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# Quantifying the Dynamic Effects of Service Recovery on Customer Satisfaction: Evidence From Chinese Mobile Phone Markets

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Zheng Fang<sup>1</sup>, Xueming Luo<sup>2,3</sup>, and Minghua Jiang<sup>4</sup>

## Abstract

This study examines two issues which have challenged prior experimental or survey research: (1) whether the time-varying effects of service recovery on customer satisfaction may follow a long decay or short decay and (2) why and what service recovery efforts have a higher and quicker buildup, with respect to the significance and timing of recovering customer satisfaction losses due to service failures. The authors do so with a real-world data set from China's mobile phone markets. The authors developed multivariate time-series model to simulate the dynamic service recovery process and implemented Bayesian estimation to resolve overparameterization problem. The empirical results surprisingly reveal that apology-based service recovery efforts are the least effective in salvaging customer satisfaction, with the shortest decay and lowest buildup intensity. In contrast, quality improvement is the most effective, with the highest buildup and longest decay but slowest buildup toward the peak impact point. Compensation has moderate and stable impact overtime. Communications' impact on customer satisfaction builds up the quickest, though with mild endurance and magnitude. Also, the decomposition models enable managers to monitor how many percentages of customer satisfaction gains are originated from which types of service rescue efforts.

## Keywords

marketing dynamics, customer satisfaction, service recovery, VAR, Bayesian estimation

## Introduction

Service recovery is an important issue for managers. Even the most popular service providers cannot guarantee “zero-defect” service; fluctuation of service quality inevitably leads to occurrences of service failure. The more severe the failure is, the more intense customer dissatisfaction will be, thus the more critical it is for managers to employ revitalization strategies to reduce customer churn rates.

Given this importance, prior studies have noted that service recovery is a dynamic process of engaging in various marketing activities to recuperate consumer satisfaction after the service does not meet customer expectation or tolerance zone.<sup>1</sup> Successful recovery efforts may resolve customer complaints and restore confidence. However, failures in recovery may lead to even more consumer disappointment toward the products and brands. In resolving service failures, firms may adopt various recovery strategies, including quality improvement, compensation, apology, and communications. These efforts are not considered temporary tactics but rather long-lasting service recovery mechanisms to sustain customer satisfaction (Bitner 1990; Davidow 2000; Goodwin and Ross 1989; Greenberg 1990; Hess, Ganesan, and Klein 2003; Johnston and Michel 2008; Luo and Homburg 2007, 2008; Maxham and Netemeyer 2002; Rust and

Chung 2006; Smith and Bolton 2002; Smith, Bolton, and Wagner 1999; Yousafzai, Pallister, and Foxall 2005).

Even though the existing literature has ample studies on the types and effects of service recovery efforts, little research attention has been paid to how dynamic these effects are when regaining customer satisfaction. Yet, such an assessment is crucial for managers to check when and what rescue initiatives can be considered a success in combating customer satisfaction loss. This study makes several contributions to the literature as follows.

First, we explore the dynamic effects of service recovery. The topic is interesting and potentially important because there are two relevant literature streams that are usually independent: service recovery papers and dynamic effects papers. On one hand, we attempt to understand service recovery effects

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dynamically. Most prior studies of service recovery are static (frequently experimental), whereas this article relies on time-series model and data. Although there are few longitudinal studies (see Bolton and Drew [1991]), their data only have three time points and could not analyze time-varying impact accurately. On the other hand, we extend time-series applications of marketing dynamics in service recovery area. Prior time-series studies have pointed out the “buildup and decay effects” of market instruments (Little 1979; Luo 2009). Following this research stream, we examine whether the effects of service recovery strategies on customer satisfaction may follow a short or long decay, and which service recovery strategy has a lower or higher buildup. We also quantify how much money the company must spend in order to fully recover the customer satisfaction losses.

Second, we also develop a theoretical model on why and which service recovery efforts have a higher and quicker buildup. Prior research suggests that buildup magnitude (peak impact) and timing (buildup time) are heterogeneous for different marketing instruments (Bronnenberg et al. 2008; Dekimpe and Hanssens 1999; Luo 2008, 2009). Following this stream of research, we compare and contrast the buildup intensity and duration with respect to the satisfaction impact of service recovery strategies. Although expectancy and disconfirmation theories predict a highest buildup for quality improvement, justice and relationship marketing perspectives suggest the greater potential of using compensation and communications to regain customer satisfaction after service failures. Our study examines the relative impact of all four service rescue strategies simultaneously. It advances services marketing literature by ranking the relative buildup effects and clarifying how well different theoretical perspectives can predict the timing and significance of service recovery for salvaging customer satisfaction.

Third, from a methodological aspect, our study is unique. Different from previous studies using perceptual soft data with survey or experiments, this article utilizes company archival hard data. The setting of our data set is interesting because it is related to a major Chinese mobile phone telecom company and how this company seeks to pull back its customer satisfaction after a major service failure caused by the deadly earthquake. The developed time-series models account for the endogenous problems due to reverse causality, full interactions among endogenous variables, autoregressive effects, market competition, and many alternative explanations. Also, we utilized Bayesian Estimation to resolve latent overparameterization problem.

Recently, the Chinese mobile telecommunication sector has grown very rapidly. Although only one of the ten Chinese had a phone 5 years ago, today more than 1.25 million cellular subscribers sign up in China every week. As of June 2010, China has 796 million mobile customers, ranking the first in the world. The mobile telecommunications industry in China is dominated by three state-run businesses: China Telecom, China Unicom, and China Mobile. The three companies were reformed by a recent revolution and restructuring launched in May 2008. Since then, the three companies have gained 3G

licenses and provided fixed-line and mobile business in China. Due to fierce competition and fickle consumer choices, the three powerful operators have to rely on superior service quality and service recovery so as to minimize the churn rate of extant subscribers and attract new subscribers from competitors. As such, the Chinese mobile phone markets offer a desirable setting to test the importance of service recovery to regain and sustain customer satisfaction and market performance.

The rest of the article is organized as follows. We begin with the literature review. Based on the literature review, we present a theoretical framework regarding the dynamic effects of service recovery efforts on customer satisfaction. Then, time-series models are developed and applied to a data set to test the hypotheses. Finally, results and their implications are provided.

## Dynamic Effects of Service Recovery on Customer Satisfaction

Marketing dynamics are important for the purpose of evaluating the time-varying effects and contribution of marketing variables in the long run. Prior time-series studies have pointed out the “buildup and decay effects” (Little 1979), or “wear-in” and “wear-out” effects of advertising (Pauwels et al. 2004) and word of mouth (Luo 2009). According to previous studies, buildup and decay impacts are modeled by impulse-response function (IRF) in dynamic models, which we will discuss in detail in Modeling Short or Long Decay and Buildup Intensity: IRF section. Buildup means the increasing impact before IRF reaches its peak impact point, while decay refers to the decreasing impact over time from the peak impact point to zero (Bronnenberg et al. 2008; Pauwels and Hanssens 2007). Other studies have proposed “persistence” or “dynamic erosion effects” (Bronnenberg, Dhar, and Dubé 2009; Bronnenberg, Mahajan, and Vanhonacker 2000) and an “adjusting period” (Pauwels, Hanssens, and Siddarth 2002) or “dust-settling period” (Nijs et al. 2001).

### Service Recovery Strategies

By and large, service recovery refers to the actions an organization takes in response to a service failure (Grönroos 1988). Recovery management has a significant impact on customer evaluations because customers are usually more emotionally involved in recovery than in routine or first-time service. They are often more dissatisfied by an organization’s failure to *rescue* than by the service failure itself (Berry and Parasuraman 1991; Bitner 1990; Hess, Ganesan, and Klein 2003; Luo 2007). Companies known for excellent service go the extra mile to cover all the costs a failure incurs. If the inconvenience is so severe to customers, the tone of recovery responses must signal the company’s deepest regret (Hart, Heskett, and Sasser 1990; Smith, Bolton, and Wagner 1999).

As shown in Table 1, services marketing literature has suggested several key recovery strategies. *Quality improvement* is the firm’s improvement in providing quality services to customers so that a similar future service failure seems remote

**Table 1.** Service Recovery Literature.

Research	Service Recovery Strategy				Data		Dynamic Effects		
	Quality Improvement	Compensation	Apology	Communications	Perceptual Soft Data	Company Archival Hard Data	Long Decay	Buildup Magnitude	Modeling Endogeneity
Bitner (1990)		✓		✓	✓				
Bitner et al. (1990)		✓	✓	✓	✓				
Kelley, Hoffman, and Davis (1993)	✓	✓	✓		✓				
Johnston (1995)				✓	✓				
Conlon and Murray (1996)		✓	✓	✓	✓				
Boshoff and Leong (1998)			✓		✓				
Smith and Bolton (1998)				✓	✓				
Boshoff (1999)		✓	✓	✓	✓				
Smith (1999)		✓	✓		✓				
Smith and Bolton (2002)		✓	✓		✓				
Wirtz and Mattila (2004)			✓	✓	✓				
Harris et al. (2006)		✓	✓		✓				
Grewal et al. (2008)				✓	✓				
This research	✓	✓	✓	✓		✓	✓	✓	✓

(Johnston and Michel 2008; Van Vaerenbergh, Larivière, and Vermeir 2009). *Compensation* is the discounts, free merchandise, refunds, coupons, and other economic incentives offered by the organization to counteract the inequity caused by a service failure (Smith, Bolton, and Wagner 1999). An *apology* from the service providers conveys politeness, courtesy, concern, effort, and empathy to customers who have experienced a service failure (Hart, Heskett, and Sasser 1990; Kelley, Hoffman, and Davis 1993; Smith, Bolton, and Wagner 1999). In addition, *communications* are those media press activities taken in order to make the customers aware of root causes identified and rescue processes implemented (Andreassen 2000; Van Vaerenbergh, Larivière, and Vermeir 2009; Yavas et al. 2004). With both surveys and experiments, Smith, Bolton, and Wagner (1999) show that recovery attributes such as apology, compensation, and response speed affect perceived justice and thus influence customer satisfaction.

This study extends the services marketing literature by tracking the *dynamic effects* of service recovery strategies on customer satisfaction. To our knowledge, we are the first to examine dynamic effects of service recovery in terms of the long decay and buildup impact. Indeed, because prior studies have focused on the cross-sectional effects of service recovery, Maxham and Netemeyer (2002) have explicitly called for research on studies examining the dynamics of recovery efforts and perceptions over time. Also, complementary to most prior studies with survey- or experiment-based “soft” data, our research takes advantages of company records-based “hard” data, in the context of a major service failure event. The developed time-series models account for reverse causality and full

interactive effects among service recovery and customer satisfaction, autoregression effects, market competition, and many alternative explanations. Table 1 summarizes the aspects by which our study advances the services marketing literature.

### *Hypotheses on the Dynamic Effects of Service Recovery*

*Short or long decay.* Do the effects of service recovery strategies on customer satisfaction have a short or long decay? Although prior literature has not provided a direct answer, some studies allude to the possibility of a short or long decay, depending on the specific type of service recovery efforts. For example, according to the Affect Infusion Model (AIM; Forgas 1995), in the short run, customers are more likely to rely on their feelings because feelings are often elicited immediately (Pham et al. 2001). That is, affective responses are evoked much quicker than cognitive responses. However, as customer experience accumulates over time, the impact of affective factors on customer satisfaction decreases, and the impact of cognitive factors on customer satisfaction increases (Homburg, Koschate, and Hoyer 2006). This is because cognitive factors are more reliable than affective factors when customers make judgments (Leventhal 1980). As such, affective factors evoke short-lived responses, thus leading to a short decay. In contrast, cognitive factors induce long-lived responses and effects on customer satisfaction, thus generating a long decay.

According to their definitions in service recovery efforts, quality improvement, compensation, and communications are closer to cognitive factors, but apology is more related to affective factors. More specifically, *quality improvement* seeks

service efficiency improvements, minimizes the reoccurrence expectation of the same service failure, and reduces customer expectation disconfirmation by enhancing service quality (Johnston and Fern 1999; Luo and Bhattacharya 2006; Oliver and Swan 1989a). All of these are in the cognitive factor category. Because *compensation* involves the economic incentives offered by the organization (Smith, Bolton, and Wagner 1999), customers would become satisfied if they recognized that economic incentives could offset their losses. So, compensation is a cognitive factor. *Communications* are endeavors to make customers aware of rescue steps and actions (Van Vaerenbergh, Larivière, and Vermeir 2009). Aiming at adjusting the expectation of service quality, communications can shape and change customer cognitions. However, an *apology* from the service providers conveys politeness, courtesy, concern, effort, and empathy to customers (Hart, Heskett, and Sasser 1990). In social exchange and equity theories, apology is viewed as a valuable reward that redistributes esteem (Hatfield, Walster, and Berscheid 1978) and would mainly evoke affective responses (Smith, Bolton, and Wagner 1999). Therefore, the AIM and services marketing literature predict that quality improvement, compensation, and communications are closer to cognitive factors and, thus, have a long decay (more enduring impact). In contrast, apology is closer to affective factors and, thus, has a short decay (less enduring impact) in their effects on customer satisfaction over time.

*Hypothesis 1:* After service failures, the time-varying impact of service recovery strategies such as quality improvement, compensation, and marketing communications on customer satisfaction has a long decay, while that of apology on customer satisfaction has a short decay.

**Buildup intensity and peak timing.** Besides decay heterogeneity, service recovery strategies may vary in terms of buildup intensity and timing of the peak impact. Many scholars have identified the dominant importance of quality improvement-based service recovery efforts for recouping customer satisfaction, thus suggesting the relative stronger buildup effects of quality improvement than those of compensation or apology when handling customer complaints and dissatisfaction (Hart, Heskett, and Sasser 1990; Tax, Brown, and Chandrashekar 1998). Furthermore, prior studies (Johnston and Fern 1999; The National Complaints Culture Survey 2006) indicated that after service failures the prime customer expectation is to have the problem fixed; tokenism and even compensation are not key customer requirements. The survey also found that the offer of free goods or services following poor service was deemed important by less than 5% of the customers. Indeed, quality improvement represents the most significant means of handling complaints with the highest impact on customer satisfaction (Hart, Heskett, and Sasser 1990; Johnston and Clark 2005; Reichheld and Sasser 1990; Stauss 1993). Therefore, it is expected that among the four service recovery strategies, quality improvement has the highest peak point in buildup regarding the impact on customer satisfaction

*Hypothesis 2a:* The time-varying impact of quality improvement on customer satisfaction has the highest buildup compared to that of compensation, apology, and communications.

According to the social exchange theory, a service recovery encounter can be viewed as an exchange in which the customer experiences a loss due to the failure and the organization's attempts to provide a gain, in the form of a rescue effort, to make up the customer's loss. Social exchange and justice theories (Oliver and Swan 1989b; Walster, Berscheid, and Walster 1973) identify three dimensions of perceived justice that may influence customer satisfaction: distributive justice, which involves resource allocation and the perceived outcome of exchange (Adams 1966); procedural justice, which involves the means by which decisions are made and conflicts are resolved (Thibaut and Walker 1975); and interactional justice, which involves the manner in which information is exchanged and outcomes are communicated (Bies and Moag 1986). A meta-analysis of 60 independent studies indicates that customer satisfaction is affected most, in terms of both intensity and response timing, by distributive justice, then by interactional justice, and only weakly by procedural justice (Orsingher, Valentini, and de Angelis 2010). Because compensation is the only recovery strategy that affects distributive justice (which is the most effective and efficient justice dimension affecting customer satisfaction), social exchange and justice theories would suggest that the impact of compensation has a higher peak point and faster buildup than that of apology and communications.

*Hypothesis 2b:* The time-varying impact of compensation on customer satisfaction has a higher and faster buildup than that of apology and communications.

The relationship marketing literature suggests that timely communications can boost customer trust and commitment, which are two key factors of boosting customer relationships and satisfaction (Morgan and Hunt 1994). Prudent communications are more effective in resolving disputes and aligning perceptions and expectations, more so than compensation or apology (Anderson and Narus 1990; Moorman, Deshpande, and Zaltman 1993). In addition, communications make customers aware that the company would try to resolve the problems rather than act opportunistically (Vázquez Casielles, Suárez Álvarez, and Díaz Martín 2010). This would enable the firm to regain more customer confidence than compensation and apology do. As such, the relationship marketing paradigm implies that effective communications of the service rescue efforts would promote customer-firm relationships and, thus, lead to higher customer satisfaction and recoup the customer satisfaction loss more quickly, more so than compensation and apology.

*Hypothesis 2c:* The time-varying impact of communications on customer satisfaction has a higher and faster buildup than that of compensation and apology.

Generally speaking, Hypotheses 2a, 2b, and 2c are competing hypotheses derived, respectively, from expectation framework, social exchange theory, and relationship marketing literature. These competing hypotheses are subject to empirical data testing as follows.

## Data and Measures

### Data Setting

Because service recovery strategies are implemented after the service failures, it is challenging to conduct systematic empirical research with real-world data on service failures recovery. If a serious service failure is involved, it is more insightful to conduct a field study on the effectiveness of the recovery strategies.

Our data set is obtained from a field study with the Chinese mobile phone telecom industry. This industry is a typical oligopoly market which is consisted of only three major competitors. One of the three (hereafter CM company) provides the data for our study. In 2007, the CM company upgraded the mobile network equipment in Chengdu (CD) regions, and the new networks were still in the commissioning phase in 2008. However, in May 12, 2008, a catastrophic earthquake occurred in Western China and seriously affected the CM's service regions more than 100 km away. After the earthquake, the newly installed networks were very unstable. That resulted in serious service failures with frequent dropped-calls during a crucial moment in the earthquake. Usually, the ratio of dropped-call rate should be less than 0.3% in common situations. However, dropped-call rate was 8% right after the earthquake, which is nearly 27 times as big as in the common situations. At the same time, two other rival networks were relatively reliable and did not experience major communication failures. Therefore, customers of the CM company became very dissatisfied. Hotline complaints were as high as 30,000 consumers a day. In order to restore the market, the CM company launched the service recovery strategies from the day of the quake.

Top management of the company engaged in a dynamic, closed-loop strategy of service recovery. More specifically, the company launched various recovery strategies to improve customer satisfaction and adapted the recovery strategies on the basis of the consumer satisfaction level each week. This closed-loop is a unique feature in our data set and requires an appropriate methodology to account for the full endogenous cycle between service recovery efforts and customer satisfaction. The recovery strategies of the CM company included quality improvement, compensation, apology, and communications. Their measures are discussed next. Because of the serious communication service failure, the whole recovery process lasted for 39 weeks until the satisfaction level had been stabilized about around 95%. Thus, the data set consists of 39 weeks (May 12, 2008 to February 14, 2009). Data were collected by telephone surveys. The samples are the same consumers who used the mobile network before the serious service failure. In ensuring the validity of the measures, more than 10% of the consumer base (over 1 million users) of the company was polled every week.

### Measures

**Customer satisfaction.** Customer satisfaction is the overall satisfaction evaluation of the mobile voice service of the CM company. The company used random sampling with the last four digits of the mobile phones in service. Customers rated their satisfaction levels in several categories: *very satisfied*, *satisfied*, *not satisfied*, or *no answer*. The final measure of customer satisfaction each week was scaled by the number of consumers surveyed.

**Quality improvement.** Quality improvement refers to the degree of improvement in providing quality mobile phone voice services to customers. We measure this variable with 100% minus the dropped-call rate. Dropped-call rate means the percentage of unexpected disruption and disconnection of voice services. This measure is an important indicator in the field of mobile communications. In common situations, the ratio of dropped-call rate is less than 0.3% in the CM company, so the nondropped-call rate is more than 99.7%. Weekly data of the nondropped-call rate track how well the quality of voice service is improved over the previous week. The smaller the dropped-call rate, the better the quality improvement for the voice service each week.

**Apology.** Apology is the behavior of requests for forgiveness of the CM company. Following Smith, Bolton, and Wagner (1999), we measure apology as a categorical variable. If the company has apologized to the public via mass media such as TV and newspapers, the value of this variable is one. Otherwise, it is zero.

**Communications.** Communications strategy is measured as the total cost of media spending that is used by the CM company to convey to its customers the ongoing progress of voice service recovery. The company used TV ads, newspaper, and radio to announce the progress of repairing communication networks and protecting communications in earthquake disaster relief stages.

### Controls to Rule Out Alternative Explanations to the Results

During the recovery process, customer satisfaction may be affected by other factors, for which we need to control. We have four categories of control variables. First, we account for the influence of marketing actions of the CM company. From the perspective of the product or channel strategies, there are no major changes in the 39 weeks. Regarding the pricing strategy, the principle way the company rewarded loyal consumers was to refund money to their accounts. This part of the expenses and the corresponding price changes will be reflected in the compensation strategy. From the promotion strategy point of view, we control for the nonroutine public activities in the 39 weeks (e.g., celebration of 3G licensing of mobile communications), which can enhance company reputation.

**Table 2.** Data Descriptions and Stationarity Tests.

Variables	Data Descriptions					Stationarity Tests		
	M	SD	Min	Median	Max	Type	Tau	p Value
CS	0.888	0.068	0.751	0.912	0.971	Zero Mean	-1.95	.049
QI	0.982	0.024	0.920	0.996	0.998	Zero Mean	-5.10	< .001
Compensation	0.443	0.337	0.000	0.357	1.000	Trend	-3.22	.097
Apology	0.179	0.389	0.000	0.000	1.000	Zero Mean	-2.29	.023
Communications	0.611	0.337	0.000	0.684	1.000	Zero Mean	-1.73	.079

Note. CS = customer satisfaction, service recovery strategies include QI = quality improvement, compensation, apology, and communications. Compensation and communications are linearly transformed into [0, 1] interval to avoid disclosing CM company's financial details. Stationarity tests are based on the standardized value of five variables.

**Table 3.** Granger Causality Test Results.

Results	Caused by				
	CS	QI	Compensation	Apology	Communications
CS	—	< .001	.009	.027	< .001
QI	.097	—	.072	< .001	< .001
Compensation	.507	.002	—	.440	.630
Apology	.196	.107	.563	—	< .001
Communications	.407	< .001	.031	.652	—

Note. CS = customer satisfaction; QI = quality improvement. Entries are the p values for the Granger causality tests.

Further, we control for market competition. We have data records on the public activities of the firm's competitors, which may affect the CM company's customer satisfaction. In addition, major economic events such as financial crisis may affect customer spending and, thus, may impact customer satisfaction. Finally, social factors such as national holidays (e.g., the Mid-Autumn Festival) and giant-scale social publicity (i.e., the Olympic torch relay) also affect customer satisfaction. In order to check the potential impacts of the above factors, we establish the Equation 1 to analyze:

$$\begin{aligned}
 CS_t = & \chi_0 + \chi_{firm\_level} \\
 & \times (\text{major promotions, nonroutine public activities}) \\
 & + \chi_{industry\_level} \times (\text{competitors' public activities}) \\
 & + \chi_{economic\_level} \times (\text{economic events}) + \chi_{social\_level} \\
 & \times (\text{national holidays, giant - scale social publicity}) + \varepsilon_t,
 \end{aligned}
 \tag{1}$$

where  $\chi_0$  is the intercept,  $\chi_{firm\_level}$ ,  $\chi_{industry\_level}$ ,  $\chi_{economic\_level}$ ,  $\chi_{social\_level}$  are vectors of coefficients, and  $\varepsilon_t$  is residual term.

CM company did not provide archival data needed in Equation 1. We collected these data by searching massing media. Therefore, these data are not very precise and could only be coded into dummy variables. Based on these data, we find from empirical data analysis that the model of Equation 1 is not significant statistically,  $F(7,31) = .860, p = .527$ . Thus, we can partly rule out the alternative explanations due to the multilevel control variables, with respect to the impact of service recovery on customer satisfaction as reported next.

### Data Stationarity and Granger Causality Tests

Stationarity is an important assumption to check in time-series data so as to prevent spurious results. There are many stationarity tests and the most common method is the Augmented Dick-Fuller (ADF) test. We implemented ADF tests after standardizing the five variables. As can be seen from Table 2, ADF test results suggest stationary time series. The null hypothesis is that there exists a unit root for the customer satisfaction and service recovery variables can be rejected at the level of  $p < .1$ .

Further, in order to understand the time-based causality, we conducted pair-wise Granger causality test. The results are shown in Table 3. First, quality improvement, compensation, apology, and communications Granger cause consumer satisfaction, which is quite consistent with the findings of previous studies. Second, there are complicated interactions among the four service recovery strategies. Compensation, apology, and communications Granger cause quality improvement, quality improvement Granger causes compensation, communications Granger causes apology strategy, and quality improvement and compensation would Granger cause communications. Third, we find reverse causal relationships. Customer satisfaction Granger causes quality improvement, which reflects the "feedback effects of management performance" (Dekimpe and Hanssens 1999). It confirms that a decrease of consumer satisfaction pressures the CM company to restore its communication network. In sum, these data reveal some complex relationships and reverse causal effects. Modeling the data set then would require a dynamic system that can account for both direct and indirect effects between endogenous variables.

**Models**

**Modeling the Marketing Dynamics: Vector Autoregressive (VAR) Model**

VAR model is appropriate for capturing the complex, dynamic relationships between recovery strategies and customer satisfaction. VAR model can treat each endogenous variable in the system as the function of lagged values of all the variables. It extends the regression of the single endogenous variable to simultaneous regressions of various endogenous variables. Thus, VAR can model a closed loop, in which (1) recovery strategies and their interactions affect customer satisfaction and (2) the weekly recovery decisions of the CM company are based on last week’s customer satisfaction. VAR model can handle this endogeneous cycle (Bronnenberg et al. 2008; Bronnenberg, Mahajan, and Vanhonacker 2000; Dekimpe and Hanssens 1999; Luo 2009; Nijs, Srinivasan, and Pauwels 2007).

In the estimates, VAR model can fully reflect the time-varying dynamic effects of endogenous variables in the system. First, the model can estimate the time-varying effects of service recovery strategies on customer satisfaction in terms of the short term (immediate  $t + 1$ ) and long term (cumulative over  $t + 1, t + 2, t + 3, \dots$ , and  $t + j$ ), or the direct effects. Second, VAR can estimate the feedback effect of consumer satisfaction on recovery strategies, or the reverse effects. Third, it can estimate the carryover effect of all the variables, that is, the influence of previous customer satisfaction on current customer satisfaction. Fourth, the model can also estimate the cross effects of recovery strategies, that is, the influence of compensation on communications. The VAR model constructed in this study is as follows:

$$\begin{bmatrix} CS_t \\ QI_t \\ Compensation_t \\ Apology_t \\ Communications_t \end{bmatrix} = \begin{bmatrix} \delta_{10} + \delta_{11}t \\ \delta_{20} + \delta_{21}t \\ \delta_{30} + \delta_{31}t \\ \delta_{40} + \delta_{41}t \\ \delta_{50} + \delta_{51}t \end{bmatrix} + \sum_{j=1}^J \begin{bmatrix} \varphi_{11}^j & \varphi_{12}^j & \varphi_{13}^j & \varphi_{14}^j & \varphi_{15}^j \\ \varphi_{21}^j & \varphi_{22}^j & \varphi_{23}^j & \varphi_{24}^j & \varphi_{25}^j \\ \varphi_{31}^j & \varphi_{32}^j & \varphi_{33}^j & \varphi_{34}^j & \varphi_{35}^j \\ \varphi_{41}^j & \varphi_{42}^j & \varphi_{43}^j & \varphi_{44}^j & \varphi_{45}^j \\ \varphi_{51}^j & \varphi_{52}^j & \varphi_{53}^j & \varphi_{54}^j & \varphi_{55}^j \end{bmatrix} \begin{bmatrix} CS_{t-j} \\ QI_{t-j} \\ Compensation_{t-j} \\ Apology_{t-j} \\ Communications_{t-j} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \end{bmatrix}$$

CS represents customer satisfaction. Service recovery strategies include quality improvement (QI), compensation, apology, and communications. Also,  $t$  is time,  $j$  is lag length, and  $\varepsilon$  is the random disturbance term.  $\delta_{10}, \delta_{20}, \delta_{30}, \delta_{40},$  and  $\delta_{50}$  are the

intercepts;  $\varphi_{12}, \varphi_{13}, \varphi_{14},$  and  $\varphi_{15}$  are direct impacts,  $\varphi_{21}, \varphi_{31}, \varphi_{41},$  and  $\varphi_{51}$  are feedback impacts,  $\varphi_{11}, \varphi_{22}, \varphi_{33}, \varphi_{44},$  and  $\varphi_{55}$  are carryover impacts, and  $\varphi_{23}, \varphi_{24}, \varphi_{25}, \varphi_{32}, \varphi_{34}, \varphi_{35}, \varphi_{42}, \varphi_{43}, \varphi_{45}, \varphi_{52}, \varphi_{53},$  and  $\varphi_{54}$  capture the full interactive effects among service recovery strategies in VAR. In eliminating the scale difference, we standardize the variables before estimating the VAR model.

**Estimating Parameters: Bayesian Method**

Because data only persist for 39 periods, we use Bayesian Estimation to avoid potential overparameterization problem that often occurs with the use of VAR models when sample size is limited (Litterman 1986). Let vector  $y_t = (CS_t, QI_t, Compensation_t, Apology_t, Communications_t)'$ , then the Equation (2) can be expressed as the simple form of VAR:

$$y_t = \delta_0 + \delta_1 t + \sum_{j=1}^p \Phi_j y_{t-j} + \varepsilon_t, \tag{3}$$

where  $t = 1, \dots, T, \delta_0,$  and  $\delta_1$  are  $k \times 1$  vector ( $k = 5$ ),  $\Phi_1, \dots, \Phi_p$  are  $k \times k$  matrix.  $\varepsilon_1, \dots, \varepsilon_T \sim N_k(0, \Sigma), \Sigma$  is a  $k \times k$  positive definite error covariance matrix.

Suppose:

$$\begin{aligned} Y &= (y_1, \dots, y_T)' \\ B &= (\delta_0, \delta_1, \Phi_1, \dots, \Phi_p)' \\ X &= (X_0, X_1, \dots, X_{T-1}) \\ X_t' &= (1, t, y_t', \dots, y_{t-p+1}') \\ E &= (\varepsilon_1, \varepsilon_2, \dots, \varepsilon_T) \\ y &= \text{vec}(Y) \\ \beta &= \text{vec}(B) \\ e &= \text{vec}(E) \end{aligned}$$

Thus, the Equation 3 is expressed as following:

$$Y = XB + \varepsilon \text{ or } y = (X \otimes I_k)\beta + e \tag{4}$$

If  $\beta \sim N(\beta^*, V_\beta)$ , then the density function of prior distribution is as follows:

$$f(\beta) = \left(\frac{1}{2\pi}\right)^{k^2 p/2} |V_\beta|^{-1/2} \exp\left[-\frac{1}{2}(\beta - \beta^*)V_\beta^{-1}(\beta - \beta^*)\right]. \tag{5}$$

The likelihood function of Gaussian process should be

$$\begin{aligned} l(\beta|y) &= \left(\frac{1}{2\pi}\right)^{kT/2} |I_T \otimes \Sigma|^{-1/2} \times \\ &\exp\left[-\frac{1}{2}(y - (X \otimes I_k)\beta)'(I_T \otimes \Sigma^{-1})(y - (X \otimes I_k)\beta)\right]. \end{aligned} \tag{6}$$

Therefore, the density function of posterior distribution is:

$$f(\beta|y) \propto \exp\left[-\frac{1}{2}(\beta - \bar{\beta})'\bar{\Sigma}_\beta^{-1}(\beta - \bar{\beta})\right], \tag{7}$$

Where the posterior mean is as follows:



$$\bar{\beta} = [V_{\beta}^{-1} + (X'X \otimes \Sigma^{-1})]^{-1} [V_{\beta}^{-1}\beta^* + (X' \otimes \Sigma^{-1})y], \quad (8)$$

the posterior covariance matrix is as follows:

$$\bar{\Sigma}_{\beta} = [V_{\beta}^{-1} + (X'X \otimes \Sigma^{-1})]^{-1} \quad (9)$$

In practice, the prior mean  $\beta^*$  and the prior variance  $V_{\beta}$  need to be specified. According to Litterman (1986): (1) the parameters are all assumed to have zero means except the coefficient on the first lag of the dependent variable, which is given a prior mean of 1, and (2) the prior variance can be given by

$$v_{mn}(I) = \begin{cases} (\lambda/I)^2 & \text{if } m = n \\ (\lambda\theta\delta_{mm}/I\delta_{nn})^2 & \text{if } m \neq n \end{cases}, \quad (10)$$

where  $v_{mn}(I)$  is the prior variance of the  $(m, n)$ th element of  $\Phi_t$ ,  $\lambda$  is the prior standard deviation of the diagonal elements of  $\Phi_t$ ,  $\theta$  is a constant in the interval  $(0,1)$ , and  $\sigma_{mm}^2$  is the  $m$ th diagonal element of  $\Sigma$ .

### Modeling Short or Long Decay and Buildup Intensity: IRF

IRFs estimate the time-varying effects of service recovery strategies on customer satisfaction. The IRF figure results can visually present the time-varying dynamics and identify the long decay or short decay pattern, as well as the buildup of the effects toward the peak point. Based on the VAR model, IRF can estimate the dynamic responses of other endogenous variables to an unexpected shock in an endogenous variable in the system. For example, if communication-based service recovery efforts change one unit in a given week, how will customer satisfaction respond to this change over time? Suppose that the Equation 3 is a stationary VAR process, Wold Decomposition Theorem suggests that Equation 3 can be decomposed in a moving average way. Each endogenous variable is expressed as current and lagged linear combinations, and the process is as follows:

$$y_t - \sum_{j=1}^p \Phi_j y_{t-j} = \delta_0 + \delta_1 t + \varepsilon_t \quad (11)$$

$$(I - \Phi_1 L - \Phi_2 L^2 \dots - \Phi_p L^p) y_t = \delta_0 + \delta_1 t + \varepsilon_t \quad (12)$$

$$y_t = (I - \Phi_1 L - \Phi_2 L^2 - \dots - \Phi_p L^p)^{-1} (\delta_0 + \delta_1 t) + (I - \Phi_1 L - \Phi_2 L^2 - \dots - \Phi_p L^p)^{-1} \varepsilon_t. \quad (13)$$

If  $(I - \Phi_1 L - \Phi_2 L^2 - \dots - \Phi_p L^p)^{-1} = \Psi(L)$ , the Equation (13) becomes:

$$y_t = \Psi(L)(\delta_0 + \delta_1 t) + \Psi(L)\varepsilon_t = \Psi(L)(\delta_0 + \delta_1 t) + \varepsilon_t + \Psi_1 \varepsilon_{t-1} + \Psi_2 \varepsilon_{t-2} + \dots \quad (14)$$

Then, at the time  $t + s$ :

**Table 4.** VAR Model Comparisons with Different Lags.

Index	VAR(1)	VAR(2)	VAR(3)
HQC	-18.929	-18.141	-17.629
AIC	-19.389	-18.985	-18.857
SBC	-18.096	-16.590	-15.338

Note. AIC = Akaike Information Criterion; HQC = Hannan-Quinn Criterion; SBC = Schwarz Bayesian Criterion; VAR = Vector Autoregressive.

$$y_{t+s} = \Psi(L)(\delta_0 + \delta_1 t) + \varepsilon_{t+s} + \Psi_1 \varepsilon_{t+s-1} + \Psi_2 \varepsilon_{t+s-2} + \dots + \Psi_s \varepsilon_t + \Psi_{s+1} \varepsilon_{t-1} + \dots \quad (15)$$

From Equation 12, we can derive:

$$\frac{\partial y'_{t+s}}{\partial \varepsilon'_t} = \Psi_s = [\Psi_{ij}^{(s)}], \frac{\partial y'_{i,t+s}}{\partial \varepsilon'_{jt}} = \psi_{ij}^{(s)}, \psi_{ij}^a = \sum_{s=1}^T \psi_{ij}^{(s)}, \quad (16)$$

where  $\Psi_s$  is  $k \times k$  matrix with each element  $\psi_{ij}^{(s)}$ ,  $\psi_{ij}^{(s)}$  is IRF which represents the impact of the innovation of  $j$ th variable on the value of  $i$ th variable which lags  $s$  periods.  $\psi_{ij}^a$  represents accumulated impulse-response function (AIRF), or the total impact of  $j$ th variable's innovation on  $i$ th variable's value from Period 1 to Period  $T$ .

Based on IRF, we can analyze the decay shape and buildup patterns in the time-varying effects of recovery strategies on consumer satisfaction. Buildup means the increasing impact before  $\psi_{ij}^{(s)}$  reaches its peak impact point. The decay shape is determined by the length of the decay, or time periods with decreasing  $\psi_{ij}^{(s)}$  from the peak to zero (Bronnenberg et al. 2008; Pauwels and Hanssens 2007).

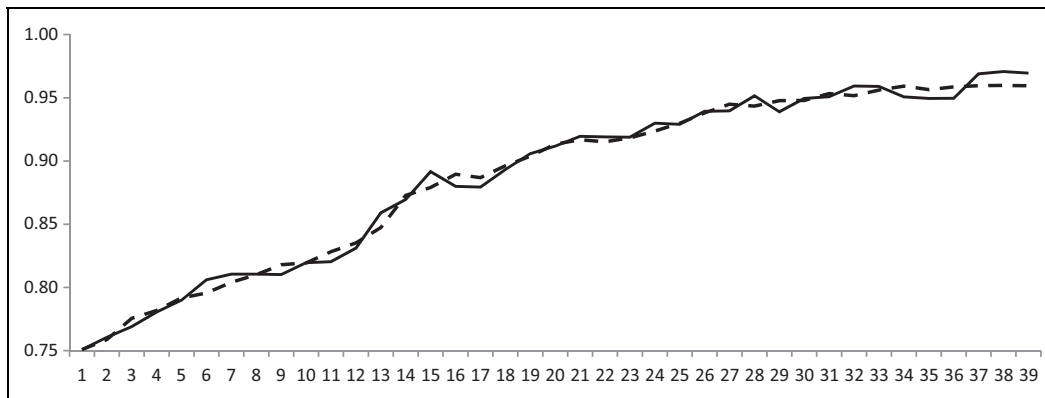
## Results

### VAR Model Results

We calculate three indices of goodness of fit to determine the optimal lag length of VAR model. As reported in Table 4, the statistics of Hannan-Quinn Criterion, Akaike Information Criterion, and Schwarz Bayesian Criterion suggest that VAR (1) model is optimal. Also, we tested various assumptions of the VAR residuals (multivariate normality, omission-of-variables bias, White heteroskedasticity tests, and Portmanteau autocorrelation). No violations of these assumptions are found at the 90% confidence level. On the basis of unit root tests of VAR (1) model, the moduli of Roots of AR Characteristic Polynomial of the model are less than 1, and all five characteristic roots fall within the unit circle, confirming the stationarity of VAR (1) process. The  $R^2$  results of the five endogenous variables are more than 80%, indicating that VAR (1) model fit the data reasonably well. Figure 1 presents the observed and fitted customer satisfaction. Again, the results support the fitness of the VAR (1) model for this data set.

### Results on Buildup and Decay

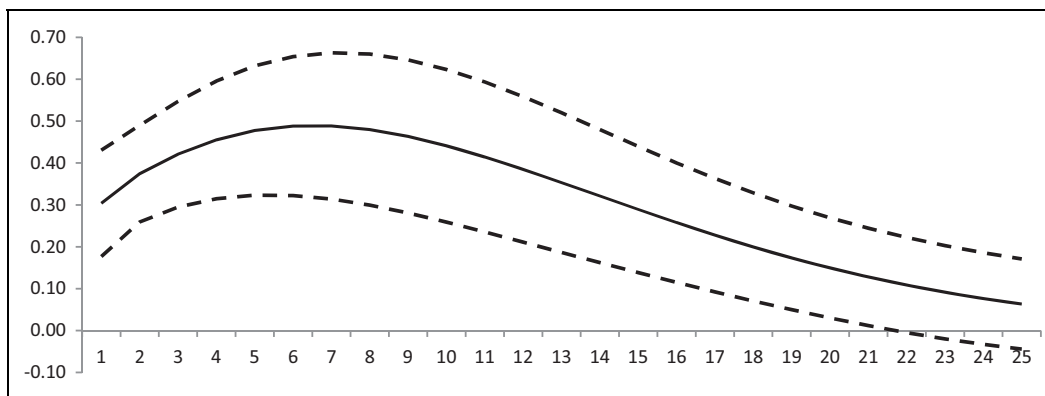
The time-varying effects of service recovery strategies on customer satisfaction as measured by IRFs are reported in



**Figure 1.** VAR results of the observed and fitted customer satisfaction series.  
 Note. Solid line is the observed customer satisfaction. Dashed line is the fitted customer satisfaction by the VAR model.

**Table 5.** Immediate and Cumulative Effects of Service Recovery on Customer Satisfaction.

	Immediate Effects				Cumulative Effects				Cumul./Immed.	Peak Impact
	Est	SD	t	p Value	Est	SD	t	p Value		
CS	.493	.108	4.570	< .001	2.196	.883	2.487	.017	4.454	.493*** (0.108)
QI	.304	.077	3.950	< .001	2.032	.925	2.197	.034	6.684	.489*** (0.106)
Compensation	.151	.048	3.180	.003	0.510	.240	2.125	.040	3.377	.181*** (0.053)
Apology	.058	.034	1.740	.092	0.058	.034	1.740	.092	1.000	.058* (0.034)
Communication	.113	.048	2.350	.025	0.399	.231	1.727	.089	3.531	.145*** (0.064)



**Figure 2.** Time-varying responses of customer satisfaction to quality improvement-based service recovery efforts.

Table 5. First, customer satisfaction has a significant carryover impact, not only for the immediate term ( $\psi_{11}^{(1)} = .493, p < .001$ ) but also the long term ( $\psi_{11}^a = 2.336, p = .094$ ). This means that the higher the previous period customer satisfaction, the easier it is to regain the lost ground of customer satisfaction. Second, the quality improvement-based service recovery strategy has immediate positive impact on customer satisfaction ( $\psi_{12}^{(1)} = .304, p < .001$ ), and the cumulative impact is also positive ( $\psi_{12}^a = 2.032, p = .034$ ). Third, compensation improves customer satisfaction for both the immediate term ( $\psi_{13}^{(1)} = .151, p = .003$ ) or cumulative terms ( $\psi_{13}^a = .510, p = .040$ ), with the cumulative effect as 3.777 times as immediate effect. Fourth,

apology has significant immediate impact on customer satisfaction ( $\psi_{14}^{(1)} = .058, p = .092$ ). But after the second week, there is no significant effect ( $\psi_{14}^a = \psi_{14}^a = .058$ ). The effects of apology on customer satisfaction drop to zero quickly, with minimum decay impact. Fifth, communications have significant positive immediate impact ( $\psi_{15}^{(1)} = .113, p = .025$ ) and cumulative effect ( $\psi_{15}^a = .399, p = .089$ ). Thus, communications tend to build intangibles with continuous impact on recovering the lost customer satisfaction.

The IRF responses of customer satisfaction to service recovery strategies are shown in Figures 2, 3, 4, and 5. In these figures, the horizontal axis represents time (in weeks), and the

**Table 6.** Buildup and Decay of the Dynamic Effects.

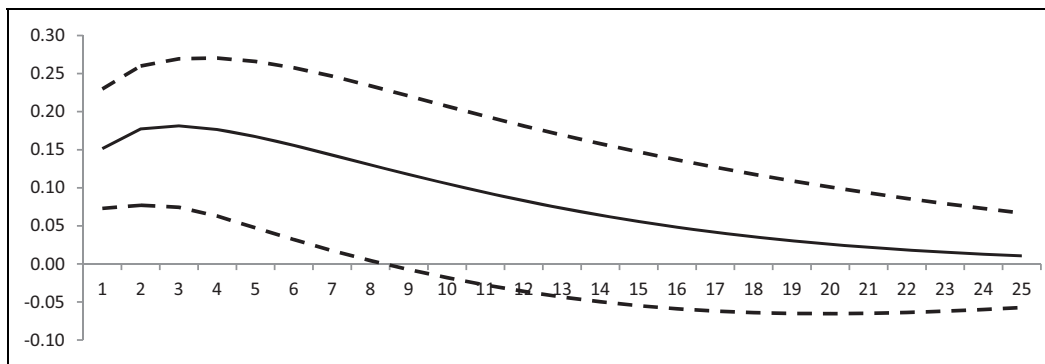
Week	QI		Compensation		Apology		Communications	
	Buildup	Decay	Buildup	Decay	Buildup	Decay	Buildup	Decay
Week	7	14	3	5	0	1	2	1

Note. QI = quality improvement. Entries are weeks.

**Table 7.** Buildup Intensity and Timing.

	Buildup Time (Week)	Buildup Intensity Peak Point	Relative Intensity
QI	7	0.489*** (0.106)	1.000
Compensation	3	0.181*** (0.053)	0.370
Apology	1	0.058* (0.034)	0.119
Communications	2	0.145** (0.064)	0.297
Hypothesis testing of relative intensity	$\beta_a - \beta_b$	0.1 level C.V.	Test Conclusion
QI > Compensation	0.308	0.197	Significant
QI > Communications	0.344	0.206	Significant
Compensation > Apology	0.123	0.105	Significant
Compensation > Communications	0.036	0.138	Insignificant
Communications > Apology	0.123	0.105	Significant

Note. Quality improvement (QI) is the baseline of relative magnitude calculation.



**Figure 3.** Time-varying responses of customer satisfaction to compensation-based service recovery efforts.

vertical axis reflects customer satisfaction responses. The solid line represents the impulse responses, and dashed lines indicate 90% confidence intervals. Figure 2 describes the time-varying impact of quality improvement on consumer satisfaction. The buildup period is from Weeks 1 to 7, with peak impact at the seventh week (also in Tables 6 and 7). The impact then gradually tapers off. The total decay periods have 14 weeks from Weeks 8 to 21, thus suggesting a rather long decay for the impact of quality improvement on consumer satisfaction.

However, for compensation’s impact on consumer satisfaction, the buildup period is from Weeks 1 to 3 with the peak at the third week. The decay period has totally 5 weeks (Weeks 4–8) before reaching zero, as shown in Figure 3. Regarding

the decay and buildup of apology, Figure 4 suggests that the impact of apology on customer satisfaction reaches peak point immediately and then drops to zero, showing the shortest decay. Figure 5 describes the time-varying impact of communications on customer satisfaction. The buildup period is the first 2 weeks before reaching the peak impact. The decay period lasts only 1 week.

Overall, these findings suggest that among the four service recovery strategies, the decay time of quality improvement’s impact is the longest. It is at least twice as long as that of compensation and communications. In contrast, the decay for apology is the shortest. The decay time of compensation and communication are in the middle. As such, the data provide some evidence supporting Hypothesis 1.

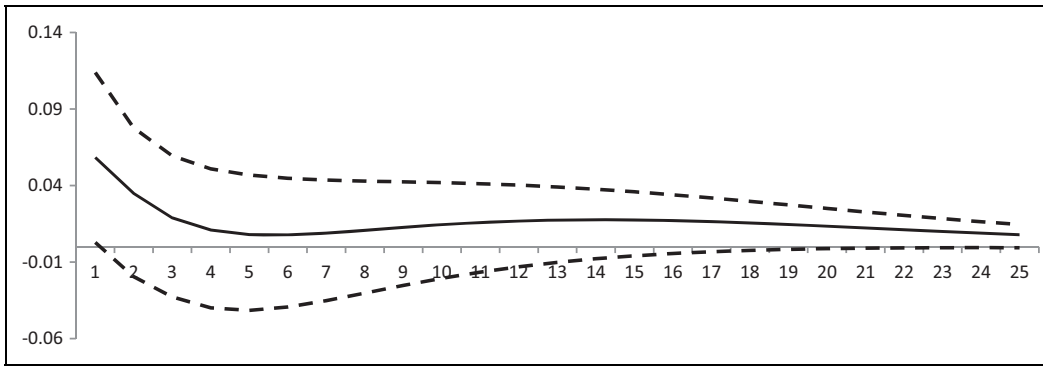


Figure 4. Time-varying responses of customer satisfaction to apology-based service recovery efforts.

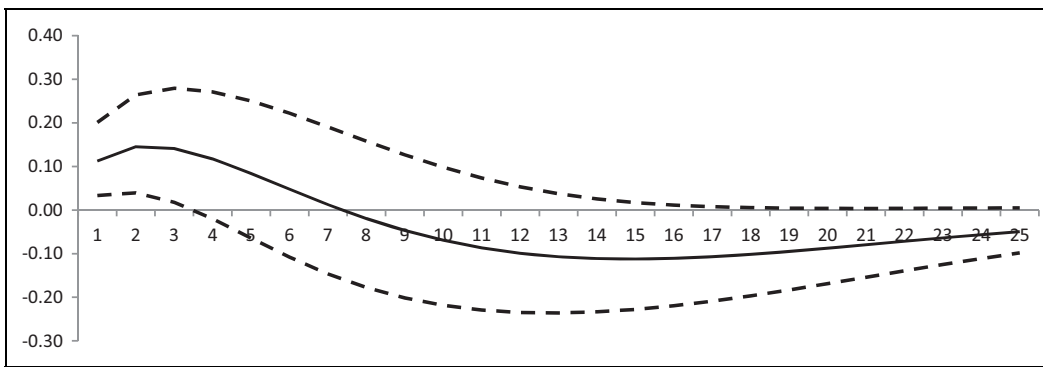


Figure 5. Time-varying responses of customer satisfaction to communications-based service recovery efforts.

Furthermore, regarding impact intensity, the data support that among the four service recovery strategies, quality improvement has the strongest impact (highest buildup), followed by compensation and communications. We also tested the significance of the relative effects and reported the results in Table 7. The peak impact of quality improvement is significantly bigger than that of compensation. Compensation’s peak impact is significantly larger than that of apology, but is not significantly larger than that of communications. The peak impact of communications is significantly larger than that of apology. Based on these results, the peak impact is ranked first for quality improvement, second for compensation and communications, and last for apology. Therefore, Hypothesis 2a is supported by the data. Nevertheless, quality improvement takes the longest time to reach the peak impact point (slowest buildup) compared to other service recovery efforts. In addition, apology has the least impact on consumer satisfaction. Interestingly, compensation tends to have a relatively higher buildup than communications, but the latter has a faster buildup than the former. As such, Hypotheses 2b and 2c are both only partially supported.

In summary, the results suggest that with the highest buildup and longest decay, quality improvement-based service recovery strategy is the most effective to regain customer satisfaction. Apology is the least effective, given the lowest buildup and shortest decay. The effectiveness of compensation and

communications is relatively stable over time, because they have relatively longer decay and higher buildup than apology.

### Managerial Implications for the Role of Service Recovery in Regaining Customer Satisfaction

#### Sources of Regained Customer Satisfaction

We also track the sources of customer satisfaction increases due to service recovery efforts for both short term ( $t = 2$ ) and long term ( $t = 39$ ). The results are calculated by AIRF coefficients and summarized as follows.

$$\begin{aligned} \Delta CS_{t=2} &= CS_2 - CS_1 = 76.05\% - 75.08\% = 0.97\% \quad (100\%) \\ &= \underbrace{0.68\%}_{(70.5\%)} + \underbrace{0.14\%}_{(14.3\%)} + \underbrace{0.07\%}_{(7.2\%)} + \underbrace{0.03\%}_{(2.7\%)} + \underbrace{0.05\%}_{(5.3\%)} \end{aligned} \quad (13)$$

impact of CS on itself    impact of QI on CS    impact of compensation on CS    impact of apology on CS    impact of communication on CS

$$\begin{aligned} \Delta CS_{t=39} &= CS_{39} - CS_1 = 96.95\% - 75.08\% = 21.87\% \quad (100\%) \\ &= \underbrace{9.24\%}_{(42.3\%)} + \underbrace{8.55\%}_{(39.1\%)} + \underbrace{2.16\%}_{(9.8\%)} + \underbrace{0.24\%}_{(1.1\%)} + \underbrace{1.68\%}_{(7.7\%)} \end{aligned} \quad (14)$$

impact of CS on itself    impact of QI on CS    impact of compensation on CS    impact of apology on CS    impact of communication on CS

**Table 8.** Required Service Recovery Money to Pull Back Customer Satisfaction from 75.08% to 95%.

		Strategy 1	Strategy 2	Strategy 3
Short term (1 week)	Compensation	726,704,624	—	181,676,156
	Communications	—	75,835,000	18,958,750
Long term (39 weeks)	Compensation	1,206,349,433	—	301,587,358
	Communications	—	98,520,710	24,630,178

Note. Entries are in RMB (\$1 = about 6.7RMB).

Equation 13 represents the decomposition of customer satisfaction increase from Week 1 to Week 2. Customer satisfaction increased from 75.08% to 76.05%. For this amount of customer satisfaction regained from Week 1 to Week 2 after the service failure, quality improvement contributes 14.3%, compensation contributes 7.2%, apology contributes 2.7%, and communications contribute 5.3%. Similarly, Equation 14 decomposes the sources of the customer satisfaction increases from 75.08% of Week 1 to 96.95% of Week 39. Among the total amount of customer satisfaction regained from Week 1 to Week 39 after the service failure, quality improvement contributes 39.1%, compensation contributes 9.8%, apology contributes 1.1%, and communications contribute 7.7%. These results suggest that managers can dynamically monitor the degree and timing of the success of using service recovery efforts to regain customer satisfaction.

### Required Service Recovery Efforts to Regain Customer Satisfaction to 95%

How much efforts would be made to regain customer satisfaction from the bottom 75.08% right after the service failure to the average 95.0% prior to the service failure? We can quantify how much money the company must spend in order to fully recover the customer satisfaction losses. Table 8 reports the simulation results regarding the required service recovery investment. If the CM company seeks to recover customer satisfaction to the 95% level in short term (just 1 week) with compensation-based service recovery efforts (Strategy 1) alone, the company should compensate a total amount of about 726.704 million Renminbi (RMB) (about 6.7 RMB = \$1), holding other things constant. Also, if using the communications strategy (Strategy 2) only, the company should spend 75.835 million RMB. Furthermore, if simultaneously introducing the four types of service recovery efforts (Strategy 3), the company only needs to compensate 181.676 million RMB and spend 18.959 million RMB investments in communications.

In addition, if the CM company decides to restore its customer satisfaction to the 95% level in *long* term (39 weeks), the amount of money spent would be dramatically larger. For example, if implementing the compensation strategy solely, it would compensate a total amount of about 1,206.349 million RMB. If adopting communications strategy only, it would spend 98.521 million RMB. Simultaneously introducing all

service recovery efforts, the company needs to compensate 301.587 million RMB and spend 24.630 million RMB in communications.

As such, these findings indicate that the earlier it takes recovery actions, the smaller the amount of money required for the company to reduce dissatisfaction. Conversely, the longer it takes for the firm to take recovery actions, the larger the amount of investment to regain customer satisfaction after service failures. *Response speed* significantly impacts customer satisfaction rescue (Smith, Bolton, and Wagner 1999). Therefore, our findings extend the literature on ROQ (Luo 2010; Rust, Zahorik, and Keiningham 1995) by quantifying how much money the company must spend in order to fully recover the customer satisfaction losses.

### Research Implications and Conclusions

This study quantifies the dynamic role of service recovery strategies for salvaging customer satisfaction after a major service failure. The developed time-series econometric models reveal some new and valuable insights of marketing dynamics (short decay vs. long decay, buildup intensity, and peak impact timing). Previous studies indicate that it is challenging to estimate the dynamics of service recovery with experiments or surveys (Bitner 1990; Smith and Bolton 2002; Wirtz and Mattila 2004). Yet, yielding to this challenge by focusing solely on the cross-sectional value would seriously underestimate and even misestimate the power of service recovery strategies that may unfold in a time-series sequence and taper off gradually. To our knowledge, this is the first study to model and compare the time series impact of service recovery efforts, thus cultivating a more exciting theory of the nuanced dynamic effects of service recovery.

Apology-based recovery efforts have only weak impact. Traditionally, apology is viewed as a valuable reward that redistributes esteem (Hatfield, Walster, and Berscheid 1978) and is proved to boost customer satisfaction after service failures (Goodwin and Ross 1992; Smith, Bolton, and Wagner 1999). However, this study finds that although apology positively impacts customer satisfaction, it has the shortest decay and the smallest buildup peak impact. In other words, its impact magnitude is the smallest, and endurance time is the shortest among the service recovery strategies. Therefore, complementing the social exchange and justice theories (Bies and Moag

1986; Orsingher, Valentini, and de Angelis 2010; Vázquez Casielles, Suárez Álvarez, and Díaz Martín 2010), our findings add a dynamic view in providing more precise and systematic understanding of apology's impact on customer evaluations.

Our empirical research reveals that compensation has the second longest decay and that the buildup peak impact is significantly bigger than that of apology. Compensation is critical to recover service failures because it will strongly impact distributive justice, which, in turn, boosts customer satisfaction (Blodgett and Jeffrey 1997; Luo, Hsu, and Liu 2008; Wirtz and Mattila 2004). Our findings imply that although compensation costs the company money, it is worthwhile because the accumulation of persistent effects on customer satisfaction gains would be substantial over time.

Moreover, the impact of quality improvement has the longest decay and the biggest magnitude, though with the slowest buildup toward the peak impact point. Although a large amount of prior studies recognized the overwhelming role of quality improvement (Hart, Heskett, and Sasser 1990; Tax, Brown, and Chandrashekar 1998), we still do not know to what extent and in which way it outperforms other recovery strategies. Based on the AIM theory (Forgas 1995) and Homburg, Koschate, and Hoyer (2006) findings, our study tackles this puzzle by finding that quality improvement persists at least twice as long as other service recovery strategies and has the highest buildup peak value. We are among the first to show that using service quality improvement to recover customer satisfaction takes the longest time before the peak value impact is reached. Thus, these findings extend the services marketing literature with a more balanced view. That is, although quality improvement is the most important strategy as time unfolds; its highest potential in salvaging customer satisfaction arrives the slowest, when compared to compensation, apology, and communications after the service failures.

We find that the dynamic effects of communications on customer satisfaction build up the quickest, though with mild endurance and magnitude. In the context of service failure, communications are widely argued to enhance customer satisfaction by boosting trust and commitment (Berry 1995; Luo and Donthu 2006; Moorman, Deshpande, and Zaltman 1993; Vázquez Casielles, Suárez Álvarez, and Díaz Martín 2010). Yet, dynamic patterns of the impact of communications, especially compared with other recovery strategies, are relatively under-addressed. Our study finds that the time-varying impact of communications builds up quickly to its peak value and decays quickly as well, with mild impact intensity between that of quality improvement and apology. In other words, the effects of communications on customer satisfaction could be evoked rather rapidly but fail to last for a long time, thus contributing more nuanced knowledge of communications' dynamic impact to the literature in a service failure context (Smith, Bolton, and Wagner 1999).

This study also extends the research on sources of customer satisfaction. Many studies have discussed various consequences of customer satisfaction in terms of willingness to pay, brand attitude, loyalty, word of mouth, repurchase, and stock

prices (see a comprehensive review in Luo and Homburg (2007)). Compared with this stream of research, we know less about the drivers, especially the time-varying pattern of these drivers' impacts on customer satisfaction. Our findings may enable managers to dynamically monitor what percentages of customer satisfaction gains are originated from which types of service rescue efforts after a major service breakdown. The monetary investment required by regaining customer satisfaction to the level prior to service failures can be staggering, as high as over one billion RMB if relying on compensation alone.

In conclusion, this study examines (1) whether the time-varying effects of service recovery on customer satisfaction may follow a short or long decay and (2) why and which service recovery efforts have a higher and quicker buildup with respect to the significance and timing of recouping customer satisfaction losses due to service failures. Though limited by the time-series archival data from only one company, our findings extend the marketing dynamics literature in the context of service recovery. We hope future research can employ the time-series models to quantify the dynamic impact of service recovery and long-run marketing effects.

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### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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### Note

1. Most prior literature is essentially atomistic, as recovery activity has been framed in terms of a customer, a service failure event, a service agent, and a recovery effort. In contrast, this paper uses the unique context of service failure (dropped-call rate) due to the unexpected earthquake shock. More than a million customers are polled every week for 39 weeks after the earthquake to assess the dynamic effects of service recovery efforts.

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