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An investigation of the effects of product recalls on brand commitment and purchase intention

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Abstract

Purpose – The purpose of this study is to examine how product recalls affect brand commitment and post-recall purchase intention.

Design/methodology/approach – The role of consumer and product recall characteristics based on attribution theory is tested using data collected through experiments and analyzed using a type of finite mixture model.

Findings – Results indicate varying effects of product recalls on commitment across these four customer groups and a strong effect of affective commitment on post-recall purchase behavior.

Originality/value – This paper proposes four types of consumers based on dichotomous levels of affective and calculative commitment, namely, Hard Cores, Don't-Cares, Lovers and Rationalists, and shows how product recalls affect these consumer groups differently, and how this information assists brand managers in developing post-product recall consumer management strategies.

Keywords Affective commitment, Attribution theory, Calculative commitment, Finite mixture models, Product recalls, Purchase intention

Paper type Research paper

An executive summary for managers and executive readers can be found at the end of this issue.

Introduction

With increasing product recall events in the marketplace (e.g. Westland recall of 143 million pounds of beef in 2008; General Motors recalled 8.45 million cars in 2014), perhaps the most important managerial question in product recall situations is, “How do we overcome the negative effects of a product recall event?” Extant marketing literature on product recalls is rich, and mostly focuses on the negative outcomes of product recalls (e.g. Mowen, 1980; Cleeren *et al.*, 2013). In particular, the findings suggest that a product recall hurts brand equity (Dawar and Pillutla, 2000; Korkofingas and Ang, 2011), damages company image and reputation (Souiden and Pons, 2009) and deteriorates shareholder returns and market share (Thirumalai and Sinha, 2011). The negative effects, however, differ across consumers based on their level of brand commitment (Ahluwalia, 2001). High brand commitment reduces the negative effects of product recalls, as consumers who are committed to a brand tend to resist or discount the brand’s negative publicity (Ahluwalia *et al.*, 2000; Pullig *et al.*, 2006). While these studies focus on

the moderating role of brand commitment in the event of product recalls, the literature is limited on how a product recall itself affects brand commitment. Therefore, the current study examines the effects of product recalls on brand commitment and then revisits the role of brand commitment on post-recall consumer behavior.

Consumer brand commitment is defined as emotional or psychological attachment to a brand (Beatty *et al.*, 1988). It is regarded as a belief in an ongoing relationship that is worthy of investing maximum effort to maintain (Morgan and Hunt, 1994). Such importance makes commitment not only the key element to predict brand–consumer relationship stability (Breivik and Thorbjørnsen, 2008) but also a driver of consumer loyalty and repeated purchases (Amine, 1998). Commitment also plays an important role during negative publicity. In particular, highly committed consumers tend to protect the brand from negativity (Pullig *et al.*, 2006), and are less sensitive to negative information about the brand they like as compared to low-committed consumers (Ahluwalia *et al.*, 2000; Ahluwalia, 2001). In other words, high commitment plays a role in restricting negativity from affecting the preferred brand. Thus, the implication of commitment on consumer retention is significant, especially under negative publicity such as a product recall.

Commitment is categorized into two types, namely, affective and calculative commitment. Calculative commitment is a “colder, more rational and economic-based dependence on

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product benefits due to a lack of choice or switching costs” (Gustafsson *et al.*, 2005), while affective commitment is a:

[. . .] hotter, or more emotional factor that develops through the degree of reciprocity or personal involvement that a customer has with a company, which results in a higher level of trust and commitment (Gustafsson *et al.*, 2005).

Therefore, the research questions investigated in this paper are: How does a product recall influence these two different types of commitment? Does it have the same effect on both types of commitment? If not, what drives the differences among them?

This paper first introduces four consumer categories based on combinations of two levels of affective and calculative brand commitment, and shows how product recalls have varying effects on their commitment levels and post-recall purchase intentions. These four consumer groups include:

- 1 *Hard Cores*, who have high affective commitment and high calculative commitment.
- 2 *Don't-Cares*, who have low affective and low calculative commitment.
- 3 *Lovers*, who have high affective commitment but low calculative commitment.
- 4 *Rationalists*, who have high calculative commitment but low affective commitment.

Next, drawing on attribution theory that explains causal influences on consumer responses to an event (Folkes, 1984), the study proposes that these four consumer groups will respond differently to a product recall depending on internal and external attributions, including internal consumer characteristics (e.g. brand trust, risk perception and thinking style) and external recall factors (e.g. recall responsibility, seriousness of the recall and core product recall).

The paper investigates the research questions through a two-stage experiment: first, it measures consumers' levels of brand commitment and categorize them into the four groups, and second, it examines how brand commitment changes in these consumer groups after a product recall event. The data were analyzed using a finite mixture model (Wedel and Kamakura, 2001; Leisch, 2004), which has the ability to control for any random and systematic errors in our study. The results indicate varying patterns of recall effects on commitment across the four customer groups, with a strong role of affective commitment on consumers' post-recall purchase intent.

The contribution of the paper is as follows: this study advances the literature on the effects of product recalls on consumer commitment and behavior. In particular, it introduces four groups of consumers based on their affective and calculative commitment levels, and examines how differently the four groups respond to a product recall, depending on dispositional (e.g. consumer characteristics) and situational (e.g. product recall attributes) inferences. Second, we also introduce a new approach, i.e. a finite mixture model, to analyze experiment data to the marketing literature, which is capable of controlling for random and systematic errors in the study. The rest of the paper is organized as follows. The second section introduces the four types of consumers and discusses the related hypotheses. The third section presents the method used to examine the hypotheses, followed by results and discussions. Finally, theoretical and practical implications are presented based on the findings.

Hypotheses development

Commitment-based customer categorization

We suggest that consumer response to a product recall will vary depending on a relative portion of affective and calculative commitment that an individual consumer exhibits toward a particular brand. To investigate this further, the study categorizes consumers into four groups based on their levels of these two commitments, namely, *Hard Cores*, *Don't-Cares*, *Lovers* and *Rationalists* (see Figure 1).

Hard Cores

Hard Cores is defined as consumers who display a high degree of both affective and calculative commitment for the brand. They are typically brand loyal and share common values with the brand they like, while their choices are influenced by rational behavior such as switching costs, economic benefit and the number of available choices (Amine, 1998; Gustafsson *et al.*, 2005; Gounaris, 2005). Because of a high level of affective commitment, the negative effects of recall events will be minimal and insufficient to break the customers' strong bond with the recalled brand (Ahluwalia *et al.*, 2000; Ahluwalia, 2001; Pullig *et al.*, 2006). Thus, these consumers will not experience a significant decrease in affective commitment after a product recall. However, calculative commitment will decrease as consumers will rationally detach themselves from the recalled brand due to the perceive risk of using it (Gustafsson *et al.*, 2005). A product recall may create a fear of quality lapse, and thus may lead to consumers' rational decision of distancing from the product. Thus, calculative commitment of these consumers will reduce after a product recall. Therefore:

H1a. Affective commitment of *Hard Cores* will not change after a product recall.

H1b. Calculative commitment of *Hard Cores* will decrease after a product recall.

Figure 1 Commitment changes in four commitment groups after a product recall

		AFFECTIVE COMMITMENT	
		High	Low
CALCULATIVE COMMITMENT	High	<p><i>Hard Cores</i></p> <p><i>H1a:</i> No change in affective commitment</p> <p><i>H1b:</i> Decrease in calculative commitment</p>	<p><i>Rationalists</i></p> <p><i>H4a:</i> Decrease in affective commitment</p> <p><i>H4b:</i> Decrease in calculative commitment</p>
	Low	<p><i>Lovers</i></p> <p><i>H3a:</i> No change in affective commitment</p> <p><i>H3b:</i> Decrease in calculative commitment</p>	<p><i>Don't-Cares</i></p> <p><i>H2a:</i> Decrease in affective commitment</p> <p><i>H2b:</i> Decrease in calculative commitment</p>

Don't-cares

Don't-Cares customer group is characteristically opposite to *Hard Cores*. They are not brand loyal consumers as they do not have any emotional attachment to the brand. Given that consumers in this category have little psychological attachment with the brand, both in terms of affective and calculative commitment, the negativity of product recalls will easily damage any positive relationship that consumers may have with the brand. Although *Don't Cares* exhibit low commitment to a brand, low-committed consumers or consumers who are uncertain about their brand attitudes respond to negative information more negatively than high-committed consumers (Ahluwalia *et al.*, 2000; Pullig *et al.*, 2006). Thus:

H2a. Affective commitment of *Don't-Cares* will decrease after a product recall.

H2b. Calculative commitment of *Don't-Cares* will decrease after a product recall.

Lovers

Lovers are defined as those who have high affective commitment but low calculative commitment. For example, nostalgic consumers, who bond with a brand through cognitive memories and affective experiences (Holbrook and Schindler, 2003), belong to this category. They are affectively committed to a brand, regardless of switching costs or utility-based decisions. Given their strong level of affective commitment, negativity will have limited effects and that their high affective commitment will shield the brand undergoing a product recall, and thus will remain unaffected. On the other hand, these consumers, like *Don't Cares*, possess a weak calculative commitment that will be negatively influenced by a product recall. Therefore:

H3a. Affective commitment of *Lovers* will not change after a product recall.

H3b. Calculative commitment of *Lovers* will decrease after a product recall.

Rationalists

Rationalists is defined as consumers who are economically committed to a brand. In other words, they are so-called "rational" consumers who seek a brand that provides the most utility among others. In particular, they are influenced by product benefits, termination costs and switching costs associated with leaving the relationship (Gounaris, 2005; Gustafsson *et al.*, 2005). Like *Hard Cores*, their calculative commitment will decrease due to the fear of quality lapse of the recalled product. Meanwhile, their affective commitment will decrease as low-committed consumers respond more negatively to a product recall. Thus:

H4a. Affective commitment of *Rationalists* will decrease after a product recall.

H4b. Calculative commitment of *Rationalists* will decrease after a product recall.

Effects of internal and external attributions on post-recall purchase

The different responses to product recall events by brand commitment can be explained by various influential factors. Attribute theory suggest that consumers respond to a certain event based on their causal influence, either dispositional (internal factors, e.g. personal factor) or situational (external factors, e.g. non-personal) (Folkes, 1984; Zhou and Whitla, 2013). Relating this to the current study, consumers' response to a product recall event is based on two types of influential factors, internal personal factors (e.g. consumer characteristics, including trust, risk perception and thinking style) and external situational factors (e.g. recall responsibility, seriousness of the recall and core product recall).

Internal factors: consumer characteristics

Three individual consumer characteristics are considered to influence post-recall consumer behavior. They include brand trust, risk aversion and holistic thinking style. Trust plays a significant role on the level of consumer commitment toward parties, brands or companies (Moorman *et al.*, 1992; Morgan and Hunt, 1994). Prior studies suggest that high trust leads to high brand loyalty (Morgan and Hunt, 1994; Gustafsson *et al.*, 2005; Gounaris, 2005) and also positively influences the purchase behavior of consumers, such as repeated purchases, recommendations or price insensitivity (Musa *et al.*, 2005). As a product recall damages the brand trust, such reduction in trust will cause negative changes to brand commitment and purchase intention after a product recall. For example, Souiden and Pons (2009) show that a strong brand has more critical damages to consumers' loyalty and purchase intention after a product recall because consumers are more disappointed with a strong brand than a weak one. Likewise, consumers with higher trust will experience greater reduction in their commitment levels and their post-recall purchase intention. Thus:

H5. Brand trust will negatively influence a) affective commitment, b) calculative commitment and c) purchase intention after a product recall.

Product recalls lead to two types of risks; a risk directly associated with the product recall, which is often life-threatening, and a risk in trying out different brands and products instead of a recalled one to avoid the product recall risk. Consumers with higher risk aversion tend to avoid risky purchase decisions (Mandel, 2003). A serious recall significantly reduces the purchase intention of a recalled brand (Souiden and Pons, 2009; Korkofingas and Ang, 2011). However, risk-averse consumers refrain from trying new products and brands as well (Matzler *et al.*, 2008). In such cases, the consumers will maintain their commitment levels. It is postulated that as long as the product recall is voluntarily conducted and alternatives are provided by the same brand, risk-averse consumers will stay with the brand after a product recall. Therefore:

H6. Risk aversion will positively influence a) affective commitment and b) calculative commitment, but negatively influence c) purchase intention after a product recall.

The thinking style of a consumer influences the way in which consumers interpret the negative information (Monga and John, 2008; Ein-gar *et al.*, 2012). For example, holistic thinkers tend to pay attention to the whole information presented to them, and process the information quickly and effortlessly (Maheswaran and Chaiken, 1991; Chaiken and Maheswaran, 1994). These consumers rather have positive effects from negative information when the negative information is added to positive description (Ein-gar *et al.*, 2012). Therefore, they are less influenced by external attributions of a product recall because they pay less attention to specific information that follows the voluntary recall announcement. Then, the fact that the product is voluntarily recalled will lead to positive reactions to a product recall. Thus:

H7. Holistic thinking will positively influence a) affective commitment, b) calculative commitment and c) purchase intention.

External factors: product recall characteristics

Based on prior literature, the study identifies three characteristics of product recalls that will generate differing changes among consumers' affective and calculative commitment, and their post-recall purchase intention. These factors are responsibility of the recall, seriousness of the recall and whether the recalled product is a core product of the brand.

The extent of the negative effects of product recalls depends on who bears the burden of the blame. Often, product recalls are perceived as a violation of corporate responsibility (Klein and Dawar, 2004; De Matos and Rossi, 2007; Vassilikopoulou *et al.*, 2009). However, if the recalled brand is not responsible for the recall, but one of its suppliers is to blame, the brand may face less negativity from the consumers. On the other hand, when the blame for the product recall falls directly on the affected brand, consumers affective and calculative commitment will be damaged, along with their post-recall purchase intention. Therefore:

H8. The origin of responsibility on a favored brand will negatively influence a) affective commitment, b) calculative commitment and c) purchase intention.

Extant literature shows that a serious recall hurts the brand equity and purchase intention of a recalled brand (Souiden and Pons, 2009; Korkofingas and Ang, 2011). Such a serious problem is directly related to risk perception and, therefore, it damages consumer trust (Dawar and Pillutla, 2000). On the other hand, if the recall cause is not considered a serious one, such as a recall due to labeling error, consumers will be more likely to continue showing a high level of commitment and purchase intention. Thus:

H9. The seriousness of a product recall will negatively influence a) affective commitment, b) calculative commitment and c) purchase intention.

Core product recalls refer to cases when a core product of the brand is recalled. Because the quality of a core product represents the brand reputation (Laufer and Coombs, 2006), any negative information associated with it will disappoint

committed consumers. Thus, when a product recall happens to a core product, the damage to the brand reputation will be greater than when a product recall occurs to a non-core product. The damage to the quality of a core product and brand reputation hurts commitment and purchase intention after a product recall. Thus:

H10. Product recalls of core products will negatively influence a) affective commitment, b) calculative commitment and c) purchase intention.

Methodology

Data

For the purpose of the study, a scenario-based experiment was conducted in a 2 (problem severity: serious vs minor issue) × 2 (core product recalls: core vs non-core product) × 2 (origin of responsibility: recalled brand's vs supplier's fault) between-subjects mixed factorial design. With a pre- and post-test, the changes in consumer commitment and purchase intention are measured within subjects before and after a product recall. Meanwhile, the between-subjects experiment in the post-test provides insights on how characteristics of consumers and product recalls influence the change in commitment and purchase intention for the four groups of consumers.

Research design

Preliminary procedures

To select a brand to use, the study followed the procedures suggested by Ahluwalia *et al.* (2000). With a survey on the most favorable brands, two brands, *Starbucks* and *Nike*, were selected based on the ranking and the high variability in brand commitment among the respondents. The main study used *Starbucks*, while a replication study was conducted with *Nike*.

Pre-test

A manipulation check with 49 undergraduate students confirmed that all manipulations worked effectively with significant mean differences between the two scenarios in each manipulation ($t = -12.48, p < 0.0001$ for severity, $t = -2.78, p < 0.01$ for core product, and $t = -5.64, p < 0.0001$ for responsibility). Reliability of measurements were successfully checked as being above 0.75 with a pilot study where 123 undergraduate students participated (> 0.75). Significant mean differences were observed before and after a recall in affective commitment, ($t = 2.76, p < 0.01$) calculative commitment ($t = -1.86, p < 0.1$) and purchase intention ($t = 3.95, p < 0.0001$).

Main study

The main study was conducted in two stages, which are pre- and post-recall tests. In the pre-recall test, 312 undergraduate students participated for extra credit. Student subjects were used for this study because *Starbucks* was used, for which they are considered as target customers of the brand (Farrell, 2013). To determine commitment differences before and after a product recall, the respondents' current affective and calculative commitment to and purchase intention toward *Starbucks* were measured without any information about a product recall. Their individual characteristics as internal attributions were also measured to reduce the order effect.

After a week, a post-recall experiment was conducted for the same sample. They were asked to read one of the eight manipulated product recall notices listed by the Food and Drug Administration, and answer the questions about their commitments and purchase intentions, which were same with the pre-recall test, to observe the changes in commitment and purchase intention. For the post-recall test, 272 participants remained in the study (female 48.5 per cent). Among them, only 19 participants had a negative experience related to a product recall, such as accidents and health problems. The respondents' frequency of visits to *Starbucks* is in the average range (3.36 of 7). Most of them perceived *Starbucks* as a superior brand (mean = 5.14/7, $\sigma = 1.08$) and knew about *Starbucks* products relatively well (mean = 4.65/7, $\sigma = 1.75$). The mean of the affective commitment in the pre-recall stage was 3.39 ($\sigma = 1.23$); that of calculative commitment was 2.99 ($\sigma = 1.57$). This mean split is used for identifying four commitment groups later in the analysis.

Measurement

Dependent variables

The dependent variables of this study are the changes in affective commitment (ΔAC), calculative commitment (ΔCC) and purchase intention (ΔPUR) after product recalls. The paper adopts and modifies scales used by Gustafsson *et al.*, (2005) for affective commitment and the scale used by Gounaris (2005) for calculative commitment. Purchase intention is measured based on the study by Baker and Churchill (1977). All scales are measured in 7-point Likert scale (1 = Strongly Disagree, and 7 = Strongly Agree). Reliabilities are high enough for the study ($\alpha = 0.88, 0.82$ and 0.80 , respectively) (see Appendix 1). The changes in these variables are calculated as a difference between pre-recall and post-recall scores. Although the dependent variable is a "change in commitment and purchase intention", the paper does control for pre-recall level in our analysis to remove any bias of using difference scores (Peter *et al.*, 1993).

Internal and external attributions

As internal attributions, individual characteristics including trust with the recalled brand (TRUST) (Chaudhuri and Holbrook, 2001) ($\alpha = 0.86$), risk averseness (RISK) (Burton *et al.*, 1998) ($\alpha = 0.77$) and analytic-holistic thinking style (HOLI) (Ein-Gar *et al.*, 2012) ($\alpha = 0.75$) were measured in 7-point Likert scale in the pre-recall study. External attributions, including the origin of responsibility (R), problem severity (S) and core product recalls (C) were manipulated in the scenario and coded as binary variables (0 = No/1 = Yes).

Control variables

Control variables in this study include brand superiority (SUP) (Chaiken and Maheswaran, 1994) ($\alpha = 0.75$), believability of announced information (INFO) (Gtirhan-Canh and Maheswaran, 2000); consumer knowledge on products of the recalled brand (KNOW) (mean = 4.6/7); frequency of the brand usage (FRQ) (mean = 3.36/7); negative emotional response to the recall announcement (AFF) (Price *et al.*, 1995) ($\alpha = 0.89$); consumers' recall experience (EXP) (0 = No/1 = Yes); and gender (0 = Male/1 = Female). Brand superiority,

information believability and negative affective response were measured in 7-point Likert scales.

Model development

Apart from investigating how affective and calculative commitments change after a product recall, the study also examines how these changes are affected by consumers' individual characteristics and product recall characteristics. Although diligence was followed during the experiment, there was the possibility of a certain level of both systematic and random errors in the study. To control for these errors, a finite mixture model is used, which is a traditional latent class regression approach, to analyze the data instead of a traditional analysis of variance[1]. Using a finite mixture model is useful in two ways. First, the finite mixture modeling approach controls for unobserved heterogeneity in the sample, which is a typical issue with experiments (Hutchinson *et al.*, 2000). Second, the model includes latent variables to control for any unobserved variables due to random and systematic errors that may impact the estimates, thus resulting in robust estimates. The general commitment change model for respondent i considered in the study:

$$\begin{aligned} (\text{Commitment Change})_i = & \sum_p A_p (\text{Internal Attributions})_{pi} \\ & + \sum_q B_q (\text{External Attributions})_{qi} \\ & + \sum_r C_r (\text{Control Variables})_{ri} + \varepsilon_i \end{aligned} \quad (1)$$

where p is the number of internal attributions (e.g. individual respondent's characteristics), q is the total number of external attributions (e.g. recall characteristics) and their interactions, and r is the number of control variable. We estimate the above model as a finite mixture model (Leisch, 2004) by using FlexMix library in R. Please see Leisch (2004) for more information on the estimation and computation process.

Results

Changes in four commitment consumer groups

The four types of consumers were determined using median split for both affective (AC) and calculative commitment (CC) (median = 3.3 for change in AC, and median = 3.0 for change in CC at the pre-recall stage). Next, the changes in the two types of commitment were compared after a product recall using paired t -tests to test $H1$ to $H4$ across four commitment groups. The results are illustrated in Table I, Figures 2–4 for changes in affective, calculative commitment and purchase intention, respectively.

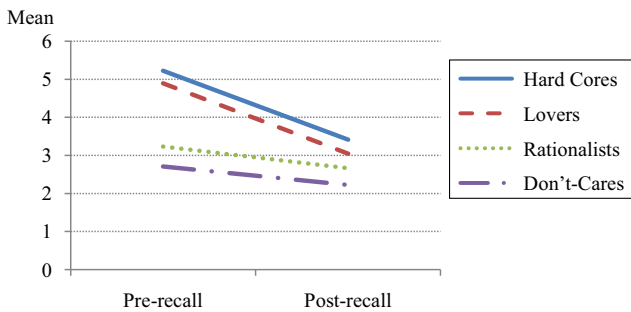
The paired t -tests show significant changes in affective and calculative commitment after a product recall. Without consideration of groups, only AC significantly decrease ($t = -11.14$, $p < 0.0001$) after the recall. However, when the changes in commitment levels are examined across the four groups, the results vary. With respect to affective commitment, all groups except *Lovers* experienced a decrease of AC after a product recall (see Figure 2). Thus, $H2a$, $H3a$

Table I Post-recall changes across four commitment groups

Study	Variables	Total (t-value)	Hard Cores (t-value)	Lovers (t-value)	Rationalists (t-value)	Don't-Cares (t-value)
Study 1: Starbucks	AC	-11.14***	-4.39***	-1.01	-9.31***	-10.10***
	CC	1.77***	3.64***	-2.33*	5.48***	-2.63***
	PUR	-1.46	1.46	-1.39	0.13	-2.90***
Study 2: Nike	AC	-1.51	1.92*	0.49	-3.10**	-3.66***
	CC	-4.55***	-0.69	-4.26***	-0.74	-3.75***
	PUR	-0.50	0.71	0.30	-0.24	1.46

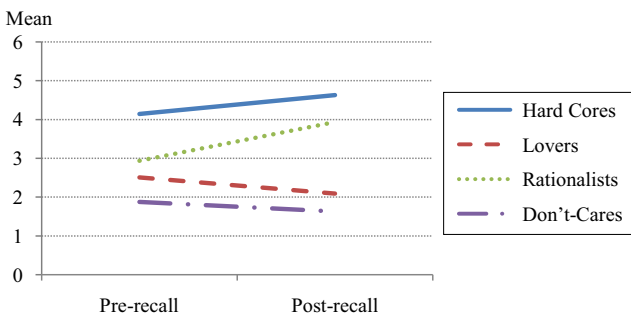
Notes: **** $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.0001$; AC = affective commitment; CC = calculative commitment; PUR = purchase intention

Figure 2 Change in affective commitment



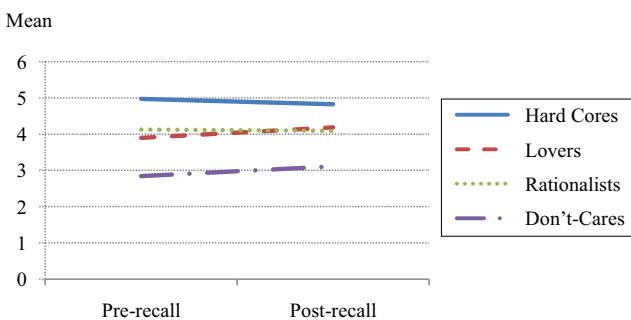
Note: The change in *Lovers* is not statistically significant

Figure 3 Change in calculative commitment



Note: All changes are statistically significant

Figure 4 Change in purchase intention



Note: Only the change in *Don't-Cares* is statistically significant

and *H4a* are supported. Interestingly, and as opposite to the *H1a*, *Hard Cores* experienced a more significant decrease of AC than any other groups. In calculative commitment, *Lovers* ($t = -2.33, p < 0.05$) and *Don't-Cares* ($t = -2.63, p < 0.01$)

have significantly lower CC values after the product recall. Meanwhile, *Hard Cores* ($t = 3.64, p < 0.01$) and *Rationalists* ($t = 5.48, p < 0.0001$) have a significantly higher CC after the event. Thus, the results support *H2b*, *H3b* and *H4b* for CC. For purchase intention, only *Don't-Cares* showed a significant decrease after a product recall ($t = -2.9, p < 0.0001$).

Effects of consumer and product recall characteristics

Affective commitment

A finite mixture model is used to determine how internal and external factors influence commitment and purchase intention. For affective commitment (Table II), the internal attributions such as trust had positive effects on ΔAC among *Hard Cores* ($\beta = 0.305$, standard error = 0.132) and negative effects on *Rationalist* ($\beta = -0.245$, standard error = 0.145), partially supporting *H5a*. Risk aversion drives positive changes in AC among *Lovers*' ($\beta = 0.313$, standard error = 0.117) and *Rationalists* ($\beta = 0.182$, standard error = 0.108). Holistic thinking style had no effect on AC changes, thus not supporting *H7a*. Among external attributions, only *Lovers* are significantly affected by the three variables, including the origin of responsibility ($\beta = 2.214$, standard error = 0.652), problem severity ($\beta = 1.452$, standard error = 0.734) and core product recalls ($\beta = 2.469$, standard error = 0.678). As opposed to the *H8*, *H9a* and *H10*, *Lovers* exhibit positive changes in AC toward external attribution. However, their AC significantly decreased by interactions between R and S and between R and C ($\beta = -1.656$, standard error = 0.631) for R and S; and ($\beta = -2.085$, standard error = 0.662) for R and C. The result implies that *Lovers* are more prone to be influenced when a life-threatening product recall happens of the brand they like, or when its core product is recalled. Finally, with respect to control variables, *Rationalists*' AC changes were positively influenced by EXP ($\beta = 0.848$, standard error = 0.24), KNOW ($\beta = 0.267$, standard error = 0.086), and negatively by gender ($\beta = -0.553$, standard error = 0.249). This result reflects the characteristics of *Rationalists* in relying on information sources for a decision-making. *Hard Cores* also exhibit the effect of KNOW on calculative commitment ($\beta = 0.19$, standard error = 0.081).

Calculative commitment

Among internal attributions, for calculative commitment (Table III), trust had negative effects on ΔCC among *Rationalists* ($\beta = -0.243$, standard error = 0.144), *Rationalists* ($\beta = -0.761$, standard error = 0.148) and *Don't-Cares* ($\beta = -0.161$, standard error = 0.093). Risk aversion positively influenced ΔCC of *Rationalists* ($\beta = 0.579$, standard error =

Table II Effects on affective commitment changes by group

Covariates	Hard Cores estimate (SE)	Don't-Cares estimate (SE)	Lovers estimate (SE)	Rationalists estimate (SE)
(Intercept)	-0.179 (1.023)	1.335 (0.935)	-3.059 (1.692)****	-3.594 (1.219)**
ACpre	-0.552 (0.146)***	-0.411 (0.127)**	-0.845 (0.326)**	0.015 (0.191)
CCpre	0.168 (0.112)	0.221 (0.118)****	-0.316 (0.257)	0.338 (0.168)*
PURpre	0.051 (0.118)	-0.004 (0.094)	0.750 (0.160)***	0.201 (0.124)
TRUST	0.305 (0.132)*	0.000 (0.096)	-0.129 (0.226)	-0.245 (0.145)****
RISK	-0.041 (0.078)	-0.021 (0.068)	0.313 (0.117)**	0.182 (0.108)****
HOLI	0.110 (0.078)	0.071 (0.064)	0.071 (0.104)	-0.086 (0.103)
R	0.032 (0.301)	0.212 (0.280)	2.214 (0.652)***	0.965 (0.728)
S	-0.279 (0.318)	-0.228 (0.269)	1.452 (0.734)*	0.665 (0.697)
C	0.140 (0.286)	-0.150 (0.258)	2.469 (0.678)***	1.000 (0.718)
R:S	-0.059 (0.340)	0.173 (0.328)	-1.656 (0.631)**	-0.585 (0.642)
R:C	-0.380 (0.347)	-0.237 (0.310)	-2.085 (0.662)**	-1.230 (0.705)****
S:C	-0.160 (0.342)	0.195 (0.307)	-0.956 (0.663)	-0.542 (0.497)
SUP	-0.186 (0.156)	-0.145 (0.090)	0.342 (0.248)	-0.068 (0.138)
AFF	0.058 (0.068)	0.087 (0.071)	0.133 (0.092)	-0.022 (0.089)
INFO	-0.145 (0.085)****	0.035 (0.062)	0.226 (0.134)	0.151 (0.125)
Exp	0.448 (0.324)	0.155 (0.397)	-0.636 (0.395)	0.848 (0.240)***
FRQ	-0.044 (0.060)	0.101 (0.074)	-0.081 (0.109)	-0.008 (0.075)
KNOW	0.190 (0.081)*	-0.074 (0.052)	0.037 (0.122)	0.267 (0.086)**
Gender	0.048 (0.203)	-0.022 (0.178)	-0.338 (0.340)	-0.553 (0.249)*

Notes: **** $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.0000$; ACpre = pre-recall affective commitment; CCpre = pre-recall calculative commitment; PURpre = pre-recall purchase intention; TRUST = brand trust; RISK = risk averseness; HOLI = holistic thinking style; R = responsibility; S = seriousness; C = core product of the brand; SUP = brand superiority; AFF = negative emotion response to recall announcement; INFO = believability of the announced information; Exp = consumers' recall experience; FRQ = frequency of brand usage; KNOW = product knowledge; Gender = male/female

Table III Effects on calculative commitment changes by group

Covariates	Hard Cores estimate (SE)	Don't-Cares estimate (SE)	Lovers estimate (SE)	Rationalists estimate (SE)
(Intercept)	-0.423 (1.113)	1.696 (0.906)****	-0.612 (2.108)	-2.226 (1.494)
ACpre	0.451 (0.158)**	0.41 (0.123)***	0.072 (0.406)	0.901 (0.234)***
CC1pre	-0.798 (0.122)***	-0.64 (0.114)***	-0.744 (0.321)*	-0.324 (0.205)
PURpre	0.568 (0.128)***	0.056 (0.091)	0.567 (0.199)**	0.087 (0.152)
TRUST	-0.243 (0.144)****	-0.161 (0.093)****	-0.24 (0.282)	-0.761 (0.178)***
RISK	-0.118 (0.084)	0.008 (0.066)	0.181 (0.145)	0.579 (0.132)***
HOLI	0.323 (0.084)***	-0.003 (0.062)	0.17 (0.129)	-0.082 (0.126)
R	-0.104 (0.328)	-0.334 (0.271)	0.893 (0.813)	1.905 (0.892)*
S	0.218 (0.346)	-0.121 (0.26)	-0.655 (0.915)	1.255 (0.854)
C	-0.21 (0.312)	0.283 (0.25)	0.685 (0.844)	1.548 (0.88)****
R:S	0.179 (0.37)	0.542 (0.318)****	-0.736 (0.786)	-1.22 (0.787)
R:C	0.077 (0.378)	-0.339 (0.3)	-1.626 (0.825)*	-1.863 (0.864)*
S:C	-0.518 (0.372)	-0.328 (0.298)	0.909 (0.827)	-0.866 (0.609)
SUP	-0.332 (0.17)****	-0.044 (0.087)	-0.146 (0.309)	-0.325 (0.169)****
AFF	0.129 (0.074)****	0.032 (0.069)	0.063 (0.114)	0.011 (0.11)
INFO	-0.182 (0.092)*	-0.082 (0.06)	-0.079 (0.167)	-0.308 (0.153)*
Exp	-0.186 (0.353)	-0.307 (0.385)	-0.03 (0.492)	0.171 (0.294)
FRQ	0.052 (0.066)	0.275 (0.072)***	0.06 (0.135)	0.05 (0.092)
KNOW	0.27 (0.088)**	-0.104 (0.051)*	0.221 (0.152)	0.534 (0.106)***
Gender	0.068 (0.221)	0.062 (0.172)	-0.382 (0.424)	-0.418 (0.305)

Notes: **** $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.0000$

0.132), while holistic thinking style (HOLI) matters for *Hard Cores* ($\beta = 0.323$, standard error = 0.084). These results partially support *H6a*. On examining the effects of external attributions (e.g. recall characteristics), the *Rationalists* were significantly affected by two of the three variables, including

the origin of responsibility ($\beta = 1.905$, standard error = 0.892) and core product recalls ($\beta = 1.548$, standard error = 0.088). These results support *H8b* and *H10b*, but not *H9b*. This suggests that consumers with high calculative commitment but low affective commitment are affected by

external factors like recall characteristics. The study also finds significant effects of interaction between R and C on ΔCC for *Rationalists* ($\beta = -1.863$, standard error = 0.864), and for *Lovers* ($\beta = -1.626$, standard error = 0.825). Finally, calculative commitment of *Rationalists* and *Hard Cores* was influenced by INFO and KNOW in a different way. INFO has a negative impact on calculative commitment for *Hard Cores* ($\beta = -0.182$, standard error = 0.092) and *Rationalists* ($\beta = -0.308$, standard error = 0.153), while KNOW had positive effects for *Hard Cores* ($\beta = 0.27$, standard error = 0.088) and *Rationalists* ($\beta = 0.534$, standard error = 0.106). These results reveal the characteristics of calculative commitment that is associated with rational decision-making.

Purchase intention

Finally, we investigate how purchase intention changes across the four groups (see Table IV). Overall, only *Hard Cores* exhibit the effects of both commitment on purchase intention for AC ($\beta = 0.288$, standard error = 0.116) and for CC ($\beta = 0.275$, standard error = 0.089). In particular, the effects of internal attributions are more evident in *Hard Cores* than other groups. Risk aversion had a negative effect ($\beta = -0.177$, standard error = 0.864), while holistic thinking style positively influenced their purchase intention ($\beta = 0.123$, standard error = 0.062). Trust decreased purchase intention in *Rationalists* ($\beta = -0.508$, standard error = 0.183). These results partially support the H5c, H6c and H7c. Among external attributions, seriousness of a product recall significantly reduced purchase intention in *Hard Cores* ($\beta = -0.665$, standard error = 0.253). *Lovers* were also marginally influenced by responsibility ($\beta = 1.335$, standard error = 0.78). Thus, the H8c, H9c and H10c were partially supported. For control variables, *Hard Cores*' purchase intention were negatively influenced by SUP ($\beta = -0.32$, standard error = 0.124), but positively by KNOW ($\beta = 0.25$, standard error =

0.064), EXP ($\beta = 0.593$, standard error = 0.258) and AFF ($\beta = 0.113$, standard error = 0.054).

Study 2: a replication study

To validate the above findings, a second replication study was performed. In this study, a product recall for Nike products was manipulated. Similar to the first study, Nike was used for its high variance in brand commitment across the respondents. A total of 137 undergraduate students participated in a two-stage experiment. Overall, the results are similar to those obtained from Study 1. We present the results for H1a-H4b for Nike in Table I. Moreover, the results also show that brand trust plays a significant role in *Hard Cores* for both affective and calculative commitment. Similar effects in the origin of responsibility, core product recalls and seriousness of product recall on commitment levels were also observed in this second study with limited variations. The rest of the results are available in Appendix 2.

General discussion

With the growing number of product recalls, understanding how such events affect consumer behavior has become a vital issue for both academics and managers. This paper investigates how a recall event changes consumers' commitment toward the affected brand. The related hypotheses were presented and analyzed using an experiment. The results were further validated using a second study. A brief summary of the results from the hypotheses testing are provided in Table V.

First, the consumers are grouped based on their levels of commitment, including *Hard Cores*, *Lovers*, *Rationalists* and *Don't-Cares*, and their commitment level and purchase intention changes are examined after a recall event. The findings suggest that affective commitment across all groups

Table IV Effects on purchase intention changes by group

Covariates	Hard Cores estimate (SE)	Don't-Cares estimate (SE)	Lovers estimate (SE)	Rationalists estimate (SE)
(Intercept)	1.796 (0.813)*	0.943 (1.052)	2.872 (2.022)	4.231 (1.539)**
ACpre	0.288 (0.116)*	0.353 (0.143)*	0.318 (0.389)	-0.208 (0.241)
CC1pre	0.275 (0.089)**	-0.208 (0.132)	-0.041 (0.307)	0.187 (0.212)
PURpre	-0.717 (0.094)***	-0.557 (0.106)***	-0.522 (0.191)**	-0.567 (0.157)***
TRUST	-0.084 (0.105)	-0.039 (0.108)	-0.046 (0.27)	-0.508 (0.183)**
RISK	-0.177 (0.062)**	0.085 (0.077)	0.059 (0.139)	-0.002 (0.136)
HOLI	0.123 (0.062)*	-0.107 (0.072)	-0.003 (0.124)	-0.125 (0.13)
R	-0.141 (0.24)	0.339 (0.315)	1.355 (0.78)****	0.145 (0.92)
S	-0.665 (0.253)**	-0.348 (0.303)	1.235 (0.878)	0.517 (0.88)
C	-0.169 (0.228)	0.035 (0.291)	1.032 (0.81)	0.822 (0.907)
R:S	-0.007 (0.271)	-0.081 (0.369)	-1.249 (0.754)****	-0.406 (0.811)
R:C	0.138 (0.276)	-0.231 (0.349)	-1.372 (0.792)****	-0.732 (0.89)
S:C	-0.2 (0.272)	0.233 (0.346)	-1.196 (0.793)	-0.813 (0.627)
SUP	-0.32 (0.124)**	0.072 (0.102)	0.103 (0.297)	0.077 (0.174)
AFF	0.113 (0.054)*	0.108 (0.08)	-0.168 (0.11)	-0.263 (0.113)*
INFO	-0.085 (0.068)	-0.012 (0.07)	-0.22 (0.16)	-0.3 (0.157)****
Exp	0.593 (0.258)*	-0.033 (0.447)	-0.597 (0.472)	0.21 (0.303)
FRQ	-0.011 (0.048)	0.201 (0.083)*	-0.227 (0.13)****	-0.154 (0.094)
KNOW	0.25 (0.064)***	-0.015 (0.059)	0.103 (0.145)	0.425 (0.109)***
Gender	-0.262 (0.162)	-0.049 (0.2)	-0.32 (0.406)	0.243 (0.315)

Notes: **** $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.0000$

Table V Hypothesis testing results

Hypotheses	Results
H1a. Affective commitment of <i>Hard Cores</i> will not change after a product recall	Not supported (decreased for Starbucks; increase for Nike)
H1b. Calculative commitment of <i>Hard Cores</i> will decrease after a product recall	Not supported (increased for Starbucks; no effect for Nike)
H2a. Affective commitment of <i>Don't-Cares</i> will decrease after a product recall	Supported
H2b. Calculative commitment of <i>Don't-Cares</i> will decrease after a product recall	Supported
H3a. Affective commitment of <i>Lovers</i> will not change after a product recall	Supported
H3b. Calculative commitment of <i>Lovers</i> will decrease after a product recall	Supported
H4a. Affective commitment of <i>Rationalists</i> will decrease after a product recall	Supported
H4b. Calculative commitment of <i>Rationalists</i> will decrease after a product recall	Not supported (increased for Starbucks; no effect for Nike)
H5. Brand trust will negatively influence a) affective commitment, b) calculative commitment, and c) purchase intention	a) Partially supported (<i>Rationalists</i>) b) Supported c) Partially supported (<i>Rationalist</i>)
H6. Risk aversion will positively influence a) affective commitment and b) calculative commitment, but negatively influence c) purchase intention	a) Partially supported (<i>Lovers/Rationalists</i>) b) Partially supported (<i>Rationalists</i>) c) Not supported
H7. Holistic thinking will positively influence a) affective commitment, b) calculative commitment, and c) purchase intention	a) Not supported b) Partially supported (<i>Hard Cores</i>) c) Partially supported (<i>Hard Cores</i>)
H8. The origin of responsibility on a favored brand will negatively influence a) affective commitment, b) calculative commitment, and c) purchase intention	a)/b) Interacted with C (<i>Lovers/Rationalists</i>) c) Not supported
H9. Seriousness of a product recall will negatively influence a) affective commitment, b) calculative commitment, and c) purchase intention	a) Interacted with R (<i>Lovers</i>) b) Not supported c) Supported
H10. Product recalls of core products will negatively influence a) affective commitment, b) calculative commitment, and c) purchase intention	a)/b) Interacted with R (<i>Lovers/Rationalists</i>) c) Not supported

except for *Lovers* decreases after a product recall. *Lovers*, having a high level of affective commitment, possess a higher level of tolerance to negative publicity (Ahluwalia *et al.*, 2000); therefore, they experienced no significant reduction in their commitment after the recall. Unlike affective commitment, calculative commitment changed differently for different group of consumers. In particular, *Hard Cores* and *Rationalists* who have higher calculative commitment show an increase in their calculative commitment after a product recall because calculative commitment is driven by the lack of choices and switching costs (Gustafsson *et al.*, 2005). The damage to a preferred choice by a product recall increases switching costs to search alternative and a feeling of loss in terms of the number of choices. The above findings suggest that a recall causes opposite effects on affective and calculative commitment. Therefore, if the two types of brand commitments are not considered properly in a recall study (as most extant studies do not), the observed effects of product recall may be an underestimate as the effects cancel out between them. Therefore, future studies on role of brand commitment after a product recall may consider using the two types of brand commitment instead of its aggregate value.

The results further show that affective commitment tends to be independent, as it is influenced only by its pre-recall affective commitment level. In particular, the affective commitment is observed to have a stronger negativity resistance than calculative commitment, as shown among *Lovers*. This suggests that building strong brand relationships with consumers (Amine, 1998) helps shield brands from the negative effects of product recalls. Unlike affective commitment, results show that effects of recall on calculative commitment

depend on the pre-recall levels of affective commitment and purchase intention along with calculative commitment. Thus, calculative commitment of consumers may be protected from the negative effects of a product recall, as long as either pre-recall purchase intention or affective commitment is high before the event.

Finally, the negative effects on brand commitment vary across the four consumer groups depending on the internal and external attributions. With respect to internal attributions, *Hard Cores* are influenced by trust and holistic thinking styles. As their commitment levels are high in both types of commitment, their tendency to look at an event as a whole rather than analyzing it in detail contributes to increased calculative commitment based on the signal of choice deletion by a product recall. *Rationalists* are prone to trust their experiences and product knowledge, which categorize them as rational decision-makers. Risk aversion is also found to be an important factor for *Lovers*. As they tend to avoid purchase risk, they rely heavily on the brand, thus increasing their affective commitment. With respect to external attributions, *Lovers* and *Rationalists* are more influenced by these attributions than other groups. The negative effects are significant especially when a product recall occurs to a core product of the brand they like. Interestingly, seriousness of a product recall decreases the purchase intention of *Hard Cores* customers rather than their commitment levels. Finally, commitment levels of *Don't-Cares* are influenced by neither the internal nor the external attributions, as they do not pay attention to a product recall in the brand. However, their purchase intention considerably decreases compared to other

groups, simply because they are aloof from the brand, and thus easy to switch brands.

Implications, limitations and future directions

Theoretical implications

From theoretical perspectives, this study is the first to introduce four types of consumers based on different levels of affective and commitment levels. It has been experimentally shown that the effects of product recalls vary across the four groups. *Lovers* are the consumers who can endure negativity more strongly than any other groups. Second, this study identifies the effects of internal and external attributions on commitment and purchase intention for each group. Third, this study emphasizes that weighted commitment (i.e. *Lovers* and *Rationalists*) rather than balanced commitment (i.e. *Hard Cores* or *Don't-Cares*) can be directly hurt by the external attributions of product recalls, even when their purchase intention is held. Thus, if the negative publicity continues, even the bumper effect of affective commitment in *Lovers* will be depleted in the long run. Likewise, this study proposes that the four commitment groups will have a different propensity to resist against a negative event such as a product recall. For example, *Don't-Cares* who have little commitment to a brand have a decrease of purchase intention right after a product recall. Meanwhile, *Lovers* tend to maintain purchase intention after a product recall, although their commitment levels are affected by a product recall.

Managerial implications

From managers' perspective, this study provides guidelines that will not only help companies to maintain the damage of recall events but also help to find opportunities to reap unexpected benefits (Smith *et al.*, 1996) from them. The results suggest that managers should have different communication strategies for the four groups after a recall event. For example, delivering a variety of substitutes under the recalled brand helps *Hard Cores* and *Rationalists* to maintain calculative commitment after a product recall. On the other hand, *Lovers* will pay attention to a message that emphasizes the psychological attachment to the brand (e.g. repeated brand advertisements), or nostalgic bonding with the brand (e.g. Grisaffe and Nguyen, 2011). Recent studies (e.g. Maity and Dass, 2014) suggest that media richness of marketing channels play a significant role on consumer decision-making. In particular, channels with high media richness such as online social media platforms (e.g. Facebook) will improve brands' affective relationship with the consumers. On the other hand, medium to low rich channels (e.g. print advertisements and informartials in magazines) may help in improving calculative commitment. Therefore, we recommend that managers should have a multi-channel communication strategy with different level of media richness in place to respond to product recalls.

This study also suggests that managers should consider having a product portfolio strategy to counter negative effects of product recalls. Byun (2014), in a recent study, has shown that loyal consumers tend to switch to substitutes with the affected brand in an event of a product recall. We extend these findings and recommend that brand managers should consider having substitutable products in their portfolio,

which will help them to retain market share from *Hard Cores* and *Lovers* consumer segments. In the long run, marketing strategies to increase affective commitment among consumers will help the brand survive the hard times such as a product recall.

Limitations and future directions

Like most experimental studies, this research has some limitations. First, although a careful account been taken to limit the systematic and random errors associated with this research using a mixture model, further research is necessary on this topic. In particular, with the availability of scanner data from consumer panels, future studies should validate the findings reported here using transaction data. Next, this paper focuses on fictitious recall events for two different product categories, including coffee (*Starbucks*) and athletic shoes (*Nike*). Inclusion of these brands was necessary due to high variability in brand commitment levels among the respondents. Although the results obtained from both studies were similar, future studies should investigate whether there is an interaction between category and brand commitment. On similar lines, we suggest that future studies should also consider different types of product categories such as medicine, children's toys, automobiles, and so on, and examine whether our findings hold across them. In this study, brand commitment was measured instead of manipulated and the relationships are considered to be linear. Future studies may consider manipulating commitment and validate whether the relationships are indeed linear. Finally, this study is limited to examining the changes in commitment and purchase intention levels after a product recall. It is possible that consumers may regain their pre-recall commitment levels after the recalled brand is reintroduced into the market. However, the question remains as to whether product recalls cause permanent damage to the purchase behavior of consumers. Future research should consider using longitudinal data to examine these important issues.

With increasing technological advancements, there is significant improvement in product safety and regulation processes. However, product recall events are as common today as in the past. This paper examines a vital issue – the effects of a product recall on brand commitment – and presents some important findings. Hopefully, this research will encourage other researchers to expand on these findings and take this research area to the next level.

Note

- 1 We considered a linear benchmark model comparable to the AVA model, but without the latent component to account for the effects of unobserved heterogeneity in the sample to examine the advantage of our approach. The log likelihood values that determine the level of fit is compared, and found that proposed finite mixture model (log-likelihood value = -180.96) had a substantially better fit than the benchmark linear model (log-likelihood value = -320.36). It suggests that it is important to account for the effects of unobserved heterogeneity in experiments, and the finite mixture model is appropriately used in this context.

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Further reading

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Appendix 1

Table AI Construct reliability

Construct (α)	Item	Item reliability	Scale source
Affective Commitment ($\alpha = 0.88$)	I take pleasure in being a customer of Starbucks	0.86	Gustafasson <i>et al.</i> (2005)
	Starbucks is the operator that takes the best care of their customers	0.83	
	I feel that Starbucks considers me as important as I consider them	0.88	
Calculative Commitment ($\alpha = 0.82$)	I have feelings of trust toward Starbucks	0.83	Gounaris (2005)
	It is hard to stop buying products from Starbucks	0.74	
	There is no worthwhile alternative to Starbucks	0.73	
Purchase Intention ($\alpha = 0.78$)	It costs high for me to switch to another brand	0.78	Baker and Churchill (1977)
	I would like to try a Starbucks product	0.73	
	I would buy a Starbucks product if I happened to see it in a store	0.66	
Trust ($\alpha = 0.84$)	I would actively seek out Starbucks products	0.70	Chaudhuri and Holbrook (2001)
	I would patronize Starbucks	0.80	
	I trust this brand	0.77	
Risk Aversion ($\alpha = 0.77$)	I rely on this brand	0.86	Burton <i>et al.</i> (1998)
	This is an honest brand	0.77	
	This brand is safe	0.70	
Holistic Thinking ($\alpha = 0.76$)	I don't like to take risks	0.71	Ein-Gar <i>et al.</i> (2012)
	Compared to most people I know, I like to "live life on the edge" (R)	0.68	
	I have no desire to take unnecessary chances on things	0.74	
Brand Superiority ($\alpha = 0.76$)	Compared to most people I know, I like to gamble on things (R)	0.73	Chaiken and Maheswaran (1994)
	The whole, rather than its parts, should be considered in order to understand a phenomenon	0.70	
	It is more important to pay attention to the whole than its parts	0.69	
Brand Superiority ($\alpha = 0.76$)	The whole is greater than the sum of its parts	0.71	Chaiken and Maheswaran (1994)
	It is more important to pay attention to the whole context rather than the details	0.72	
	It is not possible to understand the parts without considering the whole picture	0.75	
Brand Superiority ($\alpha = 0.76$)	We should consider the situation a person is faced with, as well as his/her personality	0.77	Chaiken and Maheswaran (1994)
	The brand Starbucks has many positive features	0.62	
	The brand Starbucks is superior to competing brands	0.60	
	The brand Starbucks has few negative features	0.79	

Note: (R) is a reverse item

Appendix 2

In the finite mixture modeling approach, the first step is to define a model appropriate for the current research. Therefore, the following general commitment change model for respondent *i* is considered:

$$\begin{aligned}
 (\text{Commitment Change})_i &= \sum_p A_p (\text{Internal Attributions})_{pi} \\
 &+ \sum_q B_q (\text{External Attributions})_{qi} \\
 &+ \sum_r C_r (\text{Control Variables})_{ri} + \varepsilon_i
 \end{aligned}
 \tag{A1}$$

where *p* is the number of internal attributions (e.g. individual respondent’s characteristics), *q* is the total number of external attributions (e.g. recall characteristics) and their interactions, and *r* is the number of control variables.

To explain the overall modeling process, let us consider the following generic model with *y_i* as the dependent variable (commitment change respondent *i*, *X_{ij}* are the *j* = 1,2 [. . .] *J* predictor variables for *i* consumers, and *b*’s are the corresponding model parameters:

$$y_i = \sum_{j=1}^J X_{ij}b_j + e_i \tag{A2}$$

To control for unobserved heterogeneity, there exists *k* = 1,2 [. . .] *K* heterogeneous groups of respondents in the sample, such that *b_{jk}* indicates the estimated value of the *j*th coefficient for the *k*th group or cluster. Then, assuming that commitment changes are distributed as a mixture of conditional normal densities, equation (A2) is specified as:

$$y_i = \sum_{k=1}^K \vartheta_k f_{ik}(y_i | X_{ip}, \sigma_k^2, b_{jk}) \tag{A3}$$

or

$$z(y|x, \psi) = \sum_{k=1}^K \vartheta_k f_{ik}(y_i | X_{ip}, \sigma_k^2, b_{jk}) \tag{A4}$$

where *y* is the dependent variable with conditional density *z*, ψ is a vector of all parameters, and σ_k^2 is the variance for the *k*th cluster. The commitment change values *y*₁, *y*₂, . . . , *y*_{*i*} belong to a mixture of conditional normal densities of underlying

respondent segments having unknown proportions $\vartheta_1, \vartheta_2, \dots, \vartheta_k$, with ψ as the vector of all parameters. Next, the membership of each respondent is identified in his or her respective heterogeneous segment *k* by considering his or her probability *P* of belonging to a latent class *l* as defined by the observed factors:

$$P(l | x, y, \psi) = \frac{\vartheta_l f(y|x, b_k)}{\sum_k \vartheta_k f(y|x, b_k)} \tag{A5}$$

Therefore, the commitment model is first estimated and then use the resulting coefficients to determine the above probability. In the process, the following log-likelihood function is considered:

$$\log L = \sum_{i=1}^n \log z(y_i | x_i, \psi) = \sum_{i=1}^n \log \left(\sum_{k=1}^K \vartheta_k f(y_i | x_i, \gamma_k) \right) \tag{A6}$$

The posterior class probabilities for each observation and maximize log-likelihood for each component are separately estimated using the posterior probability weights and expectation–maximization algorithm within the above maximum likelihood framework (Dempster *et al.*, 1977). This process of estimation (E) and maximization (M) was repeated to obtain the final results. The FlexMix library in R is used to estimate the above equations. Please see Leisch (2004) for more information on the estimation and computation process.

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