts. In managerial terms, it means that the combination of both compensation and process improvement is the strategy with the greatest potential to reduce a firm's idiosyncratic risk. In turn, an apology tends to increase this risk, even when combined with other recoveries.

Discussion

A summary of our results

Our investigation reveals that offering compensation (H1) or improving processes (H2) reduces firm-idiosyncratic risk; however, offering an apology can backfire for firms, as it increases this important risk (H3). These results are in line with the findings of Fang et al. (2013), who show that offering compensation and process improvement to victimized stakeholders has a longer decay time effect on satisfaction, whereas offering an apology has a shorter effect.

Table 5 Durational persistence of the impact of service crisis recoveries on firm-idiosyncratic risk (Fama-French four-factor approach) in different time horizons

Variables	Model 1		Model 1		Model 1		Model 1		Model 1	
	2 quarters (+1, +126)		3 quarters (+1, +189)		5 quarters (+1, +315)		7 quarters (+1, +441)		8 quarters (+1, +504)	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Compensation	−.225 *	.118	−.197 *	.110	−.225 **	.104	−.183 *	.110	−.136	.106
Process improvement	−.189 *	.113	−.230 **	.106	−.271 ***	.099	−.239 **	.105	−.238 **	.101
Apology	.220 *	.115	.222 **	.110	.281 ***	.103	.227 **	.108	.183 *	.105

*$p < .10$; **$p < .05$; ***$p < .01$.

Our analyses suggest that the type of victimized stakeholders (customers vs. employees), the cause of the breach, crisis severity, and apology intensity (see Web Appendix C) do not change the effects of the three recovery actions. Moreover, we show that compensation and process improvement have an equal effect size on firm-idiosyncratic risk (Web Appendix C). It should be noted that this equality differs from what was found in behavioral meta-analyses, which typically indicate a difference between these two strategies (e.g., Cohen-Charash and Spector 2001). For instance, in a customer context, Gelbrich and Roschk (2011) discovered that compensation is the most influential of the three strategies. Finally, our durational persistence analyses show that the impact of service crisis recoveries on firm-idiosyncratic risk starts after two calendar quarters and persists for two years after their announcement. Overall, the three effects reported are important, robust and durable.

Theoretical implications

General contributions Our first general contribution is to the literature on service crisis (see Table 1). Prior studies have essentially focused on individual failures and private recoveries. In addition, the literature on product-harm crisis emphasizes product recall, which is not applicable for service crises. Building on these literatures, our study expands the concept of recovery to a service crisis context in which these efforts are publicly offered to stakeholders. Importantly, investors witness these recoveries and make their own judgments about a crisis—which in turn affects financial performance.

Second, research on service recovery (e.g., Smith et al. 1999; Gelbrich and Roschk 2011) and product-harm crisis (e.g., Cleeren et al. 2013; Dawar and Pillutla 2000) has given limited attention to firm-level financial consequences. With the exception of ten Brinke and Adams (2015), who investigated the impact of offering an apology on a firm's abnormal stock return, we are not aware of any research that has investigated changes in firms' financial performance as a result of offering *multiple* recoveries. Briefly, ten Brinke and Adams (2015) examined the impact of normative (with sadness) versus deviant (with happiness) facial emotions during verbal apology on firms' abnormal stock returns. They reported negative effects for deviant facial emotions. As our second contribution, our research adds key insights to this literature by showing the long-term impact of *multiple* service crisis recoveries on firms' financial performance. In addition, we used a solid metric (idiosyncratic risk) as the key criterion for measuring this impact.

As our third general contribution, this study also adds new insights to the marketing–finance literature (e.g., Luo and Bhattacharya 2009; Rego et al. 2009). This research introduces service crisis recoveries as strategic firm decisions that contribute to the resource-based potential of firms—with a special focus on strengthening their relationships with stakeholders and the processes aiming at protecting information and data—and it provides additional support for the association between valuable resources and a firm's cash flow stability (e.g., Josephson et al. 2016; Tuli and Bharadwaj 2009).

Specific findings of importance In addition to these three general contributions, we wish to highlight two specific sets of results with important implications for both theory and practice. First, we find that the role of apologizing is negative for investors after a service crisis. This result is in sharp contrast to most behavioral studies that report a positive effect of an apology after private service failures (i.e., Gelbrich and Roschk 2011). Here, we suggest that an apology is generally positive for private service failures, whereas it is perceived negatively by investors in a service crisis context. Investors fear that an apology could be interpreted as an admission of guilt, which in turn could boost the risk of litigation (e.g., Patel and Reinsch 2003; Tyler 1997). Also, in a service crisis context, apologies are made through formal communications; it may be difficult to emphasize sincerity through these media, and as a result, these messages could be interpreted by stakeholders as a fraudulent action—which could lead to stakeholder churn. Although some research has predicted such an effect, the current research takes the extra step by showing the concrete negative effect of public apology on a firm's *financial performance*.

Second, the current study shows that investors, compared to employees and customers, process the three recovery efforts in different ways. As just noted, behavioral studies have found that offering apologies shows a firm's empathy for its stakeholders. However, since investors are loss averse (Barberis and Huang 2001), they respond negatively to an apology in order to avoid future losses. In addition, behavioral studies have found that the effect of compensation is stronger on stakeholder satisfaction, compared to process improvement (Gelbrich and Roschk 2011). This result is not replicated here. Investors possessing a long-term perspective perceive that both kinds of recoveries can equally strengthen relationships between firms and stakeholders. Finally, our analyses show that investors do not take into consideration the type of failure or severity of the crisis when they evaluate the effectiveness of recoveries. For regular stakeholders, there is evidence that these attributes matter strongly to them (Smith et al. 1999; Weun et al. 2004).

Managerial implications

Our results indicate that managers should pay special attention to both compensation and process improvement after a service crisis. The effectiveness of these plans has been supported from an individual standpoint in behavioral studies (Gelbrich and Roschk 2011), and it receives support from a market perspective in the current study. For information breaches, recoveries that are evidence of compensation include offering free credit monitoring, identity theft insurance and discount on post purchases. In turn, plans that express process improvement consist of improving information protection policies, updating security software and training employees. The absence of any significant effect of most interactions suggests that these plans could be offered for both types of victimized stakeholders and for all causes of information breaches with different degrees of severity. In addition, managers could simultaneously use these two recovery measures; their respective effects are additive (although they do not interact).

The negative effect of an apology suggests that managers should pay special attention to the way they communicate about a service crisis. Here, they face a dilemma. On the one hand, victimized stakeholders appreciate receiving an apology on a personal basis; strong cumulative evidence shows that they respond favorably to an apology after a private service failure. On the other hand, shareholders would prefer a denial of responsibility (i.e., no apology) to diminish the threat of class-action lawsuits and massive customer or employee churn. Thus, firms are somewhat "trapped" between being honest with their stakeholders or distorting the reality for shareholders (Tyler 1997). To resolve this dilemma, we suggest that firms should communicate in different ways, using different media, to their stakeholders and shareholders respectively.

For victimized stakeholders, managers should try to contact them privately, ideally using phone or face-to-face conversations. Well-trained employees should be responsible for initiating these contacts. At this stage, it is important to communicate a warm apology that would convey sincerity and empathy. The employees should also be available to answer any questions, and they should explain the next steps of the recovery. As much as possible, these employees should use the approach that is typically followed for private service failures. The general idea is to treat stakeholders with a personal touch, despite the public nature of a service crisis, so that their relationship can be restored. The evidence accumulated by behavioral research suggests that such a personal approach could elicit positive responses from stakeholders and be beneficial for firms.

Our prescription is different for investors and most public communications made in the mass media. Here, we suggest that managers should use a form of *equivocal communication*, namely, an ambiguous, tangential, and evasive communication style (Bavelas et al. 1990). In this communication strategy, firms put the blame on uncontrollable accidents such as technical errors (e.g., computer glitch, outdated firewalls and website programming errors), accidental human mistakes or employees' negligence. In this way, the firm neither denies the responsibility completely, nor does it completely accept it. In this case, the communications are probably too ambiguous to be used as triggering factors leading to expensive class action suits or stakeholder revolt leading to massive churn.

Limitations and further research

The following limitations should be considered when interpreting or applying our findings. First, similar to other articles in the marketing–finance interface, our dataset is limited to U.S. publicly-traded firms, because data on stock returns for foreign firms are not easily obtainable. Hence, the generalizability of our research is limited to the USA. Future research can replicate our results in other countries to investigate cross-cultural judgment of investors.

Second, this methodology does not provide a detailed mechanism to explain how investors react to a firm's strategies. Therefore, behavioral studies should also be conducted to better understand the process that would explain the different effects of the three recoveries, especially apology, for investors.

Third, due to limited diversity in the recovery plans in our context, we coded each of the recovery plans at the two levels of either present or absent. Further studies could extend our findings by examining how varying degrees of recovery plans can change firm performance (Tax et al. 1998). For instance, firms might offer either equal compensation to all individuals or varied levels of compensation based on the amount of their loss. Similarly, process improvement

can be offered either as broad promises or in more detail describing activities and schedules.

Fourth, this study focuses on the announcements of information breaches as service crises; however, similar research questions could be examined in other crisis contexts, such as environmental damage. Finally, some moderators could not be examined in our analyses because of constraints in collecting data: the firm's reputation in complaint handling, stakeholders' switching barriers, or crisis history.

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