ESSAYS ON PRODUCT FAILURES AND FIRM FINANCIAL PERFORMANCE

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Koç University

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ABSTRACT

Essays on Product Failures and Firm Financial Performance

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Product failures are commonly experienced across different industries. In this dissertation, the factors that determine the effects of product failures on firm market value and firm risk are examined in various industries including automotive, food, consumer electronics, cosmetics, telecommunication, and airlines. In the first essay, we study "*Product Discontinuation and Firm Market Value,*" the effect of firms' product discontinuation decisions on their markets. The findings offer important insights. First, product discontinuation announcements negatively influence both the short- and long-term stock returns. Second, product discontinuation announcements are linked to positive firm motivations such as new product development leads to positive stock returns in the short-term. Third, product discontinuation announcements with negative reasons, such as product or commercial failures, receive a higher weight and negatively affect the long-term stock returns. Fourth, product discontinuation announcements that provide a reason associated with the firm's resources or strategies (firm-specific announcements) result in lower stock returns compared to those that state a reason linked to particular industry (industry-specific announcements) in the long-term. Finally, firms' high marketing capabilities positively (negatively) affect the relationship between the product discontinuation announcements and the short-term (the long-term) stock returns. These findings have significant implications for

both the literature that focuses on the impact of marketing decision on firm market value and firms' marketing strategies. For the literature, the findings (1) are related to the understudied phenomenon of product discontinuation and (2) offer evidence linked to both the short- and long-term stock returns. Moreover, they provide evidence regarding the effects of the firms' innovation capacities on their short- and long-term stock market returns, which are missing in the literature. For firms' marketing strategies, the findings suggest that managers can emphasize the discontinuation rationale in their announcements to lessen the financial losses from their product discontinuation decisions, and subsequently build a reputation as a successful innovator.

In the second essay, "*Innovative Product Recalls and Firm Financial Performances: Firm Market Value and Unsystematic Risk,*" I study the change in both firm market value (i.e., the short- and long-terms) and firm risk (i.e., unsystematic equity risk) due to innovative product recalls. This essay argues that the certain recall- and innovation-related factors may influence the relationship between recalls of innovative products and firm market value and firm risk. The findings show that recall volume and recall severity exerted a negative effect in the short-term. Recall severity also positively influences the long-term stock returns. Voluntary recalls, on the other hand, lead to lower stock market returns compared to involuntary recalls of innovative products in the long-term. Furthermore, the results indicate that recall time negatively affects stock market returns in the long-term while it positively associated with increases in unsystematic risk. Lastly, innovation type positively affects the stock market returns in the short-term.

These insights are of great interest to both researchers and practitioners. For researchers, as contingency factors, recall time, innovative product life, and innovation type may contribute to the development of both recall and innovation literature by serving as boundary conditions. For managers, it is important to show the roles of these conditions on firm market value and

unsystematic equity risk. Managers' recall strategies may in fact depend on these conditions. Indeed, they can create strategies where the recall time and/or recall severity play key roles on developing such strategies. Moreover, managers pay great attention to the unsystematic equity risks, which often signal the firms' capabilities to stabilize their cash flow and enter new businesses. They can strategically rely on unsystematic equity risks due to innovative product recalls to predict the stability of their firms' future cash flow and evaluate the opportunity of new businesses.

ÖZETÇE

Ürün Başarısızlıkları ve Firma Finansal Performansı Üzerine Denemeler

İsmail Erzurumlu

İşletme, Doktora

Ağustos 29, 2019

Birçok endüstride başarısız ürünlerle karşılaşabiliyoruz. Bu tez çalışmasında, otomotiv, gıda, tüketici elektroniği, kozmetik, telekomünikasyon ve havayolları dahil olmak üzere çeşitli sektörlerde başarısız ürünlerin firmaların piyasa değeri ve piyasa riski üzerindeki etkilerini belirleyen faktörler incelenmiştir. Spesifik olmak gerekirse, ilk çalışmada "Ürün Sona Erdirme ve Firma Piyasa Değeri," firmaların ürünlerini piyasadan temelli çekme (ürün sona erdirme) duyurularının piyasa değeri üzerindeki etkisi incelenmiştir. Bulgular önemli görüşler sunmaktadır. İlk olarak, ürün sona erdirme duyuruları hem kısa hem de uzun vadeli hisse senedi getirilerini olumsuz etkilemektedir. İkinci olarak, ürünü sona erdirme nedeni yeni ürün geliştirme gibi olumlu firma motivasyonları ile ilişkilendirildiğinde kısa vadede pozitif hisse senedi getirilerine yol açmaktadır. Üçüncü olarak, ürün sona erdirme nedeni ticari başarısızlık gibi negatif gelişmelere dayandığında uzun vadeli hisse senedi getirilerini daha da negatif yönde etkilerken, sebepler endüstriyel gelişmelere (firmanın kendi kaynak yetersizligi yerine) temellendirildiğinde uzun vadeli hisse senedini getirilerini pozitif etkilemektedir. Son olarak, firmaların yüksek pazarlama becerileri, ürün sona erdirme duyuruları ile kısa vadeli (uzun vadeli) hisse senedi getirileri arasındaki ilişkiyi pozitif (negatif) olarak etkilemektedir. Bu bulgular, pazarlama kararlarının firma piyasa değeri üzerindeki etkilerine odaklanan literatür için önemlidir. Literatüre katkısı açısından

bakıldığında, bulgular (1) daha önce araştırmalara konu olmayan ürün sona erdirme olgusuyla ilgilidir ve (2) hem kısa hem de uzun vadeli hisse senedi getirileriyle bağlantılı kanıtlar sunmaktadır. Ayrıca, firmaların inovasyon kapasitelerinin kısa ve uzun vadeli borsa getirileri üzerindeki etkileriyle ilgili kanıtlar sunmaktadır. Firmaların pazarlama stratejileri açısından bakıldığında, bulgular yöneticilerin ürün durdurmanın neden oldugu finansal zararları azaltmak için yaptıkları açıklamalarda durma nedenini vurgulayabileceklerini ileri sürmektedir.

İkinci çalışmada, "Innovatif Ürünlerin Geri Çağırılması ve Firma Finansal Performansları: Firma Piyasa Değeri ve Sistematik Olmayan Risk," inovatif ürünlerin geri çağırılmasının hem firma piyasa değerindeki (kısa ve uzun vadeli) hem de piyasa riskindeki (sistematik olmayan hisse senedi riski) değişimler incelenmiştir. Bu araştırma bazı ürün geri çağırma ve innovasyon ile ilgili faktörlerin inovatif ürünlerin geri çağrılması ile firma piyasa değeri ve piyasa riski arasındaki ilişkiyi etkileyebileceğini savunuyor. Bulgular geri çağrılan ürün sayısının çok olmasının ve hasarın/hatanın taşıdığı olası riskin büyüklüğünün kısa vadede negatif etki yarattığını göstermektedir. Gönüllü ürün geri çağırmalar uzun vadede gönüllü olmayan ürün çağırmalara kıyasla daha düşük hisse senedi getirilerine yol açmaktadır. Dahası, sonuçlar ürün geri çağırma süresinin borsa getirilerini olumsuz yönde etkilediğini, sistematik olmayan riski artırdığını göstermektedir. Son olarak, inovasyon türü kısa vadede borsa getirilerini pozitif yönde etkilemektedir. Bu bulgular hem akademisyenler hem de yöneticiler için önemlidir. Akademisyenler için, ürün geri çağırma süresi, inovatif ürünün pazarda bulunma süresi ve inovasyon türü hem ürün geri çağırma hem de inovasyon literatürünün geliştirilmesine katkıda bulunabilir. Yöneticiler için ise, bu faktörlerin firma piyasa değeri ve sistematik olmayan hisse senedi riski üzerindeki rollerini göstermek açısından önemlidir. Yöneticilerin ürün geri çağırma stratejileri bu faktörlere bağlı olabilir. Dahası, ürün geri çağırma süresinin ve/veya hasarın/hatanın taşıdığı olası riskin büyüklüğü bu

tür stratejilerin geliştirilmesinde kilit rol oynayabilir. Ayrıca, yöneticiler firmaların nakit akışları dengesini ve yeni marketlere başarılı şekilde girip girememe becerilerini tayin edebilmeleri için sistematik olmayan hisse senedi risk rakamlarına büyük önem verirler. Inovatif ürününlerini geri çağırma kararı alan yöneticiler, stratejik olarak sistematik olmayan hisse senedi risk rakamlarını temel alarak, firmalarının gelecekteki nakit akış istikrarlarını ve yeni pazar fırsatlarını öngörebilirler.

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ABBREVIATIONS

AR	Abnormal Returns
APEAL	Automotive Performance, Execution and Layout
BHAR	Buy-and-Hold Abnormal Returns
CAR	Cumulative Abnormal Returns
CPSC	Consumer Product Safety Commission
CRSP	Center for Research in Security Prices
FDA	Food and Drug Administration
GARCH	Genaralized Autoregressive Conditional Heteroskedastic
LGAR	Long-Term Abnormal Stock Returns
NHTSA	National Highway Traffic Safety Administration
OLS	Ordinary Least Squares
SHAR	Long-Term Abnormal Stock Returns

CHAPTER 1

INTRODUCTION

> *"Many people dream of success. Success can only be achieved through repeated failure and introspection. Success represents the one percent of your work that results from the 99 percent that is called failure."*
>
> Soichiro Honda, the founder of Honda

Approximately 40% of new products fail on the market (Castellion and Markham 2012). According to the U.S. based market research firm, the rate of product failures across different industries is even more pessimistic: 80 to 90% (Copernicus Marketing, Consulting and Research, 2010). Products fail due to commercial or technical failures. *Product commercial failures* linked to poor sales or low demand are among the negative reasons that lead firms to make product discontinuation decisions. For instance, Crystal Pepsi failed in the second year due to its poor sales and hence PepsiCo discontinued the caffeine-free soft drink in 1993. *Product technical failures,* on the other hand, are associated with undesirable consequences of product use, particularly with safety concerns. In such cases, firms either discontinue or recall their products. For example, Pfizer discontinued its arthritis treatment drug Valdecoxib due to heart attack and stroke concerns in 2005. Dell, on the other hand, recalled 4.1 million fire-prone lithium-ion batteries and offered a replacement as a remedy in 2006. This recall is one of the largest recalls for electronics in history (O'Brien 2014; Dividend.com).

Product discontinuation is different from product recall. Product discontinuation is a permanent decision linked to either a commercial failure or a technical failure. In other words, product discontinuation occurs when a firm decides not to carry or produce a product in order to address its commercial loss or meet safety standards. For instance, in 2007, The

Coca-Cola Company discontinued the coffee-flavored Coca-Cola BlāK in the U.S. due to commercial failure. On May 20, 2014, Petco Animal Supplies announced that the company would stop selling their dog and cat treats made in China by the end of 2014, amid growing concerns that the treats were linked to pet illnesses and deaths (technical failure).

Product recall, on the other hand, is a temporary decision which is associated with only technical failure. Product recall occurs when a product fails to meet an obligatory safety standard, contains a defect that could cause considerable harm to consumers, creates an unreasonable risk of serious injury or death, or fails to comply with a voluntary standard adopted by the specific industry (Chen et al. 2009). The recalling firm must retrieve all the unsafe products from its distribution channels and provide remedies such as repair, replacement, or refund. Moreover, product discontinuation is a voluntary (the firm takes the initiative) decision while product recall is either a voluntary or an involuntary (government-ordered) firm decision (e.g., Siomkos 1989; Haunschild and Rhee 2004). Indeed, the Consumer Product Safety Commission (CPSC) and the U.S. Food and Drug Administration (FDA) may request a recall of consumer products, foods, and drugs, respectively. For example, in March 2010, Graco voluntarily recalled more than 1 million of its Harmony high chairs, addressing hundreds of complaints that the high chairs were prone to tipping over, and provided a free repair kit. 24 injured children were reported (O'Brien 2014; Dividend.com).

Prior research is yet to examine product discontinuation. The link between product discontinuation and firm financial performance in particular is missing. My first essay seeks to fill this void and addresses the following research questions: first, what are the effects of product discontinuation on firms' stock market performance? Second, what are the announcement-related and firm-related factors that may influence the relationship between product discontinuation and firms' stock market performance? Drawing upon both signaling theory (Spence 1974) and impression management theory (Tedeschi and Reiss 1981; Elsbach

and Sutton 1992; Elsbach 2003), the first essay argues that product discontinuation announcements may serve as signals to the market. Moreover, announcement-related and firm-related factors may influence the direction and magnitude of the signal, influencing investors' decisions. Thus, the relationship between product discontinuation and firm market value may be contingent on these factors. To test this relationship, event study methodology for short-term stock returns and buy-and-hold abnormal returns (BHAR) for long-term stock returns were used. The data sample covers a 17-year period from 1996 to 2012 and a total size of 159 product discontinuation announcements. The results contribute to both literature and managerial perspectives. For the literature, they provide important insights into the relationship between product discontinuation and firm market value, and address asymmetries between the short- and long-term effects of product discontinuations on firm market value. For managers, the results suggest that relying on impression management tactics, they can reduce the financial losses from their product discontinuation decisions by stressing the discontinuation reason in the announcement.

Contrary to product discontinuations, product recalls have received considerable attention from scholars. Specifically, researchers try to understand the linkage between product recalls and short-term stock returns. They show that product recalls lead to short-term losses in firm market value (e.g., Jarrell and Peltzman 1985; Hoffer et al. 1988; Davidson and Worrell 1992; Thomsen and McKenzie 2001; Chen et al. 2009; Zhao et al. 2013). However, theoretical and empirical evidence for the question of whether product recall influences the firm market value in the long term are lacking. Puritt and Peterson (1986) argue that the effect of a product recall on firm market value may exist in the long-term. Similarly, the effect of an innovative product recall may last for the months following the recall announcement due to a decrease in investor trust in the firms, influencing their behavior in the long-term.

The market efficiency theory assumes that investors immediately understand the information of the firm's decisions and assess the financial consequences of these decisions. Thus, they take action within a short period of time. However, if each and every one of the investors immediately understands a particular piece of information, evaluates the possible outcomes, and acts accordingly, none of them beats the stock market in the short-term. That is, there is no point investing in such a market in the short-term. On the other hand, rational learning literature argues that investors need to observe a series of realized events as well as their economic outcomes before acting. Therefore, stock prices vary not only when new information becomes available but also when investors improve their understanding of the different economic relationships that form the market dynamics (Sorescu et al. 2007b). We argue that in the short-term, investors are more likely to be oriented towards taking a positive outlook on the future of a focal firm, negatively evaluating its product discontinuation or product recall announcement. However, in the long-term, they may be more oriented towards seeing a broader picture. They may perceive the discontinued product as outdated and assess whether the focal firm is capable of replacing the discontinued product and whether it keeps producing competitive products in the future. In the case of product recall, they may assess whether the focal firm is capable of terminating the recall process in a short time efficiently and effectively. Moreover, they may evaluate how severe product recalls and/or product recalls with high volume affect the recall termination period. Therefore, we argue that diversely encoded product discontinuation or product recall announcements for the different time horizons may lead to divergent stock returns in both the short-term and the long-term. Thus, it is important to focus on both short-term and long-term abnormal stock returns due to product discontinuation and product recall decisions.

Moreover, the existing literature differentiates between kinds of product recalls, based on their product category, recall initiator, and recall severity. However, investors may place a

greater value on product innovativeness and hence innovative firms receive high shareholder returns (Jonash and Sommerlatte 1999). They may, on the other hand, severely punish innovative firms when these firms fail to deliver their innovative products. This failure may result in a decrease in the firm market value and an increase in firm risk due to the firms' future cash flow variability. Furthermore, the link between a product recall and firm risk is missing in the literature. However, marketing decisions such as innovative product recalls may affect the variability of the firms' cash flow, influencing their firm risks (Srinivasan and Hanssens 2009). Overall, the second essay seeks to fill these gaps in the literature and to investigate the effects of innovative product recalls both on firm market value (short- and long-term) and firm risk (i.e., unsystematic equity risk). Drawing upon signaling theory (Spence 1974), this essay argues that the magnitude of the effect may be determined by innovation and recall characteristics. Specifically, the following research questions are addressed: (1) what are the effects of innovative products' recalls on firms' stock market performance? (2) What is the effect of innovative products' recalls on firms' unsystematic equity risks? (3) What are the innovation-related factors that may influence the relationship between innovative products' recalls and firms' stock market performance and unsystematic equity risks? (4) What are the recall-related factors that may affect the relationship between innovative products' recalls and firms' stock market performance and unsystematic equity risks? To address these questions, product recall announcements of U.S. automotive companies listed on the New York Stock Exchange were extracted from LexisNexis. The data sample covers a period from 2009 to 2016. The automobile industry was chosen for the focus of the study due to its economic importance and high innovation investments linked to intense styling competition in this industry (Millner and Hoffer 1993; Pauwels et al. 2004). Event study methodology for the short-term abnormal returns, buy-and-hold abnormal returns (BHAR) for the long-term stock returns, and unsystematic risk employed. The results guide

both researchers and managers. For researchers who are interested in product recalls, innovation, or marketing-finance interface, the results offer insights into novel innovation (i.e., innovation type) and recall characteristics (i.e., recall time) that affect the relationship between recalls of innovative products and firm market value and unsystematic equity risk. For managers, the results provide them with an understanding of the financial consequences of recalls of innovative products, and certain factors that influence such consequences. Thus, managers can rely on this knowledge to (1) assess the risk of an innovation project and (2) create recall strategies, which take these factors into account to reduce the financial losses due to recalls of innovative products.

CHAPTER 2

PRODUCT DISCONTINUATION AND FIRM MARKET VALUE

2.1 Introduction

For effective positioning, firms strive to build product portfolios in which all products are complementary to one another (Morgan and Rego 2009), and are balanced in terms of their market potential and/or technical qualifications. Through product portfolio management, companies better assess the sales potential of their products, monitor their competitors' actions, and manage crises such as product recalls. Hence, effective portfolio managements often require the development of new products to replace dying ones. *Product discontinuation* is among the firms' product portfolio strategies, and involves a firm's strategic decision to cease the production of a product and consequently take it off the market. The product may or may not be superseded by a superior product. For example, in fast-moving consumer goods, Doritos Black Pepper Jack was on the shelves for about a decade, but was discontinued in 2008. Tic Tac recently confirmed the discontinuation of its Cinnamon and Spearmint flavors. In the high-tech market, Amazon killed one of its biggest e-readers, Kindle DX in 2014 and Apple stopped manufacturing IPhone 6 in late 2016.

Many organizations have formal product discontinuation programs. Hise and McGinnes (1975) show that all of the ninety-six Fortune 500 companies in their study have product discontinuation programs with some degree of formality and structure. Specifically, product discontinuation helps trim the products in the portfolio. LG Electronics, one of the world's largest electronic-good producers, frequently discontinues its TVs to introduce new fashionable TVs. These decisions may result in savings in overhead, production, and inventory costs. Moreover, the discontinuation of a product may create slack resources,

which can be employed for the improvement of the products retained. Therefore, product discontinuation helps firms address the changes in dynamic markets. However, these decisions may generate unfavorable stock market reactions. Specifically, investors may perceive product discontinuation decisions as negative events when they consider the reactions of the firms' customers, competitors, and distributors on such decisions. Customers who cannot find the discontinued products may satisfy their needs by purchasing substitute products from the competitors. Thus, investors expect a loss in the firms' future sales revenue (Davidson and Worrell 1992). They may even expect competitors to launch substitute products in highly competitive markets (Bayus et al. 2001). Moreover, investors may foresee a damage in channel relationships when the discontinuing firms fails to deliver the promised products to the channel partners (Anderson and Weitz 1992). Overall, product discontinuations may hurt firm market outcomes due to the loss in future sales revenue, economies of scale, and channel equity. Hence, the question as to whether the benefits of the product discontinuation decisions outweigh their detriments remain unanswered.

Due to such benefits and detriments, these decisions are of great interest to both managers and investors. For example, in 2014, Robert Yi, the Head of Investor Relations at Samsung Electronics Co., as a part of his impression management duties, informed their investors about their decision to discontinue 25% to 30% of their smartphones for cost efficiency purposes (Lee and Cheng 2014). Given that his statement entailed an early market warning to avoid possible cash flow fluctuations, the company's stock prices did not significantly change (0.3% in a three-day window) after the information was disclosed.

Hence, as part of their impression management duties, managers may purposefully share their product discontinuation decisions to influence the stock market and/or decrease market uncertainty (Lee and Cheng 2014). Indeed, firms' product discontinuation decisions are regularly featured on the news. For instance, on July 7, 2007, BevReview, which provides

beverage reviews and commentary on non-alcoholic soft drinks, declared that Coke decided to kill Coca-Cola BlāK in the United States. Precisely, the website stated "*Coke has discontinued U.S. sales of the blended Coca-Cola and coffee concoction it introduced 17 months ago in 8-ounce bottles wrapped in mocha-brown plastic, the company confirmed Thursday. Coca-Cola spokesman Scott Williamson said the company's bottlers will continue making and selling Coca-Cola BlāK until concentrate supplies run out. He said he didn't know how long that will take*" (BevReview 2007).

Despite the prevalence of product discontinuations in practice, scholarly research is yet to investigate this phenomenon. Particularly, there is lack of evidence in the marketing literature on the effects of product discontinuation decisions on firm performance. The current research seeks to fill this gap, and examines both the direction and the magnitude of the change in firm market value due to product discontinuation announcements. Specifically, the following research questions are addressed: First, what is the effect of product discontinuation on firms' stock market performance? Second, what are the announcement-related and firm-related factors that may influence the relationship between product discontinuation and firms' stock market performance? Drawing upon both signaling theory (Spence 1974) and impression management theory (Tedeschi and Reiss 1981; Elsbach and Sutton 1992; Elsbach 2003), we argue that (1) product discontinuation announcements serve as signals to the market; (2) certain announcement-related factors (i.e., the reasons to discontinue the product and the specificity in the discontinuation announcement) and firm-related factors (i.e., marketing capability and innovation capacity) may function as signal cues, influencing the subsequent investor reactions. We posit that the relationship between product discontinuation decisions and firm market value may be contingent on these boundary conditions.

This paper offers managerial insights into whether product discontinuation announcements can be used as marketing tools to reduce the stock market losses; thus, the insights are relevant to practitioners. The remainder of the paper is organized as follows. First, we begin by providing a brief review of the discontinuation literature. This is followed by our hypotheses on how product discontinuation announcements may affect firm market value. We then describe our empirical strategy and results, followed by a set of robustness tests to resolve questions about endogeneity, unobserved heterogeneity, and self-selection biases. We conclude with a discussion of our results with an emphasis on key issues and implications for theory and practice.

2.1.1 Product Discontinuation

Corporations oftentimes make firm (often referred as firm divestiture), brand, and/or product discontinuation decisions (e.g., Lee and Madhavan 2010; Wiles et al. 2012; Hise and McGinnis 1975). While there is no prior study examining the relationship between product discontinuation decisions and stock market performance, the market value effects of firm divestment and brand divestment decisions have been widely studied (Please see Table 2.1).

A large stream of literature on firm divestment announcements documents the positive short-term effects (e.g., Montgomery et al. 1984; Wright and Ferris 1997; Alexandrou and Sudarsanam 2001; Lee and Madhavan 2010), while Hanson and Song (2003) report long-term positive abnormal returns to firms' divestment decisions. Firm divestment involves adjustments to firm ownership and business portfolio via spin-offs, equity carve-outs, split-ups, or unit sell-offs (Brauer 2006). Brand divestment, on the other hand, is a firm's strategic decision to sell its brand to another party or delete its brand to adjust its own brand portfolio structure. Generally, brand divestment decisions lead to negative abnormal returns (Depecik et al. 2014; Wiles et al. 2012; Morgan and Rego 2009; Desai and Jain

1999). Regarding the long-term effects of brand divestment, Desai and Jain (1999) find that spinoffs lead to positive abnormal returns.

Even though there are similarities between product discontinuation decisions and other types of divestment decisions (Hise and McGinnes 1975; Tomkovick 1993; Martin 2002; Depecik et al. 2014; Wiles et al. 2012; Morgan and Rego 2009; Desai and Jain 1999), there still remain some differences. Firms make product discontinuation decisions to resolve product technical and/or commercial failures, or to respond to the market through new product and/or market development (Hise and McGinnes 1975; Tomkovick 1993; Martin 2002). While product discontinuation decisions involve the cease of the production of a single product or product line, brand divestment decisions refer to the un-shelving of a brand with several product categories. In other words, product discontinuation activity refers to a *permanent* action as killing the product or service whereas brand divestments generally entail the transfer of specific assets across firms (c.f., Depecik et al. 2014; Wiles et al. 2012). This means that consumers may still have access to the products of the divested brand, when the brand is sold to and produced by a different company (Wiles et al. 2012). Therefore, investors may have different reactions to firms' product discontinuation decisions compared to brand divestment decisions.

Product discontinuation decisions are also different from product recalls. Product discontinuation (due to a product technical failure) is a permanent decision, not to carry or produce a particular product, to meet safety standards. For instance, in 2014, Petco Animal Supplies decided to stop selling their dog and cat treats made in China by the end of 2014, amid the growing concerns that the treats were linked to pet illnesses and deaths. Product recalls, on the other hand, are temporary decisions in which the firm retrieves the recalled products from all distribution channels. Firms make recall decisions when a product fails to meet an obligatory safety standard, contains a defect with potential harm to consumers,

creates an unreasonable risk of serious injury or death, or fails to comply with a voluntary standard adopted by their specific industry (Chen et al. 2009). For instance, Toyota recalled around 2.3 million vehicles in 2010 to address one of the well-publicized incidents in which fatal accidents occurred due to faulty acceleration in the vehicles. Moreover, product discontinuation is a voluntary decision (a firm takes initiative) while product recall may be either a voluntary or an involuntary (government-ordered) firm decision (e.g., Siomkos 1989; Haunschild and Rhee 2004), ordered by institutions like Consumer Product Safety Commission (CPSC) or U.S. Food and Drug Administration (FDA). Finally, discontinuing firms may not offer substitute products or any other remedy while recalling firms provide remedies such as repair, replacement, or refund.

Table 2.1. Discontinuation and Firm Market Value

	Firm	**Brand**	**Product**
Short-term	Montgomery et al. (1984) Wright and Ferris (1997) Alexandrou and Sudarsanam (2001) Lee and Madhavan (2010)	Morgan and Rego (2009) Wiles et al. (2012) Depecik et al. (2014)	-
Long-term	Hanson and Song (2003)	Desai and Jain (1999)	-

Table 2.2 classifies the literature on discontinuation on five dimensions. The current study differs from prior research in several respects (Please see Table 2.2). First, drawing upon signaling theory (Spence 1974) and impression management theory (Tedeschi and Reiss 1981; Elsbach and Sutton 1992; Elsbach 2003), we contribute to the literature by examining an understudied phenomenon of product discontinuation. Second, this study is unique since it examines both short and long-term stock market returns of product discontinuation decisions. Many studies (e.g., Wright and Ferris 1997; Montgomery et al. 1984; Alexandrou and Sudarsanam 2001; Morgan and Rego 2009; Lee and Madhavan 2010; Wiles et al. 2012;

Depecik et al. 2014) examine short-term abnormal returns while very few studies (e.g., Hanson and Song 2003; Desai and Jain 1999) investigate the long-term abnormal returns. The impact of product discontinuation decisions on firm market value may not be limited to short-term effects as predicted by the efficient markets theory[1]. This is because investors may not immediately understand all the financial consequences of such announcements. As the rational learning literature suggests, investors may improve their understanding of such announcements by assessing the possible responses of various market players including customers, competitors, and collaborators (Friedman 1980; Kurz 1994; Francis et al. 2007; Sorescu 2007). During the period that follows the product discontinuation announcement, investors may learn whether the discontinued firm's launch a superior product, customers switch to competitors, competitors introduce substitute products, and/or distributors loss commitment to the channel relationship. We argue that since investors gain access to additional information about the discontinuing firms' prospects in the original announcement as well as update announcements as part of the firms' impression management strategies, their expectations will be incorporated into their stock market prices during the subsequent months or years.

2.2 Theoretical Development

2.2.1 Product Discontinuation and Market Signaling

Since corporate announcements -- including product discontinuations -- are strategic decisions made visible to the public, they serve as market signals (cf., Chaney et al. 1991; Eliashberg and Robertson 1988; Lane and Jacobson 1995; Spence 1974). Spence (1974) argues that signals are important parameters for market efficiency. Precisely, the firm

[1] Efficient markets theory posits that the stock prices reflect the actual firm market value since they incorporate the discounted value of *all* future cash flow, indicating *all* relevant information (Rao and Bharadwaj 2008; Mizik and Jacobson 2009)

Table 2.2. Overview of the Discontinuation Research

Author(s)	**Discontinuation**	**Theory/ Conceptualization**	**Key Constructs**	**Time Horizon**	**Method**
Montgomery et al. (1984)	Firm	Capital market theory	Voluntary and involuntary firm discontinuation	Short-term	Event study analysis
Wright and Ferris (1997)	Firm	Agency theory	Agency conflict, Enhancement goals	Short-term	Event study analysis
Alexandrou and Sudarsanam (2001)	Firm	Corporate portfolio approach	Economic contraction	Short-term	Event study analysis
Lee and Madhavan 2010	Firm	Corporate portfolio approach	Spin-off, sell-off, carve-out	Short-term	Meta-analytic approaches
Hanson and Song (2003)	Firm	Corporate portfolio approach	Inter-firm discontinuation	Long-term	Buy-and-hold abnormal returns analysis
Morgan and Rego (2009)	Brand	Corporate portfolio approach	Brand portfolio characteristics and customer satisfaction	Short-term	Tobin's q
Wiles et al. (2012)	Brand	Resource-based theory, corporate portfolio approach	Brand acquisition, brand disposal, mergers and acquisitions	Short-term	Event study analysis
Depecik et al. (2014)	Brand	Corporate portfolio approach	Local/regional/global brands, core and non-core business	Short-term	Event study analysis
Desai and Jain (1999)	Brand	Corporate portfolio approach	Spinoff	Long-term	Buy-and-hold abnormal returns analysis
Hise and McGinnes (1975)	Product	Corporate portfolio approach	Product elimination	Short-term	Survey analysis
Tomkovick (1993)	Product	Corporate portfolio approach	Product elimination propensity	Short-term	Interviews; survey
Martin (2002)	Product	Corporate portfolio approach	Product withdraw	Short-term	Qualitative research
This Study	*Product*	*Signaling theory; Impression management theory*	*Product discontinuation, marketing capability, innovation capacity*	*Short/long -term*	*Event study analysis, Buy-and-hold abnormal returns analysis*

(the agent) may have some information that the investor (the receiver) can infer from its market signals delivered via corporate announcements. Investors closely monitor the markets, evaluate new information, and react instantly by buying or selling the stock, ultimately influencing firms' stock prices (e.g., McAllister et al. 2012).

Signals could be directed at customers (Boulding and Kirmani 1993; Inman et al. 1990), channel members (Anderson and Weitz 1992), competitors (Prabhu and Stewart 2001; Robertson et al. 1995; Heil and Langvardt 1994; Moore 1992; Heil and Roberston 1991), or investors (Xiong and Bharadwaj 2013; Wiles et al. 2012; Sorescu et al. 2007b; Chaney et al. 1991). We focus on product discontinuation announcements directed at *investors* as the signal receivers. When a firm makes a product discontinuation announcement, investors make inferences about the intentions behind the market signal and predict future actions by the firm (Prabhu and Stewart 2001; Heil and Robertson 1991). Hence, such signals influence the investors' evaluations of the firms' current strategic and operational progress, as well as their expectations of the firms' future performance (Mizik 2010; Sorescu et al. 2007b).

Moreover, we argue that the investors' assessment of a product discontinuation decision may be influenced by their understanding of the reactions by other market actors, such as customers, competitors, and channel members. Due to potential effects of the discontinuation of a product on market actors, the discontinuing firms may face a number of negative consequences. First, firms may face loss of sales, since some current customers who seek to buy the discontinued products but fail to find them on retail shelves may switch to competitor products. The loss of current sales revenue may diminish the firm's expected cash flow leading to negative abnormal stock returns (Davidson and Worrell 1992). Second, taking a product off the shelf may affect the firm's economies of scale in production and distribution. Third, competitors may focus on the same market by introducing substitute products (Bayus et al. 2001). This may threaten the discontinuing firm's overall market share

(Eliashberg and Robertson 1988). Fourth, when a firm discontinues a product and stops delivering it to its distributor, the latter's commitment to the channel relationship may be hampered (Anderson and Weitz 1992).

Most importantly, Luo et al. (2013) find that investors are more sensitive towards negative news. They argue that negative information is more diagnostic and influential; and thus, more likely to attract investors' attention and affect their decisions. Tirunalli and Tellis (2012) also show stronger effects of negative (versus positive) information in user generated content on stock returns. This is also in line with the prospect theory, which shows that the subjective value of any given objective information is more extreme for losses (negative information) than gains (positive information; Kahneman and Tversky 1979). Therefore, due to the loss in revenue, hampered cost efficiency, and reduced market leverage, firms may experience a decrease in their cash flows due to their product discontinuation decisions. Investors may eventually sell their stocks resulting in negative stock returns.

This research also questions the validity of one of the assumptions (i.e., structural knowledge) of the efficient market theory in the case of product discontinuation decisions. If the investors were endowed with complete knowledge regarding a product discontinuation decision, the total effect of this decision's announcement would be incorporated into the stock market price around the announcement date. However, following the duration after the announcement, the investors gain more knowledge about the rationale behind these decisions. Sorescu et al. (2007b) argue that the short-term stock returns measured around the announcement date do not capture this effect, yet the long-term returns measured after the announcement do. Specifically, the events provide firms with long-term stock returns if their impact on firm value is not fully understood by investors when announced, but when investors learn new related information during the following months or years.

We believe that the negative effect of firms' product discontinuation may not only transpire in the short-term but also occur in the long-term. This is because the above-mentioned potential effects of the discontinuation of a product on market actors (i.e., loss of future sales revenue, competitor reaction, loss of economies of scale, and channel equity) may be evident in the long horizon. Hence, investors may update their beliefs about the discontinuing firm when new market information becomes available. They may improve their understanding of the different economic relationships that shape the market dynamics (Sorescu et al. 2007b), which may influence the abnormal returns accrued to the firms due to their discontinuation decisions. We hypothesize that the negative impact of the discontinuation on the market actors would escalate in the long-term. However, if the discontinuing firm provides positive updates to the market (e.g., a replacement of the discontinued product), then we expect investors to perceive the discontinuing firms as making efforts to enhance their poor market share, reduce marketing and R&D spending, and allocate initiated resources to other existing products.

H1a. *Product discontinuation announcements are likely to lead to negative abnormal returns in the short- and long-term.*

H1b. *Positive market updates provided by the discontinuing firm will positively moderate the relationship between product discontinuation announcements and long-term abnormal returns.*

2.2.2 The Effects of Announcement-Related and Firm Related Factors

Research on financial outcomes of firm decisions focuses on either announcement-related factors (Chaney et al. 1991; Pauwels et al. 2004; Rust et al. 2004; Sorescu et al. 2007b) or firm-related factors (Bahadır et al. 2008; Xiang and Bharadwaj 2011; 2013). Hence, referring to the signaling theory (Spence 1974) and impression management theory

(Tedeschi and Reiss 1981; Elsbach and Sutton 1992; Elsbach 2003; Bolino et al. 2008), we posit that a number of *announcement-related factors* (such as the discontinuation reason and the specificity of the announcement) and *firm-related factors* (such as firm marketing capability and innovation capacity) may influence investors' evaluations of product discontinuation decisions.

One of the basic tenets of signaling theory is that the receivers (e.g., investors) seek to gain from their interpretation and evaluation of market signals (firm announcements) (Connelly et al. 2011). They must interpret the information in the signal before they respond to it. Research suggests that the receivers' interpretations of signals may vary due to (1) the characteristics of the signal (such as signal clarity) and (2) the intentions and/ or capabilities of the signaler (Heil and Robertson 1991; Prabhu and Steward 2001). According to the impression management theory, signalers (e.g., firms, managers, or spokespersons) may attempt to justify their actions and signal competence. Using defensive impression management strategies, they may offer explanations for a negative event such as product discontinuation to avoid public criticism (Bolino et al. 2008; Elsbach and Sutton 1992).

Unambiguous signals with known causes are referred to as *clear* signals (Jervis 1989; Shannon and Weaver 2015). A clear signal can be read quickly and with minimum error by the receiver (Heil and Robertson 1991; Heil and Langvardt 1994). We argue that the clarity of a product discontinuation announcement will depend on whether announcing firm provides statements of *justifications* and *excuses,* which are specific type of impression management strategies (Tedeschi and Reiss 1981). *Justifications* are statements of reason announced to minimize the perceived negativity of an event when responsibility is not in question (*we have a good reason for doing it*: e.g., positive motivations such as developing a new product or reducing the cost of a production line and negative reasons such as low market share; Elsbach 2003). Specifically, the announcing firm may provide positive (e.g., new product and/or

market development) or negative (e.g., commercial failure) reasons for the discontinuation decisions.

Excuses are statements designed to minimize perceptions of responsibility for a negative event (*it is not our fault*: e.g., it is due to poor demand or emergence of new technology; Elsbach 2003). In the discontinuation announcement, the discontinuing firm may claim the responsibility of the decision or claim that the decision is driven by the industry dynamics (Anderson et al.2004; Oh et al. 2006). Hence, if the managers provide such information in their announcements, they may help investors make inferences with little error and respond by trading the firms' stocks.

Signaling theory also suggests that the receiver's interpretations depend on the *signaler's capabilities.* Firm (the signaler) capabilities are defined as their capacity to realize resources into sales and/or new products (Xiong and Bharadwaj 2013). Hence, capabilities may signal the firms' future strategic actions and potential successes (/failures). When evaluating the firms' strategic decisions, investors may not only rely on the fundamental information declared in the public announcements (Grullon et al. 2004; Xiong and Bharadwaj 2013) but also consider the firms' competitive strength and market reputation. Hence, we argue that investors may make faster and more favorable attributions of a product discontinuation decision announced by a prominent firm with superior (1) marketing capabilities, and/or (2) innovation capacity. Building on these discussions, we present a framework that links product discontinuation announcements to firm market value determined by announcement-related and firm-related factors (please see Figure 2.1).

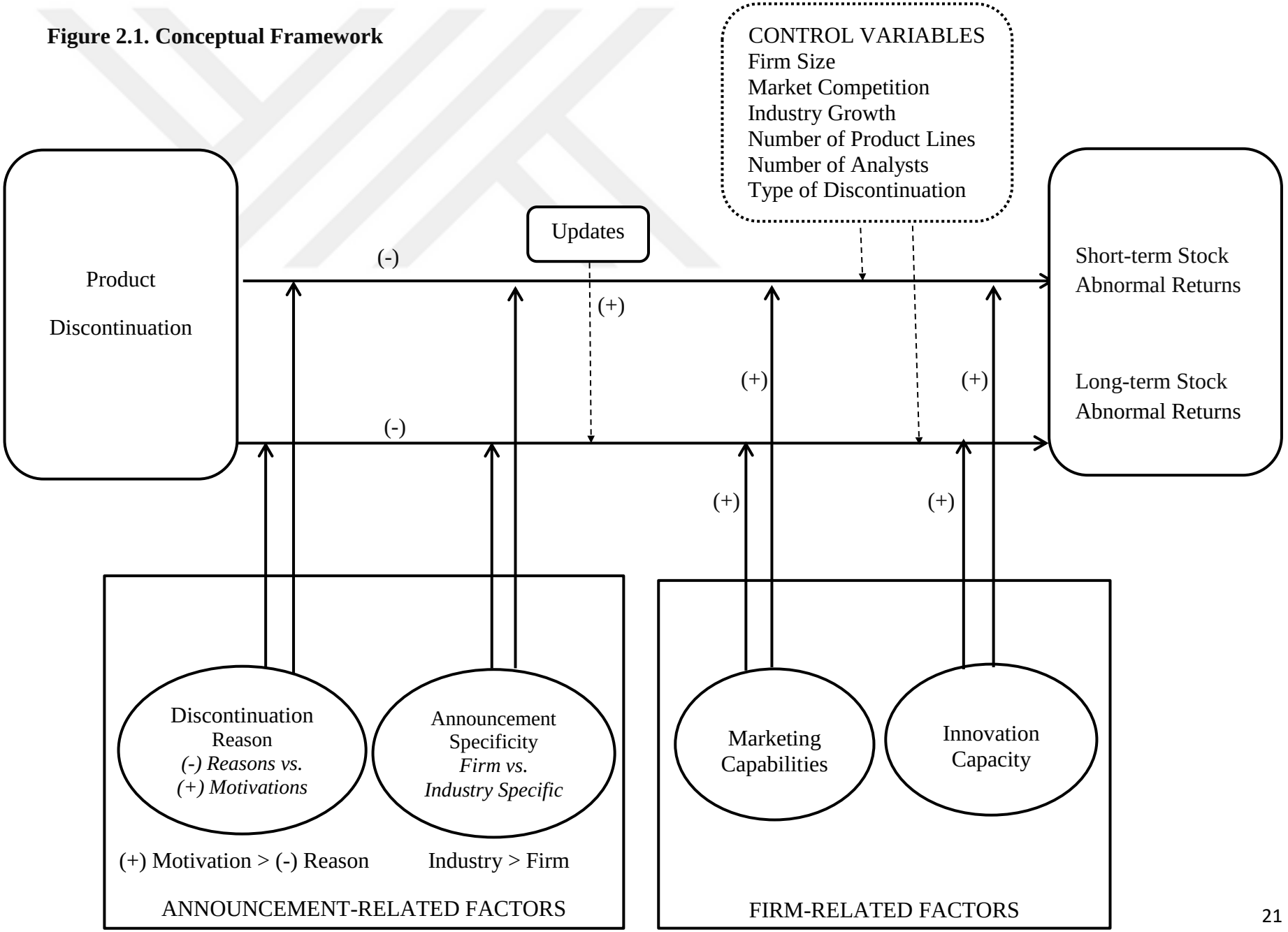
Discontinuation Reason. Firms generally offer justification statements to reduce market uncertainty and guide their stockholders. Indeed, to justify their product discontinuation decisions, they oftentimes disclose the reason for their decisions in their announcements. Firms may have *positive* motivations for their product discontinuation decisions such as (1)

new product/service development and/or (2) new market development. On the other hand, *negative* reasons such as (3) product technical failures and/ or (4) commercial failures (i.e., unmet marketing/ sales goals) may also lead firms to make product discontinuation decisions. Next, we explain these four reasons for firms' decisions to discontinue their products.

New product/service development refers to the introduction of a new product to an existing market, while *market development* entails the launch of an existing product in a new market. In order to address consumers' needs, firms may develop new products or introduce their existing products to new markets (Im and Workman 2004). To do so, firms oftentimes discontinue their existing products to utilize the remaining tangible and intangible assets for developing new ones (Chandy and Tellis 1998). For example, HP stopped selling digital cameras in Asia in 2005 to focus its efforts on home photo printing. Moreover, in 2004, Pfizer announced that they would take their product called Glibenese off the shelves to develop a new product and eventually replace Glibenese.

Product technical failures are associated with the undesirable consequences of product use, particularly with safety concerns. In such situations, firms may take their products off the market by recalling them or discontinuing their production to avoid bitter publicity. For instance, pharmaceutical firms oftentimes stop selling their products due to their side effects. Bakke and his colleagues (1995) show that, during the period between 1974 and 1993, a total of 29 drugs introduced in the United Kingdom, the United States, and Spain were subsequently discontinued. *Commercial failures* such as poor sales are other types of negative reasons that lead firms to make product discontinuation decisions. For instance, due to a low 14% sales rate, Logitech decided to discontinue its console-gaming peripherals and shut down its console peripheral business in 2013. Similarly, in 1994, the Original Pet Drink Company introduced carbonated and vitamin-enriched bottled water for pets. However, the product did not meet the sales expectations; and was consequently taken off the shelves.

Figure 2.1. Conceptual Framework



The disclosure of the reason for the discontinuation may serve as an information exchange between the managers and the investors as the reason signals the firm's current and future agenda. Accordingly, the discontinuation reason may allow the investors evaluate the performance of the firm's management (Sorescu et al. 2007b). We argue that investors are more likely to negatively assess the information on failures (e.g., poor sales or technical malfunction), and attribute the failures to poor management. They may consequently respond by selling the firms' stocks, leading the stock price to gradually fall.

On the other hand, firms may strategically discontinue their products to achieve their long-term market goals through new product and market development, which are identified as the two major growth strategies in the literature (e.g., Zhou et al. 2005). We argue that product discontinuation announcements involving positive firm motivations are more likely to be assessed more positively (or less negatively) by the investors. Firms may increase their market sales by linking their discontinuation decisions with positive motivations in their announcements since customers may make earlier purchases and faster referrals once they are informed about the firm's new products (Srivastava et al. 1999). Such announcements may signal the managers' farsightedness and increase investors' trust in managerial judgment. Thus, the product discontinuation reason may significantly moderate the relationship between the product discontinuation announcement and firm market value. More specifically:

H2. *Product discontinuation announcements due to positive motivations (such as new product development) are likely to lead to higher (/less negative) abnormal returns compared to product discontinuation announcements due to negative reasons (such as product failures).*

Announcement Specificity. Product discontinuation announcement specificity refers to the extent of information and excuses provided in the product discontinuation announcement intended to reduce investor uncertainty regarding the discontinued product. As Sorescu et al.

(2007b) suggest, there may oftentimes exist an information asymmetry problem between the firms and their investors. Managers may try to mitigate this problem by employing impression management strategies. Specifically, they may share their long-term goals and provide specific excuses for their strategic decisions.

We propose that *product discontinuation announcement specificity* can act as a credible signal of the firm's short and long-term strategies. We identify the announcement as (1) *industry/market specific* if the firm provides a reason for the discontinuation decision related to the industry such as emergence of a new technology, competitive intensity or customer readiness, or as (2) *firm specific* if the firm offers a reason related to the firm resources and capabilities such as lack of budget or R&D capabilities or the firm strategies such as product portfolio management. We argue that when the firm provides an industry-specific reason for their decision, they do not claim the responsibility for the discontinuation of the product. Hence, they may build higher investor trust, since the investors may attribute the reason to the whole industry, and not put any blame on the firm (Pevzner et al. 2015). On the other hand, the investors may perceive higher risk with regards to the firm's future cash flow when the firm admits to own actions, faults and/or characteristics as reasons for their discontinuation decisions (such as poor management, lack of market orientation, or innovation disability). Overall, we argue that the announcement specificity may significantly moderate the relationship between the product discontinuation announcement and firm market value. Formally stated:

H3. *Product discontinuation announcements with industry-specific reasons are likely to lead to higher (/less negative) abnormal returns compared to product discontinuation announcements with firm-specific reasons.*

Marketing Capabilities. Xiong and Bharadwaj (2013) define firm marketing capability as the firm's efficiency in realizing marketing resources into sales revenue. Marketing capabilities entail the efficient integration and conversion of resources into a targeted marketing outcome (c.f., Amit and Schoemaker 1993). Investors may not be cognitively able to apply the same level of expertise across all stocks in the market (Freider and Subrahmanyam 2005; Shiller 2003). Research suggests that investors consider firm marketing capabilities when they assess firm market value (e.g. Bahadır et al. 2008). Firms' marketing activities are found to increase the investors' attention and the salience of firm-related news. Grullon et al. (2004) show that firm advertising leads investors to make their investments based on familiarity rather than fundamental information. Specifically, Xiong and Bharadwaj (2013) argue that there exist *investor attention effects* in the market. They also argue that investors form their perceptions regarding a firm's marketing capabilities by relying on its history of marketing outputs given its resource inputs. Consequently, increased investor interest and familiarity due to firms' high marketing capabilities may foster favorable investor reactions.

We contend that a firm with high marketing capabilities is likely to reduce market uncertainty, decreasing the investors' risk perception related to the firm's future cash flow. This may be because firms with strong marketing capabilities may be better at predicting changes in the buyer behavior following the release of positive or negative news (Xiong and Bharadwaj 2013). Specifically, their customers may expect such firms to understand their needs; and hence, offer product or services superior to both the discontinued product and the competitors' substitute products. This lowers the likelihood of the customers' switching behavior when a product is discontinued (Tuli et al. 2010). Lower buyer switching stabilizes revenues; and hence, positive market returns. Therefore, we argue that firms' marketing capability may significantly moderate the relationship between the product discontinuation announcement and the firm market value. More specifically:

H4. *The greater the firm's marketing capability, the higher is the abnormal returns due to its product discontinuation announcements.*

Innovation Capacity. Referring to Hurley and Hult (1998), we define innovation capacity as a firm's ability introducing a new process, product, or idea. A firm's innovation capacity has been shown to contribute to its positional advantages in the market (Hurley and Hult 1998; Calantone et al. 2002; Menguc and Auh 2006). It is a firm-specific, valuable, and socially complex resource that is not easily transferable or imitable by other firms (Hult and Ketchen 2001); and hence, a key to achieving superior market performance (Cavusgil et al. 2003).

Cavusgil et al. (2003) argue that firms with higher innovation capacity employ a learning-by-doing approach making it difficult for competitors to acquire and/or imitate their knowledge (e.g., Dutta et al.1999). Research results also suggest that firms with high innovation capacity generally enjoy strong consumer loyalty and have demand-side advantages (Dutta et al. 1999; Givon et al. 1995). Hurley and Hult (1998) argue that firms with greater capacity to innovate are more likely to succeed in responding to market dynamics (Dutta et al. 1999; Cavusgil et al. 2003; Sood and Tellis 2009). Firms with high innovation capacity not only frequently develop and commercialize improved products and/ or radical innovations but also try to build their reputation by providing updates to the market regarding their product pipeline.

Hence, we argue that investors may consider firms' innovation capacity when evaluating their market value by identifying their prior product and process innovations. This is because firms with higher innovation capacity may leverage their technological strengths and quickly respond to the market (Narasimhan et al. 2006). Furthermore, such firms may not lose their economies of scale in production and distribution after announcing their product discontinuation decisions, due to their wider retail acceptance and accelerated product

diffusion (Xiong and Bharadwaj 2011; 2013). Bharadwaj et al. (2007) argue that these firms may quickly adjust their production cycles and decrease the potential mismatch between the firm inventory levels and the customer orders in a timely manner. They may do so by producing and distributing a new product or service replacing the discontinued one. All these notions may reduce the investors' perception of risk regarding the firm's future cash flow. Therefore, we argue that firms' innovation capacity may significantly moderate the relationship between the product discontinuation announcement and the firm market value. Formally stated:

H5. *The greater the firm's innovation capacity, the higher is the abnormal returns due to its product discontinuation announcements.*

2.3 Control Variables

Draw upon prior literature on firm announcements on firm market value, we include a number of control variables and provided their rationales.

Product diversification. Hendricks and Singhal (1997) show that the more diversified the firm's product portfolio, the less negative the financial impact of the product delay announcement. In a similar vein, investors' reaction to a firm's product discontinuation announcement may be affected by the degree of diversification of its product portfolio. Since firms with high product diversification develop and market various product lines, taking a product off the shelf may not have a substantial impact on their cash flow.

Firm size. Large firms tend to enjoy higher economies of scale. The larger the firm is, the lower the costs of its production and distribution operations. A large firm's decision to discontinue a single product may not significantly influence its revenues.

Market competition. We expect market competition to negatively impact stock market reactions to product discontinuation announcements. In highly competitive markets,

customers are likely to have more options of products to purchase (Hendricks and Singhal 1997). They may find a competing product even after their first options are discontinued.

Industry growth rate. Reactions to a product discontinuation may be more neutral (less negative) in a fast growing industry than in a slow growing industry. First, in a fast growing industry, new customers enter the market perpetually, and are generally not loyal to a particular product (Hendricks and Singhal 1997). Thus, the impact of a discontinued product on firm sale revenue in a fast growing industry may be trivial.

Number of analysts. Investors' reactions to firms' announcements may vary if there are a number of analysts who regularly provide earnings per share estimates for these firms (Moorman et al. 2012). These estimations may guide investors, decreasing their uncertainty.

Product type. We expect product type to affect stock market returns to product discontinuation announcements. Specifically, we argue that the loss in the economy of scale and future sales revenue may vary based on whether the firm undertakes a product or service discontinuation and discontinues a single product or a product line. While the raw materials and labor make up the variable costs in the manufacturing industries, they are primarily the labor and any materials and support- including customer service- in the services industry. However, contractual labor for customer service and support usually are treated as fixed costs in the service industries (Min et al 2016). Thus, variable costs do not change significantly when the firm discontinues its service, marginally influencing its economy of scale. Moreover, the degree of customer switching may comparatively low in service industries due to lock-in contracts or lack of substitute services, reducing the potential loss in future sales revenue. Finally, we argue that a single product discontinuation may generate less unfavorable customer reactions- compared to a product line discontinuation- since current customers may find a substitute product in the same product line. Thus, a single product

discontinuation may not lead to customer switching behavior, marginally affecting the future sales revenue.

2.4 Methodology

2.4.1 Sample Data

To examine the effect of product discontinuation (the "event") on firm market value, product discontinuation announcements of U.S. companies were extracted from the Gale Business Collection database. The data sample covers a 17-year period from 1996 to 2012. A variety of keywords were used during the search including 'product discontinuation', 'product discontinue', 'product discontinued', 'service discontinuation', 'service discontinue', 'service discontinued', 'product killing', 'take off the shelf', and 'no longer in service'. The initial search yielded 235 announcements in different manufacturing (automotive, pharmaceutical, chemical, semiconductor, consumer electronics) and services (telecommunication, airlines, financial, insurance, food, and beauty retail services) industries. The announcements related to brand discontinuations (n=6) and discontinued pharmaceutical products before their commercialization (n=22) were removed. Next, the announcements (n=31) that obtain information about other firm events in the event window were removed. This procedure helped minimize the presence of confounding effects. Lastly, 17 announcements were excluded because stock returns were missing around the event day. This procedure resulted in total sample size of 159 product discontinuation announcements.

Table 2.3 presents the summary statistics for our sample. The product discontinuation announcements which offer a discontinuation reason linked to negative reasons (e.g., commercial failure) constitute 135 (76.7%) of the announcements. Of the announcements, 20 (11.4%) provide the reason associated with positive reasons (e.g., new product development). The firm-specific reasons pertain to 99 (56.3%) announcements while the industry specific

reasons constitute 45 (25.6%) of the announcements. The number of single discontinuation and product-line discontinuation announcements are 95 (54%) and 76 (43.2%), respectively. Our sample is rather balanced between 77 (43.8%) product discontinuations and 95 (54%) service discontinuations.

Table 2.3. Summary Statistics

Variable	Categories	Descriptions/Examples
Discontinuation Reason	Negative reasons, positive motivations, and not stated.	Commercial or technical failures (n=135; 77%); new product/service development (n=20; 11%), and not stated (n=21; 12%).
Announcement Specificity	Firm specific, industry specific, and not stated.	A reason linked to the firm's resources, R&D capabilities (n=99; 56%), or strategies or reason related to the industry (n=45; 26%), and not stated (n=32; 18%).
Product Type	Single or line and product or service.	Single (n=95; 54%) vs. line (n=76; 43%) and product (n=77; 44%) vs. service discontinuations (n=95; 54%).
Industry	Airlines (n=56; 32%), IT and electronics (n=36; 20%), pharmaceutical and healthcare (n=23; 13 %), telecom (n=21; 12%), food/beverages (n= 13; 7%), automotive (n=5; 3%), semiconductor (n=5; 3%), finance (n=3; 2%), and other (n=14; 8%).	
Other Variables	*Value (means in millions)*	
Receivables	13985.03	
Sales	84297.33	
Revenue	24632.83	
R&D Expenses	2273.93	
Advertising Expenses	566.11	
Administrative Expenses	312.67	

2.4.2 Modeling Short-and Long-Term Effects

Event studies rely on the premises of the market efficiency theory and assume that the stock market responds to the information on the firm's marketing decisions within a short time period. For this assumption to be satisfied, investors need to immediately and efficiently understand the information disclosed in the announcement and assess all strategic and financial consequences. This is referred to as the "structural knowledge assumption" (Brav and Heaton 2002; Kurz 1994). Another stream in the literature investigates the validity of the

structural knowledge assumption and the analysis of short-term returns, and focuses on the long-term outcomes of firm announcements. These studies base their arguments on the rational learning (or structural uncertainty) literature in finance (Brav and Heaton 2002; Brennan and Xia 2001), which relaxes the structural knowledge assumption (Francis et al. 2007; Lewellen and Shanken 2002; Merton 1987; Timmerman 1993). In this literature, investors are viewed as rational learners, who process incomplete market information due to the uncertainty related to the outcomes of future events. Overall, it is argued that the stock market cannot incorporate the entire effect of a marketing decision over the short-term (Lewellen and Shanken 2002) as it is the period after an announcement of a decision that events unfold and information pertaining to the rationale underlying the decision is disseminated to the market (Friedman 1980; Kurz 1994; Lewis 1989).

Rational learning literature argues that investors are rational but they may not have complete structural knowledge of the economy (Brav and Heaton 2002; Brennan and Xia 2001). Yet, they are able to update their prior beliefs via a Bayesian updating scheme as more information becomes available (Lewis 1989). Specifically, investors observe a series of realized events as well as their economic outcomes. In general, they may be able to estimate the probability distribution function of the firm's future cash flow, which in turn results in a change in firm market value. Accordingly, stock prices fluctuate not only when new information becomes available but also when investors improve their understanding of the different economic relationships that shape the market dynamics (Sorescu et al. 2007b). In summary, investors may not fully estimate the impact of any event on firm market value at the time of its occurrence; and seek more information during the subsequent months or years and trade the firm's stock accordingly. Thus, similar to Sorescu et al. (2007), we collected data on the updates the discontinuing firms provided to the market, which we believe to drive the long-term effects of managerial decisions on investor evaluations.

2.4.3 Operationalization of the Abnormal Stock Returns

We employed the event study methodology to measure short-term stock returns and obtained the firms' stock prices from the Center for Research in Security Prices database. The methodology examines the statistical significance of the average abnormal returns around an event date for a sample of firms experiencing the same type of firm-specific event. Cumulative abnormal returns (CARs) indicate investors' beliefs about the firm's market value as a result of an event announcement. Positive CARs show that most investors estimate significant future cash flow associated with the event, while negative CARs represent pessimistic views.

To analyze the short-term effects, we study the firm's stock returns due to the event using the 'market model' (Brown and Warner 1985). It is a single index model which assumes a linear relation between return on a stock, over given period of time, to the return on the market portfolio over the same time period. We estimate abnormal returns to the event using the Fama-French-Carhart six-factor model (Carhart 1997; Fama and French 2015):

$$(1)\quad R_{it} - R_{ft} = \hat{\alpha}_i + \hat{\beta}_i (R_{mt} - R_{ft}) + \hat{\gamma}_i \, SMB_t + \hat{\delta}_i \, HML_t + \hat{\theta}_i \, RMW_t + \hat{\lambda}_i \, CMA_t + \hat{\psi}_i \, UMD_t + \hat{\varepsilon}_t$$

where R_{it} is the return of stock *i* on day *t* and R_{ft} is the rate of return on a US Treasury bond during the same period. Hence, $R_{it} - R_{ft}$ signify stock returns excessive to the Treasury bill risk-free rate. α_i is the intercept of the relationship for stock *i*, β_i is the slope of the relationship for stock *i*. R_{mt} denotes the corresponding daily returns on the value-weighted market portfolio (i.e., S&P 500), and $R_{mt} - R_{ft}$ denotes the excess market return on day *t,* and e_{it} is the error term for stock *i* on day *t* (i.e., $N(0, \sigma^2)$). SMB_t, i.e., size-based risk premium factor, is the difference between the rate of returns of small and big firm stocks (small minus big), HML_t, i.e., book-to-market based risk premium factor, is the difference in returns between high and low book-to-market stocks (high minus low), RMW_t, i.e., operating profitability factor, is the difference between the returns on diversified portfolios of low and

high investment stocks, CMA_t ,i.e., investment factor, is the difference between the returns on diversified portfolios of the stocks of low and high investment firms, and UMD_t, the momentum factor, is the difference between portfolios of high and low prior-return stocks, all during month *t*. γ, δ, θ, λ, and ψ are parameter loadings. Event studies use estimation intervals ranging from 30 to 250 days (e.g., Raassens et al. 2012). As the estimation interval increases, the statistical accuracy of parameters also increases (Koh and Venkatraman 1991). Thus, the trading days used were t = -250 and t= -30, where t=0 denotes the event. Then abnormal stock returns AR:

(2)
$$AR_{it} = R_{it} - E[R_{it}] = R_{it} - R_{ft} - \hat{\alpha}_i + \hat{\beta}_i (R_{mt} - R_{ft}) + \hat{\gamma}_i SMB_t + \hat{\delta}_i HML_t + \hat{\theta}_i RMW_t + \hat{\lambda}_i CMA_t + \hat{\psi}_i UMD_t$$

where R_{it} indicates the actual return for stock *i* on day *t*, and $E[R_{it}]$ is the predicted stock return based on the estimation period of $M = (E_2 - E_1)$+1 days (i.e.,221-day). $\hat{\alpha}_i$ and $\hat{\beta}_i$ indicate firm specific OLS parameters.

First, to calculate the test statistics and examine the significance of the short-term abnormal returns due to product discontinuation announcements, we calculated the average abnormal return:

(3)
$$AAR_t = \frac{\sum_{j=1}^{N} AR_{it}}{N}$$

Next, to run the time-series standard deviation test (crude dependence adjustment-CDA test) (Brown and Warner 1980), we calculated the estimated variance of AAR_t:

(4)
$$\hat{\sigma}^2_{AAR_t} = \frac{\sum_{t=E_1}^{t=E_2} (AAR_t - \overline{AAR})^2}{M - 2}$$

where the market parameters are estimated over the estimation period of M days and

(5)

$$\overline{AAR} = \frac{\sum_{t=E_1}^{t=E_2} AAR_t}{M}$$

The portfolio test statistics for day *t* in event time is

(6)

$$t = \frac{AAR_t}{\hat{\sigma}_{AAR}}$$

To reduce noise in the dependent variable and assess the market's reaction pattern over time, we use [-1,0], [0,1], [0,2], [-1,1], [-2,1], and [-2,2] event windows (Srinivasan and Bharadwaj 2004). Finally, consistent with prior studies (e.g., Dopuch et al. 1986; Brickley et al. 1991), we calculated the t-statistics for cumulative average abnormal returns, $CAAR_{T_1,T_2}$, to examine whether product discontinuation announcements have a significant impact on the market value of the firms:

(7)

$$t = \frac{CAAR_t}{(T_2 - T_1 + 1)^{\frac{1}{2}}\,\hat{\sigma}_{AAR}}$$

Consistent with prior literature (Barber and Lyon 1997; Cowan and Sergeant 2001; Carhart 1997; Fama and French 2015), we employed *buy-and-hold procedure* and Fama-French-Carhart six-factor model to estimate long-term stock returns from product discontinuation announcements. Specifically, to obtain a buy-and-hold abnormal return (BHAR) over a 1-year period ($T_2 - T_1$), both daily abnormal returns and the benchmark return were compounded, and the difference is calculated[2]:

[2] To have the concise model, BHAR formula for the single-factor model is shown (equation 8). One can extend the model to a multi-factor model by adding another term for each additional factor (i.e., SMBt, size-based risk premium factor; HMLt, book-to-market based risk premium factor; RMWt, operating profitability factor; CMAt, investment factor; and UMDt, the momentum factor). We used Eventus with a remote submission to run the Fama-French-Carhart six-factor model.

(8)

$$\left[\prod_{t=T_1}^{T_2}(1+R_{it})-1\right]-\left[\left(1+\hat{\alpha}_i\right)^{(T_2-T_1+1)}-1\right]-\hat{\beta}_i\left[\prod_{t=T_1}^{T_2}(1+R_{mt})-1\right]$$

Similar to Sorescu et al. (2007b), we assume that the unexpected content of the potentially confounding firm-specific events (e.g., announcements of product recalls, acquisitions, or product launches) within the long-horizon event window has a mean of zero. To assess the statistical significance of buy-and-hold abnormal returns of all firms over T=504 days beginning with the end of event day, we employed two statistical tests: (1) the time-series standard deviation test[3]; (2) generalized sign test. The null hypothesis for the generalized sign test is that the fraction of stocks with positive compounded average abnormal.

2.4.4 Operationalization of Independent Variables

Table 2.4 presents the measures and data sources for each variable used in the model. *Discontinuation Reason and Announcement Specificity.* Our measure of *discontinuation reason* is a dummy variable coded 1 if a firm provides a reason associated with *positive* reasons for product discontinuation decisions such as product development and/or market development t and 0 when the reason is linked to *negative* reasons such as product (e.g., product malfunction) or commercial (e.g., poor sales) failure. Similarly, to measure *announcement specificity*, we used a dummy variable coded 1 for *firm specific* announcements which offer a reason related to the firm's resources, R&D capabilities, or strategies such as lack of budget and 0 for *industry specific* announcements which state a

[3] We employ the same test statistics (i.e., time-series standart deviation test) both for the short- and long-term abnormal returns to examine the significance of the short-term abnormal returns and long-term buy-and-hold abnormal returns due to product discontinuation announcements. Thus, we did not repeat the models udpated with buy-and-hold abnormal return formulas.

Table 2.4. Measures and Data Sources

Variables	Measures/Definitions	Data Sources
Abnormal Returns	Stock returns data	CRSP
Discontinuation Reason	Coded 1 if a firm provides a reason associated with a new product development and 0 when the reason is linked to failure.	Gale Business Collection
Announcement Specificity	Coded 1 for firm specific announcements which offer a reason related to the firm's resources, R&D capabilities, or strategies and 0 for industry specific announcements which state a reason associated with particular industry.	Gale Business Collection
Marketing Capabilities	Input-output stochastic frontier model Sales, general and administrative expenses and receivables were used as resources in this model.	Compustat
Innovation Capacity	The citation-weighted number of patents developed by the firm registered in all patent offices	Thomson Innovation
Control Variables		
Firm Size	Total assets	Compustat
Market Competition	Herfindahl Index	Compustat
Industry Growth	Annual industry growth rate in sales	Compustat
Product Diversification	The number of different principal product lines in which the firms operated	Compustat
Number of Analysts	A number of analysts who regularly provide earnings per share estimates for the firms	I/B/E/S
Product Type	Coded 0 if the discontinued product a single product; 1 if it is a product line; and 0 if the discontinued product is a tangible product; 1 if it is a service	Gale Business Collection

reason associated with particular industry such as competitive intensity or customer readiness (Sorescu et al. 2007a; Piotroski and Roulstone 2004). For example, we coded following news (A) and (B) 1 for discontinuation reason and 0 for announcement specificity and 0 for the reason and 1 for the specificity, respectively:

> (A) "*Personal computer manufacturer Hewlett-Packard (HP) has revealed that it is to stop selling digital cameras in Asia. It is understood that HP will focus its business in the region on home photo printing* (product development; positive motivations) *...Some of the world's most well-known brands of digital camera, such as Canon, Nikon, originated from Asia, especially Japan, presenting significant competition for HP* (competitive intensity; industry specific) (Aug 2, 2005; Telecomworldwire).

(B) *Logitech CEO De Luca didn't mince words in announcing that the peripherals maker was giving up on its Logitech Revue companion box, noting that the Google TV device cost the company more than $100 million in operating profits (commercial failure; negative reasons … The Revue failed to gain traction as reviewers and early adopters found system difficult to set up* (lack of designing capability; firm specific) *…Logitech discounted the Revue to $99 this past July after the company confessed that returns of the box were greater than sales* (commercial failure; negative reasons*)* (Nov 13, 2011; eWeek).

Operationalization of Marketing Capability. Consistent with previous studies (e.g., Dutta et al. 1999; Xiong and Bharadwaj 2011, 2013), we measured the marketing capability by using an input-output stochastic frontier model. Specifically,

(9)

$$Revenue_{it} = f(X_{it}: Resources_{it}, \alpha) \times \exp(\varepsilon_{it}) \times \exp(-\eta_{it}),$$

where ε_{it} captures random shocks and η_{it} captures the firm's inefficiency of converting resources into revenue. Following Xiong and Bharadwaj (2013) and Dutta et al. (1999), our operationalization of marketing capabilities includes firm's sales, general and administrative expenses, and receivables. Consistent with Xiong and Bharadwaj (2013), we employed Koyck lag function with higher weights on more recent years because prior years' capabilities may influence firm's current revenue. Then, we used each capability dimension as inputs (X_{it}: $Resources_{it}$) in equation 13. We derived the maximum likelihood estimate of the inefficiency term η_{it}, then rescaled the estimate η_{it}* to be between 0 and 100, and use 100 - η_{it}* as the marketing capability measure (higher inefficiency means lower marketing capability).

Operationalization of Innovation Capacity. R&D is the main driver that leads successful innovation outputs (both product innovations and process innovation. To measure innovation

capacity, we used the citation-weighted number of patents issued by the firm in all patent offices in the globe using the Thomson Innovation Database (Deeds and Decarolis 1999).

2.4.5 Operationalization of Control Variables

Product diversification. To measure product diversification, we collected data on the number of different principal product lines in which each firm operated (c.f., Hendricks and Singhal 1997) from the Compustat industry segment data.

Firm size. Similar to Hendricks and Singhal (1997) and (Geyskens et al. 2002), we operationalized firm size as the log-transform of total assets to account for potential diminishing returns to scale, and to avoid having a few extreme observations to drive the results by decreasing the skewness in this variable. We obtained the data for each firm in our sample from the Compustat Database.

Market competition. To measure market competition, we calculated Herfindahl index for each firm by summing of the squared fraction of the industry sales by each firm (Hendricks and Singhal 1997). We obtained the data for each firm in our sample from the Compustat Database. Table 2.5 presents the descriptive statistics and correlations among the constructs.

Industry growth rate. Drawing upon Hendricks and Singhal's (1997) study, we operationalized industry growth rate as the annual growth rate in industry sales. We used the same primary three-digit SIC code to determine the industry for each firm. We collected the industry sales data from the Compustat Database.

Number of analysts. We obtained the number of analysts following each firm from the Institutional Brokers' Estimate System (I/B/E/S) database (Moorman et al. 2012).

Product type. We created dummy variables to control product type. Using the announcement

Table 2.5. Descriptive Statistics and Correlation Matrix

		M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1	Short-Term Abnormal Stock Returns	-.01	08	1.00											
2	Long-Term Abnormal Stock Returns	-.42	1.94	-.237**	1.00										
3	Discontinuation Reason	-	-	.090	.055	1.00									
4	Announcement Specificity	-	-	-.002	.213*	.316**	1.00								
5	Marketing Capabilities	8.89	1.90	.099	.098	-.021	-.007	1.00							
6	Innovation Capacity	14.18	5.39	.042	-.023	.022	.060	.462**	1.00						
7	Firm Size	8.45	1.86	-.013	.381**	.195*	.145	.680**	.457**	1.00					
8	Market Competition	-2.67	.48	.063	-.028	.111	.153	.125	.187*	.113	1.00				
9	Industry Growth	1.88	1.08	.044	.043	.095	-.041	-.029	-.172	.047	.134	1.00			
10	Number of Product Lines	.90	.80	-.060	.072	.200*	074	.403**	.480**	.340**	.151	.059	1.00		
11	Number of Analysts	16.53	10.48	.144	-.004	.134	.047	.506**	.470**	.504**	.146	-.011	.220*	1.00	
12	Single or Line Discontinuation	-	-	-.072	-.008	.048	-.021	-.116	-.088	-.195*	.132	-.034	-043	-.177*	1.00
13	Product or Service Discontinuation	-	-	.020	-.226*	-.212*	-.113	-.246**	-.432**	-.347**	-.302**	-.145	-.371**	-.310**	.058

Note: *, ** indicate significant correlations at 0.05 and 0.01 levels, respectively.

text, we coded 0 if the discontinued product a single product; 1 if it is a product line; and 0 if the discontinued product is a tangible product; 1 if it is a service (Calantone et al. 2010).

2.4.6 Main Results and Robustness Checks

Table 2.6 displays the CARs for six different windows: (1) a two-day event period from the event date to one day after; (2) a three-day event period from the one day prior to one day afterward; (3) a three-day post-event period from the announcement date to day 2 afterward; (4) a four-day event period from day –1 to day 2; (5) a four-day event period from day -2 to day 1; and (6) a five-day event period from day –2 to day 2 afterward. We employed various test statistics to examine short-term abnormal stock returns to ensure that our results were not driven by event-induced volatility: (1) the traditional time-series standard deviation test (Brown and Warner 1985); (2) Patell's (1976) test statistic (which is robust to potential bias caused by stocks with large standard deviations in returns); and (3) Boehmer et al.'s (1991) standardized cross-sectional test (which is robust to event-induced changes in variance and useful for detecting abnormalities in the presence of autocorrelation, event clustering, and event-induced heteroskedasticity). For further robustness checks, we used different estimation methods (OLS and GARCH), weighted scheme (equal and value weighting index), and lengths of estimation periods (250 and 100 days). All produced materially similar results.

Our findings show significant negative short-term stock returns to the announcement. For the 159 discontinuation announcements in our sample, the average dollar loss in market value is $481,635 in the short-term, and $29,587,415 in the long-term. For robustness, we employed the Wilcoxon sign-rank test to test the null hypothesis that the observed returns are symmetrically distributed around 0 and the proportion of sample stocks having negative returns is equal to 0.5. The results reject the null hypothesis and indicate that stock returns to the announcements are negative, supporting H1a. In this sample, the one-day post-event

Table 2.6. Event-study analysis of short-term abnormal returns with Fama-French five-factor and Carhart's momentum effect for product discontinuation announcements (n=159)

Day	Mean Cumulative Abnormal Return	Positive: Negative Returns	t-statistic	Significance
(0,+1)	-1.03%	76:83	-2.626	<0.01
(-1,+1)	-1.24%	78:81	-2.392	<0.01
(0,+2)	-0.59%	77:82	-1.090	ns
(-1,+2)	-0.74%	84:75	-1.158	ns
(-2,+1)	-1.51%	80:79	-2.532	<0.01
(-2,+2)	-1.01%	85:74	-1.448	<0.10

NOTE: ns indicates non-significance.

period from the announcement day to one day afterward (-1;1) generated the least significant CARs, satisfying the market efficiency assumption (-1.24%, $p < 0.01$). To be conservative, this event window was chosen as the dependent variable in the overall model. Moreover, since this event window was after the announcement and of short duration, it allows control for any confounding effects as a result of information leakage about the product discontinuation prior to the formal announcement. Thus, our analysis satisfied the 'unanticipated events' assumption.

Table 2.7 displays the buy-and-hold returns over a 2-year horizon of the overall sample, respectively, for (1) one-year period starting from the first day following the short–term event window (-1;1) and (2) two-year period starting from the first day following the short–term event window (-1;1). The statistical significance was tested using two different test statistics to assure that event-induced volatility did not drive the results. We employed (1) the traditional time-series standard deviation test (Brown and Warner 1985) and (2) Cowan's (1992) Generalized Sign test. The findings show significant negative long-term stock returns to the announcement in two-year period (-38.24%, $p < 0.01$), supporting H1a. Thus, as the

dependent variable, we chose two-year period starting from one day after the announcement date to isolate the effect of any confounding events that have occurred within the event window in order to evaluate the precise response of the market to a particular decision.

We further collected data on the updates discontinuing firms provided to the market within the two-year period after the initial announcement using Lexis-Nexis Press Releases. We checked whether firms' additional updates to the market within the two-year period after the product discontinuation announcement exert an influence on long-term abnormal returns. We assigned the firms in the sample into two portfolios (i.e., updated versus not updated) and estimated the long-term abnormal returns (using the five-factor model and Carhart's momentum effect) for each portfolio. No statistically significant difference (29.33%; p=.712) was observed between the long-term returns of the 'updated' portfolio [-25.95%; positive vs. negative (22:46); p<0.01] compared to the 'not updated' portfolio [(-55.28%; positive vs. negative (30:37); p<0.05]). This result indicates that the long-term stock returns to the announcements do not vary whether the firms provide positive market update, rejecting H1b.

Table 2.7. Buy-and-hold abnormal returns with Fama-French five-factors and Carhart's momentum effect for product discontinuation announcements (n=157)

Event Window	Mean Compound Return	Positive: Negative Returns	t-statistic	Significance	Generalized Sign Z	Significance
1-year	-6.89%	69:88	-1.222	ns	-1.106	ns
2-year	-38.24%	61:96	-2.517	<0.01	-2.384	<0.01

NOTE: ns indicates non-significance.

2.4.6.1 Effects of Exchange Conditions: Short-Term and Long-Term Abnormal Stock Returns

The proposed models were tested with a cross-sectional regression of both the short-term and long-term abnormal stock returns against the proposed set of antecedent variables. The

following multiple regression models using ordinary least squares estimation is employed to test our hypotheses:

(10) $SHAR = \beta_1 DREA + \beta_2 ASPEC + \beta_3 MCAP + \beta_4 ICAP + \beta_5 SIZE + \beta_6 MCOMP + \beta_7 INDGR + \beta_8 ANLST + \beta_9 SDLD + \beta_{10} PRDSRV + \varepsilon$

(11) $LGAR = \beta_1 DREA + \beta_2 ASPEC + \beta_3 MCAP + \beta_4 ICAP + \beta_5 SIZE + \beta_6 MCOMP + \beta_7 INDGR + \beta_8 ANLST + \beta_9 SDLD + \beta_{10} PRDSRV + \varepsilon$

where SHAR= short-term abnormal stock returns, LGAR= long-term abnormal stock returns from product discontinuation, DREA= discontinuation reason, ASPEC= announcement specificity, MCAP= marketing capability, ICAP= innovation capacity, and SIZE= firm size, MCOMP= market competition, INDGR= industry growth, ANLST= number of analysts, PLINE= number of product line, SDLD= a single product or a product line discontinuation, and PRDSRV= product or service discontinuation as control variables. The parameter estimates (*β's*) are reported in Table 2.8.

Our short-term results indicate that product discontinuation announcements due to positive reasons such as new product development lead to higher abnormal returns compared to the announcements due to negative reasons such as product failures (β_{reason} = 0.19, p=.05). Thus, H2 is supported in the short-term. However, this result is reversed in the long-term: product discontinuation decisions due to positive motivations lead to lower abnormal returns compared to those due to negative reasons (β_{reason} = -0.16, p=.05). We fail to find support for H3 since market reactions to the announcement specificity is not significant in the short-term. However, in the long-term, product discontinuation announcements with firm-specific reasons result in lower abnormal returns compared to those with industry-specific reasons ($\beta_{specificity}$ = 0.15, p=.05). Thus, we find support for H3 in the long-term. Marketing capability exerts positive effects in the short-term, supporting H4 ($\beta_{mktg\_capability}$ = 0.33, p=.01). The effect switchs to negative in the long-term ($\beta_{mktg\_capability}$ = -0.23, p=.04). Innovation

capacitydid not influence abnormal stock returns in the short-term. Similar to marketing capability, innovation capacity exerts negative effects in the long-term ($\beta_{innovation\_cap}$ = -0.31, p=.00. The results do not lend support to H5. The control variables find to be significant which exert negative effects in the short-term are firm size (β_{size} = -0.35, p=.01) and number of product lines ($\beta_{product\_line}$ = -0.19, p=.07). Industry growth, on the other hand, positively affects the abnormal returns in the short-term (β_{growth} = 0.16, p=.07). In the long-term, firm size, the number of analysts, and product type (i.e., product or service) are the only control variables, which influence the abnormal returns. Firm size exerts positive effects (β_{size} = 0.65, p=.00) whereas the number of analysts and product type negatively influence the abnormal returns ($\beta_{analysts}$ = -0.16, p=.08; β_{prdsrv} = -0.24, p=.01).

Checks for Outliers, Heteroskedasticity, and Multicollinearity. We conducted several regression robustness checks. We tested for the presence of outliers, heteroskedasticity, and multicollinearity. We checked for multivariate outliers, by analyzing the Mahalanobis distance and Cook's distance coefficients, the leverage statistic, and standardized and studentized residuals. An observation is considered an outlier if the corresponding Mahalanobis distance is more than 31.36 (at 0.001 alpha level, df= 11, where df is the number of independent variables) and/ or Cook's distance is greater than 0.034 [i.e., 4/ (n - k - 1), where n is the number of cases and k is the number of independent variables]. Moreover, if a case has a leverage statistic over 0.5, the case has undue leverage and is identified as an outlier. Outliers were observations with +/- 3.3 standardized residuals (corresponds to 0.001 alpha level). Observations that have studentized residuals outside the +/- 2 range were considered as outliers. We repeated the regression after removing observations with large residuals (outliers with potentially undue influence and/or high leverage on the results) and the results did not materially change. We also examined the plots of the residuals versus fitted values for any patterns of increasing residuals and found no such patterns. The tolerance

Table 2.8. Analysis of short-term and long-term abnormal returns (estimates and significance levels)

Variables	Short-Term Returns					Long-Term Returns				
	Beta	**p-value**	**Tolerance**	**VIF**	**Conclusion**	**Beta**	**p-value**	**Tolerance**	**VIF**	**Conclusion**
Discontinuation Reason	0.19	**0.05**	0.771	1.297	(+) Motivations > (-) Reasons	-0.16	**0.05**	0.783	1.278	(-) Reasons > (+) Motivations
Announcement Specificity	-0.03	0.79	0.856	1.168	ns	0.15	**0.05**	0.882	1.133	Industry Specific > Firm Specific
Marketing Capabilities	0.33	**0.01**	0.437	2.287	+	-0.23	**0.04**	0.402	2.489	-
Innovation Capacity	0.16	0.19	0.514	1.945	ns	-0.31	**0.00**	0.500	2.000	-
Control variables										
Firm Size	-0.35	**0.01**	0.453	2.205	-	0.65	**0.00**	0.403	2.479	+
Market Competition	0.04	0.67	0.845	1.183	ns	-0.05	0.56	0.859	1.164	ns
Industry Growth	0.16	**0.07**	0.878	1.139	+	-0.08	0.31	0.873	1.145	ns
Number of Product Lines	-0.19	**0.07**	0.652	1.533	-	0.08	0.35	0.708	1.413	ns
Number of Analysts	0.11	0.33	0.604	1.655	ns	-0.16	**0.08**	0.579	1.726	-
Single/ Line Discont.	-0.11	0.20	0.911	1.098	ns	0.06	0.38	0.941	1.063	ns
Product/ Servis Discont.	0.06	0.57	0.668	1.498	ns	-0.24	0.01	0.681	1.468	-

NOTE: ns indicates non-significance.

values and variance inflation factors were within acceptable levels.

Checks for Multiple Announcements by the Same Firm. There are 62 firms in our sample with multiple product discontinuation announcements. We analyzed sub-sample data in which each firm discontinued a product no more than once, by retaining only the first announcements from the repeating firms in our sample. The results remained almost the same.

Checks for Endogeneity, Unobserved Heterogeneity, and Self-selection Biases. Our announcement specificity variable may be endogenous: firms may attribute the discontinuation to the industry versus the firm itself, depending on the characteristics of the market environment, the discontinued product, or the focal firm itself. Hence, we tested for potential endogeneity of announcement specificity, following the procedure by Raassens et al. (2012). In a first-stage model, we regressed the potentially endogenous variable on the other variables in our short-term model (i.e., discontinuation reason, marketing capabilities, innovation capacity, firm size, market competition, industry growth, number of analysts, number of product line, and product type (single product versus product line, and product versus service discontinuation). As instrumental variables, we used the firm's prior R&D investments, and the industry type[4]. We then assessed the instruments' relevance. We find support for the validity of our instruments using Sargan's (1958) test ($\chi2$= .497; p = 0.48). Durbin-Wu-Hausman tests indicated that endogeneity of the announcement specificity variable is not an issue in our study ($\chi2$=.004; p = 0.95). Notably, none of the variables in our short-term model significantly influenced the firms' attribution of the discontinuation to their industry or to the firm.

Furthermore, Ichecked for potential unobserved heterogeneity and self-selection bias (as well as endogeneity) using the Heckman two step estimation approach (Chen et al. 2009).

[4] Information for firm's prior R&D investments and the industry type were obtained from Compustat.

We collected an additional sample of firm announcements (n=51) which entailed new product introductions coupled with the discontinuation of previous versions. We compared this sample to the one we used in our analysis, in which the major event is the discontinuation of a product (as opposed to the introduction of a product). Forward looking firms may choose to publicly announce their product-related decisions for the sake of future returns, depending on the characteristics of their company and the market. In the first stage of the Heckman estimation approach, we estimated a probit model on the major product decision (i.e., discontinuation versus introduction). The inverse Mills ratio λ in the Heckman model serves as the self-selection correction parameter and its significance is indicative of the existence of self-selection bias. The second stage includes ordinary least squares (OLS) regressions of abnormal returns on the explanatory variables and λ. In the model estimation, we included the firm's diversification[5], prior R&D investments, acquisition strategies[6], and the type of industry they operate (i.e., high versus low technology), as they may influence the focal firm's decision to discontinue or introduce products. Furthermore, since these four variables do not have direct effects on abnormal returns, they are excluded from the second stage. We find a non-significant inverse Mills ratio ($\lambda = 0.06$, $p = 0.11$), indicating that self-selection bias is not a concern. Hence, based on our overall Heckman results, we did not find any other unobserved heterogeneity that is not accounted for in our model.

2.5 Discussion

Many Fortune 500 companies employ product discontinuation programs for effective product portfolio management. Product discontinuations are key corporate decisions that senior managers often make to shape their product portfolios and generate slack resources.

[5] To measure the firm's diversification, we used Palepu's (1985) entropy measure of diversification based on the weighted average of the shares of a firm's industry segments (the weight being the logarithm of the inverse of its share). The data for this measure is drawn from Compustat.
[6] A dummy variable coded 1 if the firm engaged in acquisition; 0 otherwise.

However, such decisions may have detrimental effects on firm market value due to the loss in future sales revenue, economies of scale, and channel equity. To reduce such unfavorable consequences, managers may rely on (1) the impression management strategies (i.e., disclosing excuse or justification statements) and (2) the firms' capabilities. Simply, they may try to decrease the market uncertainty and guide their investors when they disclose their product discontinuation decisions. This study aims to find out whether (1) product discontinuation decisions lead to negative stock returns; (2) such strategies can help firms to mitigate their stock market losses. In particular, we examine whether announcement-related (i.e., discontinuation reason and announcement specificity) and firm-related factors (i.e., marketing capability and innovation capacity) lessen the negative effects of product discontinuations on firm short- and long-term market value. This section summarizes the study findings, suggests implications, discusses some key issues, and lists the study limitations.

2.5.1 Summary of Findings

We first summarize the major findings:

1. Product discontinuation announcements lead to negative stock returns both in the short- and long-term.
2. Positive market updates provided by the discontinuing firm do not drive the long-term stock returns.
3. Product discontinuation announcements linked to positive firm motivations (such as new product development) increase the short-term stock returns.
4. Product discontinuation announcements associated with negative reasons such as product or commercial failures receive a higher weight and reduce long-term returns.
5. Product discontinuation announcements which state a reason related to the firm's resources or strategies (*firm specific announcements*) resulted in lower stock returns

compared to the announcements which offer a reason linked to particular industry (*industry specific announcements*) in the long-term.

6. Firm's high marketing capabilities positively influence the short-term stock returns from product discontinuation announcements. However, in the long-term, firms' high marketing capabilities and innovation capacities lead to negative returns (Please see Table 2.9).

Our findings contribute to the literature in the following ways.

By examining the overlooked phenomenon, we offer the first investigation of the short- and long-term stock market returns of firms' product discontinuation decisions. This is also the first study on financial outcomes of firm decisions to cover both announcement- and firm-related factors. Research suggests that (1) the characteristics of the firm announcements (e.g., announcement-related factors); and (2) the firms' capabilities (e.g., marketing and innovation capabilities) may influence the investors' assessments of the announcements (Heil and Robertson 1991; Prabhu and Steward 2001). Indeed, we contribute to marketing literature by showing that investors do take into account announcement- and firm-related factors when they evaluate the product discontinuation announcements.

Furthermore, it fills a gap by examining the impact of innovation capacity on stock market performance of a firm decision. Effective product portfolio managements often entail the development of new products to discontinue the current products. Benefiting from their innovation capacity, firms often leverage their technological strengths to develop new products (Narasimhan et al. 2006). We argue that product discontinuation is linked to product portfolio management strategies and the discontinuing firms rely on their innovation capacity when they introduce new products. Thus, we contribute to the marketing-finance literature by providing insights into innovation capacity. Specifically, our results show that investors do (not) incorporate the innovation capacity into long- (short-) term stock returns. Although we

argue that innovation capacity signals competence and is a key to achieving greater market performance (Cavusgil et al. 2003), the result demonstrates that investors may simply ignore discontinuing firms innovation capacity when they evaluate the discontinuation announcements in the short-term. This is because there may be exist an opposing impact of innovation capacity linked to high innovation costs, uncertain innovation payoffs, and difficulty of adequately measuring innovation returns (Sood and Tellis 2009). Specifically, investors may not perceive the discontinuing firms with high innovation capacity as making endeavors to be a serial innovator. Instead, they may perceive these firms as short-term oriented firms, which only try to meet their short-term stock market expectations since their top managers usually are expose to stock market incentives.

2.5.2 Key Issues

Why product discontinuation announcements due to positive motivations (such as new product development) lead to lower long-term abnormal returns compared to product discontinuation announcements due to negative reasons (such as product failures)?

Impression management strategies to advise the stockholders may not work as managers expected. Managers disclose product discontinuation announcements involving new product development to justify their decisions in the long-term. However, such announcements may have perceived as an excuse and hurt investors' trust in managerial judgment due to the following reasons. First, the investors simply may not see the benefits of the new product launched and linked the excuse to poor management (Sorescu et al. 2007b). This may increase their perception of risk regarding the firm's future cash flow. Thus, they sell the firms' stocks, leading the stock price to gradually fall. Second, investors may perceive such announcements as a cost saving strategy rather than a growth strategy. Discontinuing a product may lead to savings in inventory costs which may not have a

substantial impact on the firms' cash flow and market value. Thus, they react by selling the stock in the long-term, ultimately decreasing firms' stock prices.

Why do investors penalize firms with higher marketing capabilities and innovation capacity for their product discontinuation decisions in the long-term?

Firms' marketing capabilities and innovation capacities boost both investors' and consumers' expectations. Thus, a failure to address such expectations may significantly damage firms' reputation, trust, and brand equity. We show that product discontinuation announcements overall are evaluated negatively; and hence, may be perceived as failure by investors. Investors may assess product discontinuation decisions by firms with high marketing capabilities and innovation capacities even more negatively, as they set the bar even higher for these firms. Such firms' discontinuation decisions may fall far short of investors' and consumers' expectations, leading a high market uncertainty in the long-term. This uncertainty increases the risk with regards to the firm's future cash flow (Srivastava et al. 1999). Thus, investors may gradually sell their stocks, resulting in negative stock returns.

2.5.3 Implications

This study has the following implications.

First, firms engage in a product discontinuation need to consider a discontinuation announcement cautiously. In general, such announcements may negatively influence the firms' stock market performance. Indeed, we find that such announcements decrease firm market value both in the short-term and in the long-term.

Second, the discontinuing firms should not spend their resources for market updates. Although they provide positive market updates to guide their investors, the additional information in the update announcements may not be well received. The investors may not perceive these firms as putting efforts into enhancing their product portfolios. Contradictory

to Sorescu et al. (2007), we find that investors' long-term stock market expectations do not vary due to market updates.

Third, firms should use product discontinuation announcements as marketing tools to build a reputation as a skilled marketer and a serial innovator. However, they should be very careful when using such announcements as marketing tools (Please see Table 2.10). They should first decide on whether to prioritize mitigating the short- or long-term stock return decreases due to their product discontinuation decisions. Stressing the discontinuation reason and announcement specificity in their announcements may not always help firms to abate their stock market losses. We find that investors punish firms in the long-term – while they reward them in the short-term – for their discontinuation decisions linked to positive firm motivations such as new product development. Thus, firms should not emphasize their positive motivations behind their product discontinuation decisions in their announcements if they concern the long-term stock market losses.

Fourth, firms should pay attention to potential benefits of industry specific drivers and accentuate them in their announcements to mitigate the long-term stock market losses from their product discontinuation decisions.

Fifth, we argue that the discontinuing firms can rely on their strengths and uniqueness linked to their marketing capabilities in the short-term. However, they should be aware of the exacerbating effect of high marketing capabilities in the long-term. Finally, we speculate that firms need to give more thought to the role of their innovation capacity in their long-term stock market returns when they undergo product discontinuation decisions. We find that investors penalize firms with high innovation capacity for their product discontinuation decisions in the long-term.

Table 2.9. Summary Results

	Hypothesis	Short-term	Long-term
Product Discontinuation	H1: -	Supported	Supported
Discontinuation Reason	H2: (+) Motivations > (-) Reasons	Supported	Rejected
Announcement Specificity	H3: Industry Specific > Firm Specific	Not Supported	Supported
Marketing Capabilities	H4: +	Supported	Rejected
Innovation Capacity	H5: +	Not Supported	Rejected

Table 2.10. Recommendations to Managers

Firm Objective	To mitigate stock market losses due to a product discontinuation	Short-term	Long-term
Possible Firm Strategies	Stressing the positive firm motivations (e.g., new product development or market development) in the product discontinuation announcement as a reason to discontinue a product.	Advisable	Not advisable
	Stressing the industry specific drivers (e.g., emergence of new technology and lack of customer readiness) in the product discontinuation announcement as a reason to discontinue a product.	Not advisable	Advisable
	Relying on firm strengths and uniqueness linked to marketing capability.	Advisable	Not advisable
	Relying on firm strengths and uniqueness linked to innovation capacity.	-	Not advisable
	Relying on positive market updates linked to product portfolio.	-	Not advisable

2.5.4 Limitations

While this study has implications for both research and practice, and provides a number of new insights into abnormal stock returns on firm announcements, it is not without limitations.

First, stock prices may sometimes behave randomly as a result of temporary shocks referred to as 'noise'. For example, the stock price can be influenced by speculators, temporary traders, 'noise traders' as well as the firm's managers who often trade the stock for liquidity. Second, no one can know which date exactly an investor acquires the related information. Investors may acquire other information along with product discontinuation reason that may guide them during their decision making process. Future research employing primary data may examine the investor decision making process in reaction to product discontinuation decisions and enhance our understanding of this important phenomenon.

Third, this research only covers U.S. firms. Thus, the findings are limited to the U.S. stock market. It could be speculated that investors in the long-term oriented countries (e.g., South Korea, Japan, and German) may evaluate discontinuation reasons more consistently in the long-term. Specifically, by adopting a long-term perspective, they may incorporate discontinuation reasons such as positive motivations to their announcements. It could be also argued that investors in the high uncertainty avoidance countries (e.g., Italy, France, and Mexico) may be more likely to take a quick action on product discontinuation announcements. They may incorporate the information in the announcements into short-term stock returns. However, those from low uncertainty avoidance countries (e.g., China, the UK, and India) may be more likely to collect the additional information about the discontinuing firms and incorporate the collected information into long-term stock returns. Future studies should examine a product discontinuation across different stock markets.

CHAPTER 3

RECALLS OF INNOVATIVE PRODUCTS AND FIRM FINANCIAL PERFORMANCES: FIRM MARKET VALUE AND UNSYSTEMATIC EQUITY RISK

3.1 Introduction

Firms recall their products due to the product technical failures. Such recalls are ubiquitous in the marketplace, ranging from drugs that induce temporary and/or medically reversible health effects, to contaminated food products, to toys that pose choking hazards, to cars with faulty airbags. For instance, in 2016, Mars recalled its chocolate bars in 55 countries after a piece of plastic was found in a *Snickers* bar in Germany. Samsung recalled *Galaxy Note 7* worldwide only weeks after its launch in 2016 due to fire-prone batteries. Toyota recalled around 2.3 million vehicles in 2010, addressing one of the well-publicized incidents in which fatal accidents occurred due to faulty acceleration in the vehicles. The prevalence of product recalls in practice is of great interest to scholars. The existing literature shows that product recalls damage a firm's reputation, trust, and brand equity (e.g., Dawar and Pillutla 2000; Rhee and Haunschild 2006) and lead to losses in market value (e.g., Van Heerde et al. 2007; Cleeren et al. 2008; Chen et al. 2009; Liu et al. 2017). Recalls of innovative products, on the other hand, may result in greater market losses compared to recalls of any other products.[7] Specifically, recalls of innovative products may have a

[7] Both recalls of innovative products and any other products - like other corporate announcements - provide investors and consumers with information that helps in their decision-making processes. Specifically, they both serve as signals to the market; however, the magnitude of the signal may vary depend on whether the event is linked to an innovative product. A recall of an innovative product may destroy the *innovation premium effect* which refers to placing a higher value on innovative products than on any other products (Jonash and Sommerlatte 1999). Thus, the investors' and consumers' backlashes against innovative product recalls would be different from those of against product recalls.

significant impact on both firm market value and firm risk due to significant increases in firms' future cash flow variability, as illustrated in several recent examples. First, on 12 September 2016, Samsung Electronics' stock price plunged by 7% to its lowest level in nearly two months right after the company announced its recall of Galaxy Note 7, an innovative smartphone with iris scanner and waterproof S-Pen. Investors wiped the previously earned 15.9 trillion won ($14.3 billion) of Samsung Electronics' firm market value (Reuters 2016; Fortune 2016). Similarly, Kraft's stock price dropped by 11% in 2007, after the company recalled 3 million pounds of its innovative (grilled or fully cooked) Oscar Mayer chicken strips that were believed to be contaminated with Listeria (Poppick 2015).

Recalls of innovative products refer to recall events in which innovative products are found to be faulty or hazardous and involve either a voluntary or an involuntary firm decision to retrieve such products from market and end-users. Existing literature has yet to examine recalls of innovative products, despite the frequency of such recalls on the market and their potential negative impacts on firm financial performances (e.g., firm market value, firm risk, and return on investment). Specifically, there exists a gap in the marketing and innovation literature on the impacts of recalls of innovative products on firm market value (i.e., short- and long-term) and firm risk (i.e., unsystematic equity risk). The current research seeks to fill this gap.

The literature shows that product recalls hurt firm market value in the short-term; however, there is limited evidence on the effects of product recalls on firm market value in the long-term. Liu et al. (2017) find that negative effect of product recall volume lingers over time and brand advertising positively influences the relationship between recall volume and long-term abnormal returns. Recalls of innovative products may significantly damage firm's intangible assets such as brand equity (Dawar & Pillutla 2000; Cleeren et al. 2008), customer loyalty (McAlister et al. 2007), reputation (Rhee and Haunschild 2006), and marketing

effectiveness (Van Heerde et al. 2007). The damage to such assets may significantly affect firm cash flow in the long term, which may be difficult for investors to assess (Liu et al. 2017). Thus, it is important to understanding the effect of innovative product's recall on long-term firm market value. For managers this research offers valuable insights into both short- and long-term consequences of such recalls; it will enable them to properly state or adopt their firms' short- and long-term objectives.

A firm's marketing decisions such as recalls of innovative products influence the variability of the firm's future cash flow and increase its unsystematic equity risk (Srinivasan and Hanssens 2009). A recall of an innovative product may significantly harm the trust relationship between the firm and its equity holders including its investors, increasing its cash flow variability (Anderson and Weitz 1992; Srivastava et al. 1998). Moreover, such recall may signal incompetency to the investors, which leads to an increase in the firm's cash flow variability (Lei et al. 2012). The increase in the variability of the cash flow results in greater unsystematic equity risk, which serves as a red flag indicating firm failures (Lubatkin & Chatterjee, 1994). Thus, from a managerial perspective, it is worth studying how recalls of innovative products affect unsystematic equity risk. Specifically, managers can benefit from the insights into the unsystematic equity risk by better assessing future cash flow and taking the necessary precautions against firm failures. Moreover, providing theoretical and empirical evidence of the effect of a firm's marketing decision (i.e., recall of an innovative product) on firm risk (i.e., unsystematic equity risk) will contribute to marketing literature by filling this gap in the literature.

Drawing upon signaling theory (Spence 1974), I argue that recall announcements of innovative products like other strategic firm announcements (e.g., product discontinuation announcements), serve as signals to the market. Moreover, innovation and recall characteristics may influence the magnitude of the signal and the subsequent equity holders'

reactions. I argue that market loss and growth in firm risk due the recall of an innovative product may vary depending on innovation and recall characteristics. These boundary conditions are of great interest to both researchers and practitioners. From a theoretical standpoint, this research contributes to both innovation and recall literature by offering a better understanding of how innovation type, innovative product life, recall time, recall volume, recall initiator, and recall severity alleviate (or exacerbate) the negative effect of innovative product recalls on firm market value and unsystematic equity risk. From a practitioner perspective, managers require guidance on how to manage such conditions to minimize the negative impact of such recalls in the short and long term (Liu et al. 2017). Similarly, managers may rely on understanding linked to the conditions under which they should voluntarily engage in recalls of innovative products and disclose the innovation type, recall volume, and/or recall severity in their recall announcements. Specifically, the following research questions are addressed:

(1) What are the effects of innovative products' recalls on firms' stock market performance?
(2) What is the effect of innovative products' recalls on firms' unsystematic equity risks?
(3) What are the innovation-related factors that may influence the relationship between innovative products' recalls and firms' stock market performance and unsystematic equity risk?
(4) What are the recall-related factors that may affect the relationship between innovative products' recalls and firms' stock market performance and unsystematic equity risk?

This research is unique in three ways. First, it reveals the impact of innovative products' recalls on stock returns. Second, this research provides evidence on the effect of

product recalls on unsystematic risk. Third, it introduces novel boundary conditions such as recall time, innovative product life, and innovation type into recall literature.

The remainder of the essay is organized as follows. The next section defines product recall and presents a brief review of the recall literature. I then present conceptualization of the effects of innovative products' recalls on firm market value and unsystematic equity risk. In the next section, I present the methodology and results. Lastly, I conclude with a discussion of the results.

3.1.1 Research Background: Product Recall

Product recalls are defined as well-publicized events in which products are found to be defective or dangerous (Siomkos and Kurzbard 1994; Dawar and Pillutla 2000) and involve a firm's decision (*voluntary*) or a government request (*involuntary*) to recall these products from all distribution channels and end consumers (Chen et al. 2009).

Studies that are particularly relevant to this research investigate the impact of product recalls on firm market value (Please see Table 3.1). In contrast to other product recall studies in the literature, these studies on firm market value reveal mixed findings. Several studies show that product recall announcements lead to negative abnormal returns (Jarrell and Peltzman 1985; Davidson and Worrell 1992; Chu et al. 2005; Zhao et al. 2013; Germann et al. 2014; Gao et al. 2015; Lee et al. 2015; Hsu and Lawrence 2016; Eilert 2017) whereas others find no effect or attribute any effects to boundary conditions (Hoffer el al. 1988; Thomsen and McKenzie 2001). Specifically, food and consumer products, drug, and automotive recalls damage firm market value (Jarrell and Peltzman 1985; Chu et al. 2005; Zhao 2013; cf., Hoffer el al. 1988) while meat and poultry recalls involving fewer threats to consumer health do not hurt firm market value (Thomsen and McKenzie 2001).

These mixed results call for more studies examining contingency factors such as recall remedy, recall strategy, and social media engagement that may influence the relationship

between product recalls and firm value. Specifically, the recalls damage firm market value more when products are replaced (or purchase price is returned) than when the products are checked and repaired (Davidson and Worrell 1992). Lee et al. (2015) find that a firm can attenuate the negative effect of a recall by increasing the frequency of tweets. Hsu and Lawrence (2016), on the other hand, show that all three dimensions (volume, valence, and growth rate) of online word-of-mouth exacerbate the negative effect of the recall. Lastly, Zhao et al. (2013) show that passive recall strategies (compared to proactive) lead to more negative stock returns on Chinese markets while Chen et al. (2009) conclude that proactive recall strategies result in more negative stock returns in US markets than passive strategies.

In addition to these studies, another research stream in the marketing literature focuses on the characteristics of the recall itself. The voluntary recalls are more effective than involuntary recalls regarding the attitude change toward recalling firms, and they result in more learning than involuntary recalls (Siomkos 1989; Haunschild and Rhee 2004). Moreover, recalls involving serious health threats lead to negative financial returns while those involving less serious violations do not (Thomsen and McKenzie 2001). Overall, these papers only provide short-term evidence associated with the investors' immediate reaction following product recalls. However, the effect may still exist months later following the recall announcement due to indirect cost of such events (Puritt and Peterson 1986; Liu et al. 2017). The effect of innovative product's recalls on firm market value is missing in the literature. Many studies distinguish a product recall based on its product category (e.g., food, automotive or consumer products), initiator (i.e., the firm itself or government-ordered), severity (involving a serious or less serious violation or health threat to consumers) (Please see Table 3.1). However, equity holders' assessments of a product recall may be affected by the innovativeness of the product. Indeed, Jonash and Sommerlatte (1999) argue that Wall Street experiences innovation premium effect, increasingly placing a higher value on

Table 3.1. Classification of Relevant Literature on Product Recall

Study	Key Constructs	Focus on product innovativeness	Focus on recall time	Focus on recall volume	Focus on recall severity	Focus on recall initiator	Focus on short-term stock market performance	Focus on long-term stock market performance	Focus on firm stock risk	Coverage of multiple markets
This study	*Recalls of Innovative products, innovative product life, innovation type*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes, three markets*
Jarrell and Peltzman (1985)	Goodwill and competitor loss	No	No	No	No	No	Yes	No	No	Yes, two markets
Pruitt and Peterson (1986)	Reputation in direct costs	No	No	No	No	No	Yes	No	No	Yes, non-auto recalls
Pruitt et al. (1986)	Domestic or foreign competitors	No	No	No	Yes	No	Yes	No	No	No, only automotive
Hoffer et al. (1988)	Competitor loss	No	No	No	No	No	Yes	No	No	No, only automotive
Davidson and Worrell (1992)	Repaired and replaced recalls	No	No	No	No	Yes	Yes	No	No	Yes, non-auto recalls
Thomsen and McKenzie (2001)	Food contamination	No	No	No	Yes	No	Yes	No	No	No, only meat and Poultry

Study	Key Constructs	Focus on product innovativeness	Focus on recall time	Focus on recall volume	Focus on recall severity	Focus on recall initiator	Focus on short-term stock market performance	Focus on long-term stock market performance	Focus on firm stock risk	Coverage of multiple markets
Chu et al. (2005)	Industry type	No	No	No	No	No	Yes	No	No	Yes, non-auto recalls
Chen et al. (2009)	Proactive or passive strategies	No	No	No	No	No	Yes	No	No	Yes, consumer products
Zhao et al. (2013)	China, passive or proactive	No	No	No	No	No	Yes	No	No	Yes, four markets
Germann et al. (2014)	Brand commitment	No	No	No	Yes	No	Yes	No	No	No, only automotive
Gao et al. (2015)	Pre-recall advertising adjustment	No	No	No	Yes	No	Yes	No	No	No, only automotive
Lee et al. (2015)	Corporate social media	No	No	No	No	No	Yes	No	No	Yes, nine markets
Hsu and Lawrence (2016)	Online word-of-mouth	No	No	No	No	No	Yes	No	No	Yes, three markets
Eilert et al. (2017)	Time to recall, Brand diversification	No	Yes	No	Yes	No	Yes	No	No	No, only automotive
Liu et al. (2017)	Crisis management, advertising	No	No	Yes	No	Yes	No	Yes	No	No, only automotive

innovation than on virtually any other growth-generating approach. Thus, innovative firms enjoy the highest shareholder returns (Jonash and Sommerlatte 1999). They may, on the other hand, experience a dramatic decrease in the stock returns when they recall their faulty or dangerous innovative products. These firms, on the other hand, may enjoy high credibility subsequent to product failures due to high firm reputation, customer loyalty, or product popularity, which may help them avoid experiencing dramatic stock return decreases when they recall their innovative products.

Table 3.2 summarizes the existing literature other than event studies. Product recalls have potential to tarnish a firm's brand equity and reputation (e.g., Dawar and Pillutla 2000; Rhee and Haunschild 2006), influence consumers' consumption decisions (Folkes 1984), spillovers to rival products (e.g., Van Heerde et al. 2007; Borah and Tellis 2015), and decreases future recalls (Kalaignanam 2013). Other studies examine the boundary conditions such as CEO compensation, CEO tenure, corporate social responsibility, trust, pre-crisis loyalty, and brand familiarity and commitment, which all affect customers' reactions to product recalls (e.g., Liu et al. 2016; Germann et al. 2014; Rubel et al. 2011; Lin et al. 2011).

3.2 Theoretical Development

Based on the signaling theory (Spence 1974), the receivers can read the signal quickly and with minimum error (Heil and Robertson 1991). With their innovative claims, innovations clearly signal a firm's proficiency, boosting both consumers' and investors' expectations. Thus, a failure to address such expectations may significantly damage the firm's reputation, trust, and brand equity, hurting in turn its market value and increasing its risk. This research argues that several recall related factors such as recall time, recall volume, recall initiator, and recall severity contribute to the clarity of an innovative product's recall announcement, which may help investors assess the consequences of the recall.

Table 3.2. Classification of Relevant Literature on Product Recall Other than Event Studies

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Mowen et al. (1981)	The consumer's knowledge of a recall, the perceived danger of the product, the company's social responsibility in making the recall, the length of time to recall, the number of previous recalls	Perception of the company	Mixed: Airlines, cookware dishes, tires, and automotive	Survey	Regression	The length of time to recall, and the number of previous recalls by the company influenced consumer favorability regarding the company. In no cases was knowledge of previous recalls and the length of time to make the recall significantly related to corporate perceptions.
Folkes (1984)	Product failure, causal stability, locus, controllability, expectancy reactions, stable or unstable attributions, refund or exchange, anger reactions, apology, and market equity reactions	Expectancy reactions, market equity reactions, and anger reactions	Mixed	Participants in the laboratory (lab)	Laboratory (lab) experiments	The stability and locus of product failure similarly influenced expectancies for future product failure and preference for a refund rather than an exchange.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Folkes (1984) *continued*						Consumers expect the product to fail in the future when the cause was stable and they prefer a refund rather than an exchange when the cause of failure was stable. Locus strongly influences whether refunds and apologies are deserved.
Siomkos (1989)	Companies reputation and image, external effects, organizational response	Pre-crisis attitude toward the company, post-crisis attitude toward the company, attitude change, interest in new model	Household appliance	Participants in the lab	Lab experiments, ANOVA	A firm is more likely to handle the crisis if it is a well-known company and government and press reactions are positive Voluntary recall is more effective than involuntary recall.
Dawar (1998)	Brand equity, brand signals, signal credibility, brand awareness, brand associations, consumer brand experience, perceived brand investment	Brand equity, brand signal credibility, and brand associations	NA (not available)	NA	Conceptual article	The crisis creates heightened awareness among consumers about the firm and the brand. During the heightened awareness, the firm may consolidate the beliefs about the brand by supporting its brand.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Dawar and Pillutla (2000)	Brand equity, product-harm crisis, firm responses, such as unambiguous support, ambiguous response, and unambiguous stonewalling	Brand equity	Beverage and computer	Telephone interviews and participants via lab experiments	Lab experiments: ANOVA	The results indicate that consumers interpret firm response based on their prior expectations about the firm. The interaction of expectations and firm response is shown to affect post-crisis brand equity.
Haunschild and Rhee (2004)	Organizational learning, voluntary or involuntary recalls, prior production experience, volition, and generalist or specialist firms	The annual number of severe recalls	Automotive	NHTSA	Learning-outcome model	Voluntary recalls result in more learning than mandated recalls. The effect of volition is different for generalist and specialist automakers.
Rhee and Haunschild (2006)	Quality reputation, liability, product defect, substitutability, generalism or specialism, and severe or non-severe recalls	Change in market-share	Automotive	NHTSA	Power function	When firms make mistakes, those with good reputations suffer more market penalty than those with poor reputations.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Rhee and Haunschild (2006) *continued*						Non-substitutability signals uniqueness within quality reputation categories and helps buffer good-reputation organizations from market penalties. Good-reputation specialists are more protected from market penalties than good-reputation generalists are.
Laufer and Coombs (2006)	Blame, reputation, perceived severity, gender, super effort, recall, uncertainty avoidance	Super effort or voluntary recall strategy	Not available	Not available	Conceptual article	Reputation and consumer-based cues (gender and nationality) should be incorporated in the corporate decision-making process.
Van Heerd et al. (2007)	Brand equity, price, advertising, and sales	Change in sales	Food	AC Nielsen Australia	Vector-error correction model (VEC)	A firm experiences a loss in base-line sales, reduced effectiveness for its marketing actions, increased cross-sensitivity to rival firms' marketing-mix actions, decreased cross-impact of its marketing mix activities on the sales of competing, unaffected brands.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Cleeren et al. (2008)	Brand equity, own and cross advertising, time, pre-crisis loyalty, brand familiarity, and category usage, cross and competitive purchases	First-purchase decisions for the affected brands following a product-harm crisis	Food	AC Nielsen Australia	Multiple-event hazard model	Pre-crisis equity provides protection against product-harm crises. Pre-crisis loyalty and familiarity are found to form an important buffer against the crisis. Heavy users tend to purchase the affected brands sooner, unless their usage rate decreased significantly during the crisis.
Xie and Peng (2009)	Competence, integrity benevolence, forgiveness, customer trust, negative publicity, affective repair, functional repair, and informational repair	Organizational integrity, benevolence, and competence, consumer trust and forgiveness	Electronics	Participants in the lab	Lab experiments, MANOVA	Rebuilding a trustworthy image and earning consumer forgiveness are crucial steps in repairing consumer trust Providing sufficient information is a key activity for enhancing consumers' judgments about the firm's competence.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Hora et al. (2011)	Preventive or reactive recall strategy, manufacturing defect or design flaw, supply chain player, hazard type, and country of manufacture (China vs. others)	Time to recall	Toy	CPSC	Regression	The time to recall is associated with (1) the recall strategy (preventive vs. reactive) adopted by the firm, (2) the type of product defect (manufacturing defect vs. design flaw), and (3) the supply chain entity that issues the recall (toy company vs. distributor vs. retailer).
Rubel et al. (2011)	Advertising, brand sales dynamics	Optimal pre-crisis and post crisis advertising	Automotive	NHTSA	Stochastic model	The optimal pre-crisis advertising decreases, but the post-crisis advertising increases as the crisis likelihood (or damage rate) increases. Ad effectiveness increases while carryover effect decreases. There is a remarkable noteworthy correspondence between the observed and optimal advertising decisions.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Zhao et al. (2011)	Consumer learning, price, experienced quality of the product, and advertising	Consumer choice	Food	AC Nielsen Australia	Structural model	The model outperforms the standard consumer learning model. The findings show that how a product-harm crisis affects consumers' choice behavioral responses.
Dutta and Pullig (2011)	Performance- or values-based crisis, brand confidence, attitude, or consideration, functional, social, or psychological risk, and corrective, denial, or reduction-of-offensiveness	Brand confidence, brand attitude, brand consideration, functional risk, social risk, and psychological risk	Sports outfit	Participants in the lab	Lab experiments, ANOVA	The relative effectiveness of response strategies depends on the nature of the brand crisis. For a performance-related crisis, the corrective action is uniquely the most effective response while for a values-related crisis, reduction-of-offensiveness is, for the most part, as effective as corrective action. Denial is the least effective response regardless of crisis type.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Lin et al. (2011)	Purchase intention, perceived corporate ability (CA), corporate social responsibility (CSR), negative publicity, trust,	Perceived negative publicity, affective identification, trust, and purchase intention	Automotive	Survey of working professionals	Structural equation modeling (SEM)	Purchase intention is indirectly influenced by perceived CA, negative publicity, and CSR via mediation of trust and affective identification. The impact of perceived negative publicity on trust and affective identification are moderated by perceived CA and CSR, respectively.
	purchase intention, perceived corporate ability (CA), corporate social responsibility (CSR), negative publicity, trust, and affective identification	Perceived negative publicity, affective identification, trust, and purchase intention	Automotive	Survey of working professionals	Structural equation modeling (SEM)	
Yannopoulou et al. (2011)	Brand trust, mass media, generalized public images of a product crisis, perception of risk	Public perception of risk	Food	Interviews with consumers	Case study	Generalized public images of a product crisis initiate a public perception of risk, which provides more negative effects on brand trust than the actual consumer experience does.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/ Propositions
Yannopoulou et al. (2011) *continued*						The mass media is consumers' main reliable source of information, and thus the basis for the formation of their perceptions of the brand crisis.
Cleeren et al. (2013)	Product-harm crisis, blame, negative publicity, category advertising, category price, brand share, and category purchases	Change in brand share and change in the category purchases	FMCG	Food Standards Agency, Trading Standards Institute, the archives of the Voedsel Waren Autoriteit (Food Products Authority), and the Consumentenbond (Consumer Reports).	Regression	The effectiveness of brand (or category) advertising is greater with a high level of negative publicity surrounding the crisis. Category price sensitivity is greater with a high level of negative publicity surrounding the crisis. The effectiveness of brand (category) advertising is low when the affected brand acknowledges blame.
Kalaignanam et al. (2013)	Recall magnitude, product assets, brand quality, future product reliability,	Future product reliability, future number of injuries, and future recall frequency	Automotive	NHTSA	Regression	Increases in recall magnitude lead to decreases in future recalls.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/Propositions
Kalaignanam et al. (2013) *continued*	number of injuries, and recall frequency					The positive effect between the magnitude and future product reliability becomes stronger for firms with higher shared product assets.
Borah and Tellis (2015)	Spillover, wear-in wear-out, online chatter, halo effect	Perverse halo (negative spillover)	Automotive	Third-party data provider	Vector autoregressive models with exogenous variables (VARX)	Perverse halo exists both for nameplates within the same brand and for nameplates across brands. The effect is stronger from a dominant brand to a less dominant brand than vice versa. The effect is strongest between brands from the same country. The effect influences the sales and stock prices. Apology advertising increases concerns for both the recalled brand and its rivals.

Study	Key Constructs	Dependent Variable	Industry	Data Source	Method/Model	Key Findings/Propositions
Liu et al. (2016)	CEO compensation, remedy cost, severity, CEO tenure, and full or partial remedy	The likelihood of providing full (vs. partial) remedy	Consumer products, such as toys, household products, and sporting goods	CPSC	Probit model	Firms are more likely to provide a full remedy for more severe product hazards. Full remedy is less likely when the CEO receives greater cash compensation or less equity incentive, and when the CEO has longer tenure in the position.

Drawing upon signaling theory, this study argues that the investors' (the receiver's) evaluations be contingent on the innovation related factors. Specifically, they may not only rely on the essential information stated in the firm announcements (Grullon et al. 2004; Xiong and Bharadwaj 2013) but also consider the innovation-related factors such as an innovative product life and innovation type. Such factors may signal possible direct (e.g., cost of retrieving the defective products from the distribution channels) and indirect costs (e.g., damage in firm reputation or brand equity) of innovative product recalls to the investors. Thus, investors may evaluate the possible consequences of the recall quickly and with minimum error.

3.2.1 Definitions

Recall time is the duration between recall initiation date and recall termination date. The longer this period, the greater is market uncertainty, which influences the firm market value and firm risk (Srivastava et al. 1999). *Recall volume* refers to total quantity/amount that firms announced to recall. The higher the volume, the greater is the total cost (the direct and indirect cost) which affects the predictability of the firm's future cash flow, influencing its market value and risk (Puritt and Peterson 1986; Rappaport 1997; Srivastava et al. 1998). *Recall initiator,* on the other hand, is the actor that initiates the recall. Firms either voluntarily engage in recall or they are mandated to do so (e.g., Siomkos 1989; Haunschild and Rhee 2004). Voluntary actions in negative situations such as recalling an innovative product may seem sincere and signal to the investors that firms care about their consumers. *Recall severity* refers to the degree of a defective product's danger to consumers' health. Investors are more likely to closely monitor the recall of an innovative product involving an adverse health consequence or death, which has a greater impact on a firm's cash flow.

Innovative product life is defined as the duration between an innovative product's launch date and its recall initiation date. An innovative product with a long life may contribute to firm reputation. Equity holders may know the reputation of the innovative product and closely follow its performance and assess its failure accordingly. *Innovation type,* on the other hand, refers to types of innovation (i.e., a tech-based or market-based innovation) that develop innovative products. Firms develop tech-based innovations to create a unique product while they introduce market-based innovations to capture emerging markets (Zhou et al. 2005). Innovation type may offer additional insights into the recall costs of innovative products. Thus, investors evaluate the innovative product recalls accordingly.

3.2.2 Recalls of Innovative Products, and Firm Market Value and Risk

Equity holders such as investors and shareholders are motivated by cash flow expectations (Srinivasan et al. 2009). Thus, managers may decrease equity holder confidence in their firms in one of four ways: (1) decelerating cash flow, (2) decreasing the level of the firm's cash flow, (3) increasing the risks to the firm's cash flow, and (4) reducing the residual value of the firm (Rappaport 1997; Srivastava et al. 1998). I develop a conceptual framework to capture the effects of innovative product recalls on firm market value and firm risk using two of these four routes. Specifically, such effects may be driven by (1) a decrease in the level the firm's cash flow and (2) an increase in risk linked to cash flow. I argue that equity holders and managers are concerned not only with assessing the recalling firm's expected returns (i.e., the level of cash flow) but also with associated risk, which are used to discount the cash value (Day and Fahey 1988; Fama and French 1993; Rego et al. 2009).

Existing research shows that product recalls hurt firm market value (e.g., Jarrell and Peltzman 1985; Davidson and Worrell 1992; Chen et al. 2009; Lee et al. 2015; Hsu and Lawrence 2016). However, there is lack of evidence on the effect of product recalls on firm risk. Indeed, equity holders take firm risk into consideration when they value a firm's cash

flow in relation to its strategic decisions. They immediately react to these decisions when they perceive low firm risk, thereby influencing firm market value positively (Amit and Wernerfelt 1990).

The type of risk (variability-based or vulnerability-based) and type of investor risk perspectives (debt- or equity holder risk) are important concepts in understanding the firm-level risk (Rego et al. 2009). The existing marketing literature mostly focuses on variability-based risk (e.g., McAllister et al. 2007), whereas finance and accounting literature investigate vulnerability-based risk (e.g., Miller and Leiblein 1996; D'Aveni and Ilinitch 1992). The basic tenet is that variability in the firm cash flow creates uncertainty, leading to lower predictability of the future cash flow. Investors expect higher rates of return to compensate for lower predictability, which translates into lower stock prices. In terms of vulnerability-based risk, investors assess firm cash flow based on the likelihood that the cash flow will be sufficient to cover the firm's financial needs (Rego et al. 2009).

Marketing literature has recently begun to focus on equity holder risk while finance literature mostly investigates debt-holder risk. Finance studies argue that vulnerability of cash flow is the key concept of risk, which shows the firm's capability to manage its debt (e.g., Merton 1974). Relying on the capital asset pricing model, the perspective of equity holder risk views *total equity risk* as the variability of a firm's stock returns (Markowitz 1999; Rego et al. 2009). Total equity risk is partitioned into (1) systematic equity risk in which the variability of the stock returns reflects macroeconomic events (e.g., interest rates) that influence entire market portfolio returns, and (2) unsystematic equity risk in which the variability of the stock returns is associated with specific firm events (e.g., innovative product recalls or a product launch) that only affect the firm's returns (Markowitz 1952; Kroll et al. 1999; Srinivasan and Hanssens 1999; Rego et al. 2009). Consequently, managers may manage unsystematic risk while they cannot control systematic risk. Thus, insights regarding

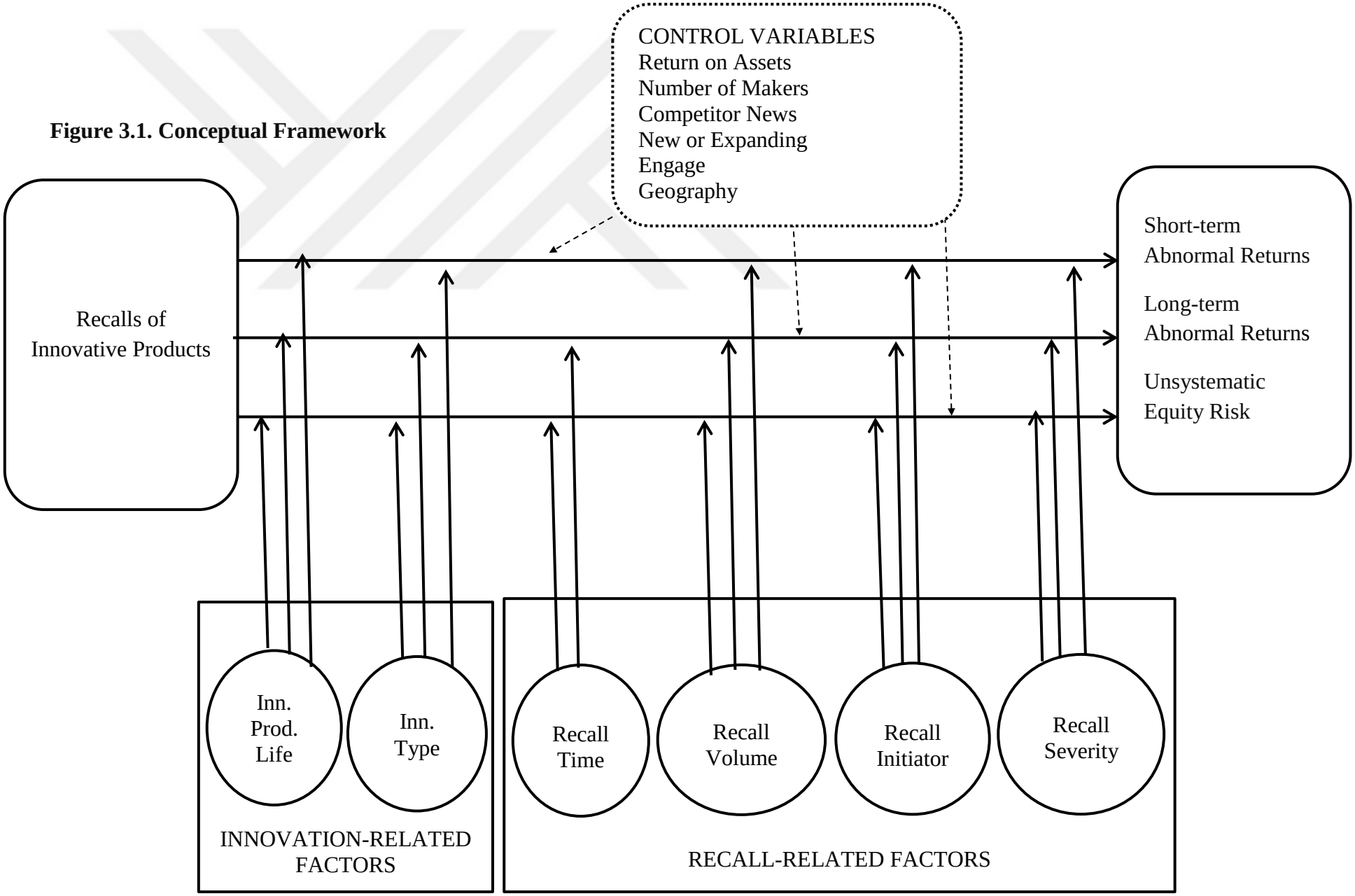
unsystematic risk are greatly off interest to managers. Indeed, unsystematic risk explains 80% of total equity risk (Goyal and Santa-Clara 2003; Gaspar and Massa 2006). This study focuses on equity holder risk and examines unsystematic risk in particular.

The impact of an innovative product's recall on firm market value may be more perturbing than that of a non-innovative product's recall. Due to the innovation premium effect, equity holders build high expectations and hence place an extravagant value on firms' cash flow. When firms fail to address such expectations, and recall their innovative products, equity holders may perceive high uncertainty and assess the firms' future cash flow poorly, destroying the firm market value while increasing the unsystematic equity risk. However, these firms may enjoy high credibility subsequent to product failures due to high firm reputation, customer loyalty, or product popularity. Equity holders may take a holistic approach and not evaluate innovative product failures at the time of the recall. Instead, they update their assessment during the recall processes (Pauwels et al. 2004). Thus, these firms may not experience losses in their firm market value and may not bear high firm risk. I argue that certain contingency factors may determine the effect of innovative product recalls on firm market value and unsystematic equity risk. Thus, I focus on recall and innovation characteristics (recall time, recall volume, recall initiator, recall severity, innovative product life, and innovation type) to examine the relationship between innovative product recalls and firm market value and unsystematic equity risk (Please see Figure 3.1).

3.2.3 The Moderation Effect of Recall-Related and Innovation-Related Factors

Signaling theory suggests that the receivers (e.g., investors) evaluate market signals (firm announcements) to gain information (Connelly et al. 2011). They must interpret the information before they respond to it. Their interpretation may differ based on (1) the characteristics of the signal (such as signal clarity) and (2) the intentions and/ or capabilities of the signaler (Heil and Robertson 1991; Prabhu and Steward 2001). I argue that recall-

Figure 3.1. Conceptual Framework



related characteristics (i.e., recall time, volume, severity, and initiator) can contribute to signal clarity while innovation-related characteristics (i.e., innovation type) can signal the firm's intention. I argue that having a clear signal and understanding the firm's intention help investors to assess the firm's future cash flow fluctuations due to recalls of innovative products. Thus, it is worth studying both the recall-related and innovation-related characteristics.

Recall Time. Recalling firms may bear significant direct costs (e.g., taking all products off the distribution channel) and indirect costs (e.g., damage in firm reputation or brand equity) due to innovative product recalls (Jarrell and Peltzman 1985; Pruitt and Peterson 1986; Hsu and Lawrence 2016). Thus, they may often act quickly and try to terminate the recall as early as possible. The longer the recall time, which is the difference between the recall initiation and its termination date, the greater is the total cost. High direct cost may lead the firm to experience a decrease in the level of its cash flow (Srivastava et al. 1998). Moreover, during the recall process, firms may need additional working capital to cover their short-term expenses, reducing the level of its cash flow (Srivastava et al. 1998). This reduction in cash flow due to these two factors may hurt the shareholder value of the firm.

As recall time passes, the likelihood of retaining a large part of customers may decrease. In other words, churn among customers is likely to increase, leading to a greater variability in the firm's cash flow, which in turn increases unsystematic risk (Srivastava et al. 1998; Rappaport 1997). Moreover, there may be a negative relationship between recall time and firm reputation. As recall time increases, more consumers may hear of the product recall. More and more consumers may be exposed to news on innovative products' recalls since such events are increasingly likely to be covered, even in local media outlets. Thus, the longer the recall time, the greater is the damage in firm reputation, which signals higher

unsystematic risk to equity holders (McAlister et al. 2007; Singh et al. 2005). Lastly, consumers and equity holders develop high expectations for innovative products (Jonash and Sommerlatte 1999; Bertini et al. 2009). When firms fail to meet such expectations and recall their innovative products, the resulting dissatisfaction may spread to the firm's other products. The degree of dissatisfaction may increase just as the recall time increases. Increased dissatisfaction leads to high variability in the firm's cash flow, increasing unsystematic risks (Fornell et al. 2006; Anderson, et al. 2004; Srivastava et al. 1998). Considering all these notions, I argue that unsystematic risk grows as recall time increases.

Recall Volume. Recall volume, which is the total quantity/amount of the recalled product, moderates the relationship between product recalls and firm market value and unsystematic equity risk due to an increase in costs, hampered channel relationships, and tarnished firm reputation and/or competence. Simply, both direct and indirect costs increase as the recall volume rises. Recalling firms need more time and money to fix or replace a large volume of recalled products compared to small volumes of products. Moreover, they are more likely to face unexpected costs such as lawsuits and regulatory fines (Govindaraj et al. 2004; Liu et al. 2017). Consequently, recalling firms are more likely to use high working capital, leading to a decrease in their cash flow (Srivastava et al. 1998). Moreover, when these firms fail to deliver a significant number (high volume) of the promised innovative products to their distributors, they may damage the channel relationship which may negatively affect both the level and variability of their cash flow (Anderson and Weitz 1992; Srivastava et al. 1998).

Recalling firms may signal incompetence to their consumers and equity holders, and the degree of this incompetence may increase as the recall volume escalates (Lei, Dawar, and Gurhan-Canli 2012). Lastly, product recalls with high volume may draw media attention nationally and trigger both online and offline negative word of mouth, leading to a greater visibility and salience of the recalled products (Borah and Tellis 2016; Liu et al. 2017). The

negative media coverage may significantly hurt firm reputation and consumer loyalty (Dawar and Pillutla 2000; Rhee and Haunschild 2006; Siomkos and Kurzbard 1994), resulting in losses in firm market value (Van Heerde et al. 2007; Cleeren et al. 2008; Chen et al. 2009) and increases in unsystematic equity risk (Rappaport 1997; Srivastava et al. 1998).

Recall Initiator. Signaling of product recalls may also depend upon recall initiators (a firm or government agency) (e.g., Davidson and Worrell 1992). Indeed, existing research examines the impact of regulatory agencies on firm performance during product recall crisis, resulting in mixed findings (Siomkos 1989; Davidson and Worrell 1992; Siomkos and Kruzbard 1994; Laufer and Coombs 2006). For example, Siomkos (1989) and Siomkos and Kruzbard (1994) find that voluntary recall is more effective than involuntary recall in handling product-harm crises. Chen et al. (2009), on the other hand, show that proactive (voluntary) recall strategies lead to more negative stock returns than passive (involuntary) recall strategies. Moreover, Davidson and Worrell (1992) provide limited evidence which shows that involuntary recalls produce more negative returns than voluntary recalls. Innovative firms may be perceived to be more responsible, trustworthy, and sincere when they voluntarily initiate the recall before regulatory agencies order them to do so (e.g., Jolly and Mowen 1985; Shrivastava and Siomkos 1989). These firms' sincerity and trustworthiness may reassure consumers that they do care about their customers and that they can manage such crises (Davidson and Worrell 1992; Chen et al. 2009). For example, Mattel Inc. was selected by Fortune magazine for the 2008 list of "100 Best Companies to Work For" due to its quick and responsible actions in recalling defective products in 2007 (Chen et al. 2009). Consequently, customers may stay loyal to such a firm, which in turn contributes to the firm's cash flow stability (Srivastava et al. 1998). Moreover, the sincerity signal may mitigate the negative impact of the innovative products' recalls on the firm's reputation. Thus, voluntary recall may be less damaging to the firm's reputation than involuntary recall, signaling lower risk to equity holders (Rego et al.

2009). Overall, I expect that voluntary recalls alleviate the negative effect of innovative product recalls on the level and the variability of the firm's cash flow, thereby influencing the firm market value and unsystematic equity risk, respectively.

Recall Severity. Recall severity, which refers to the degree of hazard of a recalled product, may contribute to the signal clearness, influencing the perceived ambiguity (Cheah et al. 2007; Germann et al. 2014). Germann et al. (2014) argue that severe recalls tend to appear unambiguous while non-severe recalls do not. Thus, equity holders may comprehend severe product recall announcements linked to innovative products quickly, and with minimum error, compared to non-severe product recall announcements linked to innovative products (e.g., Heil and Robertson 1991; Heil and Langvardt 1994). Consumers and equity holders may have high tolerance toward non-severe product recalls linked to innovative products. They may believe that the failure is a must to be creative. Consequently, innovative firms may have high credibility upon failing. If the failure is not associated with a serious health threat to the end users, consumers and equity holders may attribute the failure to the firm learning. Thus, consumers may still prefer the firm's brands while equity holders may be still interested in the firm's stock, resulting in a steady level of the cash flow. Moreover, this learning may even contribute to the firm's reputation, influencing the cash flow variability (Rego et al. 2009; Rhee and Haunschild 2006). Similarly, I argue that an innovative firm image may lessen the negative impact of innovative products' recalls on firm reputation. Thus, equity holders' confidence in the firm may not significantly change. Specifically, non-severe recalls of innovative products may not damage the firm's reputation, whereas severe recalls of innovative products do. Thus, non-severe recalls of innovative product announcements may signal lower risks to equity holders. Overall, I expect that the degree of severity influences the effect of innovative products' recalls on the level and the variability of

the firm's cash flow, affecting the firm's market value and unsystematic equity risk respectively.

Innovative product life. Existing literature suggests that customers form loyalties toward innovative and quality products, and quality and innovativeness tend to increase firm reputation and firm market value (e.g., Bharadwaj and Menon, 1993; Hendricks and Singhal, 1996; Sood and Tellis 2009; Pappu and Quester 2016). An innovative product with a short life may not survive long enough in the market to build (or contribute to) firm reputation while the innovative product with a long life may do so. A firm which recalls its innovative product with a long life may suffer greater losses on its reputation compared to one that recalls its innovative product with a short life. Indeed, firms with good reputations who recall products suffer more market penalty than firms with poor reputations, resulting in a significant decrease in the level of their cash flow (Rhee et al. 2006). Moreover, the loss in firm reputation is linked to the variability of the cash flow, increasing unsystematic firm risk (McAlister et al. 2007; Singh et al. 2005). Thus, I argue that innovative product life has a direct effect on the level and the variability of the cash flow, which influences firm market value and firm unsystematic risk respectively.

A firm may experience increasing demand for its innovative product as time passes. That demand may result in a larger market share, providing an economy of scale that offers lower per unit costs in purchasing, manufacturing, distribution, financing, R&D, and marketing (Kroll et al. 1999). Thus, an innovative product with a long life may have a significant impact on the firm's direct cost. When the firm recalls such a product, it may lose its economy of scale, due to broader retail acceptance and accelerated innovation adoption (Xiong and Bharadwaj 2011; 2013). An innovative product with a short life, on the other hand, may not survive long enough to experience accelerated diffusion and hence it may not contribute to the firm's economy of scale. These two related drivers – the loss of economy of

scale and an increase in direct costs – may decrease the level of cash flow, in addition to the risk associated with the cash flow (Rappaport 1997; Srivastava et al. 1998). Thus, I argue that the recall of an innovative product with a long life would have a greater impact on firm market value and unsystematic risk.

Based on the above, I hypothesize that:

H1a. *The greater the innovative product life, the lower the abnormal returns due to the recall announcement of an innovative product.*

H1b. *The greater the innovative product life, the higher the unsystematic risk due to the recall announcement of an innovative product.*

Innovation Type. The innovative firms employ new technologies both for marketing benefits and cost reduction (Cohen and Klepper 1996). However, the degree of the used technological advances may vary, influencing the end-product and its perceived value. Indeed, the literature differentiates between two innovation types based on their (1) advance in existing technology (tech-based innovations) and (2) departure from the existing market (market-based innovations) (Benner and Tushman 2003; Zhou et al. 2005). Zhou et al. (2005) define tech-based innovation as an innovation that "adopts new and advanced technologies and improves customer benefits relative to existing product for customers in existing markets", and market-based innovation as an innovation that "departs from serving existing, mainstream markets" (p.43). They argue that the two innovations vary in terms of the technology and the market dimensions. Specifically, tech-based innovations often involve unique advanced technologies while market-based innovations usually employ a simple new technology (Chandy and Tellis 1998; Zhou et al. 2005). Moreover, tech-based innovations serve existing markets and offer better customer value compared to existing products (Chandy and Tellis 1998). In contrast, market-based innovations address the needs of new

markets and their performance may be poor in comparison to that of existing products (Zhou et al. 2005). Equity holders who carefully monitor the innovative firms may be aware of these differences, evaluating each innovation accordingly.

The negative consequences of the recall of an innovative product associated with a tech-based innovation may be different from those linked to a market-based innovation. Tech-based innovations require greater investments compared to market-based innovations. Furthermore, the perceived market risk of a tech-based innovation is lower than the risk of a market-based innovation (Zhuo et al. 2005). That is, an innovative product linked to tech-based innovation is targeted to existing customers who are well aware of their needs. On the other hand, there are no existing customers of an innovative product associated with market-based innovation. Thus, consumers may find it difficult to use or adopt the products linked to market-based innovations (Zhuo et al. 2005). Moreover, market-based innovations provide consumers with new benefits which are oftentimes perceived less favorably than those of existing products (Christensen 1997). Thus, recalling a product linked to a market-based innovation that is not likely to be adopted in the market may exacerbate negative brand image, leading to customer dissatisfaction, hurting their loyalty, and eventually resulting in brand switching (Singh et al. 2005; McAlister et al. 2007). Moreover, such a recall may tarnish a firm's reputation more compared to the recall of an innovative product associated with tech-based innovation, generating a significant indirect cost (e.g., Rhee and Haunschild 2006). On the other hand, a firm's expectations for its innovative products may vary based on the innovation type. Indeed, tech-based innovations may lead to larger returns compared to market-based innovations. By closely monitoring these firms, the equity holders may take firms' expectations into consideration when they evaluate their future cash flow due to innovative product recalls (Srinivasan et al. 2009).

Due to the large amount of cash to create a product associated with a tech-based innovation, the firms may need to wait for a relatively long period for the break-even point. When they recall such products before the break-even points, investors may consider the recall cost as a part of product development cost or test marketing cost. Thus, these firms may not experience substantial direct costs when they develop, introduce, and recall innovative products linked to tech-based innovations (c.f., Kroll et al. 1999). Both direct and indirect costs are linked to the firm market value and firm risk (Srivastava 1998; Rappaport 1997). Thus, equity holder who closely monitor these firms may expect a decrease in these firms' cash flow and an increase in the variability of their cash flow. Overall, the recalls of innovative products linked to market-based innovations are likely to have greater impacts on firm market value and unsystematic risk due to brand switching and direct and indirect costs (Srivastava et al. 1998; Kroll et al. 1999; Shin and Stulz 2000; Srinivasan et al. 2009).

Based on the above, I hypothesize that:

H2a. *Recalls of innovative products linked to market-based innovations are likely to lead to lower abnormal returns compared to recalls of innovative products linked to tech-based innovations.*

H2b. *Recalls of innovative products linked to market-based innovations are likely to lead to higher unsystematic risk compared to recalls of innovative products linked to tech-based innovations.*

3.3 Control Variables

Return on assets. Similar to several studies in the recall literature, I calculated the return on assets to capture firm profitability (e.g., Eilert et al. 2017). This helps in assessing how well managers generate earnings from their assets. I expect return on assets to positively influence

stock market reaction to recalls of innovative products. Indeed, firms with a high return on assets may easily deal with the direct cost of the recall compared to a firm with a low return on assets.

Number of makers. I argue that as the total number of different makers in the announcement increases, investors' negative assessments toward product recall grows. This is because the number of different makers signals to the market whether the recall is linked to one or two makers or the firm's entire portfolio. If it is the entire portfolio, investors may think of the failure as a firm failure rather than just a product failure, and severely punish the firm due to its product recall decisions.

Competitor news. I argue that competitor news positively influences the relationships between product recalls and firm market value and product recalls and unsystematic equity risk. If the recalling firm's competitor also deals with product recalls (e.g., airbag problem), equity holders may attribute the failure to the industry rather than to the recalling firm itself.

New recall or expanding recall. I argue that it is important to control whether the recall is new or attached to a prior recall. If it is new, then it is a completely new signal (information) to the market, which may guide equity holders in assessing the firm's future cash flow.

Recall engagement. Recall engagement captures how often focal firms experience product recalls. If it is too often, then it signals to the market that such an incident is almost a daily routine of the focal firm. Therefore, equity holders may not update their assessments based on a recent recall. Thus, it is important to control recall engagement.

Geography. I argue that it should be important for equity holders to know whether it is a local product recall, a country-based or worldwide recall, particularly in the automotive industry. The likelihood of local news exposure of a product recall is lower than the likelihood of noticing the news on worldwide recalls. Thus, equity holder is more likely to act on the news about worldwide recalls.

3.4 Methodology

3.4.1 Sample Data

The effect of innovative product's recalls on firm market value and unsystematic equity risk has been tested in the U.S. automobile industry. The automobile industry is a focus of this study due to its economic importance and high innovation investments linked to the intense styling competition in this industry (Millner and Hoffer 1993; Pauwels et al. 2004). Indeed, car manufacturers and their suppliers are the largest manufacturing industry in the U.S., representing 3% of the U.S. gross domestic product (American Automotive Policy Council, August 2018). They engage in styling competition due to both demand reasons (e.g., restyling may increase demand) and cost reasons (e.g., restyling can reduce the production cost) (Millner and Hoffer 1993). They used their styling as a "market weapon" beginning in the 1920s with Ford's reliable Model T (Menge 1962). To win the styling competition, car manufacturers invested in both market-based and tech-based innovation in the form of product-line changes (Menge 1962; Pauwels et al. 2004; Zhou et al. 2005). However, innovation costs in the form of styling can be substantial and will continually increase. Indeed, the cost of a styling change was up to $100M in the late 1950s, and it has increased to $4B since the year 2000 (Shaerman and Hoffer 1971; Pauwels et al. 2004). Thus, some car manufacturers may choose to differentiate themselves or some of their models/makers by restyling (via market-based innovation) rather than technological innovation (Millner and Hoffer 1993).

This industry also offers several benefits, some of which contribute both internal and external validity of product recall studies. As Liu et al. (2017) argue, (1) industry factors are mutual for all the firms within the industry which improves the internal validity of the studies; (2) the data from this industry does not require cross-industry factors to control for heterogeneity; (3) the data covers strategic variables such as innovation level, recall volume,

and recall initiator since automobile manufacturers are required to report the numbers of such variables. On the other hand, the similarities across industries in terms of product recall characteristics strengthen the external validity of the recall studies (Liu et al. 2017). More specifically, firms in various industries, including automobile, food, and toys, engage in multiple recalls over time (Hsu and Lawrence 2016). Each of these recalls involves serious, or less serious, health threats to consumers. Moreover, government agencies regulate the firms in these industries and each of these firms offers post-recall remedies.

Product recall announcements of U.S. automotive companies listed on the New York Stock Exchange have been extracted from LexisNexis. The data sample covers a period from 2009 to 2016. The initial search yielded 276 announcements after confounding events such as recall updates, other firm events, and duplicate news were removed. 44 announcements were excluded due to lack of stock returns around the event day. Overall, a total sample size of 232 recalls of innovative products was collected.

Table 3.3 presents the summary statistics for the sample. Voluntary recalls constitute 144 (67.29%) of the recall announcements. Of the announcements, only 51 (22%) provide the news related to the competitor's recent recall. Recall engagement pertains to 197 (85%) announcements while the new product recalls compared to expanding recalls constitute 174 (75%) of the announcements. The numbers of announcements covering the U.S. and worldwide are 54 (23%) and 42 (18%), respectively.

The data was compiled from four sources: National Highway Traffic Safety Administration's (NHTSA) website for recall characteristics and the innovative product's end of manufacturing date, J.D. Power U.S. Automotive Performance, Execution and Layout (APEAL) Study for innovation type, Center for Research in Security Prices (CRSP) for stock returns, and COMPUSTAT for firm performance variables.

Table 3.3. Summary Statistics

Variable	Categories/Definitions	Descriptions/Examples
Recall volume	Total quantity that firms announced to recall	Mean (785722.60); Min (414); Max (21000000); Std. Dev. (1818543); (n=226)
Recall time	The duration between recall initiation date and recall termination date	Mean (697.28); Min (487); Max (1828) Std. Dev. (217.61) (n=116)
Recall severity	Principal component analysis for four variables	Mean (7.76); Min (-0.50); Max (11) Std. Dev. (1) (n=232)
	The number of (1*) crash/accident/fire, (2*) injuries, (3*) death, (4*) complaints/incidents	(*1) Mean (11.42); Max (1300); Std. Dev. (99.13) (n=173); (2*) Mean (7.09); Max (141); Std. Dev. (25.03) (n=177); (3*) Mean (1.08); Max (23); Std. Dev. (3.19) (n=179); (4*) Mean (150.20); Max (3069); Std. Dev. (522.14) (n=50) Min values for all the variables are zero.
Recall initiator	The actor that initiates the recall	Voluntary (n=144; 67.29%); Involuntary (n=59; 27.57%); Mix (n=11; 5,14%)
Innovative product life	The duration between the innovative product's introduction and its recall initiation date.	Mean (1127); Min (0); Max (4628.25) Std. Dev. (1148.30) (n=187)
Innovation Type	Tech-based or Market-based innovation	Mean (3.20); Min (2); Max (5) Std. Dev. (.80) (n=150)
Return on assets	Net income is divided by total assets to capture firm probability	Mean (.032); Min (.003); Max (.113) Std. Dev. (.019) (n=232)
Number of makers	The total number of different makers in the announcement	Mean (1.81); Min (1); Max (13) Std. Dev. (1.81) (n=224)
Competitor news	Whether the news mentions the competitor's recall	Yes (n=51; 22%) vs. No (n=181; 78%)
New or expanding recall	Whether the recall is new or expanding from a prior recall	New (n=174; 75%) vs. Expanding (n=51; 22%) Not stated (n=7; 3%)
Recall engagement	Whether the recalling firm engaged in a recall in the last three months	Yes (n=197; 85%) vs. No (n=34; 15%)
Geography	Places where the recalls occurred	Worldwide (n= 42; 18%) recalls, the countries located outside of North America (n=8: 3%), regions of the U.S. (n=12; 5%), worldwide except the U.S. (n=3; 1%), North America (n=74; 32%), the U.S. (n=54; 23%), and not stated (n=39; 17%)

3.4.2 Modeling Short-and Long-Term Effects and Firm Stock Risk

I used event study methodology for the short-term abnormal returns. The "event" in this study is the recall announcement of an innovative product. The date of the first news about the recall in a U.S newspaper is the event date (Day 0). I examined the firm's stock returns due the event using "market model" (Brown and Warner 1985). Similar to first essay, I estimated abnormal returns to the event using the Fama-French-Carhart six-factor model (Carhart 1997; Fama and French 2015):

(1) $$R_{it} - R_{ft} = \hat{\alpha}_i + \hat{\beta}_i (R_{mt} - R_{ft}) + \hat{\gamma}_i \, SMB_t + \hat{\delta}_i \, HML_t + \hat{\theta}_i \, RMW_t + \hat{\lambda}_i \, CMA_t + \hat{\psi}_i \, UMD_t + \hat{\varepsilon}_t$$

where R_{it} is the return of stock *i* on day *t* and R_{ft} is the rate of return on a US Treasury bond during the same period. Hence, $R_{it} - R_{ft}$ signify stock returns excessive to the Treasury bill risk-free rate. α_i is the intercept of the relationship for stock *i*, β_i is the slope of the relationship for stock *i*. R_{mt} denotes the corresponding daily returns on the value-weighted market portfolio (i.e., S&P 500), and $R_{mt} - R_{ft}$ denotes the excess market return on day *t,* and e_{it} is the error term for stock *i* on day *t* (i.e., $N(0, \sigma^2)$). SMB_t, i.e., size-based risk premium factor, is the difference between the rate of returns of small and big firm stocks (small minus big), HML_t, i.e., book-to-market based risk premium factor, is the difference in returns between high and low book-to-market stocks (high minus low), RMW_t, i.e., operating profitability factor, is the difference between the returns on diversified portfolios of low and high investment stocks, CMA_t, i.e., investment factor, is the difference between the returns on diversified portfolios of stocks of low and high investment firms, and UMD_t, the momentum factor, is the difference between portfolios of high and low prior-return stocks, all during month *t*. γ, δ, θ, λ, and ψ are parameter loadings. I used a period of $M = (E_2 - E_1)+1$ prior trading days (i.e., Day –255 to Day –46) (Cowan 2007) and calculated the abnormal stock returns AR:

(2)
$$AR_{it} = R_{it} - E[R_{it}] = R_{it} - R_{ft} - \hat{\alpha}_i + \hat{\beta}_i (R_{mt} - R_{ft}) + \hat{\gamma}_i SMB_t + \hat{\delta}_i HML_t + \hat{\theta}_i RMW_t + \hat{\lambda}_i CMA_t + \hat{\psi}_i UMD_t$$

where $E[R_{it}]$ is the predicted stock return based on M = 210-day estimation period.

The average abnormal return, AAR_t, is the sample mean:

(3)
$$AAR_t = \frac{\sum_{j=1}^{N} AR_{it}}{N}$$

Next, to employ the time-series standard deviation test which is also called *crude dependence adjustment* test (Brown and Warner 1980), I calculate the estimated variance of AAR_t:

(4)
$$\hat{\sigma}^2_{AAR_t} = \frac{\sum_{t=E_1}^{t=E_2} (AAR_t - \overline{AAR})^2}{M - 2}$$

where the market parameters are estimated over the estimation period of $M = (E_2 - E_1)+1$ days and

(5)
$$\overline{AAR} = \frac{\sum_{t=E_1}^{t=E_2} AAR_t}{M}$$

The portfolio test statistics for day *t* in event time is

(6)
$$t = \frac{AAR_t}{\hat{\sigma}_{AAR}}$$

I choose relatively short event windows to minimize the potential confounding effects and assess the market's reaction pattern over time, consistent with prior research (McWilliams and Siegel 1997; Srinivasan and Bharadwaj 2004). Specifically, I employ [-1,0], [0,1], [0,2],

[-1,1], [-2,1], and [-2,2] event windows. The significance of the t-statistics indicates that the recalls of innovative product announcements have a significant impact on the firms' market value.

The test statistics for $CAAR_{T_1,T_2}$ is

(7)

$$t = \frac{CAAR_t}{(T_2 - T_1 + 1)^{\frac{1}{2}} \hat{\sigma}_{AAR}}$$

To measure *long-term effects*, following the approach of Barber and Lyon (1997), Cowan and Sergeant (2001), I estimated long-term buy-and-hold abnormal returns after the event using the Fama-French-Carhart six-factor model (Carhart 1997; Fama and French 2015). Specifically, I compounded both daily abnormal returns and the benchmark return, then compute the difference to obtain a buy-and-hold abnormal return (BHAR) over a 1-year period $(T_2 - T_1)$[8]:

(8)

$$\left[\prod_{t=T_1}^{T_2}(1 + R_{it}) - 1\right] - \left[\left(1 + \hat{\alpha}_i\right)^{(T_2 - T_1 + 1)} - 1\right] - \hat{\beta}_i \left[\prod_{t=T_1}^{T_2}(1 + R_{mt}) - 1\right]$$

To assess the statistical significance of buy-and-hold abnormal returns for all firms over T=252 days beginning with the end of event day, I employed two statistical tests: (1) the time-series standard deviation test*; (2) generalized sign test. The null hypothesis for the

[8] BHAR formula for the single-factor model is shown (equation 7) to present the concise model. To extend to a multi-factor model, one needs to add another term for each additional factor (i.e., SMBt, size-based risk premium factor; HMLt, book-to-market based risk premium factor; RMWt, operating profitability factor; CMAt, investment factor; and UMDt, the momentum factor). I used Eventus with remote submission to run the Fama-French-Carhart six-factor model.

generalized sign test is that the fraction of stocks with positive compounded average abnormal returns is expected to the same with those in the estimation windows.

To capture the firm stock risk, I measured the unsystematic risk for each event over 252 trading days (Rego et al. 2009). This risk is the part of the total risk whereby the variability of the stock returns is associated with firm specific events (e.g., the recall of an innovative product) that only affect the firm's returns (Markowitz 1952; Kroll et al. 1999; Srinivasan and Hanssens 1999; Rego et al. 2009). The variance of the residuals in the following model was estimated to measure the unsystematic risk (Srinivasan and Hanssens 2009; Bansal and Clelland 2004):

$$(9) \quad R_{it} = \hat{\alpha}_i + \hat{\beta}_i R_{mt} + \hat{\varepsilon}_{it},$$

Specifically, I regressed daily returns for each event against market returns and used the standard deviation of the error terms as a measure of the firm's unsystematic equity risk (e.g., Rego et al. 2009).

3.4.3 Operationalization of Independent Variables

Table 3.4 presents the measures and data sources for each variable used in the model. Table 3.5 presents the descriptive statistics and correlations among the constructs.

Recall time. To measure the recall time, I calculated the difference between recall announcement date and recall termination date. For recall termination date, I used the last submission date of the recall quarterly report, which indicates the number of total remedied and total unreachable vehicles.

Recall volume. I obtained the total number of recalled products from NHTSA website to measure the recall volume.

Recall severity. I derived recall severity by performing principal component analysis on the number of (1) crash/accident/fire, (2) injuries, (3) death, and (4) complaints/incidents (Eilert et al. 2017). Higher scores imply greater problem severity.

Recall initiator. The measure of a recall initiator is a dummy variable coded 1 for voluntary recalls, 2 for involuntary recalls, and 3 for mix (when there exist at least two recalls in a single announcement).

Innovative product life. I calculated the time difference between the end of manufacturing date of the recalled product and the recall announcement date to operationalize innovative product life.

Innovation type. I used style scores from the J.D. Power U.S. Automotive Performance, Execution and Layout (APEAL) Study. APEAL investigates how new vehicle owners assesses the *performance*, *styling*, *comfort*, *features*, and *usability* of their new vehicle after 90 days of ownership. The study data offers manufacturers and suppliers insight into quality and design satisfaction. Specifically, the style scores were used (=5 "among the best," scoring in 10% of the range from the highest index score; =4 "better than most," scoring 10% of the range above the industry or the segment but below the scores for "among the best;" =3 "about average," scoring between 10% of the range above the industry or the segment and 20% below the industry or the segment; =2 "the rest," scoring 20 percent of the range below the industry or the segment) based on owner satisfaction with the vehicle's uniqueness of interior and exterior styling and colors. I treat score "5" as the vehicle using the highest tech-based innovation (styling) while I treat score "2" as the vehicle used the lowest market-based innovation (restyling).

Table 3.4. The Measures and Data Sources

Variables	Measures/Definitions	Data Sources
Abnormal Returns	Stock returns data	CRSP
Recall time	The difference between recall announcement date and recall termination date	LexisNexis, NHTSA
Recall volume	The total number of recalled products	NHTSA
Recall severity	The principal component analysis on the number of (1)crash/accident/fire,(2)injuries,(3)death,and (4)complaints/incidents	Compustat
Recall initiator	A dummy variable coded 1 for voluntary recalls, 2 for involuntary recalls, and 3 for mix (when there exist at least two recalls in a single announcement)	NHTSA
Innovative product life	The time difference between the end of manufacturing date of the recalled product and the recall announcement date	LexisNexis, NHTSA
Innovative type	(1) Market-based (restyling) or (2) tech-based innovations (styling). Style ratings =5 "among the best"; =4 "better than most" =3 "about average", 2 "the rest"	J.D. Power
Control Variables		
Return on Assets	Net income is divided by total assets	Compustat
Number of makers	The total number of different makers in the announcement (e.g., Cadillac, GMC, Saab, Chevrolet, Pontiac, etc. for General Motors)	LexisNexis
Competitor news	A dummy variable coded 1 if the announcement mentions competitors' recent recalls and 0 otherwise	LexisNexis
New or expanding recall	A dummy variable coded 1 for new recall and 0 for expanding a prior recall.	LexisNexis
Recall engagement	A dummy variable coded 1 if the recalling firm engage in a recall in the last three months and 0 otherwise	LexisNexis
Geography	A dummy variable coded 1 for worldwide recall, 2 for recalls take place in countries located outside of North America, 3 for regional US recalls, 4 for worldwide recalls except the U.S. recalls, 5 for recalls in North America, 6 for the U.S. recalls, and 0 for not stated	LexisNexis

3.4.4 Operationalization of Control Variables

Return on assets. Net income is divided by total assets to operationalize return on assets. I collected relevant data from the Compustat Database.

Number of makers. I operationalized number of makers as the total number of different makers in the announcement (e.g., Cadillac, GMC, Saab, Chevrolet, Pontiac, etc. for General Motors).

Table 3.5. Descriptive Statistics and Correlation Matrix

		M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Short-Term Abnormal Stock Returns	0.00	0.03	1.00												
2	Long-Term Abnormal Stock Returns	-0.06	0.53	0.01	1.00											
3	Unsystematic risk	0.00	0.00	-0.10	-.152*	1.00										
4	Recall Time	697.28	217.61	-0.12	0.11	0.03	1.00									
5	Recall Volume	785723	1818543	-.152*	-0.05	0.08	.259**	1.00								
6	Recall Severity	0.00	1.00	-0.04	0.11	0.05	0.09	-0.11	1.00							
7	Recall Initiator	1.38	0.58	-0.01	-0.05	0.01	.176**	.255**	0.12	1.00						
8	Innovative product life	1127	1148	-0.04	-0.01	-0.03	.266**	.422**	0.01	.258**	1.00					
9	Innovation Type	3.20	0.79	0.03	0.05	0.00	-.168*	-0.04	.269**	0.01	-0.09	1.00				
10	Return on Assets	0.03	0.02	-0.08	0.05	-0.08	0.01	-0.08	.236**	-0.01	0.05	0.06	1.00			
11	Number of Makers	1.81	1.28	0.06	-0.01	0.10	0.05	.230**	.137*	.150*	0.04	.150*	-0.11	1.00		
12	Competitor News	-	-	-0.01	0.03	0.09	.168*	.177**	-0.03	.155*	.187**	-0.09	-0.04	0.01	1.00	
13	New or Expanding	-	-	0.10	0.00	-.144*	-0.10	-0.13	0.04	0.00	-.275**	0.06	-0.09	0.03	-.23**	1.00
14	Engage	-	-	-0.13	0.02	0.00	0.04	0.05	-.139*	-0.08	0.02	-0.02	-0.01	-0.07	0.08	0.01
15	Geography	-	-	-0.10	-0.10	-0.08	0.02	-0.08	0.09	-0.03	0.01	0.05	.233**	-.164*	-0.02	-0.11

Note: *, ** indicate significant correlations at 0.05 and 0.01 levels respectively.

Competitor news, new recall or expanding recall, and recall engagement. The measure of *competitor news* is a dummy variable coded 1 if the announcement mentions competitors' recent recalls and 0 otherwise. Similarly, to measure *new recall or expanding recall,* I used a dummy variable coded 1 for *new recall* and 0 for *expanding* a prior *recall.* Lastly, the measure of *recall engagement* is a dummy variable coded 1 if the recalling firm engage in a recall in the last three months and 0 otherwise.

Geography. To capture the difference across geographical areas in which recall occurs, I used a dummy variable coded 1 for worldwide recall, 2 for recalls take place in countries located outside of North America, 3 for regional U.S recalls, 4 for worldwide recalls except the U.S. recalls, 5 for recalls in North America, 6 for the U.S. recalls, and 0 for not stated.

3.4.5 Main Results and Robustness Checks

Table 3.6 displays the CARs for six different windows: (1) a two-day event period from the event date to one day after; (2) a three-day event period from the one day prior to one day afterward; (3) a three-day post-event period from the announcement date to day 2 afterward; (4) a four-day event period from day –1 to day 2; (5) a four-day event period from day -2 to day 1; and (6) a five-day event period from day –2 to day 2 afterward. I used several test statistics to examine short-term abnormal stock returns to ensure that our results are robust: (1) the traditional time-series standard deviation test (Brown and Warner 1985); (2) Cowan's Generalized Sign test (1992), and Boehmer et al.'s (1991) standardized cross-sectional test. For further robustness checks, I used both equal and value weighting indexes, and various lengths of estimation periods. All produced materially similar results. The results indicate significant negative short-term stock returns to recall announcements of innovative products.

Table 3.7 shows the buy-and-hold returns over a two-year horizon of the overall sample respectively, for (1) one-year period (2) two-year period starting from the first day following the short-term event window (-2;2). To ensure the event-induced volatility did not bias the results.

Table 3.6. Event-study analysis of short-term abnormal returns with Fama-French five-factor and Carhart's momentum effect for product recall announcements (n=232)

Day	Mean Cumulative Abnormal Return	Positive: Negative Returns	Portfolio Time Series t	Significance	Generalized Sign Test	Significance
(0,+1)	-0.16%	96:136	-1.247	Ns	-1.104	ns
(-1,+1)	0.03%	102:130	0.176	Ns	0.197	ns
(0,+2)	-0.29%	103:129	-1.819	<0.05	-1.670	<0.05
(-1,+2)	-0.10%	105:127	-0.541	Ns	-0.449	ns
(-2,+1)	0.11%	119:113	0.608	Ns	0.329	ns
(-2,+2)	-0.02%	111:121	-0.077	Ns	-0.278	ns

NOTE: ns indicates non-significance.

I employ two different statistics tests to test statistical significance: (1) the traditional time-series standard deviation test (Brown and Warner 1985) and (2) Cowan's (1992) Generalized Sign test. The results indicate significant negative long-term stock returns to recalls of innovative product announcements over a two-year horizon (-6.3%, $p < 0.01$; -33.19%, $p < 0.01$, one- and two-year periods respectively). To be conservative, I chose a one-year period as the dependent variable.

Table 3.7. Buy-and-hold abnormal returns with Fama-French five-factors and Carhart's momentum effect for product recall announcements (n=232)

Event Window	Mean Compound Abnormal Return	Positive: Negative Returns	Portfolio Time Series t	Significance	Generalized Sign Z	Significance
1-year	-6.03%	129:103	-4.166	<0.01	2.285	<0.05
2-year	-33.19%	129:103	-16.209	<0.01	2.285	<0.05

NOTE: ns indicates non-significance.

3.4.5.1 Effects of Exchange Conditions: Short-Term and Long-Term Abnormal Stock Returns, and Unsystematic Equity Risk

The proposed models were tested with a cross-sectional regression of the short-term, long-term abnormal stock returns, and unsystematic equity risk against the proposed set of antecedent variables. The following multiple robust regression models using MM-estimator (Yohai) is employed to test our hypotheses:

(10) $$SHAR_{i\,(-t_1,+t_2)} = \beta_1 RVOL_i + \beta_2 RINIT_i + \beta_3 RSEV_i + \beta_4 INPLIFE_i + \beta_5 INNTYP_i + \beta_6 ROA_i + \beta_7 NMAKER_i\ \beta_8 CNEWS_i + \beta_9 NEWEXP_i + \beta_{10} ENGAGE_i + \beta_{11} GEOG_i$$

(11) $$LGAR_{i\,(t_1,+t_2)} = \beta_1 RTIME_i + \beta_2 RVOL_i + \beta_3 RINIT_i + \beta_4 RSEV_i + \beta_5 INPLIFE_i + \beta_6 INNTYP_i + \beta_7 ROA_i + \beta_8 NMAKER_i + \beta_9 CNEWS_i + \beta_{10} NEWEXP_i + \beta_{11} ENGAGE_i + \beta_{12} GEOG_i$$

(12) $$RISK_{i\,(t_1,+t_2)} = \beta_1 RTIME_i + \beta_2 RVOL_i + \beta_3 RINIT_i + \beta_4 RSEV_i + \beta_5 INPLIFE_i + \beta_6 INNTYP_i + \beta_7 ROA_i + \beta_8 NMAKER_i + \beta_9 CNEWS_i + \beta_{10} NEWEXP_i + \beta_{11} ENGAGE_i + \beta_{12} GEOG_i$$

where SHAR= short-term abnormal stock returns, LGAR= long-term abnormal stock returns, and RISK= unsytematic equity risk due to recalls of innovative products, RTIME= recall time, RVOL= recall volume, $RINIT_i$ RINIT = recall initiator (=1 when it is a voluntary recall, =2 when it is an involuntary recall, and =3 when it is a mix), RSEV= recall severity, INPLIFE= innovative product life, and INNTYP= innovation type. As control variables, ROA= return-on-assets, NMAKER= the total number of different makers, CNEWS= competitor news, NEWEXP= new or expanding recall, ENGAGE= recall engagement, GEOG= geography.

The findings on abnormal returns show that recall volume exerts negative effects in the short-term (β_{volume_s} = -.0039, p=.01) while the effect disappears in the long-term. Recall time negatively influences long-term abnormal stock returns (β_{time_l} = -.2095, p=.00). Voluntary recalls of innovative products have no impact on short-term abnormal stock returns; however, they lead to lower stock market returns compared to involuntary recalls of innovative products in the long-term ($\beta_{initiator\_l}$ = -.1096, p=.05). Recall severity exerts negative effect both in the short-term and the long-term ($\beta_{severity\_s}$ = -.0045, p=.00; $\beta_{severity\_l}$ =.0586, p=.01). Innovative product life does not influence abnormal stock returns in the short- and long-terms. Thus, the result does not lend support to H1a and H1b. Innovation type, on the other hand, positively affects the abnormal returns in the short-term ($\beta_{innovation\_s}$ = .0074, p=.00) while it does not affect the long-term abnormal returns. I find support for H2a while failed to find support H2b. As control variables, recall engagement, and number of makers are found to be significant in the short-term. Specifically, recall engagement exerts negative effects (β_{engage_s} = -.0145, p=.01) while the number of makers positively influences short-term stock returns (β_{makers_s} = -.0073, p=.00). In the long-term, geography is found to be partially significant, negatively influencing the abnormal stock returns ($\beta_{geography}$ -.0201, p=.09) (Please see Table 3.8).

The results on unsystematic risk show that only recall time, innovative product life, and new or expanding recall are found to be significant. More specifically, recall time positively associated with increases in unsystematic risk (β_{time_r} = .00016, p=.00). Lastly, new or expanding recall negatively influences unsystematic risk (β_{ne_r} = -0.00013, p=.09) (Please see Table 3.9). Since the data sample covers product recall announcements disclosed by only five firms (i.e., Fiat Chrysler Automobiles, Ford, General Motors, Honda, and Toyota) from 2009 to 2016, I also estimate the models with firm-fixed and year-fixed effects. The results were similar. Due to parsimony, I report the results without fixed effects.

Table 3.8. Analysis of short-term and long-term abnormal returns (estimates and significance levels)

Variables	Short-Term Returns					Long-Term Returns				
	Beta (Ustd)	**p-value**	**Tolerance**	**VIF**	**Conclusion**	**Beta (Ustd)**	**p-value**	**Tolerance**	**VIF**	**Conclusion**
Recall Time	-	-	-	-	-	-0.2095	0.000	0.8460	1.18	-
Recall Volume	-0.0039	0.014	0.6781	1.47	-	-0.0136	0.488	0.6563	1.52	ns
Recall Severity	-0.0045	0.002	0.8012	1.25	-	0.0586	0.017	0.7806	1.28	+
Recall Initiator	0.0019	0.458	0.8664	1.16	ns	-0.1096	0.059	0.8617	1.16	-
Innovative product life	0.0002	0.814	0.7023	1.42	ns	0.0096	0.560	0.7017	1.43	ns
Innovation Type	0.0074	0.009	0.8902	1.12	+	-0.0027	0.936	0.8636	1.16	ns
Control Variables										
Return on Assets	-0.0003	0.941	0.8732	1.15	ns	0.0139	0.708	0.8729	1.15	ns
Number of Makers	0.0073	0.000	0.8497	1.18	+	0.0041	0.825	0.8497	1.18	ns
Competitor News	0.0000	0.000	0.8891	1.12	+	-0.0752	1000	0.8798	1.14	ns
New or Expanding	0.0061	1.000	0.8733	1.15	ns	-.0752	0.299	0.8733	1.15	ns
Engage	-0.0145	0.017	0.9621	1.02	ns	0.0090	0.918	0.9596	1.04	ns
Geography	-0.0002	0.816	0.8934	1.06	ns	-0.0201	0.095	0.8918	1.12	ns

NOTE: ns indicates non-significance.

Table 3.9. Analysis of unsystematic risk (estimates and significance levels)

Variables	**Unsytematic Equity Risk**				
	Beta (Ustd)	**p-value**	Tolerance	VIF	Conclusion
Recall Time	0.00016	0.002	0.8460	1.18	+
Recall Volume	0.00003	0.248	0.6563	1.52	ns
Recall Severity	0.00003	0.272	0.7806	1.28	ns
Recall Initiator	0.00000	0.896	0.8617	1.16	ns
Innovative product life	-0.00002	0.559	0.7017	1.43	ns
Innovation Type	0.00006	0.270	0.8638	1.16	ns
Control Variables					
Return on Assets	-0.00005	0.262	0.8729	1.15	ns
Number of Makers	0.00001	0.647	0.8497	1.18	ns
Competitor News	0.00000	0.608	0.8798	1.14	ns
New or Expanding	-0.00013	0.096	0.8733	1.15	ns
Engage	0.00000	0.710	09596	1.04	ns
Geography	-0.00001	0.587	0.8918	1.12	ns

NOTE: ns indicates non-significance.

3.5 Discussion

Product recalls are omnipresent in various industries including food, drugs, toys, cars, and consumer products. Such events may have a detrimental impact on firm performance, destroying firm reputation, trust, and brand equity (e.g., Dawar and Pillutla 2000; Rhee and Haunschild 2006) and leading to significant losses in firm market value (Chen et al. 2009; Liu et al. 2017). However, product recalls may not hurt firm market value as much if the recalled products are innovative products. Equity holders may not assess such events unfavorably, perceiving the recalling firms as making an effort to enhance their innovative

products. This essay aims to find out whether (1) recalls of innovative products lead to losses in firm market value; (2) a short recall time and voluntary recall can help innovative firms to lessen their stock market losses; (3) innovative product life (i.e., the duration between product launch and product recall) and innovation type (i.e., market-based and tech-based innovation) can influence the relationship between recalls of innovative products and stock market returns.

This section summarizes the study findings, suggests implications, and lists the study limitations.

3.5.1 Summary of Findings

I first summarize the major findings:

1. Recall volume negatively influences stock market returns in the short-term.
2. Recall severity exerted a negative effect in the short-term; however, the effect switched to positive in the long-term.
3. Voluntary recalls have no impact on short-term abnormal stock returns; however, they lead to lower stock market returns compared to involuntary recalls of innovative products in the long-term.
4. Recall time negatively affect stock market returns in the long-term while positively associated with increases in unsystematic risk.
5. Innovation type, on the other hand, positively affects the stock market returns in the short-term.

The findings contribute to the literature to the extent that this is the first study to cover the short- and long-term stock returns and unsystematic risk due to recalls of products that are linked to innovation. Thus, it contributes to both marketing and innovation literature by showing certain recall-related and innovation- related factors help equity holders assess the

consequences of such recalls. Third, it introduces novel boundary conditions such as recall time, innovative product life, and innovation type into recall literature.

3.5.2 Implications

This study has the following implications.

First, innovative firms engaging in the recall of an innovative product need to resolve the issues as soon as possible. This is because such events have a very weak effect on the short–term stock returns while they have a detrimental impact on the long-term stock returns. In the short-term, equity holders may perceive these firms as putting efforts into enhancing their innovative products.

Second, managers of innovative firms should immediately (voluntarily) recall their products and make sure to invest in the recall process to keep the recall time as short as possible. Otherwise, equity holders severely punish such firms in the long-term.

Third, managers dealing with the recall process of an innovative product should not worry about the effect of disclosing information on the numbers of complaints, injuries, accidents, and deaths. Even though such figures negatively influence short-term stock returns, they positively affect long-term stock returns due to recalls of innovative products, leading to less negative abnormal stock returns. Drawing upon *big bath* strategy in accounting, I argue that the focal firm may believe that a negative result related to firm performance or a negative news makes its future results appear better. Moreover, taking all the negative news at once and properly addressing it is likely to be appreciated by investors in the long-term. Specifically, the recall of an innovative product with a high degree of severity may draw significant media attention and generate negative online word-of-mouth, putting a spotlight on the focal firm whose action is closely monitored by its investors. The focal firm may assure its investors that it puts efforts into an efficient and effective recall process. Thus, the

investors may appreciate this effort and punish the firm less for its severe product recall in the long-term.

Fourth, managers should be aware of the potential short-term benefits of a tech-based innovation. Because, equity holders penalize the firms less for their recall decisions involving innovative products linked to tech-based innovation compared to such decisions involving innovative products related to market-based innovation.

3.5.3 Limitations

This study has some limitations.

First, the findings are limited to the U.S. The innovation premium effect that Wall Street experiences may not exist in other countries. Innovative firms in these countries may not enjoy the highest shareholder returns giving the fact that equity holders may not place a greater value on product innovativeness. Thus, their assessments of a firm's cash flow due to the recall of an innovative product may be different compared to those in U.S.

Second, to operationalize innovation type, I average the styling scores of all makers/models in the announcement, which mentions more than one maker and/or models. (e.g., some of GM's makers/models are Cadillac/CTS, GMC/Envoy, and Chevrolet/Spark). I employ the same approach for innovative product life. Another approach could be estimating the models by brand, converting the innovation type to the maker level.

CHAPTER 4

CONCLUSION

Product failures may help firms launch efficacious products across different industries in the long-term while they may hurt firm performance (e.g., sales, firm market value, and return on investment) in the short-term. In this dissertation, we offer insights regarding two distinct phenomena linked to product failures: *product discontinuations* and *innovative product recalls*. Specifically, I examine the factors that determine the effects of product discontinuation and innovative product recall announcements on firm market value and firm risk. My findings provide both academics and practitioners with a better understanding of product failures in various situations and markets.

In my first essay, we focus on the overlooked phenomenon of product discontinuation and examine the impact of product discontinuation announcements on firm market value. We find that product discontinuation announcements negatively influence both the short and long-term stock returns. Moreover, product discontinuation decisions due to positive firm motivations such as new product development lead to positive stock returns in the short-term. On the other hand, product discontinuation decisions linked to negative reasons such as product or commercial failures negatively influence the long-term stock returns. Furthermore, firm specific product discontinuation announcements result in lower stock returns compared to industry specific product discontinuation announcements in the long-term. Lastly, a firm's high marketing capabilities have a positive impact on the short-term stock returns due to product discontinuation decisions. However, in the long-term, a firm's high marketing

capabilities and innovation capacities negatively moderate the relationship between product discontinuation decisions and firm market value. These findings may enlighten managers who are responsible for a firm's product portfolio decisions. Thus, managers can minimize their firm's stock price losses due to their discontinuation decisions by creating strategies based on these findings.

In my second essay, I focus on recalls of innovative products, which are also overlooked in the literature and investigate the effects of innovative products' recalls on both short- and long-term stock returns and the firm's unsystematic equity risk. I find that recall volume exerts a negative effect in the short-term. Recall severity also negatively affects short-term abnormal returns while it positively influences long-term abnormal returns. Voluntary recalls, on the other hand, lead to lower stock market returns compared to involuntary recalls of innovative products in the long-term. Moreover, I show that recall time negatively affects stock market returns in the long-term while it is positively associated with increases in unsystematic risk. Lastly, innovation type positively affects the stock market returns in the short-term.

These insights will be valuable for both academics and managers. This study introduces novel boundary conditions (recall time and innovative product life) that contribute to the development of both recall and innovation literature. For managers, it is important to know the impact of these conditions on possible financial returns. In a similar vein, managers' recalling strategies may be contingent on these conditions. Thus, they can create recalling strategies where some of these conditions (i.e., recall time) can be the core component of these strategies. Unsystematic risk is an important tool for managers who seek to enter new business. These managers use this tool to evaluate their capabilities for a possible action. Moreover, the results provide managers with a fuller understanding of the effects of recall time to enable them to cogently deal with significant unsystematic risk

(which could possibly lead to firm failure) due to recalls of innovative products (Lubatkin & Chatterjee, 1994).

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