

# Working Paper SERIES

Date October 21, 2014

WP # 0009MSS-068-2014

## **Can Product Recalls Be Profitable? Insights from Behavior Economics Models and Empirical Studies**

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Sept 30, 2014

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## Abstract

Product recalls are often associated with quality failures and considered negative with regard to customer satisfaction and firm performance. Motivated by anecdotal evidence and equipped with new development in decision economics, we develop an endogenous consumer reference model to examine the consumer's willingness to buy in the events of recalls, and construct an empirical study to associate value of recalls with firm profitability. We find that as the consumer forms a different reference point under recalls, she may react positively to the recalls with higher willingness to buy. The positive effect of recalls is substantiated by estimation results from an econometric model of firm profitability in association with recall value, with data collected from public sources in the U.S. A main reason for this counter-intuitive result is that recalls change the quality distribution under which the consumer expects to buy the product, which in turn changes her view of product quality as her reference in making the buying decision. In addition, we find that supply chain offshoring as reflected in consumer loss aversion, may mitigate the effect of recalls on consumer willingness to buy and firm profitability, as demonstrated in both of our analytical model and empirical test.

**Keywords:** Product recall, consumer reference dependency, firm profitability, offshoring.

JEL Classifications: C8, C12, D03, D81, L6, L15.

# Can Product Recalls Be Profitable? Insights from Behavior Economics Models and Empirical Studies

## INTRODUCTION

Tesla, a premium brand of electric vehicles, initiated a recall of its premium Model S because of fire accidents. Facing the mounting criticisms, Tesla's co-founder, Elon Musk, questioned the meaning of recall during an interview as he indicated "the word 'recall' needs to be recalled". As if to help make his point, Tesla witnessed 20% higher sales after the fire accidents than expected (Murphy and Ramsey, 2014). This is puzzling because recalls, often initiated to retrieve defective products from the market and from the consumer, are costly, with compensation usually expended for the damage, and are considered a negative signal of the product quality (Thirumalai and Sinha 2011, Zhao, Li and Flynn 2013) as they are naturally associated with defective products.

Recent recalls with broad media coverage have affected brand image and consumer loyalty of the brand owners. The list includes industry leaders such as Mattel in toys, Toyota in the automobile industry, and Johnson & Johnson in the pharmaceutical industry. However, the negative implication of product recalls on firm performance has not led to consistent efforts to reduce recalls; instead, the total number of recalls for consumer goods has been steadily increasing for the past years, as indicated in Figure 1. Furthermore, the conventional belief that recalls would inevitably result in lower profit is challenged by anecdotal evidence from the few high profile recalls. Toyota, after experiencing its highly publicized quality recalls in January 2010, witnessed a highly profitable year. Its financial performance improved from a loss of 461 billion yen in 2009 to a profit of 244 billion yen in 2010, and to 465 billion yen in 2011. In recent surveys of American consumers, estimates of product reliability ratings for Toyota brands

have plunged from nearly 95% pre-recall to 72% after recall, but only 13% surveyed felt that Toyota would probably not regain its prominence in the auto sector (Piotrowski and Guyette 2010). The extant literature of quality management has long established the importance of product quality, and therefore, this counterintuitive pattern, if consistently observed, is potentially conflicting with the existing literature (Zhao et al. 2013, Zhang and Xia 2013, Choo, Linderman and Schroeder 2007, Chen, Gilbert and Xia 2011). This research is aimed to better understand the relationship between quality recalls, consumer behavior, and firm profitability, empirically with actual recall data, and analytically from the perspective of consumer reference.

[Insert Figure 1 about here]

Globalization of supply chains adds another level of complexity to the impact of recalls. Mattel's worldwide recalls of its toys for substandard paint is well known to have resulted in substantial losses in profitability, brand value, and customer loyalty (Tang 2008). Mattel's supply chains are largely outsourced and offshored, which has contributed to the negative reactions from the consumers to the brand. Comparing Mattel's recall experience with that of Toyota's, and considering that the Toyota supplier involved in the recalls, CTS, was based in the U.S., one would raise the question: is it possible that supply chain outsourcing or offshoring may affect consumer reaction to recalls and recalls' impact on firm performance? This research focuses on recalls' impact on consumer quality reference and willingness to buy, and empirically examines the relationship between recalls and firm profitability, moderated by supply chain offshoring.

Academic literature of product recalls has been limited and mixed. Much of the research has linked product recall to stock market reactions, and the consequences of recalls have been

shown to be less damaging or even insignificant. The reasons of insignificant impact of recalls can be different. The market may adjust their expectations of a firm's performance when the firm introduces a product with new technologies involved (Thirumalai and Sinha 2011), and so when recalls do occur, the market reactions may be measured. When the recalls involve less severe hazards, the visibility and consequences of the recalls may be less significant, and so can the market reactions (Thomson and McKenzie 2001). In addition, firm strategies in response to recalls can be effective in mitigating market reactions to recalls (Chen, Gansen, and Liu 2009), and markets in different countries may have different reactions to recalls (Zhao, Li, and Flynn 2013). However, much less is known regarding the impact of recalls on firm profits and the underlying mechanism under which consumers react to recalls in their buying behavior.

To investigate the impact of recalls, we address the following research questions: *could quality recalls lead to higher consumer willingness to buy and firm profitability, by affecting consumer quality references? And how does offshoring play a role in the effect of recalls on consumer willingness to buy and firm profitability?* We first establish an analytical model with consumer utility based on consumer quality references. The consumer reference point defines the psychological *gains or losses* the consumer feels from buying or not buying the product. We then propose an empirical model of firm profitability and product recalls, and estimate the model with data collected from public sources. Our main analytical findings are as follows: first, we find that the impact of recalls on consumer willingness to buy depends on how consumers use the perceived quality as their references in evaluating their potential satisfaction from their buying decision. More importantly, when they generate the references endogenously, recalls may indeed increase their willingness to buy the recalled products. Second, when the recalled product is from an offshore supply chain party, the higher loss aversion of the consumer as a result of offshoring

would negatively affect the relationship between recalls and the consumer willingness to buy. The main intuition is as follows: the consumer has a high perceived quality level at which she will buy the product and a low level at which she does not buy. The consumer buys the product with a probability when the quality is between the high and the low quality levels. When a recall is announced, it may lower the likelihood of which the consumer buys the product at the high quality level. Buying the product below this level, the consumer feels a loss, but the lower likelihood of buying at the high quality mitigates the loss. Alternatively, if the recall lowers the low quality level under which she will not buy the product, her expectation of buying the product at a quality higher than the new low quality level is actually increased. These are the “comparison” and “attachment” effects that lead to greater willingness to buy the product affected by the recall (Koszegi and Rabin 2006). In essence, recalls change the quality distribution under which the consumer expects to buy the product, which in turn changes her view of product quality as her reference in making the buying decision. As a result, the perceived loss from buying the product, i.e. the loss associated with buying below the desired high quality level, is lower with the recalls.

Our empirical findings are largely consistent with the analytical results. Assembling and estimating a panel of eighty four firms in five industries with recalls over six years, we find that the total product value involved in recalls by a firm is positively associated with the firm’s profits; however, when such recalls involve products from an offshore party, the negative moderating effect from offshoring on the association of recalls and profits may turn the net effect of recalls to negative.

The contribution of this research to the operations literature is three-fold. First, this research establishes an endogenous consumer reference point model to examine the effect of

recalls on consumer willingness to buy. The role of consumer response to recalls has not been formally investigated and our modeling approach based on the new developments in decision economics serves as the first such theoretical attempt to study product recalls. Second, based on our analytical results, we propose an empirical relationship between quality recalls and firm financial performance. Our data, collected from public records, support a positive and significant relationship between the two. This finding is counter-intuitive but is consistent with our analytical model results. Third, we extend our models, both analytically and empirically, to investigate the role of offshoring on the effect of recalls. The negative moderating effect of offshoring indicates that the effect of recalls on firm performance is complex and contingent on the structure of the supply chain.

The rest of the paper is organized as follows: the next section reviews the related literature; an endogenous consumer reference point model for recalls is proposed and analyzed in Section 3, followed by an empirical study focusing on the relationship between recalls and firm profitability in Section 4; Section 5 provides discussion of results and conclusion.

## LITERATURE REVIEW

The extant literature related to product recalls is extensive and broad. We focus on the three streams of research that may be the most relevant to our study. First of all, the operations management literature has empirically examined quality recalls and their financial consequences, which offers a major research background for this study. Second, product recalls are quality failures, and therefore the literature of quality management and firm performance provides a broader perspective for our research. Third, product recalls have a direct impact on consumer decisions, which has significant implications on firm performance.



The direct impact of quality recalls on firm financial performance includes increased costs, such as the costs of fixing the defective products and unsold inventory, and lower revenues from lost sales. Indirectly, it may negatively affect the firm's reputation and customer loyalty in the long term (Thirumalai and Sinha 2011, Hendricks and Singhal 2001). The long term effects of recalls may also damage brand equity and destroy market confidence of investment (Laufer and Coombs 2006, Rhee and Haunschild 2006, Siomkos and Kurzbard 1994, Sullivan 1990, Van Heerde, Helsen, and Dekimpe 2007). However, research has shown that the impact of quality recalls is far from universally negative. Using data from the medical device industry, Thirumalai and Sinha (2011) study the financial consequences and sources of recalls, and find that at an aggregate level, the market penalties for medical device recalls are not significant, i.e., at the aggregate level, the costs of poor quality are not severe. They argue that perhaps as technologies are introduced and as they evolve, the market learns to expect recalls. In addition, based on food safety data, Thomsen and McKenzie (2001) find that in cases where the product recalled poses a serious threat to consumers' health, there is a loss in shareholder wealth of between 1.5% and 3%, although they do not directly measure the various costs or lost revenues that may result from a product recall. However, they also find no evidence that the stock market reacts negatively when recalls involve less severe hazards. Also based on the event study method on 12 years of consumer product recall data in U.S., Chen, Ganesan, and Liu (2009) show that regardless of firm and product characteristics, proactive strategies have a greater negative effect on firm value than that of passive strategies. They suggest that this is likely because the stock market interprets proactive strategies as a signal of substantial financial losses to the firm. In contrast, Zhao, Zhao and Helsen (2011) find that a proactive approach can help manage the recall crisis effectively.

Extant research has also examined cultural effects of recalls, recall strategies, and timing of recalls. Based on an event study approach and using a sample of product recall announcements made during the period from 2002 to 2011 in China, Zhao, Li and Flynn (2013) find significant negative abnormal returns on the day following a product recall announcement, and that the negative abnormal return in the China market is generally larger than that in the United States market. Haunschild and Rhee (2004) investigate the learning-curve effects of voluntary and involuntary recalls on subsequent recall rates in the automotive industry, and find that past voluntary recalls have a negative effect on future recalls. Hora, Bapuji and Roth (2011) study the important issue of recall timing with the data from the U.S. toy industry and find that time to recall is related to recall strategies, source of the defect and supply chain position of the recalling firm. Furthermore, recall cost sharing is also studied as a tool to induce quality improvement efforts in a supply chain. For instance, using supermodular game theory framework, Chao, Iravani, and Savaskan (2009) study how to design an optimal recall cost sharing contract when both the supplier's and the manufacturer's quality improvement efforts are subject to moral hazard and when the manufacturer has uncertainty regarding the quality of the supplier's process.

The literature of operations management has also examined the effectiveness of quality management (Choo et al. 2007), which has direct implications to product recalls, as firm strategies. Handley and Gray (2013) focus on the quality management mechanisms in supply chains involving contract manufacturers (CM). Specifically they find that both external failure penalties and facility audits have a unique positive effect on the CM's perception of relative quality importance. More interestingly, they find that although external failure penalties correspond to a lower use of facility audits (i.e., they are substitutes-in-use), each of these mechanisms is more effective in the presence of the other (i.e., they are complements-in-

effectiveness). Hendricks and Singhal (2001) empirically examine the long run stock price movement of firms, and find that firms which effectively implement TQM principles and philosophies enjoy significant wealth creation. In particular, they find evidence that major positive effects for the TQM award winners mainly show up in the post-TQM implementation period (5 years), while the extent of such outperformance by the award winners ranges from 38-46%, depending on the control group used.

Manufacturing offshoring tends to influence the relationship between quality management and firm/supply chain performance. Gray, Roth and Leiblein (2011) empirically examine the differences in quality risk across domestic and offshore plants in the pharmaceutical industry setting. Specifically, using a sample of 30 pairs of regulated drug manufacturing plants in the U.S. mainland and Puerto Rico, they find that Puerto Rican plants operate with a significantly higher quality risk than matching plants operated by the same firm located in the mainland U.S., on average. Jun, Cai and Shin (2006) study the offshoring manufacturing sites and find that employee empowerment, teamwork, and employee compensation have a significant and positive influence on employee satisfaction, leading to employee loyalty. Based on the sample of 189 manufacturing plants between Eastern (Japan and South Korea) and Western (Germany, United States, Finland, and Sweden) countries, Naor, Linderman and Schroeder (2010) find that organizational culture inside plants differs in three dimensions (power distance, future orientation, and performance orientation). More importantly, they find that organizational culture has more of an effect on manufacturing performance than does national culture or the fit between them. In addition, Country Developmental Indexes, both Economic and Infrastructural, do not impact manufacturing performance.

It has long been recognized that people's preference is reference dependence and is subject to various degrees of loss aversion. Loss-aversion and reference dependence involving quality attributes have long been investigated as important determinants of consumer's choice of quality product (Hardie, Johnson and Fader 1993), in multi-location newsvendor ordering problem (Ho, Lim and Cui 2010), and in capacity decision (Liu and Shum 2012). Hardie et al. (1993) find that loss aversion for quality is greater than loss aversion for price. Sivakumar (2011) examines the same issue of relative loss aversion in price and quality in terms of brand choice, and finds that the relative loss aversion between price and quality can be category specific and can thus identify some of the factors that may influence the relative loss aversion. Abdellaoui, Bleichrodt and Paraschiv (2007) propose a method to measure loss aversion in an experimental study without making any parametric assumptions. Zhao and Stecke (2010) also consider consumer loss aversion in the pre-order of soon-to-released products. They find that for products with a higher profit margin than the high threshold on profit margin, a retailer should always use deep discount for pre-orders (DAS), while for products with a medium profit margin within the two thresholds, a retailer should adopt moderate discounts for pre-orders (MAS) if the consumer's expected valuation is lower than the high threshold and use DAS otherwise.

## A BEHAVIORAL MODEL OF QUALITY RECALL

In behavioral economics, consumers make decisions based not only on their economic payoffs, but also on their psychological reactions to the changes of such economic payoffs relative to a reference point (Kahneman and Tversky 1979). When a consumer purchases a product, she is subject to the same emotional reactions because the expected product quality may be different from the realized quality she uses as the reference point in such consumption decision. Below we follow a general framework of Koszegi and Rabin (2006) that unifies the prospect theory,

reference dependence and loss aversion to analyze the consumption decision of a quality product, and to study how the prospect of a product recall may impact the consumer's assessment of or willingness to buy such a product.

Let's consider a product that can be sold to consumers at a price of  $p$ . The consumer views the product ownership as two dimensions of choice ( $c_i$ ) to form the consumption utility, where the  $c_1 \in \{0, z\}$  represents whether the consumer has a unit of the product or not, while  $c_2 \in \{0, q\}$  represents a consumption value of the product with respect to the quality level  $q \in R^+$  expected. Here  $z$  is the intrinsic value of the product from the perspective of the consumer.

The consumer also incurs a gain-loss utility  $n(c|r)$  for her consumption decision “ $c$ ”, based on her reference point ( $r$ ) (Koszegi and Rabin 2006). Thus the overall utility function is

$$U(c | r) = c_1 + c_2 - p + \sum_{i=1}^2 n(c_i | r).$$

We assume the gain-loss utility  $n(\bullet)$  takes the function form  $\mu(x) = \eta x$  for  $x > 0$  and  $\mu(x) = \lambda \eta x$  for  $x \leq 0$ . Here  $\eta > 0$  is the weight the consumer attaches to the gain-loss utility, while  $\lambda > 1$  is the “coefficient of loss aversion”, representing that consumer typically assigns higher psychological dissatisfaction to losses than psychological satisfaction to gains.

The reference point ( $r$ ) is defined as “a person's probabilistic beliefs about the relevant consumption outcome held between the time she first focused on the consumption decision determining the outcome and shortly before consumption occurs” (Koszegi and Rabin, 2006). Additionally, an endogenous reference point is the probabilistic distribution over the quality level and product acquisition determined by her plans whether to purchase at each possible quality level, combined with the consumer's beliefs about the quality level she might face.

When the product quality level  $q$  is deterministic, the consumer's reference point is simply the product acquisition as to whether to purchase the product. The consumer views  $q$  as a combination of loss and foregone gain, depending on whether the consumer expects to buy the product at quality  $q$  (or higher) [denoted by superscript "e"], or does NOT expect to buy [denoted by superscript "ne"], and whether the product ownership is viewed as an avoided loss or foregone gain. The consumer total utility from buying ( $B$ ) the product with quality  $q$  would be

(1) If the consumer views the product as a foregone gain:

$$U_B^{ne} = z + q - p + \eta q + \eta z = (1 + \eta)z - p + (1 + \eta)q, \text{ or} \quad (1)$$

$$U_B^e = z + q - p + \lambda \eta q + \eta z = (1 + \eta)z - p + (1 + \lambda \eta)q. \quad (2)$$

(2) If the consumer views the product as an avoided loss:

$$U_B^{ne'} = z + q - p + \eta q + \lambda \eta z = (1 + \lambda \eta)z - p + (1 + \eta)q, \text{ or} \quad (3)$$

$$U_B^{e'} = z + q - p + \lambda \eta q + \lambda \eta z = (1 + \lambda \eta)z - p + (1 + \lambda \eta)q. \quad (4)$$

Here  $z + q - p$  is the direct utility of consuming the quality product.  $\lambda \eta z$  ( $\eta z$ ) represents the consumer's gain-loss utility of viewing the product ownership as an avoided loss (foregone gain), while  $\lambda \eta q$  ( $\eta q$ ) represents the gain-loss utility of whether expecting to buy the product or not. Then in the most favorable expectations for buying (the consumer views the product as an avoided loss), no matter the consumer's expectations as references, the consumer will never buy the product ( $U_B^{e'} < 0$ ) for

$$q < q_{\min} = p / (1 + \lambda \eta) - z. \quad (5)$$

Now, given the expectations least favorable for buying, the customer will still buy the product ( $U_B^{ne} > 0$ ) for

$$q > q_{\max} = p/(1 + \eta) - z. \quad (6)$$

Summarizing from equations (5) and (6), we have the following lemma.

LEMMA 1. (a) A lower  $q$  decreases the consumer's likelihood of purchasing the quality product; (b) A higher  $\lambda$  decreases the consumer's likelihood of not purchasing the quality product.

When the product quality is deterministic, there is little ambiguity from the consumer's perspective regarding the reference point and the associated gain-loss utility, so the consumer's total utility of buying the product is clearly positively related to the product's quality and its intrinsic value. When the product quality is lower because of product recall, there is a clear sense of decreasing gain relative to not expecting to buy the product, or decreasing avoided loss relative to expecting to buy the product. On the other hand, when the loss aversion is higher, the critical quality level for not buying the quality product is decreased, because the consumer has a higher utility when viewing the product ownership as an avoided loss and expecting to own the product beforehand. This effect of higher loss aversion can also imply higher willingness or likelihood for the consumer to purchase the product. As elaborated below, higher loss aversion could be the result of a consumer's reaction to products that are made offshore ("offshoring").

This result conforms to the conventional wisdom that recall usually reduces the product quality and thus leads to lower consumer demand for the product. However, as we demonstrate below, such effect from recall becomes unclear when uncertain quality level and consumer's endogenous reference point are involved. Consumers are usually imperfectly informed and thus uncertain about product attribute levels such as quality (Zhao, Zhao and Helsen 2011). Purchase

decision-making in expectation of perceived quality uncertainty may challenge the conventional wisdom based on deterministic references.

Now the consumer expects product quality levels  $q_H (> q_{\max})$  and  $q_L (< q_{\min})$  with probabilities  $\alpha$  and  $1 - \alpha$  respectively. She will buy at a quality level  $q_M$  (i.e.,  $q_L < q_M < q_H$ ) that may be signaled by the firm or derived from the consumer's overall expectation of quality, and expects to consume the product at quality  $q_H$  with probability  $\alpha$  and not to consume the product at quality  $q_L$  with probability  $1 - \alpha$ . The consumer utility of buying ( $B$ ) at quality level  $q_M$  is thus

$$U_B = [z + q_M - p] + \alpha\lambda\eta(q_M - q_H) + (1 - \alpha)\eta(z + q_M - q_L). \quad (7)$$

The first term  $z + q_M - p$  is the product consumption utility from buying the product. The second term  $\alpha\lambda\eta(q_M - q_H)$  is the gain-loss utility from comparing buying at the quality  $q_M$  with buying at the high quality level because the consumer would choose to buy if expecting a high quality  $q_H$ . The third term  $(1 - \alpha)\eta(z + q_M - q_L)$  is the gain-loss utility from comparing buying at  $q_M$  with not buying at low quality level (since the consumer would choose not to buy if expecting a low quality  $q_L$ ), which consists of the intrinsic value of the product, and the gain from buying at the higher quality level at  $q_M$ .

The consumer utility of not buying ( $NB$ ) is the loss of the product intrinsic values, but saving the problem of paying the price  $p$  when the quality turns out to be  $q_H$ :

$$U_{NB} = \alpha[\lambda\eta(-q_H - z) + p]. \quad (8)$$



Therefore,

$$U_B - U_{NB} = [1 + (1 - \alpha)\eta + \alpha\lambda\eta]z - (1 + \alpha)p - (1 - \alpha)\eta q_L + [1 + \alpha\lambda\eta + (1 - \alpha)\eta]q_M. \quad (9)$$

Consider  $q_M$  as a fixed quality level signaled by the firm to the consumer. The consumer needs to decide whether to buy the product at this level between the high and the low quality. If so, the consumer will purchase the product according to (9), if

$$q_M > \frac{(1 + \alpha)p + (1 - \alpha)\eta q_L}{[1 + \alpha\lambda\eta + (1 - \alpha)\eta]} - z = q_W. \quad (10)$$

$q_W$  is the lowest acceptable quality level that makes the consumer indifferent between buying and not buying. The smaller the lowest acceptable quality  $q_W$  relative to  $q_M$ , the more likely that the consumer will purchase the product, indicating higher willingness for the consumer to purchase the product. According to (7), the lower  $q_L$ , the higher the gain  $\eta(q_M - q_L)$  perceived if buying at quality level  $q_M$ .

Product recalls may lead to a lower consumer perception of product quality (Feng et al. 2010), which means a lower  $\alpha$ , i.e., a lower chance for high quality but a higher chance for low quality level, or a lower  $q_L$ . For instance, Feng et al. (2010) find that consumers tend to assign higher judged probabilities to the actual risk of product under recall, implying lower probabilities to the high quality of the product under recall. Moreover, when a dramatic event such as a product-harm crisis or recall happens, consumers' uncertainty about the affected brand in the category may increase (Zhao, Zhao and Helsen 2011), which is captured by a lower  $\alpha$ . Another example is that in recent surveys of American consumers, estimates of product reliability ratings for Toyota brands have plunged from nearly 95% pre-recall to 72% after recall (Piotrowski and

Guyette 2010), which is captured by a decrease in the low quality  $q_L$ . The following results indicate how  $q_W$ , which represents the consumer's willingness to buy, responds to quality recalls. All proofs of our propositions are provided in the Technical Appendix at the end of the paper.

PROPOSITION 1. The effects of recalls on consumer willingness to buy:

- a). If a recall leads to a lower  $\alpha$ , it will result in a greater consumer's willingness to buy when  $[1 + \eta - \eta(\lambda - 1)]p > (1 + \lambda\eta)\eta q_L$ .
- b). If a recall leads to a lower  $q_L$ , it will result in a greater consumer's willingness to buy.

In contrast to conventional wisdom where the impact of recall is often viewed negatively as indicated in Lemma 1, this proposition suggests that the effects of a recall on consumer willingness to buy can be positive when the consumer's perceived quality levels are uncertain. This is because the consumer has differing best perceived options under uncertain quality outcomes to assess not only the economic payoff but also the psychological gain-loss of the purchase decision. Compared with the case when the product quality is deterministic and the consumer reference point is exogenously determined, the key difference is that the consumer makes the best decision under each uncertain quality level to form her reference point to evaluate her psychological gain /loss. This endogenous reference point tends to present more loss than gain, which distorts the behavior of a loss-averse consumer from using an exogenous or expected reference point. In other words, buying the product below the desirable high quality level, the consumer feels a loss, but the lower likelihood of buying at this high quality mitigates the sense of loss, increasing the consumer's willingness to buy. Alternatively, if the recall lowers the low quality level under which she will not buy the product, her expectation of buying the product at a quality above the lowest acceptable quality level is actually increased. These are the "comparison" and "attachment" effects that lead to greater willingness to buy the product affected by a recall (Koszegi and Rabin 2006).

Specifically, as recalls may lower the probability of the consumer buying at the high quality, a lower value of  $\alpha$  would decrease the loss utility  $\alpha\lambda\eta(q_M - q_H)$  of buying at an intermediate quality compared with buying at the high quality, and increase the gain utility  $(1 - \alpha)\eta(z + q_M - q_L)$  from buying relatively to not buying at the low quality. These two positive effects can overcome the sense of loss of not buying under the expectation of a high quality (under the condition of sufficiently small loss aversion, i.e.,  $0 < \lambda - 1 < \frac{(1 + \eta)(p - \eta q_L)}{\eta(p + \eta q_L)}$ ).

The combined effects would increase the consumer's expectation of buying vs. not buying, implying greater consumer's willingness to buy in Proposition 1(a).

On the other hand, when recalls lower the low quality under which the consumer will not buy, a lower level of  $q_L$  would increase the expectation of buying the product, as the gain utility  $(1 - \alpha)\eta(z + q_M - q_L)$  of buying relatively to not buying at the low quality level decreases in  $q_L$ . This is the “attachment effect” in Koszegi and Rabin (2006), as the consumer expects to buy the product more when she is attached to the product and the bar of not buying is dropped to a lower level, implying the consumer has a greater willingness to buy. In essence, recalls change the quality distribution under which the consumer expects to buy the product, which in turn changes her view of product quality as her reference in making the buying decision. This attachment effect can be found in many established brands. For example, Nikon, one of the best known camera manufacturers, recalled the battery packs of its D800 camera worldwide in September 2012. This, however, did not seem to negatively affect the “attachment” of its core customer base, as the D800 was still rated by photography addicts as the second best camera in the same year, despite the widely recognized potential burn hazard because of the battery pack problem (<http://www.dpreview.com/news/2013/01/01/best-camera-of-2012-results>).

In addition, as globalization of supply chains has become a ubiquitous industry-wide phenomenon (Mishra and Shah 2009), its association with recalls may have significant implications for firm performance. In fact, major corporations such as Mattel outsourced the manufacturing of a large portion of their products to Asian contract manufacturers to achieve cost savings through production and labor efficiencies (Beamish and Bapuji 2008, Tang 2008). The practice of offshoring may have direct effects on how consumers perceive product quality from an offshore source, because such products may be considered low price and low quality, or because of deeper personal traits such as ethnocentrism, patriotism, economic animosity, and perceived economic threats. More importantly, consumer attitude towards such products, in terms of the gain-loss utility, may be different when the consumer is aware that the products are offshored. Specifically, the consumer may become more loss averse after being informed of the source of the offshored products. For example, due to ethnocentrism, many domestic consumers tend to view one's own group as central and superior to those found in other societies, and feel more dissatisfied when the offshored products do not perform up to the high quality standard than similar domestic products (Durvasula and Lysonski 2009, Netemeyer, Durvasula and Lichtenstein 1991).

In contrast, consumers often feel affinity or emotional attachments to a domestically made product because of implicit value match, shared pride and history, or simply their sources of their employment and income (Durvasula and Lysonski 2009), and thus perceive less loss if the product quality is not up to their standard. Research generally supports the notion that highly ethnocentric consumers in the U.S. and other developed countries overestimate the value of domestic products, but underestimate the value of imports (Netemeyer et al. 1991, Sharma, Shimp and Shin 1995). Recent studies have found that American consumers who are more prone

to “Buy American” have various personal qualities such as empathy, social concern, and ethnonational tendencies (Granzin and Olsen, 2005). These qualities allow the consumers to be more tolerant of quality loss from domestically made products. The impact of recall on consumer’s willingness to buy may be influenced by the greater degree of loss aversion  $\lambda$  as a result of offshoring, which is discussed in the following proposition.

PROPOSITION 2. Offshoring increases consumer loss aversion; and a greater degree of consumer loss aversion,  $\lambda$  :

- a). Increases a consumer’s willingness to buy; and
- b). Mitigates the effect of recall on consumer willingness to buy.

Proposition 2(a) indicates that *ceteris paribus*, the greater the loss aversion  $\lambda$ , the lower the lowest acceptable quality  $q_W$ , and thus the higher consumer willingness to buy. This is because the greater loss aversion makes a consumer feel a greater sense of loss from not buying at a high quality than from buying below a high quality, indirectly increasing the consumer’s expectation to buy. Specifically, a greater degree of loss aversion would increase the loss,  $\alpha[\lambda\eta(-q_H - z) + p]$ , the consumer feels from not buying the product, relatively to the loss utility  $\alpha\lambda\eta(q_M - q_H)$  of buying at an intermediate quality. This would increase the consumer’s expectation and willingness of buying the product.

Proposition 2(b) examines the role of a greater degree of loss aversion, as a result of offshoring, on how recalls affect consumer willingness to buy. As Proposition 1 indicates, when recalls lower the probability of the consumer buying at the high quality, the loss the consumer feels from buying the product below the high quality is reduced, leading to a higher expectation of buying the product. This feeling of a loss, however, is strengthened by the greater degree of loss aversion under offshoring, which mitigates the reduction of the loss as a result of the recalls.

In other words, the reduction of loss felt from buying below the high quality due to recalls is offset to an extent by the greater loss aversion under offshoring. Consequently, the increase in expectation and willingness to buy following the recalls is tapered by greater loss aversion and offshoring.

In particular, from proposition 1, a lower  $\alpha$  as a result of product recalls decreases the loss utility  $\alpha\lambda\eta(q_M - q_H)$  of buying below the high quality and increases the gain utility  $(1 - \alpha)\eta(z + q_M - q_L)$  from buying at a higher quality, projecting a decrease in lowest acceptable quality to buy. However, the greater loss aversion  $\lambda$  due to offshoring intensifies the sense of loss of buying below the high quality, mitigating the decrease of the loss due to recall. The net result of recalls under a higher  $\lambda$  is the smaller decrease in  $q_W$ , the lowest acceptable quality to buy, indicating a smaller increase in expectation to buy.

Alternatively, product recalls may also lower the low quality level  $q_L$  under which the consumer does not buy the product, and therefore the lowest acceptable quality level to buy. As indicated in Proposition 1, the consumer expectation to buy is increased by the lower  $q_L$  as a form of the “attachment” effect. Offshoring, or a higher degree of consumer loss aversion, further intensifies the feeling of a loss from buying the product below the high level, because such a loss is also strengthened because of the higher consumer expectation to buy following the recalls. This too mitigates the effect of recalls in increasing the consumer willingness to buy the product being recalled. More specifically, when a lower  $q_L$  from recalls reduces the lowest acceptable quality of buying without offshoring, the greater loss aversion  $\lambda$  associated with offshoring amplifies the greater loss of buying below the high quality level with the increased expectation to buy. This greater sense of loss from buying offsets some of gains from buying

above  $q_L$ , i.e., reduces the “attachment” effect. Again in this case, the net effect of recalls under a higher  $\lambda$  is the smaller decrease in  $q_W$ , the lowest acceptable quality to buy, indicating a smaller increase in expectation to buy.

In sum, developed from the theoretical framework of consumer reference, our results indicate that when the consumer reference of product quality is endogenous, formed from the consumer’s perceived options of quality, the consumer’s willingness to buy may be positively affected by product recalls that may lower the probability of the quality level at which the consumer will buy the product or the quality level at which the consumer will not buy. This counter-intuitive result is because the perceived loss from buying the product (i.e. the loss associated with buying below the desired high quality level) is lower, or the expectation of buying the product at a quality higher than the new low quality is higher, with the recalls. Furthermore, the feeling of loss may be heightened with a greater degree of consumer loss aversion, as a result of supply chain offshoring, leading to a negative moderating effect on the positive effect of product recalls on consumer willingness to buy.

## EMPIRICAL ANALYSIS

The above results based on the consumer reference model have interesting empirical implications. First of all, an increased consumer willingness to buy as a result of recall indicates that recalls may actually improve the recall firm’s financial performance. Second, offshoring may lead to a greater willingness to buy and therefore could improve the firm’s financial performance. Third, offshoring may also moderate the relationship between recall and firm performance, indicating that if the recalled product is from an offshore source, the effect of recall may be mitigated.

Given the model implications, we propose the following empirical research questions: *First, is the total value of the recalled products positively associated with the recall firm's annual profits? Second, does offshoring of the product under recall weaken the association of the recall and firm profits?* The empirical operations literature has pointed out that recalls can result in substantial revenue and market share losses (Chen et al. 2009), but anecdotal evidence such as that of Tesla and Toyota suggests otherwise (Murphy and Ramsey 2014). Others have found insignificant stock market reactions to recalls (Thirumalai and Sinha 2011, Thomson and McKenzie 2001). Our analytical results further suggest that the effect of recall on consumer's willingness to buy may actually be positive, implying a possible positive association between recalls and firm performance. Furthermore, based on the stronger consumer attitude towards quality losses of products offshored (Durvasula and Lysonski 2009, Netemeyer et al. 1991, Sharma et al. 1995), we could argue that the effect of recalls on firm profit is negatively moderated by supply chain offshoring. In the following, we empirically examine these research questions by assembling a dataset with recall and firm performance information, constructing an econometric model connecting recall value and offshoring to firm profitability, and estimating the model with the assembled dataset to address the research questions. Our main empirical findings are highly consistent with the model results.

#### Research Setting and Data

In this research, we focus on firms that have filed recalls over the years covered in this research. As a result, we study the effects regarding the extent of recall, rather than compare firms with and without recalls. Our data on recalls were collected from the United States Consumer Product Safety Commission website ([www.cpsc.gov](http://www.cpsc.gov)). The following information was extracted from the CPSC recall announcements for this study: a) the date of recall; b) the name of the recalling



company and its position in the supply chain, i.e. manufacturer, distributor, or retailer; c) country of manufacturer; d) the number of units recalled; and e) the retail price of product recalled (Freedman et al. 2009, Hora et al. 2011).

Initially, 1770 recall announcement records were obtained from CSPA website from year 2007 to year 2012, but cases where the price of product, the number of units recalled, or the manufacturer country could not be identified were immediately eliminated. Also excluded were the cases where the recall company could not be clearly identified. To accurately capture the position of the recall company in the supply chain, we searched for and identified the business activities of the company to assure the accuracy of the position. In the next step, recall related information based on individual recall announcements was aggregated at the firm level. As a result, we collected the number of recalls each firm announced per year from 2007 to 2012, and calculated the total value of recalls for each firm per year. The sample, therefore, contains only firms with recalls.

To obtain a firm's financial performance and other firm-level information, we collected relevant data from Compustat to match with the firms in the recall dataset. The following information was extracted from Compustat for each firm: a) the global company key; b) fiscal year that each recall was included; c) sales of each identified fiscal year; d) profits of each identified fiscal year; and e) global industry classification standard code. Firms that cannot be identified in Compustat or were missing critical values such as profits or sales were omitted. The final dataset is an unbalanced panel dataset with 148 observations, which has 84 firms across six years in five industry sectors. These industry sectors include materials, industrials, consumer discretionary, consumer staples, and information technology. The highest number of recalls across years by firm is 9 and the lowest is 1.

### Econometric Model and Variables

In this study, we construct two empirical models to examine the effects of recalls in association with firm profits. The first model, Model 1, has only linear terms to show the direct effect of recalls, while the second, Model 2, contains an additional interaction term that indicates the moderating effect of offshoring on recalls. The dependent variable in both models is *Net Income (PROFIT)* of the firm, which represents the fiscal year income or loss reported by a company after subtracting expenses and losses from all revenues and gains. Profitability has been used as a measure of a firm's operating performance in similar extant studies (e.g., Hendricks and Singhal 1997, Zhang and Xia 2013).

The two key independent variables include *Total Recall Value (RECALL\_VALUE)*, and *Offshoring (OFFSHORING)*. *Total recall value* is the total value of the recalled products and is used to measure the extent of recall impact. In this study, annual recall value of a firm is based on the aggregated value of all the recalls by the firm in a year. The value of each recall is calculated as the product of two variables - the number of units of the products recalled and the retail price of each product recalled which separately have been used in a number of studies involving product recall (e.g., Chen et al. 2009, Hora et al. 2011). The number of units for the products recalled and unit prices can be directly extracted from the CPSC website. In the cases where different products were involved in a recall and the products have a range of prices, a volume-weighted value is calculated. For example, Build-a-bear announced recall of its Colorful Heart Teddy bears in 2011. It recalled 284,000 units in the United States and 13,200 in Canada. The retail price was \$18 in the U.S. and \$23 in Canada. The total recall value was calculated as  $\$18 \times 284,000 + \$23 \times 13,200 = \$5,415,600$ . Since recalled products vary significantly across firms,

total units of product or product price may be limited in measuring the extent of recall impact, whereas total recall value as aggregated by dollar value provides a better measure.

For offshoring, the geographical location of a recall source is identified to determine whether the recalled product is manufactured or sourced from an offshore party in the supply chain. Maruchek et al. (2011) point out that the growing complexity of global supply chains as the result of offshoring and outsourcing has created product safety and security challenges. Source countries of the recalled product are directly extracted from the recall announcements. For the purpose of this study, recalls from countries such as the United States and Canada are identified as domestic, whereas countries such as Mexico, China or European countries are categorized as offshoring. The offshoring variable is defined as a dummy variable, with offshoring being 1.

Control variables in the study include: *Sales (SALES)*, which represents gross sales (the amount of actual billings to customers for regular sales completed during the year) minus cash discounts, trade discounts, and returned sales and allowances for which credit is given to customers, for each operating segment. The information regarding firm sales was obtained from Compustat. *Sales* has frequently been used as a control variable in similar quality management studies (e.g., Jacob, Madu & Tang 2004, Chen et al. 2009, Thirumalai & Sinha 2011). *Industry (INDUSTRY)* is defined by following the Global Industry Classification Standard (GICS), which identifies industry sectors by using a two-digit industry taxonomy. Included in this study are Materials (15), Industrials (20), Consumer Discretionary (25), Consumer Staples (30), and Information Technology (45). We coded the industry variable as four dummy variables, where the base category is information technology industry.

In the following model, let subscript  $i$  denote firm and subscript  $t$  denote year:

$$\text{Model 1: } PROFIT_{it} = \beta_0 + \beta_1 SALES_{it} + \beta_2 RECALL\_VALUE_{it} + \beta_3 OFFSHORING_i + \sum_{j=4}^7 \beta_j INDUSTRY_{ij-3} + \varepsilon_{it}$$

$$\text{Model 2: } PROFIT_{it} = \beta_0 + \beta_1 SALES_{it} + \beta_2 RECALL\_VALUE_{it} + \beta_3 OFFSHORING_i + \beta_4 RECALL\_VALUE_{it} \times OFFSHORING_i + \sum_{j=5}^8 \beta_j INDUSTRY_{ij-4} + \varepsilon_{it}$$

Table 1 shows descriptive statistics such as sample means, standard deviations, and the correlation matrix for the key variables.

[Insert Table 1 about here]

In estimating the models with our unbalanced panel dataset, we conducted the following tests: first, variance inflation factor (VIF) showed a range of values between 1.17 to 3.71, much lower than the common cutoff value of 10 (Kennedy 2003), indicating that there is no multicollinearity. In addition, since SALES may be endogenous, we performed a Durbin-Wu-Hausman test, which is insignificant, indicating endogeneity is not a statistical concern. However, further tests for heteroscedasticity and autocorrelation suggested these were significant concerns, and as a result, we estimated the models using Feasible Generalized Least Square (FGLS) method (Greene 1997), with which we controlled for AR(1) and uncorrelated heteroscedasticity. We estimated the models using STATA 12, and tested a linear and a log-linear version of the models. All models fit well as the Wald Chi-square statistics are all significant, indicating that the null hypothesis of the coefficients being jointly zero is rejected. The results are consistent between the two. Table 2 shows the estimation results for the models. To check for robustness of our results, we also estimated a fixed effect model and the results are also consistent with the random effect model we present in the paper. The fixed effect model results can be obtained from the authors upon request.

[Insert Table 2 about here]

### Empirical Results and Discussion

The key empirical findings are mostly consistent with our analytical model results. Interestingly, based on the results from the log linear model with the interaction term, the total value of recalls of a firm (RECALL\_VALUE) is positively and significantly associated with the firm's final performance (PROFIT) ( $\beta = 0.136$ ,  $p < 0.001$ ). As indicated in the analytical results, recalls may indeed increase consumer willingness to buy, which may translate into higher firm profitability, everything else being equal. This is an important finding because despite the negative publicity of quality recalls, we argue that the change, as a result of the recalls, in consumer quality reference and buying behavior may actually motivate them to buy from the firms that have announced recalls, as they may be attached to the brand regardless of the quality. Our empirical findings provide significant evidence for the positive association between recall value and firm profits, which was also witnessed in recent recalls by Bose in 2012 of its home theater speaker system, as its sales increased from \$2.28 billion in 2011 to \$2.5 billion in 2013 (<http://www.forbes.com/companies/bose/>). Furthermore, the interaction term between recall value (RECALL\_VALUE) and offshoring (OFFSHORING) is negative and significant ( $\beta = -0.142$ ,  $p < 0.001$ ), indicating that the positive association between recalls and firm profitability is mitigated when the source of the recalled product is from an offshore manufacturer. This, too, offers significant empirical evidence for our analytical results, which indicate that offshoring, when it affects the degree of consumer loss aversion, may reduce the positive effect of recalls on consumer willingness to buy. Offshoring (OFFSHORING), which is not a focal variable in this study, shows mixed results depending on the function form and the interaction term. It is consistent with the globalization literature, which has documented mixed results from the extent

of globalization (Paul and Wooster 2010). However, the results may imply that recalls, as they are often associated with quality issues in the supply chain, do negatively affect the role of offshoring in the firm's financial performance.

The main control variable, the firm's annual sales (SALES), is positive and significant ( $\beta = 0.609$ ,  $p < 0.001$ ), and is highly consistent across models and treatments, and with literature (e.g., Majumdar 1997), indicating the effect of scale on firm profitability. The other control variables, i.e. industry dummies, are mixed. The materials and industrials industries are significantly more profitable than the information technology industry while the consumer industries are indifferent from the information technology industry.

This empirical analysis proposes two major implications developed from an analytical model of consumer decisions associated with product recalls. The first one connects the value of product recalls to firm profitability and the second focuses on the moderating effect of offshoring on the association between recall value and firm profitability. We find that the higher the value of recalled products, the greater the profits of the firm. This is consistent with our analytical results that indicate a product's potentially greater willingness to buy when it is recalled, but it is also counter-intuitive to conventional thinking with regard to quality recalls. Literature related to recalls has shown mixed results, relying mostly on stock market return as the recall impact variable—some argue that recalls have both short- and long-term effects on the firm's financial performance due to its negative impact on customer satisfaction, brand loyalty and value, and future demand; however, others have found insignificant impact of recalls (e.g., Archer and Weslowski 1996, Thirumalai and Sinha 2011). The reasons range from the nature of the quality problems behind the recalls to firm strategies recovering from the recalls (Chen et al. 2009). However, most of such studies are based on stock market reactions (see, for instance, a summary

of these studies in Zhao et al. (2013)), which represent mostly investors' attitude instead of customers' attitude and are short-term in nature, and none has found a positive association between recalls and firm performance. In fact, Archer and Weslowski (1996) find that product recalls do not impact customer loyalty to manufacturer or dealer, supporting our notion of "attachment effect" identified in our model. Moreover, Chen et al. (2009) suggest that in product-recall crises, though overtly socially responsible behavior by a firm may generate positive responses from consumers, it may be interpreted by the stock market negatively. This research examines the effect of product recalls from a consumer reference perspective and indicates that consumer purchase decisions reacting to recalls are more complicated, which indicates that a potential positive response to recalls may have a longer term, positive effect to firm profitability.

Also interesting is the role of offshoring in moderating the association of recall and firm profitability. Our analytical results suggest that if offshoring leads to a change in the degree of consumer loss aversion toward the recalled product, offshoring will mitigate the positive association of recalls and firm financial performance. Our empirical findings indeed show that the interaction between offshoring and recall value produces a negative and significant moderating effect, which reduces the positive and significant role recalls play in firm financial performance. On average, a firm's annual product value involved in recalls generates a marginal profit of 13.6% toward its annual net income, when the products involved are manufactured domestically. However, when the products are offshored, this marginal value turns to negative, or a -0.06% toward its annual profit ( $0.136 - 0.142$ ). Therefore, in an industry that is overwhelmingly offshored, such as toys, recalls may indeed damage the firm's bottom line.

## CONCLUSION

In this study, we examine the effects of product recalls on consumer buying decisions analytically and firm profitability empirically. Following recent developments in behavioral economics, we propose a consumer reference model to connect quality recalls and consumer willingness to buy. We further incorporate offshoring of the recalled products as it affects consumer loss aversion, and develop a moderating effect of offshoring on the relationship between recalls and firm profitability. These effects have direct implications to firm financial performance and are tested based on an archival panel dataset developed from CPSC recall records and Compustat. In particular, we construct and test an empirical model focusing on the relationship between the value of product recalls and firm profitability, moderated by offshoring of the recalled products.

Using the modeling framework developed by Koszegi and Rabin (2006), we have established direct impacts of product recalls on consumer willingness to buy. Interestingly, we found that such impacts can be positive, which is counter-intuitive to common belief and the recall literature. In addition, we have identified a negative role of offshoring in moderating the positive effect of recalls on consumer willingness to buy. This helps explain why much of the evidence of recalls has been negative. The empirical tests of the implications of the analytical results have consistently supported the positive effect of product recalls and the negative role of offshoring in moderating the relationship between recalls and firm profitability. In fact, we found that a greater value of recalls by a firm is positively associated with a higher profit level of the firm, controlling for offshoring. However, offshoring has a negative moderating effect that could turn the positive effect of recalls on firm profitability to negative.



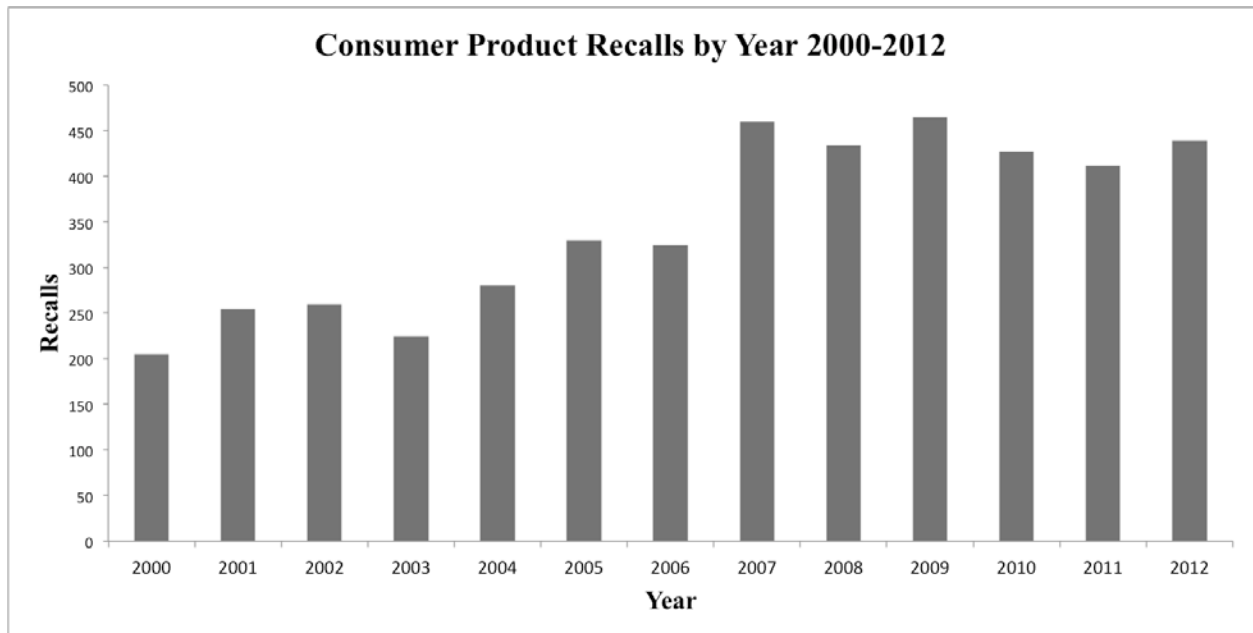
This research, based on analytical modeling and empirical analysis, contributes to the operations literature as follows. First, previous literature on product recalls have reported mixed results regarding the impact of recalls (Zhao et al. 2013, Shah, Bell, Netessine 2013). While some have found the recall impact insignificant, none has proposed or found a positively association between recalls and firm performance; nor has any explored the recall impact from a theoretical perspective of consumer decision-making. Based on a framework of consumer reference, we show that the psychological gain and loss a consumer feels from buying, or not buying, the product involved in recalls may lead to a higher willingness to buy the product. For example, a consumer may be attached to the product or the brand such that when recalls lower the bar under which she will not buy, her expectation to buy may actually increase. Such a view has been supported by the empirical evidence that negative incidents such as product recalls do not impact customer loyalty to manufacturer or dealer (Archer and Weslowski 1996). This new perspective of product recalls and consumer reference modeling has not been explored in the extant literature. Second, while product recalls are often associated with outsourcing or offshoring the products' manufacturing processes, and sparse evidence has linked aspects of recalls to offshoring (Hora et al. 2011, for example), little research has been done to examine the role of offshoring in the effects of product recalls (Beamish and Bapuji 2008). This research is the first such effort, to our best knowledge, to investigate this role of offshoring, and has established analytical results and empirical findings that indicate a negative moderating effect of offshoring toward the relationship between recalls and consumer willingness to buy, as well as firm profitability.

The findings of this research also have significant implications to practitioners. A better understanding of recall impact is necessary to better control recalls and to minimize the negative

aspects of recalls. However, an assumption that recalls always negatively affect consumer willingness to buy and firm profitability is not necessarily true. Rather, firms should focus on building brand loyalty and long term quality reputation of their products to minimize the negative exposure of quality risks. Furthermore, it is essential to connect recall impact to supply chain offshoring, as offshoring plays a significant role in how recalls affect firm performance. A firm that has an extensive part of its supply chain offshored should be more cautious to potential quality issues that may lead to product recalls.

Our research findings, in that recalls may have positive effects on consumer willingness to buy and firm performance, are counter-intuitive. While we provide explanations based on behavioral economics, these findings call for more in-depth investigations regarding the nature of recalls and their impact on consumer behavior and firm performance. Taking a fresh perspective of consumer reference to study recall impact, and combining an analytical model and an extensive empirical study, this research is inevitably limited by the extent to which each methodology can be applied. To focus on the key issues and to coordinate the analytical and empirical studies, we made an effort to simplify the models and analyses while concentrating on the most important aspects of each analysis. Future study can be conducted to first, examine other potential effects of recall combined with offshoring, and capture the benefit and cost tradeoffs involved in different recall strategies; and second, to expand the coverage of the panel data.

**Figure 1. Total Annual Recalls of Consumer Products: 2000-2012**



Source: Consumer Product Safety Commission (CPSC) and National Highway Traffic Safety Administration (NHTSA).

**Table 1: Descriptive Statistics and Correlation Matrix (N= 148)**

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8
1. Net Income (\$ million)	1308.128	3582.926	-12650	16999	1.000							
2. Sales (\$ million)	32434.68	81053.04	1.253	467231	0.844	1.000						
3. Total Recall Value (\$)	4.02e+07	1.15e+08	4500	8.67e+08	0.235	0.157	1.000					
4. Offshoring	0.784	0.413	0	1	0.057	0.135	-0.362	1.000				
5. Materials Industry	0.027	0.163	0	1	-0.045	-0.054	-0.025	-0.216	1.000			
6. Industrials Industry	0.162	0.370	0	1	0.032	-0.063	0.134	-0.481	-0.073	1.000		
7. Consumer Discretionary Industry	0.669	0.472	0	1	-0.266	-0.308	-0.073	0.363	-0.237	-0.625	1.000	
8. Consumer Staples Industry	0.074	0.263	0	1	0.482	0.608	-0.019	0.024	-0.047	-0.125	-0.403	1.000

**Table 2: Estimation Results (Dependent Variable – Net Income)**

	Linear Model Net Profit		Log Linear Model Net Profit	
	Linear Terms Model 1	With Interaction Model 2	Linear Terms Model 1	With Interaction Model 2
Intercept	-2730.497 (3375.767)	-3093.008 (3390.039)	-4.254*** (0.707)	-4.205*** (0.725)
Sales	0.045*** (0.002)	0.044*** (0.002)	0.618*** (0.021)	0.609*** (0.024)
Total Recall Value	1.81e-06* (7.21e-07)	3.89e-06*** (9.82e-07)	0.014* (0.006)	0.136*** (0.024)
Offshoring	208.207 (161.773)	692.427 (126.950)***	-0.263* (0.115)	0.010 (0.112)
Interaction Term	--	-5.54e-06* (2.55e-06)	--	-0.142*** (0.028)
Materials Industry	2761.273 (3372.163)	2938.743 (3388.662)	1.351* (0.664)	1.525* (0.683)
Industrials Industry	2663.998 (3375.313)	3148.008 (3389.277)	1.259 <sup>+</sup> (0.671)	1.130 <sup>+</sup> (0.688)
Consumer Discretionary Industry	2342.633 (3371.919)	2181.721 (3389.472)	0.856 (0.661)	0.836 (0.681)
Consumer Staples Industry	-1466.646 (3447.315)	-816.184 (3462.713)	0.459 (0.661)	0.500 (0.680)
<b>Model Statistics</b>				
N	148	148	148	148
Wald Chi2	4108.35***	4278.13***	29805.53***	9525.59***

a) +  $p < 0.10$ ; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

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