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Influences of Product Concept Demonstrations in Trade Shows: Two Essays

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Abstract

I study the effects of product concept demonstrations on firm value and on firms' profit using two different methods: empirical and analytical approaches.

Utilizing an event study, in Essay 1, I assess the effects of product concept demonstrations in trade shows on abnormal stock returns and risks. My investigation has two interconnected parts: (1) analysis of the firm's decision on how many concepts to demonstrate and what would be the concept mix; and (2) analysis of investor reactions to the demonstration that influence the firm value and risk. I find that the number of concept demonstrations are influenced by the innovativeness of the concept mix, the demonstrating firm's past conversion history of concepts to commercialization, and the total number of concepts demonstrations, reflecting the size of the trade show. As a result, the concepts demonstrations for the first-time positively influence cumulative abnormal return, but the effects of demonstrating previously demonstrated concepts are negative.

In Essay 2, I develop a two-period game-theoretic model to analyze the inter-temporal strategic interactions in a firm's pricing strategy for the old and new models with a product concept demonstration. My analysis provides new insights into the interplay of product positioning and a product concept demonstration that induces varying degrees of purchase delay while shaping the firm's dynamic pricing strategy. As a result, I find that a product concept demonstration can lower the new model price even below what it would be without a demonstration; further, I find that the volume of delayed purchases induced by a product concept demonstration is the greatest at very low or very high levels of product substitutability, exhibiting a U-shaped pattern. My findings suggest that differentiating the new model

either horizontally or vertically is a critical factor for profitable pre-launch product concept demonstration. However, the mechanisms that lead to concept demonstration profitability are quite different between the two types of differentiation. Allowing various scenarios of product line and pricing policies, I find that the simpler pricing policy can dominate more complex pricing strategies.

Overall, the influences of the product concept demonstrations are researched through both empirical and analytical methods. The results of this dissertation suggest that innovative product concept demonstration generates positive firm value in the short run. Product concept demonstration also creates greater profit when the new product concept is either horizontally or vertically differentiated.

Keywords: Product concept demonstration, firm value, event study, pricing, inter-temporal, product differentiation, game theory.

INFLUENCES OF PRODUCT CONCEPT DEMONSTRATIONS IN TRADE SHOWS: TWO ESSAYS

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DISSERTATION

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Dedications

To my wife, who has been there for the last five years. Thank you for all of the love, support, and pray. To my parents, who have been there from the day one. Thank you for all of the love, trust and encouragement. To my grand father, who inspired me constantly and consistently to dream, plan, start, and complete this long academic journey. Thank you for your passionate encouragement. To my sister, who have been supported me from the very beginning of my study at Stanford University. Thanks for your care and guidance.

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Chapter 1

Introduction

This dissertation consists of three chapters: Chapter 1 introduces the fundamentals of product concept demonstration; Chapter 2 deals with the effects of product concept demonstrations on firm value and risks; and Chapter 3 studies the inter-temporal pricing strategy with a product concept demonstration in a monopoly market.

1.1 Overview

In this chapter, I provide a thorough review on a product concept demonstration by utilizing two different modeling approaches. The first empirical method captures the overall effects of product concept demonstrations on firm value and risks. By assessing this short-term impact of marketing actions, the results suggest that technology-oriented product concept demonstration generates greater firm values than design oriented concept demonstration.

Managers in many durable product-markets are faced with a variety of challenges even before launching products. One challenge is that firms require marketing metrics to forecast the market potential of new products based upon a tangible measure of feedbacks from consumers and investors. Specifically, annual auto shows in major cities are popular examples of a concept testing procedure. In this process, trade shows are necessary for firms

not only to test concepts while receiving feedback from potential customers but also to develop and demonstrate concepts in a variety of stages from the pure concept stage to the production-ready car. A unique feature of demonstrations of new product concepts (rather than production-ready products) is the long lag time between the initial demonstration of a concept and its launch, and the consequent uncertainty about whether the demonstrated concept will be developed or commercialized at all.

Another issue of interest to managers is how to strategically demonstrate firm's new product concepts in trade shows to maximize both firms' profit and firms' value. Exacerbating these challenges, the success of a new product introduction partially depends on understanding what drives the equilibrium level of quality without cannibalizing own product line demand and maximizing profit. I develop two models: one empirical model to study the effects of product concept demonstrations on the firm value and risk, and one game-theoretic model to study inter-temporal pricing strategies for the old and new model with a product concept demonstration in a trade show. Furthermore, it is important for managers to communicate these product concepts with consumers through trade show. Traditionally, a trade show is a kind of direct market so that potential consumers can visit the show, experience the product attributes, interact with sales persons, and, as a result, possibly purchase the product.

Trade shows have become a popular venue for firms to showcase their innovative activities to their industry cohorts and to the public in general. Demonstrations of new "production-ready" products in trade shows are aimed at creating awareness, interest, and sales leads. Product concepts, on the other hand, are demonstrated months or even years before their actual launch, and indeed many concepts do not even make it to the next stages of the product development process. Because of the uncertainty in the conversion of the concepts into a marketable product, and because the benefits of concepts, if any, accrue far into the future, it is difficult to assess the contemporaneous effects via commonly used marketing metrics such as sales leads or actual sales. Therefore, I employ an event study methodology

to assess the effects of concept demonstrations in a trade show context. In Essay 1 presented in Chapter 2, I examine the signaling effects of concept demonstrations on firm value and risk.

After showing managerial implications of product concept demonstrations by using marketing metrics, in Essay 2 presented in Chapter 3, I employ a game theoretic approach to examine the roles of product concept demonstrations in inter-temporal pricing strategies for the product line to maximize the total profit of two periods. Thus, the second essay provides micro-economic foundations of product concept demonstrations in a monopoly market. Incorporating both vertical and horizontal product differentiation, I provide new insights into the interplay of product positioning and a product concept demonstration that induces varying degrees of purchase delay while shaping the firm's dynamic pricing strategy.

1.2 Effects of Product Concept Demonstration (PCD) in Trade Shows on Firm Value & Risks

Trade shows have become a popular venue for firms to demonstrate new products or new product concepts to their industry cohorts and to the public in general. In the U.S. alone, approximately 2,500 trade shows are organized each year by different industry groups (http://tradeshow.tradekey.com/). Products demonstrated in trade shows range from food, agriculture, and consumer goods to consumer electronics, computers, and construction materials. Over the years, the popularity of product demonstrations in trade shows has grown exponentially. For instance, computer shows organized by COMPUTEX Taipei (or Taipei International Information Technology) in June 2008 attracted over 100,000 visitors. Likewise, the video games convention organized by Leipzig Games Convention in August 2008 brought in over 200,000 visitors. Although some trade shows restrict admissions only to trade representatives or exhibitors, most open the shows to the public, press, and business analysts.

Despite the widespread use of trade shows as a means to create interests and develop sales leads, especially for industrial products, research on the effectiveness of demonstrating commercial products or product concepts is limited. Utilizing data on one trade show, Gopalakrishna and Lilien (1995) demonstrate that trade show characteristics such as preshow promotions, booth space, and use of attention-getting techniques increase the likelihood of trade show attendees to visit the booth, while the number and training of booth salespersons positively affects the likelihood of establishing contacts with the salesperson at the booth and producing sales leads. In a more comprehensive study covering large samples of trade shows in the U.S. and U.K., Dekimpe et al. (1995) generalizes the positive influence of trade show characteristics on the probability of trade show attendees visiting the booth and obtaining product literature.

While the focus of these studies have been on assessing the effectiveness of trade shows in terms of their ability to create interests and sales leads for exhibited products, many trade shows serve as a venue for firms to showcase their innovations, which include demonstration of items that are not yet ready for sale. Indeed, many trade shows demonstrate product concepts, which have to go through several product development hurdles before being ready for commercial introduction. For instance, concepts of Sony's PlayStation and Nintendo's Wii were demonstrated in trade shows (e.g., Tokyo Game Show) several years prior to their actual launch. In the 2008 Chicago Auto Show, Honda revealed its Honda CR-Z concept for a new sports hybrid, the kinds of which never existed in the line of Honda automobiles.

A feature of product concepts demonstrations is the long lag time between the initial demonstration of a concept and its actual launch, and the consequent uncertainty about whether a concept will be developed and commercialized at all. Therefore, it is difficult to assess the contemporaneous effects of concept demonstrations via commonly used marketing metrics such as sales leads or actual sales. Still, the concepts demonstrated signal to the external world the innovativeness of firms as well as new product pipelines with revenue potentials. Thus, the effects of concept demonstrations are better assessed with metrics such as

stock returns, which accounts for long term return prospects, as well as the risks. Abnormal stock returns have been used by marketing scholars to measure the followings: the effects of actual new product introductions (Kelm, Narayanan, and Pinches 1995), the announcements of imminent new product introductions (Chaney, Devinney, and Winer 1991), and new product preannouncements (Shrinivasan et al. 2007; Sorescu, Shankar, and Kushwaha 2007).

The objective of this paper is to assess the effects of concept demonstration in trade shows in order to examine its effects on firm value and risks. I frame the investigation as a two-stage process – when the firm decides on the number of concepts to demonstrate and when the investors react to the concepts demonstrated by a firm which is reflected in its stock return. There are at least four unique features of this study that are not present in prior studies on the effects of product introductions and preannouncements. First, because of the space limit in a trade show, firms have to judiciously determine the concept mix, perhaps allocating space to more innovative concepts than to concepts with minor changes. Second, in placing the concepts in a trade show to signal innovativeness, firms are mindful of their credibility (e.g., their past records of converting their concepts to commercial products). Third, trade shows are a venue where all firms demonstrate their concepts, producing a competitive effect in which firms may try to out – do each other with the number of concepts. Finally, in a trade show, a firm may demonstrate concepts for the first time (hereafter "debut"), concepts that have been demonstrated in prior auto shows (hereafter "concept"), as well products that are ready to sell. This mix may impact investors differently.

1.2.1   Research Questions

I. Why do firms demonstrate their product concepts in trade shows?

II. What are the rewards of the first-time concept demonstration?

III. What other factors of product concept demonstration affect the firm value and risks?

1.3 Inter-temporal Pricing Strategy with PCD

Product concept demonstrations in trade shows would not only generate buzz for the new concept which will be launched soon (especially in the durable goods category) but would also encourage some consumers to wait for the new model instead of purchasing a currently available model without delay. The below article published in Motor Trend on April 2012 describes well what kinds of information is revealed by the concept demonstration at the trade shows:

> "... The next-generation Santa Fe would be unveiled at the New York auto show. ... Hyundai expects front-drive Santa Fe Sports equipped with the 2.4-liter I-4 to achieve 23/33 miles per gallon (mpg) city/highway, and front-drive turbo models to get 23/31 mpg. ...Pricing hasn't yet been announced, but expect the 2013 Santa Fe Sport to start around $25,000, and the 2013 Santa Fe to carry a base price closer to $30,000. ...As for styling, the Santa Fe and Santa Fe Sport wear Hyundai's new "Storm Edge" design language. Up front, both Santa Fe models feature Hyundai's large trapezoidal chrome grille with three bars on the Santa Fe Sport and four bars on the Santa Fe." (Seabaugh 2012)

Information about quality (e.g., fuel efficiency, safety rate, engine specification), design, introduction schedules, and price are distinguished from preannouncement, which only covers some key features of the attributes and tentative release date. Recently, Mercedes-Benz revealed Mercedes CLA with premium style and budget price:

> "This car is a little smaller than the C-Class, a staple of the Mercedes lineup. With a projected starting price of around $30,000 its also expected to cost a little less than its stablemate about five grand less. The CLA-Class design borrows heavily from the CLS as it should. The company is building them both a four-door coupes. Mercedes representatives say the cars styling is very emotional, and it truly makes a bold statement on stage. Its side glass, also known as the

"daylight opening, or DLO for short looks like it was pulled directly from the CLS, at about three-fifths scale. Interestingly, that design isnt just for looks. The CLA-Class positively slices through the air. Its coefficient of drag is a claimed 0.22, which Mercedes says is the best for any production car. As for the mechanicals, the only powertrain mentioned at the unveiling was a 208 horsepower, turbocharged 2.0-liter, four-cylinder engine with 258 lb-ft of torque. It should be matched to a seven-speed dual-clutch automatic transmission for lightening-fast shifts. All-wheel drive will be offered. The companys latest 4MATIC system was tailor made for front-wheel-drive applications and it supposedly tips the scales at a featherweight 70 kilograms, about 155 pounds. If you were hoping to get a glimpse of the brand-new Mercedes-Benz CLA-Class in Detroit, heres a bit of bad news. The car will not be shown in COBO hall. Its official revealing will be at the Geneva Motor Show in March." (Cole 2013)

Mercedes-Benz revealed not only the product information such as the design angle but also quality information including the approximate starting price. This type of market behavior distinguishes itself from a preannouncement that only releases some key numbers of the attributes and expected launching schedule.

Why do consumers delay purchasing a new product? One explanation is that the new model is more attractive than the current one because of either improved quality or new design. An alternative explanation is that the new model may be the better deal than the old model based on the ratio of valuation to price. In Chapter 3, I present a game theoretic model of inter-temporal pricing allowing the monopolist to demonstrate the new model in a trade show before launch. The firm has incentives to utilize these trade shows to maximize profits coming from expected sales by demonstrating a product concept. I capture many aspects of product information revealed at trade shows in two dimensions; vertical differentiation and horizontal differentiation. For example, milage per gasoline (MPG) is a good proxy to measure quality improvements; therefore, one can capture how new model is

vertically differentiated from the old model by comparing MPG. On the other hand, a change in style is an example of horizontally differentiation from the old model. Also, I notice that price information will be revealed so that potential consumers for the new model can evaluate two options: either buy the current model or wait and buy the new model. The main idea of this paper is to address these questions: What is more likely to influence consumers to wait for the new model, superior quality or brand new design of the new model? Which conditions can guarantee that the firm achieves positive profits when demonstrating a new concept model?

1.3.1 Illustrative Examples

I start my discussion with a numerical illustration shown in Table 1.1 (constructed using the theoretical model developed later). In the first example, the firm demonstrates the quality upgraded concept model in a trade show with the firm charges new model price ($44,636), which is lower than the old model price ($45,305). According to a consumer survey report, 745 consumers would like to wait for the new model that will be launched in next period because of the high quality and lower price of the new model, while only 10 consumers prefer buying the old model in period 1. The consequence is that entire unit sales for both models are greater than the benchmark case when the firm does not demonstrate the new concept in the trade show (1,509 1,100 = 409 units) and the net benefit of product concept demonstration is $6.3 million. (See Case 1 in Table 1.1.)

Now consider what happen when the firm demonstrates a product concept in a trade show, focusing on new style (Case 2 in Table 1.1). The old model sales would not be affected by the demonstration of the new model if the new model looks totally different. Consumer research reveals that the uniqueness of the new model attracts only about 10% of old model buyers compared to cases without demonstration; however, the new model attracts 979 consumers, including 467 delayed consumers who opted to wait for the new model. Customers purchase the new model because of the uniqueness and the demand of new model

Table 1.1: Illustration for the Benefits of Product Concept Demonstration

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Case 1 Quality Upgrade		Case 2 New Style		Case 3 Almost Same	
Variables		No Demo	Demo	No Demo	Demo	No Demo	Demo
Price	Old model	$50,000	$45,305	$50,000	$50,187	$50,000	$39,721
	New model	$60,000	$44,636	$50,000	$48,745	$50,500	$29,158
Sales	Old model	500	10	500	456	500	77
	New model	600	1,499	500	979	505	1,368
Delayed Purchases		0	745	0	467	0	649
Revenue	Period 1	$25.0M	$.5M	$25.0M	$22.9M	$25.0M	$3.1M
	Period 2	$36.0M	$66.9M	$25.0M	$47.7M	$25.5M	$39.9M
	Total	$61.0M	$67.4M	$50.0M	$70.6M	$50.0M	$42.9M
Net benefit of PCD^a			$6.3M		$20.6M		$-$7.6M

^{a} PCD denotes a product concept demonstration.

doubles in comparison when no demonstration occurs. As a result of demonstrating new style new model, the firm earns $20.6 million of net benefits compared to no demonstration.

The third case in Table 1.1 is when the firm demonstrates concepts in the new model that are similar to the old model. In other words, quality has been improved in the new model but major parts are still the same or the style has been changed with only minor updates. The best strategy of the firm is to drop the new model price drastically to attract as many consumers as possible in the second period. The consequence of demonstrating the new model is the shrinkage of the old model demand; therefore, the total profit is also decreased. Even though the total sales increased due to the new model sales, new model profit margin is too small. Hence, the net benefit of demonstrating new model with only minor updates is the loss of $7.6 million.

My analysis provides new insights into the interplay of product positioning and product concept demonstration that induces varying degrees of purchase delay while shaping the firms dynamic pricing strategy. Interestingly, I find that product concept demonstration can decrease the new product price compared to the case without a demonstration, and

the amount of delayed purchases induced by the product concept demonstration is greatest at very low or high levels of product substitutability, exhibiting a U-shaped pattern. My results indicate that engaging in pre-launch product concept demonstration is not always the optimal strategy for the monopolistic firm.

1.3.2   Research Questions

I. How do product concept demonstrations affect the firm's inter-temporal pricing strategy?

II. What are the underlying strategic forces that shape the optimal pricing strategy for old and new models?

Chapter 2

Effects of PCD on Firm Value & Risks

2.1 Literature Review

Guided by the commonly held view that new products are a significant driver of corporate growth, several researchers have attempted to empirically validate whether information about firm innovations indeed increase firm value. Placed on a time line when the information is available to public relative to the actual new product introduction, these studies range from R&D project announcements, to preannouncements of new products, to announcements of new product introductions. The review of the literature is organized as such.

2.1.1 R&D Projects and Innovation Stages

Effects of R&D and innovation project announcements are found to depend on the stage of the innovation (Kelm, Narayanan, and Pinches 1995; Sood and Tellis 2009) and the technology orientation of the firm (Chan, Martin, and Kensinger 1990). Kelm, Narayanan, and Pinches (1995) find that announcements about projects undertaken at the early phase of the product development (e.g., finding a technical solution to a problem) have positive effect on stocks, but the effect is restricted to the firms with technological capabilities. For other

firms, investors wait for information about the product introductions before reacting positively. Chan, Martin, and Kensinger (1990) find that high-technology firms that announce increase in R&D spending experience positive abnormal returns, when a high-technology firm increases its R&D expenditures. Chan, Lakonishok and Sougiannis (2001) find that high ratio of R&D to equity leads to large excess returns.

2.1.2   New Product Preannouncements

This stream of literature typically examines the benefits and pitfalls of new product preannouncements. Some of the main benefits of preannouncements include: (1) creating entry barrier and preempting competition for dominant firms with low cost of product development (Bayus, Jain, and Rao 2001), (2) alerting consumers so they wait for the impending release of a new product (Eliashberg and Robertson 1988; Greenleaf and Lehmann 1995), and (3) creating dominant standard in an industry with competing technologies or formats (Farrell and Saloner 1986). The negative effects of product preannouncements include alerting competitors (Robertson, Eliashberg, and Rymon 1995), and the firm introducing the product either later than what was promised or never at all (Hendricks and Singhal 1997), phenomenon commonly termed as a "vaporware."

Research on the effects of new product preannouncements on firm value is limited. Mishra and Bhabra (2002) find weak positive effects. In a more comprehensive study, Sorescu, Shankar, and Kushwaha (2007) utilize a market signaling framework (Spence 1974) and demonstrate that new product preannouncements signals the market about future earning potentials, thereby positively impacting the firm value. The effect is stronger when the information about preannouncement is specific, when the information is updated, and when the credibility of the firm is high. In summary, positive effects of innovations on firm value are not restricted only to actual new product introductions, but are also present in cases of announcements of R&D investment and innovations stages, as well as new product preannouncements.

2.1.3 Announcement of New Product Introductions

Early studies, using small samples and weekly stock returns, find marginal or no effect of new products announcements on stock returns (Eddy and Saunders 1980). In a more comprehensive analysis involving 24 industries, 336 firms, and 1,348 new products, Chaney, Devinney, and Winer (1991) find negative effect of the number of introduction announcements on cumulative abnormal returns (CAR) in 11 of the industries indicating that the fewer, rather than many, introductions of new product raises firm valuations. Focusing on 66 publicly traded pharmaceutical firms, introducing 3891 new products (including 255 breakthrough drugs) during a period of 1991-2000, Sorescu, Chandy, and Prabhu (2003) find that technological and market breakthrough new products have positive impacts on firm values.

In the automobile industry, Pauwels et al. (2004) find that introductions of new automobiles increase firm values, especially if the new products enter a new market. The firm value is found to grow as more information about the new products become available. Using data for 20,000 new consumer packaged goods products, Sorescu and Spanjol (2008) find that breakthrough new products add to firm value as well as risks.

2.1.4 Return versus Risks

Potential return associated with R&D investments and new product initiatives is likely associated with firm-specific (i.e., idiosyncratic) risks manifested by return volatility (Merton 1987; Ghysels et al. 2005). Tirole (1988) however argues that breakthrough innovations are so unique that demonstrating firm can achieve monopolistic share due to patents or because they are differentiated, hence it is difficult to imitate. When the innovative products are launched and adopted, they presumably increase the predictability of future cash flows because there is no close competitor which launches substitutes. Contrary to Tirole (1988), Chan, Lakonishok and Sougiannis (2001) find that high ratio of R&D to equity raises volatility of the firm returns. Sorescu, Chandy, and Prabhu (2003) find that the positive effect of technological breakthrough on firm values is associated with greater idiosyncratic risk than

market breakthroughs. Similarly, Sorescu and Spanjol (2008) find that breakthrough new products add to firm risks. In summary, past research shows that information about innovation projects, new product preannouncements, and actual launch generally have a positive effect on firm returns and idiosyncratic risk. A gap in this research stream is that it has not considered situations where multiple firms displays several of their new products at different stages of development in the same location. Trade shows offer such a context. While trade shows have similar characteristics as product/project announcements or preannouncements, there are significant differences. First, firms can demonstrate multiple concepts and the concept mix in a trade show. Second, trade shows offer opportunities for visual inspections and sometimes physical experience of the concept and prototypes. These experiences offer information about the nature of innovation and also readiness of the product to be commercially introduced. Third, concept demonstrations in a trade show take place in a venue where other competing firms also demonstrate their concepts. Finally, like product preannouncements, a firm's prior history in converting a concept into a commercial vehicle in a timely manner indicates the credibility of the firm to follow through on its promise. These features are incorporated in Figure 2.1, which serves as a conceptual framework for guiding this research.

2.2   Conceptual Frameworks

Since much of corporate innovations take place within the confines of a firm, there is information asymmetry between investors and the firm. Through their product demonstrations in trade shows, firms therefore signal the market about incremental cash flow potential from the new products converted from the concepts demonstrated (Sorescu, Shankar, and Kushwaha 2007). The signaling effort includes: (1) conveying information about the innovativeness of the concepts demonstrated, (2) establishing credibility of the firm to convert the concepts into commercial products, and (3) using influential trade shows as venues to communicate information about firm innovations.

2.2.1 Concept Innovativeness

In a trade show a firm can display multiple concepts with different degree of innovativeness. Some concepts may entail new-to-the-world technology (e.g., Prius gasoline-electric hybrid engine, Volt electric car concept, or interactive video game consoles by Nintendo Wii), others may involve significant design changes (e.g., the boxy design of Scion by Nissan, the retro redesign of Ford Mustang, or Fiat 500 mini cars redesigned For Two, etc.), and yet other entail small improvements (e.g., a styling change of previous years model, e.g., grill redesigns, headlight or fender contours, etc.). As discussed before, relative to incremental new products, breakthrough or radical new products are found have to have greater positive effect on firm value (Chaney, Devinney, and Winer 1991; Sorescu, Chandy, and Prabhu 2003; Soreuscu and Spanjol 2008). Thus, concepts with significant technological innovations will be viewed by investors more positively than those demonstrating concepts incremental innovations.

H1 Concepts that employ new technologies or significant design changes will have greater positive effect on firm value than will concepts with minor incremental improvements.

There are also certain firm-specific factors that may enhance or limit a firms ability to signal its innovativeness to the public. In the context of concept demonstration, a firm that invest more in R&D should have more new product concepts in their product pipelines (Chan, Martin, Kensinger 1990). However, firms may have their own internal innovation strategies that place different emphasis on different types of innovation (i.e., breakthrough versus incremental) (Kelm, Narayanan, and Pinches 1995). Firms may also employ different strategies of disclosing their innovation to the public in trade shows. Some firms hold their new product concepts a secret while others are more generous in disclosing their innovative activities.[1]

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[1] While a firms R&D investments are public information, the internal strategies are not observable. I incorporate firm fixed effects to account for this unobserved heterogeneity in such strategies.

2.2.2   Concept Conversion History

Since concept demonstrations in a trade show also serve as a concept screening function, only a proportion of demonstrated concept is pursued further. Even those that survive may not meet the technical, manufacturing, or commercial targets. Thus, for demonstrated concepts to positively influence firm value, the firm must credibly convince investors its ability to convert the concepts into marketable product. Sorescu, Shankar, and Kushwaha (2007) find that firms who are more reliable in delivering a preannounced product reap greater return from providing updates about the status of preannounced products.

H2 Firms with better history of converting concepts to commercial products will have a stronger positive effect of concept demonstrations on firm value.

2.2.3   Trade Show Size

For the firm to effectively communicate its new product activities to the public, it should select the right venue to do so same way firms select media outlets. Larger trade shows bring in prominent industry analysts, have more room for display a wide range of new products, and attract more firms to show case their new products for greater visibility. As competing firms vies for attention of the visitors, firms are fearful that their concepts may be crowded out. Thus, firms are likely to display more concepts to counter the competitive effects as well as to capitalize on the buzz that bigger trade shows generate. Thus, larger trade shows should have stronger impact on firm value than venues that accommodate fewer display items.

H3 The bigger the trade shows in which firms demonstrate their concepts, the stronger will be the effect of concept demonstration on firm value.

2.2.4 Trade Show Display Mix

Firms participate in a trade show not only to present their early stage innovations to the public but also to create interest in their production ready products. Some of the concepts are revealed to the world for the first time (hereafter, the "debuts), while others have been shown before in prior trade shows (hereafter, the "concepts). Finance theory suggests that stock price reflects all publicly available information (Campbell, Lo, MacKinlay 1997). Thus in assessing firm value and idiosyncratic risk, investors consider only new information. In the current context, only the debuts should be a relevant input to the assessment of firm value. However, because the debuts are subject to considerable product development and market risk, the positive effect of demonstrating concepts for the first time is associated with larger volatility of returns, i.e., idiosyncratic risk. Also, since the debuts demonstrated in a trade show are a mix of technological break-through concepts and incremental improvement, the variability in the mix adds to the assessment of future cash flows, and therefore, firm value. Finally, previously demonstrated concepts and product-ready new products are already a part of public information, and therefore, should not influence firm value. The following hypothesis encapsulates these assertions:

H4 (a) positively influenced by the number of debuts (concepts demonstrated for the first time), (b) negatively by the variability in the types (i.e., breakthroughs versus incremental) of debuts demonstrated, and (c) not influenced by previously demonstrated concepts and production ready new products.

H5 Firm idiosyncratic risk will be (a) positively influenced by the number of debuts demonstrated, (b) positively by the variability in the types of debuts demonstrated, and (c) unaffected by previously demonstrated concepts and production ready new products.

Figure 2.1: A Conceptual Framework of Concept Demonstrations in Trade Shows

Concept Innovativeness

Trade Show Size → **Demonstrated Mix** (Debuts, Concepts, and Production-ready New Products) ← **Concept Conversion History**

Cumulative Abnormal Returns
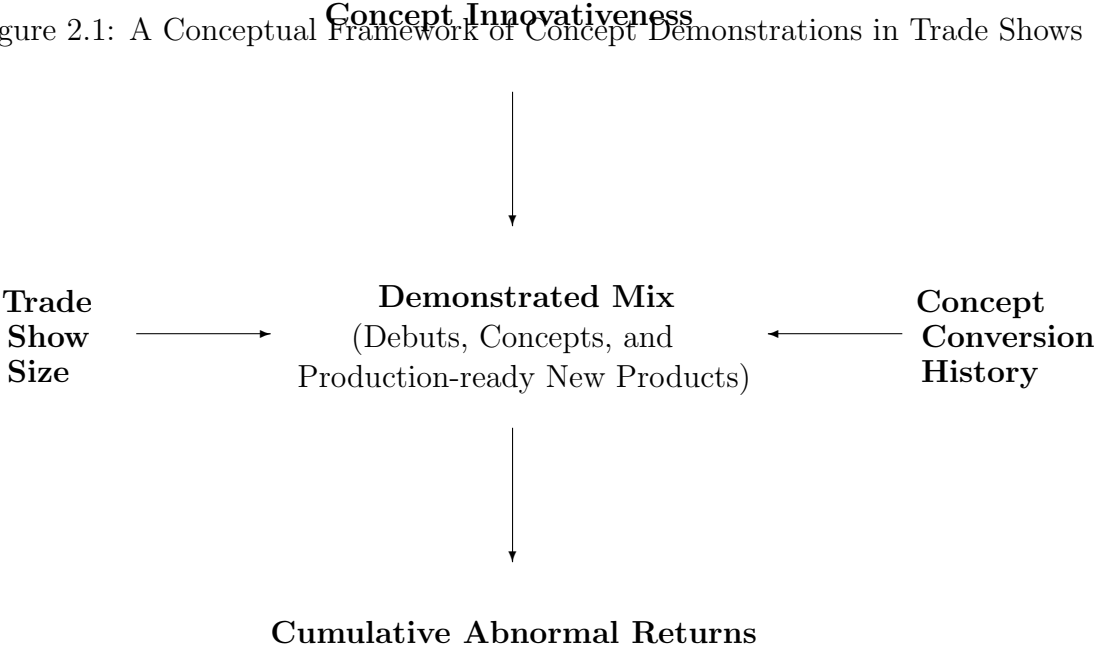
2.3   Method

2.3.1   Research Context

As noted before, I utilize auto shows as a context for the study. Auto shows are a popular form of trade shows, in which world's leading automakers showcase their innovative activities to the world. The popularity of auto shows among industry experts, media, financial analysts, as well "regular" consumers has grown exponentially over the years. For instance, since its inauguration in 1901, Chicago Auto Show expanded its attendance from a meager 2000 to 6000 to anywhere between a half to a three quarter of a million people in recently concluded auto show in 2008, a ten-day event covering 1.3 million square feet of space. Detroit Auto Show attracted an estimated about 700,000 visitors, including auto experts, industry analysts, and celebrities. The largest attended auto show, New York Auto Show has more than 1 million visitors per year and it generates nearly $250 million in economic impact for New York City. A March 17, 1996 New York Times story indicates that just the rental cost for New York auto show is about $1.9 million, and GM, Ford and Chrysler each spent an additional $1.6 million to produce the auto show. Costs for auto shows account for a big part of the promotional budget of auto companies. Products demonstrated in an auto show can be broadly divided in two groups: production-ready vehicles and automobile concepts. Production vehicles are expected to be available at the dealers' lots during the current model year. Trade shows offers a convenient means for buyers in the market for a new product to compare different production ready products. Dealers and distributors often play a significant role and providing sales and marketing support for these products in the hope of potential sales. Unlike production ready products, which are typically managed by marketing and sales personnel, the demonstration of concepts is a domain of the designers, primarily interested in demonstrating the technical aspects of the products. Also, unlike production ready products, which are to be introduced during the same year, concepts are subject to considerable product development risks, and some concept demonstrated in an

auto show are never commercialized.

I focus on three U.S. automakers (GM, Ford, and Chrysler) and three Japanese automakers (Toyota, Honda, and Nissan). Collectively, these six automakers account for 87% of the United States automotive market. I included all production-ready cars and concepts demonstrated by these firms in all the major auto shows (e.g., Chicago, Detroit, New York, Frankfurt, Tokyo, etc.) during the 2002-07 period. As Table 2.1 indicates, the six automakers demonstrated, on average, about thirteen concept cars each. Also, the number of concepts demonstrated by the US automakers is significantly higher than those demonstrated by Japanese automakers. The concepts demonstrated differ on the degree of their innovativeness.

2.3.2 Event Study

I use an event study methodology to compute the cumulative abnormal stock return for the six automobile manufacturing firms over time windows focused on the before and after days of auto show. As discussed earlier, a number of researchers in marketing have utilized event study to assess the long term effects of marketing actions on firm value, especially when the effects are not contemporaneous to these actions (e.g., see Chaney, Devinney, and Winer 1991; Tellis and Johnson 2007; Sorescu, Shankar, and Kushwaha 2007). Event study measures the effect of new information released on the market value of a firm's stock price. This approach depends on the assumption that the financial markets are efficient, that is, stock prices reflect all available relevant information in the market (Fama 1970, 1998). Hence, only new or unanticipated events will change the stock prices affecting the future prospects of the firm. It also implies that the speed with which new information is incorporated into prices is instantaneous and the magnitude of the price change is a measure of the value of this information (Brown and Warner 1985). When an event occurs (for example, when a new product concept demonstrated), investors update their expectations about the firm's future cash flow and risks, and react by buying or selling the shares of firm will be affected

by the event. The daily return in the stock price between day $t-1$ and day t is:

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1} + D_{i,t}}{P_{i,t-1}} \tag{2.1}$$

where P_{it} is the closing stock price of firm i at the end of trading day t, D_{it} is dividend at time t, and R_{it} captures the market's expectations of the long-term impact of all relevant information that are known between $t-1$ and t.

To calculate abnormal returns, I use Fama-French three-factor model which includes market capitalization, firm size, market value (Fama and French 1993), to which I add price momentum (Carhart 1997), making it a four-factor model:

$$R_{i,t} - R_{ft} = \alpha_i + \beta_{1i}(R_{mt} - R_{ft}) + \beta_{2i}SMB_t + \beta_{3i}HML_t + \beta_{4i}UMD_t + \varepsilon_{it} \tag{2.2}$$

$$AR_{it} = R_{i,t} - R_{ft} - [\hat{\alpha}_i + \hat{\beta}_{1i}(R_{mt} - R_{ft}) + \hat{\beta}_{2i}SMB_t + \hat{\beta}_{3i}HML_t + \hat{\beta}_{4i}UMD_t] \tag{2.3}$$

where

t : Subscript for day of the estimation window i.e. $-300 \le t \le -31$

i : Subscript for automobile manufacturing firm

R_{it} : Stock returns on event i on day t

R_{mt} : Market rate of return, the average return of the New York Stock Exchange

R_{ft} : Theoretical rate of return attributed to a risk-free investment

SMB : The difference between the rate of returns of small and large stocks

HML : The difference in returns between high and low book-to-market stocks

UMD : A momentum factor, the difference in the returns of firms between high and low prior stock performances

Hypothesis of efficient markets implies that the abnormal return is a random variable with mean of zero, since the deviations between the actual returns to asset i and their expected values, conditional on all available information at time (t-1), should be zero systematically. To test if abnormal returns resulted due to an event, test the hypothesis that the cross-sectional mean of abnormal return at the event day is different from zero. As I notice that in every auto show, events of product concept demonstration are clustered in the calendar time. This cross-sectional dependence in the abnormal returns generates downward bias of standard deviation estimate thus inflating the test statistics (Jeffe 1974). Hence, I use portfolio method for correcting downward bias of standard deviation estimate (See Equation 2.6 and 2.7 below). This accounts for the correlation between residuals of different securities. I calculate average cumulative abnormal return and the t-statistic (Brown and Warner 1985) for portfolio of securities as follows:

$$CAR_{it} = \sum_{i=1}^{N} AR_{it} \tag{2.4}$$

$$ACAR_t = \frac{1}{N} \sum_{i=1}^{N} AR_{it} \tag{2.5}$$

$$t.stats = \frac{ACAR_t}{SD(ACAR_t)} = \frac{ACAR_t}{\sqrt{\frac{1}{(T-1)} \frac{1}{N} \sum_{t=-300}^{-31} (ACAR_t - A^*)^2}} \tag{2.6}$$

$$A^* = \frac{1}{270N} \sum_{t=-300}^{-31} \sum_{i=1}^{N} AR_{it} \tag{2.7}$$

where CAR_{it} is cumulative abnormal return. $ACAR_t$ is average cumulative abnormal return for an event, the average value of the summation of the abnormal return from event time t_0, the first day of the event window and t_n, the last day of the event window (see Figure 2). Under the null hypothesis of no abnormal return, $ACAR_t$ has a zero mean and standard deviation of σ_{ACAR}. T is the days for estimation window that begins from -300 day to -31 day, i.e. 270 days. N is the days of event windows, e.g. N=2 for (0,+1). As discussed later,

Figure 2.2: Time Line for an Event Study

Estimation Window   **Event Window**

-300   -31   -1 0 +1   t
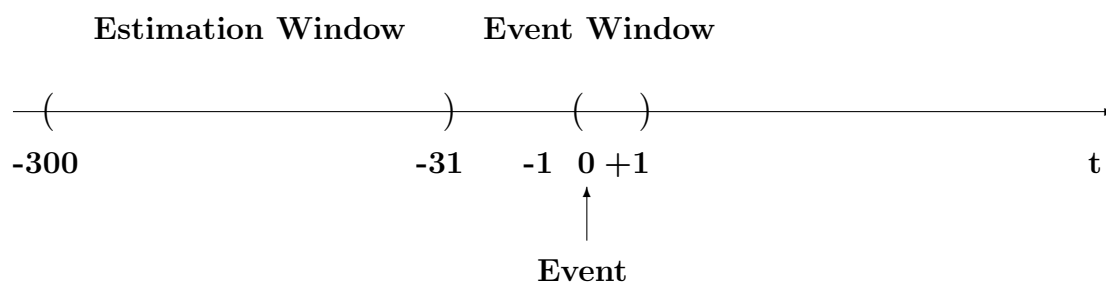
Event

I try several event windows, and pick the window that gives us the best model fit.

2.4 Data

The data come from two different sources. For auto show data, I use "From concepts to production," at http://www.conceptcarz.com/. For firms' stock prices, I utilize Wharton Research Data Services, Center for Research in Security Prices (CRSP). The CRSP is a value weighted index that is used as the proxy for the market when estimating alpha and beta in the one factor market model. Total observations are 228 information release events

Table 2.1: Descriptive Statistics: Firms

(1)	(2)	(3)	(4)	(5)
Firms	Number of Debut	(%)	Number of Concept	(%)
Chrysler	38	18.0	90	21.0
Ford	42	20.0	73	17.1
GM	66	31.7	121	28.3
Honda	15	7.1	53	12.4
Toyota	23	10.9	57	13.3
Nissan	27	12.8	34	7.9
Total	211	100	428	100

Table 2.2: Brands for Each Company

(1)	(2)	(3)	(4)	(5)	(6)
Chrysler	Ford	GM	Honda	Toyota	Nissan
Chrysler	Ford	Buick	Acura	Lexus	Infiniti
Dodge	Lincoln	Chevrolet	Honda	Toyota	Nissan
Jeep		Cardilac			
		GMC			
		Hummer			
		Pontiac			
		Saturn			

Table 2.3: Descriptive Statistics: Auto Shows

(1)	(2)	(3)	(4)	(5)	(6)
Auto Shows	Number of Debut	(%)	Number of Concept	(%)	Observations
Detroit	64	30.3	102	23.8	36
New York	35	16.6	108	25.2	36
Chicago	16	7.6	125	29.2	36
LA	9	4.3	43	10.0	36
Geneva	9	4.3	16	3.8	30
Frankfurt	9	4.3	4	0.9	18
Tokyo	19	9.0	18	4.2	18
SEMA	50	23.7	12	2.8	18
Total	211	100	428	100	228

Table 2.4: Cross Tabulation between Firms and Auto Shows

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Chrysler	Ford	GM	Honda	Toyota	Nissan	Total
Detroit	19	14	15	3	6	7	64
New York	3	6	11	4	4	7	35
Chicago	2	3	7	0	1	3	16
LA	1	2	4	2	0	0	9
Frankfurt	2	3	0	1	2	1	9
Geneva	3	1	1	1	2	1	9
Tokyo	2	1	0	2	6	8	19
SEMA	6	12	28	2	2	2	50
Total	38	42	66	15	23	27	211

(i.e., 48 auto shows 6 firms = 228) that includes data for six automobile firms and 38 auto shows for 5 years from Jan 6, 2002 Detroit Auto Show to Nov 16, 2007 LA Auto Show. I summarize brands of the company in Table 2. Eight auto shows are Chicago, Detroit, Frankfurt, Geneva, LA, New York, Specialty Equipment Market Association (SEMA), and Tokyo auto show. I exclude auto shows where no concept debut is demonstrated. I include six automakers Chrysler, Ford, GM, Honda, Toyota, and Nissan, which cover 87% of total U.S. automobile market share. I report the descriptive statistics of six firms and auto shows in Table 2.1 and Table 2.3.

2.4.1   Cross Tabulation of Debut

In Table 2.4, I present a cross-tabulation of the number of debut between firms and auto shows. Three US auto makers demonstrate more number of debut in major three auto shows (e.g., Detroit, New York, and Chicago) than the three Japanese auto makers do. GM demonstrated the smallest number of debut at auto shows held outside of US among the three US firms and Honda demonstrated the smallest number of debut at auto shows held outside of US among the three Japanese firms.

I have the two sets of firm specific data: R&D Intensity and Firm Size. Both firm specific

data sets are measured by quarterly and I transform quarterly data to the daily data using a decaying model that the closer date gets the higher expenditure to expend. R&D Intensity is ratio of R&D expenditure and sales of firm and Firm Size measures total sales of firm.

Other dependent variables are risk measures; systematic risk and idiosyncratic risk. I use daily stock market index data to compute firm i's systematic risk measure β_i for a period by using four factor model (Carhart 1997) and I obtain the idiosyncratic risk by calculating the standard deviation of residuals from Equation. First I measure idiosyncratic risk with several windows such as only event date (0,0), two days (0,+1), three days (-1,+1), five days (-2,+2), two weeks (-5, +5), and one month (-10, +10).

2.4.2 Variable Operationalization

I quantify the description with photos of each concept demonstrated in auto shows into three innovation types: new technology, new design change, and incremental change (See Table 2.5). As Shrinivasan, Pauwels, Silva-Risso, and Hanssens (2007) classified the extent of innovation, I modify an innovation scale ranging three categories for parsimonious classification as follows; (1) mere trimming, styling and design changes (levels 1 and 2 of J.D. Power and Association(JDPA) specialist scale), (2) 'design' and 'new benefit' innovations (levels 3 and 4), and (3) brand entry in a new category (level 5) in the empirical analysis. First, I only consider a concept as technology that is pioneering innovation such as Toyota's "Prius", electric car. Next type is design change that concept demonstrated is focused on new or updated design. Third, introduction type is that the purpose of the concept demonstration is pre-launched advertising the model. Fine-tuned design especially inside of the model can be found in this type.

In addition to the two sets of concept classifications, I create two firm-specific variables for the signal strength of the concept debut; introduction ratio and average time to launch. First, introduction rate is defined as the ratio of eventually launched concept debut and all demonstrated concept debut. This implies that the high introduction rate, the stronger

Table 2.5: Classification of Concept: Concept Focus

Concept Focus	Example in recent auto shows
Technology: The objective is to demonstrate a concept that contains one or more feature(s) that is (are) available for the first time ever. For example, first incorporation of anti-brake, traction control, passenger side air bag, etc.	2006 Toyota Fine-X: "...on-the-spot 180-degree rotation, afforded by the combination of four-wheel independent drive, four-wheel independent steering and a large-steering-angle, and steering mechanism with electric in-wheel motors housed in each of the four wheels."
Design Change(s): The objective is to demonstrate changes in interior and/or exterior designs, and the resultant improvement of functionality of the driver and passengers. Typically, the design changes involve reconfigurations of doors, windows, seats, etc.	2007 Nissan Bevel Utility Wagon: "...features an asymmetrical exterior with a long driver's side door which pivots on a special hinge designed for ease of entry and exit. On the passenger side of the Nissan Bevel's body are two doors, with the rear door hinged at the rear to provide an exceptionally wide door opening... The interior of the Nissan Bevel is organized into three specific zones. The first zone is the comfort zone (driver's area). The second interior zone of the Nissan Bevel concept is the "command central" information/technology zone... The third Bevel zone is the utility/pet zone."
Minor Change(s): The objective is to demonstrate production ready concepts and announce short-term direction of the brand(s). Frequently, next generation concept(s) of existing model is(are) present as commercial car.	2006 Infiniti Coupe concept:"... Among the Coupe Concept's exterior design features are a full-length glass panel roof, modulated front fenders and hood, deep front spoiler and large projector headlights, polished bare metal-look paint, compact camera outside rearview mirrors, hidden door handles and large 20-inch, 9-spoke painted aluminum-alloy wheels. The Coupe Concept interior combines a performance-inspired cockpit with a luxurious passengers' space featuring a 'double wave' instrument panel design, with large, violet-color gauge illumination and a dramatic, full-length center console."

signal for each concept debut of the firm in the year. I measure the introduction ratio auto show basis with firm specific so that in every auto show, each firm has own value of introduction rate. Second, Thus in each auto show each firm has one measure of introduction rate.

2.5 Models

In this section, I present three models to estimate the effects of product concept demonstrations in auto shows on abnormal stock returns. First, I run a cross-sectional regression model to show the basic results. To consider an endogeneity issue between firm's choice of demonstrated debuts and concepts I conduct test for endogeneity and develop a three-stage least square model. Another 3SLS model with new variable definition is developed and estimated as well. Finally, simple models for the two risk measures are also modeled.

2.5.1 Initial Model (No Endogeneity Considered)

My initial model is a cross-sectional ordinary lease square regression model that the average cumulative abnormal return is regressed on all of the independent variables. In this model, I do not consider possible endogenous variable issues.

$$
\begin{aligned}
ACAR_{ij01} \;=\; & \omega_0 + \omega_1 Tech.D_{ij} + +\omega_2 Design.D_{ij} + \omega_3 Minor.Change.D_{ij} \qquad (2.8) \\
& +\; \omega_4 Intro.Ratio.D_{ij} + \omega_5 Tech.C_{ij} + \omega_6 Design.C_{ij} + \omega_7 Minor.Change.C_{ij} \\
& +\; \omega_8 Intro.Ratio.C_{ij} + \omega_9 Var.Debuts_{ij} + \omega_{10} Current.Model_{ij} + \omega_{11} R\&D_{ij} \\
& +\; \omega_{12} Firm.Dummy_i + \varepsilon_{Iij}
\end{aligned}
$$

where

$ACAR_{ij01}$: average cumulative abnormal return of firm i on auto show j on the event window (0,+1) day.

$Tech.D_{ij}$: the number of debuts focusing on technology innovation of firm i on auto show j.

$Design.D_{ij}$: the number of debuts focusing on design updates or incremental innovation of firm i on auto show j.

$Minor.Change.D_{ij}$: the number of debuts focusing on minor updates of firm i on auto show j.

$Tech.C_{ij}$: the number of concepts focusing on technology innovation of firm i on auto show j.

$Design.C_{ij}$: the number of concepts focusing on design updates or incremental innovation of firm i on auto show j.

$Minor.Change.C_{ij}$: the number of concepts focusing on minor updates of firm i on auto show j.

$Intro.Ratio.D_{ij}$: introduction ratio of debuts for firm i on auto show j.

$Intro.Ratio.C_{ij}$: introduction ratio of concepts for firm i on auto show j.

$Var.Debuts_{ij}$: the variance of the number of debuts of firm i on auto show j based on five recent demonstrations including current one.

$Current.Model_{ij}$: the number of current model demonstrated of firm i, available in the market at the time of auto show j.

$Total.Debut_j$: the total number of debuts demonstrated on auto show j.

$R\&D_{ij}$: decaying estimation of yearly R&D intensity of firm i on auto show j.

$Firm.Dummy_i$: Firm specific dummy. Nissan is the baseline firm.

ω's are coefficients to be estimated and, ε_{Iij} is the error term. R&D intensity is an instrumental variable to capture the degree of firms' willingness to invest on new projects. $Intro.Ratio.D_{ij}$ ($Intro.Ratio_{ij}$) shows the firm's past historical momentum of concept conversion rate for a debut (a concept) as a backward-looking variable. Total debut (concept) stands for the venue effect that the larger generates the greater impact on the firm values from the demonstrating their product concepts. $Firm.Dummy_i$ capture the fixed effect of firm specific differences, especially breath of the product line.

2.5.2   Reduced Form Equation Model

To interpret the coefficients of three-stage least square (3SLS) model, I run ordinary least square (OLS) regression model in which $ACAR_{01}$ is regressed on all of the independent variables including an endogenous variable (e.g., the number of debut). As a result, we have a merged equation (Equation (2.9)) from Equation (2.13) and (2.14).

$$ACAR_{ij01} = \alpha_0 + \alpha_1(\gamma_0 + \gamma_1 Tech.D_{ij} + \gamma_2 Design.D_{ij} + \gamma_3 Intro.Ratio.D_{ij} \qquad (2.9)$$
$$+\gamma_4 Total.Debut_j + \gamma_5 R\&D_{ij} + \gamma_6 Firm.Dummy_i + \varepsilon_{2ij})$$
$$+\alpha_2 Var.Debuts_{ij} + \alpha_3 Concept_{ij} + \alpha_4 Current.Model_{ij} + \varepsilon_{1ij}$$

After rearrangement, we get (2.10).

$$ACAR_{ij01} = \alpha_0 + \alpha_1\gamma_0 + \alpha_1\gamma_1 Tech.D_{ij} + \alpha_1\gamma_2 Design.D_{ij} + \alpha_1\gamma_3 Intro.Ratio.D_{ij} \quad (2.10)$$
$$+\alpha_1\gamma_4 Total.Debut_j + \alpha_1\gamma_5 R\&D_{ij} + \alpha_1\gamma_6 Firm.Dummy_i$$
$$+\alpha_2 Var.Debuts_{ij} + \alpha_3 Concept_{ij} + \alpha_4 Current.Model_{ij} + \alpha_1\varepsilon_{2ij} + \varepsilon_{1ij}$$

α's and γ's are coefficients to be estimated and, ε_{1ij} is an error term.

2.5.3 Test for Endogeneity

I conduct Durbin-Wu-Hausman test to confirm if there is an endogeneity issue in the system of equations. First, I run OLS regression model to predict a residual (ε_{2ij}) in Equation (2.14). Second, I estimate the main equation (Equation (2.13)) including the estimated residual $\hat{\varepsilon}_{2ij}$ as an additional independent variable. If the coefficient of this estimated residual is significant, then the significant explanatory power of the estimated residual confirms that there is an endogeneity issue.

$$
\begin{aligned}
Debuts_{ij} =\ & \eta_0 + \eta_1 Tech.D_{ij} + \eta_2 Design.D_{ij} + \eta_3 Minor.Change.D_{ij} \quad (2.11) \\
& + \eta_4 Intro.Ratio.D_{ij} + \eta_5 R\&D_{ij} + \epsilon_1
\end{aligned}
$$

$$
ACAR_{ij01} = \xi_0 + \xi_1 Debuts_{ij} + \xi_2 Var.Debuts_{ij} + \xi_3 Concept_{ij} + \xi_4 Current.Model_{ij} + \xi_5 \hat{\epsilon}_1 + \epsilon_2
$$
$$(2.12)$$

where

$Debuts_{ij}$: the number of the first time demonstrated concept debuts of firm i on auto show j.

$Concepts_{ij}$: the number of the second or more times demonstrated concepts of firm i on auto show j.

2.5.4 Three-Stage Least Square

I consider that investors react to the information releases available at the auto show, which includes the debuts, the concepts, and the production ready automobiles that are ready for sale. I suspect that the number and type of debuts and concepts demonstrated are endogenously determined by the firms, hence those are unobservable. Since the error terms among Equation 2.13, 2.14, and 2.15 are correlated because of the firm's incentive to select successful product concepts that can generate greater abnormal return, I treat them as a

system of equations and estimate them via three-stage least squares (3SLS). Hence, I have the following models: an abnormal return model with only decision variables of demonstrations such as the number of debuts, variance of debut, the number of concept, and the number of current model. The two dependent variables, the number of debut and the number of concept are fitted exogenous variables and control variables. Therefore I run three-stage least square model to estimate the effects of product concept demonstrations on firm value.

$$ACAR_{ij01} = \alpha_0 + \alpha_1 Debuts_{ij} + \alpha_2 Var.Debuts_{ij} + \alpha_3 Concept_{ij} + \alpha_4 Current.Model_{ij} + \varepsilon_{1ij}$$

$$(2.13)$$

$$
\begin{aligned}
Debuts_{ij} \;=\; & \gamma_0 + \gamma_1 Tech.D_{ij} + \gamma_2 Design.D_{ij} + \gamma_3 Intro.Ratio.D_{ij} \quad (2.14) \\
& +\; \gamma_4 Total.Debut_j + \gamma_5 R\&D_{ij} + \gamma_6 Firm.Dummy_i + \varepsilon_{2ij}
\end{aligned}
$$

$$
\begin{aligned}
Concepts_{ij} \;=\; & \delta_0 + \delta_1 Tech.C_{ij} + \delta_2 Design.C_{ij} + \delta_3 Intro.Ratio.D_{ij} \quad (2.15) \\
& +\; \delta_4 Total.Concept_j + \delta_5 R\&D_{ij} + \delta_6 Firm.Dummy_i + \varepsilon_{3ij}
\end{aligned}
$$

However, the demonstrations of the concepts and the currently available for sales in the market do not have any unanticipated information at the auto show; therefore, it would not affect the firm value.

2.5.5 Three-Stage Least Square using New Variable Definitions

I also run the 3SLS with new definitions for the number of debut: *Tech Ratio, Design Change Ratio, Minor Change Ratio*. Specifically speaking, *Tech Ratio* denotes the ratio of the number of technology-oriented debut and the own number of debut. For illustration, if the number of technology-oriented debut is 2, and the own number of debut is 5, then *Tech Ratio* would be 40%. I only include two variables (e.g., *Tech Ratio* and *Design Change*

Ratio) because it causes a multicollinearity issue to include the third variable (*Minor Change Debut*).

$$ACAR_{ij01} = \alpha_{10} + \alpha_{11}Debuts_{ij} + \alpha_{12}Var.Debuts_{ij} + \alpha_{13}Concept_{ij} + \alpha_{14}Current.Model_{ij} + \varepsilon_{11ij}$$
$$(2.16)$$

$$Debuts_{ij} = \gamma_{10} + \gamma_{11}Tech.Debut.Ratio_{ij} + \gamma_{12}Design.Debut.Ratio_{ij} \qquad (2.17)$$
$$+ \gamma_{13}Intro.Ratio.D_{ij} + \gamma_{14}Total.Debut_{j} + \gamma_{15}R\&D_{ij} + \gamma_{16}Firm.Dummy_{i} + \varepsilon_{12ij}$$

$$Concepts_{ij} = \delta_{10} + \delta_{11}Tech.Ratio_{ij} + \delta_{12}Design.Ratio_{ij} \qquad (2.18)$$
$$+ \delta_{13}Intro.Ratio.C_{ij} + \delta_{14}Total.Concept_{j} + \delta_{15}R\&D_{ij} + \delta_{16}Firm.Dummy_{i} + \varepsilon_{13ij}$$

2.5.6   Models for Risks

As McAlister, Srinivasan, and Kim (2007) showed that advertising and R&D reduce the systematic risk of the firm, I expect that product concept demonstrations also lower the firm's systematic risk because product concept demonstrations also have a role of pre-launch advertising. I also run cross-sectional regression model for idiosyncratic risk expecting product concept demonstrations increase the idiosyncratic risk.

$$Systematic.Risk_{ij} = \beta_0 + \beta_1 Debuts_{ij} + \beta_2 Var.Debuts_{ij} + \beta_3 Concept_{ij} + \beta_4 Current.Model_{ij} + \varepsilon_{4ij}$$
$$(2.19)$$

$$Idiosycratic.Risk_{ij} = \xi_0 + \xi_1 Debuts_{ij} + \xi_2 Var.Debuts_{ij} + \xi_3 Concept_{ij} + \xi_4 Current.Model_{ij} + \varepsilon_{5ij}$$
$$(2.20)$$

Where

  $Systematic.Risk_{ij}$: the slope, β_{1i} of the regression equation for the term $(R_{mt} - R_{ft})$ in Equation 2.2.

$Idiosycratic.Risk_{ij}$: standard deviation of error term in the four factor model in Equation 2.3.

2.6 Results

Table 2.6 through Table 2.12 show us the results of the models. First, I select the best event-window to analyze the effects of product concept demonstration on both firm value and risks. Next, I present the estimation results for the initial model which does not consider endogeneity issue. After conducting test for endogeneity, I present reduced-form model, 3SLS model, and 3SLS model with the new variable definitions.

2.6.1 Selection of Event Window

I first select event window size based on goodness of fit, R-square and Chi-square. In Table 2.6, (0,+1) is the most significant in terms of R-square measure, (-1,+1) has the greatest Chi-square measure meaning that the model explains the most among the models with the certain numbers of independent variables. However, (-1,+1) includes the day before event which is biased by unrevealed facts so I choose (0,+1) as our focus of analysis. As a result, consistent to the common knowledge in event study, the narrow event window gets the greater the goodness of fits. Furthermore, consistent coefficient estimations from 3SLS of the different event windows do validate that our estimation results are stable. Now I discuss key findings.

2.6.2 Initial Model (No Endogeneity Considered)

Table 2.7 shows the estimation result of initial model. First of all, the coefficient of *Tech.Debut* and *Desing.Debut* are positive and significant (.0117, p<.01 and .0027, p<.05, respectively). However, the coefficient of Tech.Concept is negative and significant (-.0044, p<.1). This shows that only unanticipated information release positively affect the firm value through

Table 2.6: Event Windows

(1)	(2)	(3)	(4)
Event Window	$R^2(\%)$	χ^2	N
(0,0)	3.62	12.58** [a]	228
(0,+1)	4.49	19.55***	228
(-1,+1)	4.15	36.36***	228
(-2,+2)	1.19	22.87***	228
(-5,+5)	2.60	12.95**	228
(-10,+10)	1.91	7.50	228

[a] $^*p < .10,^{**}p < .05,^{***}p < .01$

increasing abnormal stock returns of the demonstrating firm. Relatively low R^2 indicates a clue of possible endogeneity issue in this initial model.

2.6.3   Reduced Form Equation Model

In Table 2.8, I present the results for the reduced form regression model. This reduced-form model also estimate the model assuming that there is no endogeneity issue in the system of equations. Hence, the results of the model are consistent with the initial model estimations. Tech.Debut

It is important to note that the effects of the debut classification on abnormal return are multiplicative form of α and γ in Equation (2.13) and (2.14) (i.e., $\alpha_1\gamma_1$ is the coefficient of the number of the technology-oriented debut).

2.6.4   Test Result for Endogeneity

Remember that there is an endogeneity issue if I run cross-sectional regression of cumulative abnormal returns on all independent variables of marketing actions. After conducting the Durbin-Wu-Hausman test (augmented regression test) for endogeneity, I confirm that the error term (ε_{2ij}) in the first stage model in Equation (2.13) is correlated with the error term (ε_{1ij}) in the main model in Equation (2.14). Because firms are likely to choose product

Table 2.7: Effects of Product Concept Demonstrations on Abnormal Returns: Initial Model

Variables	ACAR(0,+1)
Tech Debut	.0117***
Design Debut	.0027*
Minor Change Debut	.0002
Intro.Ratio.Debut	.0011
Tech	-.0044*
Design	.0001
Minor Change	-.0003
Intro.Ratio	.0039
Var.Debut	-.0001
Commercial Model	.0002
Total Debut	.0002
R&D Intensity	.0011
Chrysler	-.0062*
Ford	-.0016
GM	-.0058*
Honda	-.0019
Toyota	-.0029
Constant	.0014
$R^2(\%)$	14.22
$Adj.R^2(\%)$	7.28
$F_{(13,214)}$	1.02***
N	228.

concepts to demonstrate concepts which will be successful among many product concepts. In addition, the Variance Inflation Factor (VIF) shows that there is no multicollinearity issue in the model. The coefficients of the full model are consistent to those of simple regression results.

2.6.5 Three-Stage Least Square

First of all, I propose a greater reward of breakthrough innovation meaning that firms that demonstrate a technology oriented debut will obtain greater positive abnormal returns than firms that demonstrate a design oriented concept. As I show in second column of Table 2.10, the coefficient of the Tech Debut is positive, significant (1.1483, p<0.01), and greater than that of the Design Debut(.8991, p<0.01 for Design debut), which support H1. This result is

Table 2.8: Effects of Product Concept Demonstrations on Abnormal Returns: Reduced Form Model

Variables	ACAR(0,+1)
Tech Debut	.0107***
Design Debut	.0025*
Intro.Ratio.Debut	.0014
Var.Debut	-.0001
Concept	.0001
Commercial Model	.0002
Total Debut	.0002
R&D Intensity	-.0409
Chrysler	-.0059*
Ford	-.0026
GM	-.0064**
Honda	-.0014
Toyota	-.0040
Constant	.0035
$R^2(\%)$	12.44
$Adj.R^2(\%)$	7.13
$F_{(13,214)}$	2.34***
N	228.

consistent with the results from Sorescu and Spanjol (2008).

Second, my model has two different kinds of control variables; firm specific variable and auto show specific variable. The concept convergence ratio and the size effect of the auto show are the two backward-looking auto show specific variables. Consistent with H2, I find that concept convergence rate (or Introduction Ratio) enhance the abnormal return through the number of product concept demonstration (.9193, p < .01 for Debuts, 1.5309, p<.01 for Concepts in Table 2.10). This supports the argument that auto maker earns greater firm values by demonstrating the concept debuts that will have greater probability to convert into commercial model in an auto show because consumers and investors not only observe product concept demonstration in the current auto show, but will consider the firm's demonstrating momentum from the previous shows or other sources of information from the media. Therefore, H2 is empirically supported.

Third, the second control variables is the auto show specific variable. The size effect of

Table 2.9: Test Results for Endogeneity

Variables	ACAR(0,+1)
Debut	.0028***
Var.Debut	-.0001
Concept	.0002
Commercial Model	.0000
$\hat{\epsilon}_1$	-.0050**
Constant	.0004
$R^2(\%)$	7.06
$Adj.R^2(\%)$	4.96
$F_{(5,222)}$	3.37***
N	228.

the auto show is one of the two backward-looking auto show specific variables. Consistent with H3, I find that the size effect of auto show (Total Debut or Total Concept) also increase the abnormal return (.0737, p<.01 for Debuts, .0544, p<.01 for Concepts in Table 2.10). This supports the argument that larger trade shows should have stronger impact on firm value than venues that accommodate fewer display items. Hence, H3 is also empirically supported.

Next, as I show in the forth column in Table 2.10, the results support H4: (a) the product concept debut demonstration has a strong and significantly positive effect on average cumulative abnormal returns of demonstrating firm (.0021, p<.01) through auto shows, (b) the coefficient of the Variance of Debut is negative and significant (-.0003, p<.05 in Table 2.10) which suggest that high variance of debut decreases the effects of product concept demonstration on the abnormal stock returns. Variance measure captures the consistency for the quality of concept products offered by the specific firm. Hence, these results suggest that overall product concept demonstrations in trade shows increase firm values of the demonstrating firm and if it is consistent, then the effect will be greater.

As I discussed before, only first time demonstrations of product concept derive positive abnormal stock return. However, the estimation of model (the forth column of Table 2.10) show that the coefficient of the effect of product concept demonstrations on abnormal stock

Table 2.10: Effects of Product Concept Demonstrations on Abnormal Returns: 3SLS

(1)	(2)	(3)	(4)
Variables	Debuts	Concept	ACAR(0,+1)
Debut (First time)			.0021*** [a]
Var.Debut			-.0003**
Concept (Previously demonstrated)			-.0011**
Commercial Model			.0004**
Tech Debut	1.1483***		
Design Debut	.8991***		
Intro.Ratio.Debut	.9193***		
Total Debut	.0737***		
R&D Intensity	16.1823*		
Tech Concept		.9215***	
Design Concept		1.0337***	
Intro.Ratio.Concept		1.5309***	
Total Concept		.0544***	
R&D Intensity		-31.5604***	
Chrysler	.3354**	.3471**	
Ford	.2764	-.0751	
GM	.1997	.8366***	
Honda	-.4084**	.4084*	
Toyota	-.0139	-.1797	
Constant	-.7271*	.7607	.0010
$R^2(\%)$	88.04	84.41	5.94
χ^2	1680.63***	1237.94***	38.95***
N	228.	228.	228.

[a] $^*p < .10,^{**} p < .05,^{***} p < .01$

return is significantly negative (-.0011, p<.05) suggesting that demonstrating a new product concept which is already demonstrated before in an auto show does not generate abnormal stock returns for the firm rather decrease the firm values. The negative influence of demonstrated concepts confirms that only new information release can increase firm value. According to this result, however, this incremental amount of new information from the second or third time demonstrated concept model result in negative abnormal stock return. For the second part of H4c: The production ready new products affect firm value positively (.0004, p<.05). This positive response of production ready new products shows that if the demonstrated model is close to be launched, then demonstrating the production ready new products boosts firm value as well. This result can be explained by public relations or advertising perspectives when firms demonstrate not only futuristic concept but also current selling car in the auto show in order to have synergic effects of them. This also confirms that event study is appropriate research method for this kinds of researches. Therefore, H4c is empirically supported.

Sixth, I propose a positive effect of R&D Intensity on abnormal stock return. As Table 2.10 shows, the coefficient of the R&D Intensity is positive but not significant (16.1823, p<.10). However, the effects of R&D Intensity of the demonstration for a concept demonstration is significantly negative (-31.5604, p<.01 in Table 2.10.) This suggests that R&D intensity is usually a good proxy for the positive expectation for the future cash flow increases along the new product development plan, however, if the product concept is either not promising or too far away from being commercialized or close enough to launch the model in the market, then R&D intensity could not be valid information to estimate the future cash flows from demonstration.

Last, the other group of firm specific variables is the firm dummy. First, for a concept debut, the coefficient of the firm dummy for Honda is negative and significant and that for Chrysler is significantly positive. This suggests that overall effect of demonstrating a concept debut from Honda is smaller than that for other firms. As Table 2.1 shows, the number of

debut from Honda is the lowest (16, 8%). On the other hand, for a concept, Chrysler, GM, and Honda have positive and significant coefficients (.3471, p<.05 for Chrysler, .8366, p¡.01 for GM, .4084, p<.05 for Honda). It can be explained by the descriptive statistics in Table 2.1. GM has the biggest share of total concept demonstration (146, 29.6%) and Honda demonstrated 51 (10.3%) concepts during those data period which is greater than the smallest share, Nissan's 38 concept demonstration (7.7%). This result of positive effect of many concept demonstrations from GM suggests that regarding concept demonstration consistently demonstrate many models can be earned positive stock returns from the auto show.

2.6.6   3SLS using New Variable Definitions

Table 2.11 presents the consistent results with previous findings in Table 2.10. The coefficient of the *Debut* is positive and significant (.0023, p<0.05 in Table 2.11). However, in column (4) in Table 2.11 shows that previously announced variables (e.g., *Concept*, *Commercial Model*, and *R&D Intensity*) are not statistically significant, which are consistent with the theory in finance which says that only the unanticipated information release affects the abnormal returns.

2.6.7   Idiosyncratic Risk

The results in Table 2.12 are consistent with common knowledge in finance that the greater stock returns come with the greater idiosyncratic risk for two weeks of windows. Tuli and Bharadwaj (2009) show that improvement in customer satisfaction result in reduction in overall and downside systematic and idiosyncratic risk. I find that demonstrating new concept in auto show increases the idiosyncratic risk (.0014, p<.01 in Table 2.12). This result supports the argument that positive abnormal stock returns will also bring increasing idiosyncratic risk of the firm. On the other hand, I also propose that demonstrating concepts will not affect idiosyncratic risk. As Table 2.12 shows, the coefficient of Concept is positive

Table 2.11: Effects of Product Concept Demonstrations on Abnormal Returns: New Variable Definition

(1)	(2)	(3)	(4)
Variables	Debuts	Concept	ACAR(0,+1)
Debut (First time)			.0023** [a]
Var.Debut			-.0000
Concept (Previously demonstrated)			-.0005
Commercial Model			.0003
Tech Debut R	1.1405**		
Design Debut R	1.2683***		
Intro.Ratio.Debut	1.0377***		
Total Debut	.1378***		
R&D Intensity	59.8363***		-.0682
Tech Concept R		1.2654**	
Design Concept R		-.0001	
Intro.Ratio.Concept		.3966	
Total Concept		.1517***	
R&D Intensity		-60.0354***	
Chrysler	.7957**	.7877**	-.0066*
Ford	1.0614***	.1708	-.0038
GM	.9422***	2.1625***	-.0062*
Honda	-.9561***	1.0685***	-.0007
Toyota	.5108	.0462	-.0030
Constant	-2.8012***	1.5065*	.0058
R^2(%)	59.46	57.03	8.01
χ^2	334.23***	302.04***	17.90**
N	228.	228.	228.

[a] $*p < .10, ** p < .05, *** p < .01$

but not significant (.0003, n.s.). This suggests that there is no significant correlation between second or third time concept demonstration and idiosyncratic risk. This result seems reasonable because a second or third time demonstrated concept does not have unanticipated information, therefore, demonstrating concepts would not affect the idiosyncratic risk.

2.6.8   Systematic Risk

I expect that demonstrating current models decreases the systematic risk; however, the coefficient of Commercial models is close to zero and not significant (.0000, n.s.). The firm's

Table 2.12: Effects of Product Concept Demonstrations on Idiosyncratic and Systematic Risk

(1)	(2)	(3)
Dependent Variables	Idiosyncratic Risk	Systematic Risk
Debut	.0014***^{a}	.0000
Var.Debut	-.0001	.0003
Concept	.0003	.0000
Commercial Model	-.0001	.0000
Constant	-.0131***	-.0003***
$R^2(\%)$	2.95	1.78
χ^2	13.80***	5.82
N	228.	228.

^{a} $*p < .10,** p < .05,*** p < .01$

systematic risk reflects the extent to which its stock's return responds to movement of the average return on all stocks in the market. This result suggests that there is no incentive for firm to demonstrate current commercialized model in the auto show in order to reduce the systematic risk.

2.6.9   Sensitivity Analysis

In order to check robustness of our analysis, I analyze the model with different event windows for average cumulative abnormal returns (See Table 2.6). There is no significant change in the substantive conclusions of the current study with various event windows including (-1, +1), (-2, +2), (-5, +5), and (-10, +10). This confirms that our event analysis is robust and the events are not contaminated by other unanticipated information release such as an earning announcement or a unexpected change from the firm.

2.7   Conclusion and Discussion

In this paper, I study firms' product concept demonstration behavior on the trade show. I analyze data from over six years of demonstrations and six different automakers over the

thirty eight auto shows. This study is unique in several aspects. First, I analyze new product concept demonstration data that are not well researched yet because most of prior researches are only focus on actual launch of new product or preannouncement. Second, I provide better assessment framework for the concept stage marketing actions. The long lag between the initial demonstration of a concept model and its launch makes it difficult to assess the contemporaneous effects of concept demonstration. Unlike commonly used marketing metrics such as sales leads or actual sales, abnormal stock returns clearly capture the effects of concept demonstrations such as the innovativeness of the firms as well as the new product pipeline with revenue potentials. Third, unlike previous studies, I analyze concurrent event study of six firms marketing actions and find synergic effect of new product concept demonstrations.

The study of the relationship between product concept demonstrations and firm values with both systematic risk and idiosyncratic risk contributes new insights to the emerging marketing-finance literature by highlighting that demonstration of product concept contributes to the financial performance of the firm. I show that more number of technology focused concept, design focused concept, and incremental changed concept have a robust impact in increasing the abnormal return of the firm.

This study focuses on the fact that unanticipated information release of product concept demonstrations affects the financial market hence on firm values. Thus first time demonstrated product concepts in auto show can increase future cash flow and sales lead when the concept launches. However, strategic interactions between competing firms of demonstrations cannot be measured directly so that I could not capture the part that is canceling competitive effect out each other. Research on the inter-dependence of product positioning and product concept demonstrations can be a possible future research is. In most of auto shows, all the six automakers are consistently demonstrates their concepts even though the economic situation is not optimistic. Thus, another possible future research opportunity lies in this question: why firm should demonstrate product concepts even though they don't have

a big shot to demonstrate even in economic recession? Finally, firms also need to consider a strategic decision for cannibalization. Not only positioning of the new concept, but also the price of it can be a crucial choice variable for firm to maximize the long term total profit.

Researchers also can study following questions: how much impact of the product concept demonstration on the actual sales, and what would be the optimal level of product concept demonstrations. Data set of advertising intensity and R&D intensity from COMPUSTAT and Nielson Media Research consists of yearly basis values so that I need to implement two possible scenarios of budget allocation. One can improve the results of analysis with monthly or quarterly data set with my model. For future research opportunity, one can enhance the empirical results by controlling more general financial variables such as profitability, profits volatility, firm size, leverage, market-to-book ratio, market capitalization, dividend pay, firm age, and firm diversification.

2.7.1   Limitations and Future Research Opportunities

This research focuses on the fact that only unanticipated information release of product concept demonstrations affects the financial market hence on firm values. Thus unexpected demonstrations in auto shows increases future cash flow and sales lead when the product concept launches. However, the strategic interaction of demonstrations between competing firms cannot be measured directly. Research on the inter-dependence of product positioning and product concept demonstrations will contribute the current literature in this area.

Most of auto shows show that all the six firms are consistently demonstrates their concepts even though the economic situation is not optimistic. One can try to answer this question: why firm should demonstrate product concepts even though they do not have a promising successful product concept to demonstrate in an economic recession?

For the future research opportunities, researchers can study following questions. How much impact of the product concept demonstration on the actual sales? What would be the optimal level of product concept demonstrations?

Chapter 3

Inter-temporal Pricing Strategy with PCD

3.1 Literature Review

Trade shows are popular venues for automotive firms to showcase their innovative activities to their industry cohorts and to the general public. A trade show serves a few different functions for firms' strategic marketing actions such as sales leads, signaling to investors their passion for developing innovative products and pre-launch advertising (Kerin and Cron 1987, Kim and Mazumdar 2012, Gopalakrishna, Sridhar, Lilien, and Siwale 2012.) An important effect that has not been researched in this context is the shifting of demand toward a new model because some buyers, who are perhaps informed by the trade show, prefer to wait for the new model instead of purchasing a currently available model without delay. In general, consumers want to maximize their utility based on the price and quality of the product when deciding to purchase a product. If there is more than one product on the market, consumers would most likely compare the utilities of the alternative options. Similarly, the announcement of a new model launch motivates consumers to consider whether they wait for the new model until the next new car season or not.

Product positioning is an important issue not only for competing manufacturers but also for the monopolistic firm because launching a new product can cause cannibalization of a firm's own sales of the old model if the new model is not well differentiated from the old one. There are a number of analytical papers that model demand for differentiated products. In regards to quality-based segmentation, Mussa and Rosen (1978), Katz(1984), and Moorthy (1984) analyze problems of price and quality in monopoly settings investigating the product positioning game with consideration both horizontal and vertical differentiation based upon the fact that consumers self-select the product. Vandenbosch and Weinberg (1995) analyze two-dimensional vertical differentiation models showing the maximum differentiation on one dimension and minimum differentiation in the other dimension. In regards to spatial models, Hotelling (1929) analyze the localized competition of the Hotelling model. Desai (2001) also examines whether the cannibalization problem affects a firm's price and quality decisions in a model with consumer differences in quality valuation as well as taste differences in both monopoly and duopoly settings.

In contrast to these previous studies which either focus on vertical or horizontal differentiated products, I consider both vertical and horizontal product differentiation at the same time to improve managerial implications. Analyzing both horizontal and vertical differentiations using a spatial model and a self-selection model is inefficient and seldom feasible to result in a closed-form solution. Thus, I use the representative consumer utility model (Dixit and Stiglitz 1977, Häcker 2000, Choi and Coughlan 2006, Coughlan and Ingene 2010, Park, Staelin, Choi, and Borle 2011) and derive a demand model based on this utility formulation. This methodological decision is important not only because the representative utility model provides closed form solutions for the two systems of demand (with a product concept demonstration and without a product concept demonstration) but also because it provides clear insights into the effects of changes in underlying utility parameters (such as a substitutability between the old and new model, as well as the quality, discount rate, on market outcomes, profits, and prices of the new model). From the derived demand function

parameters and consumer behavior parameters – such as quality of the product and marginal utility of consumption – I can determine how substitutability between old and new models affects demand while holding other consumer parameters fixed.

To examine the inter-temporal strategic behavior, I extend the analysis of Dhebar (1994) who models the problem of a durable-goods monopolist selling sequential versions of a product. Previously, Kornish (2001) extended the analysis of Dhebar (1994) to show two possible subgame perfect equilibrium pricing strategies: the first strategy occurs when the firm offers an extremely low first-period price to attract a large number of consumers purchasing, while the second strategy is when the monopolist charges the single-period optimizing price. I modify the sequential versions of a product setting (Dhebar 1994) into the old and new model set up and follow the inter-temporal pricing model (Kornish 2001) for firm's profit maximization.

3.2   Model

I first introduce our assumptions about the product and the players needed to set up the model. Even though I discuss the automotive industry, the model applies to any durable product category. In order to emphasize the inter-temporal strategic decisions of the players, I develop a two-period model in a monopoly market.

3.2.1   Product

A firm sells the old model(product 1) in only period 1, and the new model (product 2) in only period 2. In period 1, the firm chooses whether to demonstrate the new product concept in the trade show or not. In period 2, only the new model is available for purchasing on the market. q_i is the quantity of product i where product 1 denotes the old model and product 2 does the new model, p_i is the price of the product i, and α_i represents the intrinsic valuation of product i and it can be interpreted as the perceived quality of product

i. Thus, $|\alpha_2 - \alpha_1|$, captures vertical product differentiation. Substitutability, parameter γ measures the decline rate of marginal utility of consumption for one product with respect to the consumption of one of the other products (Choi and Coughlan 2006). Thus, it captures the horizontal differentiation between the old and new model. Lastly, low γ means a high degree of horizontal differentiation and high γ denotes less horizontal differentiation.

Unlike frequently purchased goods, durable goods last for more than one period; therefore, demand is linked over time. The product I consider is an automobile and the venue of the demonstration is an auto show, currently one of the most popular types of trade shows. I assume that there is no resale of merchandise, both between the consumers, and between consumer and the manufacturer. I also assume that there is no second-hand market.

3.2.2 Consumer

My model starts with the representative consumer utility model and extends previous works such as Dixit and Stiglitz (1977), Dhebar (1994), Häcker (2000), Choi and Couglan (2006), Coughlan and Ingene (2010), Park, Staelin, Choi, and Borle (2011) by adding inter-temporal strategic decisions for both the monopolistic firm and a representative consumer. The representative consumer is rational and decides on market participation and purchase timing to maximize his surplus (gross utility minus price). The representative consumer utility function is widely used in economics and marketing because it has favorable tractability especially to result in a closed-form solution of the game theoretic model since it is continuous and differentiable.

When the monopolistic firm does not demonstrate a product concept, the representative consumer considers only one product in each period. Thus, the utility function in period 1 is

$$U(q_1) = (\alpha_1 - p_1)q_1 - \frac{\beta_1 {q_1}^2}{2} \tag{3.1}$$

and the utility function in period 2 is

$$U(q_2) = (\alpha_2 - p_2)q_2 - \frac{\beta_2 q_2{}^2}{2} \tag{3.2}$$

where q_i is the quantity of product i where product 1 denotes an old model and product 2 does a new model, p_i is the price of the product i; and where α_i represents the intrinsic valuation of product i and can be interpreted as the perceived quality of product i. β_i denoting the degree of marginal utility of consumption that declines with increasing consumption so that the second term captures the diminishing marginal utility of consumption.

This system of utility function gives us a parsimonious comparison between the two demand systems: demand with a demonstration and demand without a demonstration (even though this system of utility function does not allow us to incorporate heterogeneity across consumers). When the monopolistic firm demonstrates the new product concept in period 1, the representative consumer utility is

$$U(q_1, q_{2D}) = (\alpha_1 - p_1)q_1 - \frac{\beta_1 q_1{}^2}{2} + \delta \left\{ (\alpha_2 - p_2)q_{2D} - \frac{\beta_2 q_{2D}^2}{2} - \gamma q_1 q_{2D} \right\} \tag{3.3}$$

and the representative consumer utility in period 2 is

$$U(q_2) = (\alpha_2 - p_2)q_2 - \frac{\beta_2 q_2{}^2}{2} \tag{3.4}$$

where α_i, β_i,and δ are positive. The difference between the quality of the old and new products, $|\alpha_2 - \alpha_1|$, captures vertical product differentiation. q_{2D} denotes the expected demand of delayed purchases from the consumers in period 1 who decide to wait for the new product concept, which will be launched in the next period. Parameter γ measures the decline rate of marginal utility of consumption for one product with respect to the consumption of one of the other products (Choi and Coughlan 2006). Specifically, γ denotes horizontal product differentiation driven by the substitutability between the old and new

product (Häcker 2000, Singh and Vives 1985). If $\gamma = 0$, horizontal product differentiation is maximized, and if $\gamma = \beta_i$, the two products are perfect substitutes for $i = 1, 2$. Both the firm and a representative consumer share a discount factor (δ) that lowers the present value of future consumption. This parameter is related disutility, which is driven by the substitutability between the old and new products.

It is important to note that in period 1, consumers have two choices: to buy the old model or to wait for the new model if they believe that the new model price will be significantly lower in the second period, (will have a higher quality with unchanged price levels or will be quite different from the previous version. Incentives to wait for the new model depend on (i) the price difference perceived, (ii) the style difference perceived, (iii) the quality difference, and (iv) the discount factor. By demonstrating a new product concept model, the firm can help the portion of the consumers not purchase the old model of the product but wait for the next generation model because the quality, style and price levels of the new model are announced in period 1 through the new product concept demonstration, hence, known to consumers.

Based on the utility maximization, I present a demand model derived from the representative consumer utility framework in a monopoly market. The goal of the monopolistic firm is to maximize the total profit during the entire two periods by setting new model quality and its design (substitutability) and implementing a product concept demonstration of the new model. The quadratic and concave utility function gives rise to a linear demand structure. For the parsimonious parameter set, I assume $\beta_1 = \beta_2 = \beta$. There are two possible options: to demonstrate a new model or not. When the monopolistic firm does not demonstrate a new product concept, I have simpler demand functions from the representative utility, as follows.

$$q_1 = \frac{\alpha_1 - p_1}{\beta} \tag{3.5}$$

$$q_2 = \frac{\alpha_2 - p_2}{\beta} \tag{3.6}$$

When the monopolistic firm demonstrates a new product concept, I obtain the following
demand system:

$$q_1 = \frac{\beta(\alpha_1 - p_1) - \delta\gamma(\alpha_2 - p_2)}{\beta^2 - \delta\gamma^2} \tag{3.7}$$

$$q_2 = \frac{\alpha_2 - p_2}{\beta} \tag{3.8}$$

$$q_{2D} = \frac{\beta(\alpha_2 - p_2) - \gamma(\alpha_1 - p_1)}{\beta^2 - \delta\gamma^2} \tag{3.9}$$

$$Q_2 = q_2 + q_{2D} = \frac{\alpha_2 - p_2}{\beta} + \frac{\beta(\alpha_2 - p_2) - \gamma(\alpha_1 - p_1)}{\beta^2 - \delta\gamma^2} \tag{3.10}$$

where $\gamma^2 \leq \beta^2$, and $0 \leq \gamma < \beta$. The total demand for the new model in period 2 is the
summation of two parts: one part from the delayed purchases in period 1 and the other from
demand in period 2. This effect of this demonstration can be captured by the difference
of baseline demands and that of inter-temporal price sensitivities. I normalize the quality
level of the old model (α_1) as 1 and the quality of the new model as positive so that the
quality of the new model can be either higher or lower than the old model. It is clear that a
high quality product gives consumers a higher utility and $|\alpha_2 - \alpha_1|$ is the quality difference
between the old and new model. Also, I assume that new model quality is greater than or
equal to the old model quality because in the real world firms seldom introduce lower quality
in the new model ($\alpha_2 \geq \alpha_1 = 1$).

3.2.3   Monopolistic firm

For analytical simplicity, I assume that there is zero marginal cost for production and no
fixed cost for a product concept demonstration. I also assume that the manufacturer does not
sell the old product in period 2. This assumption is consistent with the real world situation
where the old model is no longer available for purchase when the new model launches. I will
relax this assumption by allowing the old model purchasing in period 2 in the extension.

Suppose that a monopolist has the flexibility to charge different prices for each time
period (inter-temporal price discrimination) and to make different design and quality over

time. The profit function that the monopolistic firm faces is as follows:

$$\Pi_1 = p_1 q_1 \tag{3.11}$$

$$\Pi_2 = p_2(q_2 + q_{2d}) \tag{3.12}$$

$$Total\Pi = \Pi_1 + \Pi_2 = p_1 q_1 + p_2(q_2 + q_{2d}) \tag{3.13}$$

3.3   Analysis

By using a backward induction, I solve the two periods game described above. Assuming that the variables in period 1 are given, I solve the profit maximizing problem. After obtaining the solution in period 2, I insert those solutions and maximize the total profit for both period 1 and period 2. Given the equilibrium quantity of product 1 and product 2, I solve for the new model price in period 2. Finally, I solve for the old model price to maximize the total profit from the two periods. In Table 3.1, I summarize the optimal solutions for price, quantity, and profit both as a benchmark case and a demonstration case.

3.4   Results

In this section, I present the equilibrium solutions for quantity, delayed purchases, price, and profit for both cases – that is, in cases with a product concept demonstration and without a product concept demonstration. I also highlight results related to delayed purchases: the price of the new and old model, and the profit differences between cases with and without a product concept demonstration.

Table 3.1: Equilibrium Solutions

	With a Demonstration[a]	No Demo
p_1^*	$\dfrac{-4 + \gamma\{\gamma + 3\gamma\delta - \alpha_2(-1+\delta)(-2+\gamma^2\delta)\}}{-8 + \gamma^2(1+6\delta)}$	$\dfrac{\alpha_1}{2}$
p_2^*	$\dfrac{-4\gamma + 3\gamma^3\delta + \alpha_2(-2+\gamma^2\delta)(-8+7\gamma^2\delta)}{2(-2+\gamma^2\delta)\{-8+\gamma^2(1+6\delta)\}}$	$\dfrac{\alpha_2}{2}$
q_1^*	$\dfrac{-1 + p_1 - (p_2 - \alpha_2)\gamma\delta}{-1 + \gamma^2\delta}$	$\dfrac{\alpha_1}{2}$
q_2^*	$\alpha_2 - p_2$	$\dfrac{\alpha_2}{2}$
q_{2D}^*	$\dfrac{(p_2 - \alpha_2) + (1 - p_1)\gamma}{-1 + \gamma^2\delta}$	0
π_1^*	$\dfrac{(4-\gamma^2(1+3\delta)+\alpha_2\gamma(-1+\delta)(-2+\gamma^2\delta))\{-(4-3\gamma^2\delta)^2+\alpha_2\gamma(-2+\gamma^2\delta)[-4+\delta\{-4+\gamma^2(4+3\delta)\}]\}}{-2\{-8+\gamma^2(1+6\delta)\}^2\{2+\gamma^2\delta(-3+\gamma^2\delta)\}}$	$\dfrac{\alpha_1^2}{4}$
π_2^*	$\dfrac{(-4\gamma + 3\gamma^3\delta + \alpha_2(-2+\gamma^2\delta)(-8+7\gamma^2\delta))^2}{4\{-8+\gamma^2(1+6\delta)\}^2\{2+\gamma^2\delta(-3+\gamma^2\delta)\}}$	$\dfrac{\alpha_2^2}{4}$

[a] Without loss of generality, I set $\alpha_1 = 1, \beta = 1$.

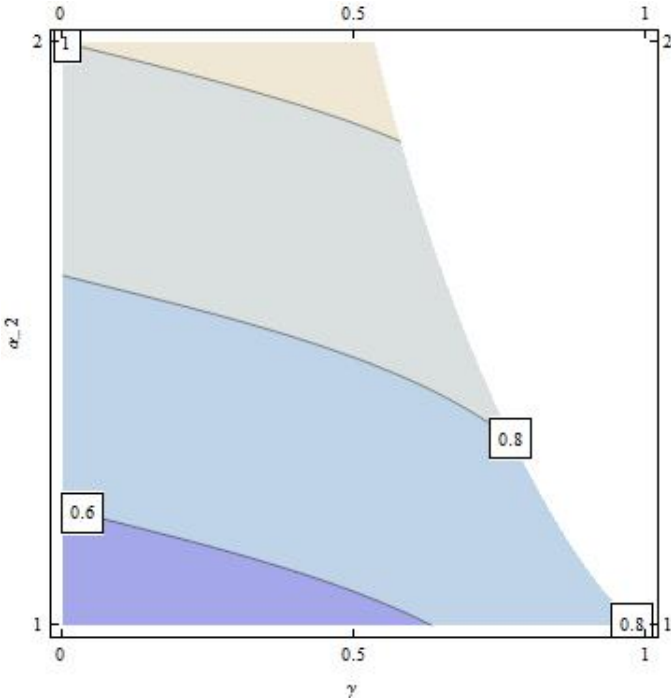Figure 3.1: New Model Quantity (q_2^*)
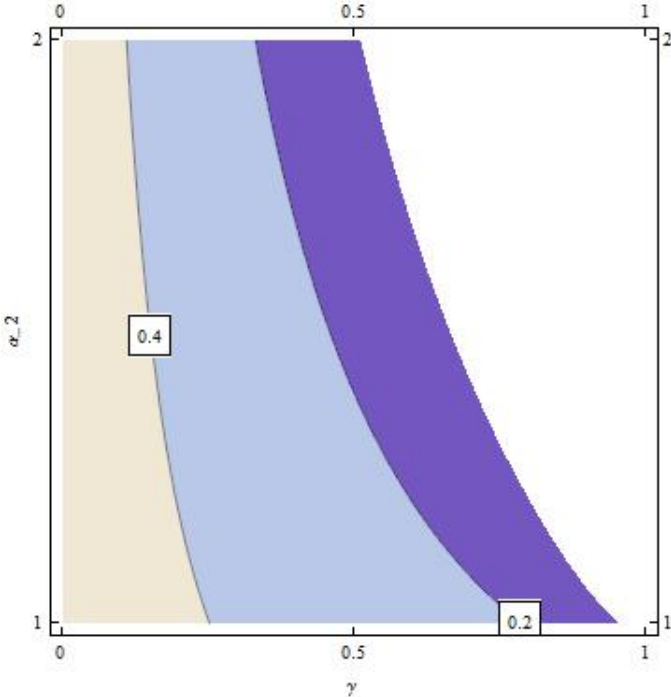(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)

Figure 3.2: Old Model Quantity (q_1^*)
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)
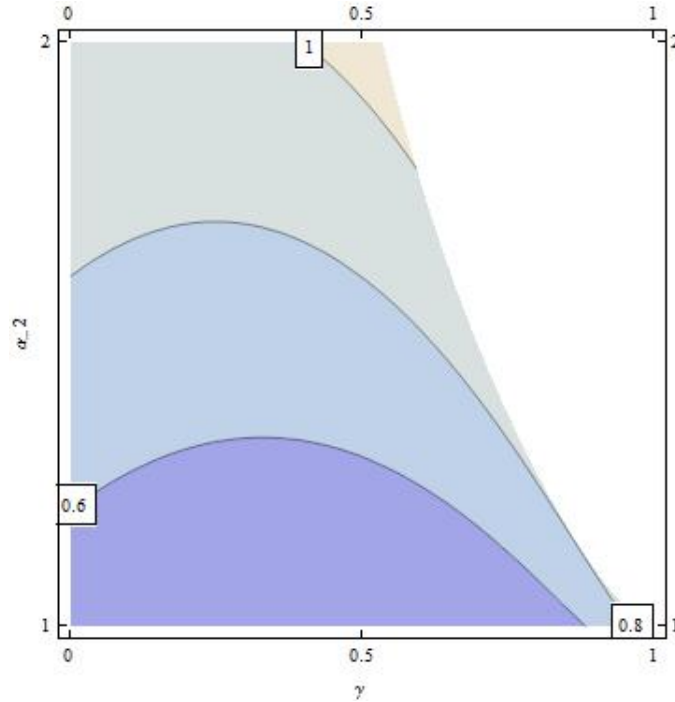
Figure 3.3: The U-Shaped Delayed Purchases (q_{2d}^*)
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)

3.4.1 Quantity and Delayed Purchases

Figure 3.1 and Figure 3.2 show the new and old model quantity with two product differentiation parameters: the level of new model quality (α_2) and substitutability between the old and new model (γ). These two figures present consistent results to the comparative statics for the quantity of the old and new model as seen in Table 3.2. Figure 3.1 and Figure 3.2 show that the more vertically differentiated the new model is (the higher is the new model quality, α_2), the greater quantity of the new model and the less quantity of the old model are sold. Similarly, the more the new model is horizontally differentiated (the lower is the substitutability, γ), the greater quantity of the new model and the less quantity of the old model are sold.

Figure 3.3 shows that the delayed purchase of the new model is positively correlated to the quality of the new model; however, the delayed purchase has the U-shaped pattern with respect to the substitutability (γ). The U-shaped pattern of delayed purchase is reflected

in two concepts for distinct strategic forces: ***distinctive alternatives*** and ***new product superiority***. First, some portion of the consumers might prefer waiting for the new model because of the horizontal differentiation of the new model from the old model, even in the situation where the new version has not been improved. I call this '***distinctive alternatives***.' One example of this horizontal differentiation is the newness or styling change of the new model in the automobile industry. This phenomenon supports the increase of the delayed purchases as the substitutability of two products decreases (see Result 1 a). In other words, when the new product is more horizontally differentiated from the old product, the delayed purchases can increase. Second, another portion of the consumers might wait for the new product in Period 2 because of the improved higher quality of the new product. For example, the new model can have a larger engine size and better gas mileage. I call instances like this '***new product superiority***.' Figure 3.3 plots delayed purchases which increase as the new product quality improves. I formalize these findings in Result 1.

Result 1 *(Delayed Purchases)*

(a) The delayed purchases show a U-shaped pattern with respect to the product substitutability over a certain range of the new mode's quality and the discounting factor.

(b) The more the new model is vertically differentiated (the higher is the new model quality, α_2), the more delayed purchases for the new model are sold.

A product concept demonstration generates delayed purchases from consumers who have a willingness to wait for the new model, which presumably will have an improved quality or/and a differentiated design from the old model. In order to achieve greater analytical tractability, I distinguish the demand of the delayed purchases (q_{2D}) from the demand of the new model in period 2 (q_2). Before I explain the delayed purchases driven by the product concept demonstration, Table 3.1 shows the optimal solutions of a two period game for the demand of the old model, the demand of the new model, and the delayed demand for the new

model. Figure 3.1 and Figure 3.2 show the quantity of the new and old models, respectively, while Figure 3.3 shows the delayed purchases. I seek to gain a deeper understanding of how delayed purchases change with respect to the three parameters: the substitutability between the old and new model, the quality of the new model, and the discounting factor.

Comparative statics in Table 3.2 show two findings about delayed purchases with respect to the new model quality and the discounting factor. First, delayed purchases increase as long as the quality of the new model increases(e.g., $\frac{\partial q_{2D}}{\partial \alpha_2} > 0$). It is easy to understand that superior quality of the new product can attract more consumers to wait for a period to purchase a higher quality model. Second, delayed purchases increase as long as the discounting factor increases (e.g., $\frac{\partial q_{2D}}{\partial \delta} > 0$). It is clear to see that, if the cost of waiting for the new model decreases – or, in other words, as the discounting factor (δ) increases – then more consumers want to wait because the opportunity cost for waiting reduces with higher δ. See Table 3.2

The delayed purchases show a U-shaped pattern with respect to the product substitutability with a certain range of the quality level of the new model such as $\alpha_2 \geq 1$ and the range of the discounting factor such as $\delta \geq 0.485$. See Figure 3.4 and Figure 3.5. Given a certain level of parameter value, I present the relationship between the two parameter in the two dimensional spaces . The highest curve on Figure 3.4 is the delayed purchases with the highest quality level of the new product, $a_2 = 1.3$ (meaning that 30% of quality level is greater than that of old product). The lower curves are the delayed purchases with new quality levels of $a_2 = 1.2, 1.1, 1.01, 1, 0.99, 0.9, 0.8, 0.7$ respectively. With this specific discounting factor, if the quality of the new product is greater than the one of the old model, the delayed purchases with respect to product substitutability have a U-shaped curve. Figure 3.5 shows the delayed purchases with respect to product substitutability with a certain quality level of new product ($\alpha_2 = 1$). With the same quality level of both old and new products, if the discounting factor is greater than 0.485, then delayed purchases have a U-shaped curve with respect to substitutability of the old and new product.

Table 3.2: Comparative Statics

	Substitutability (γ)		New Model Quality (α_2)	Discount Factor (δ)
q_1	$-$		$-$	$-$
q_2	$+$		$+$	$+$
$q_{2D} > 0$	$\begin{cases} -/+\ ^a & \text{if } \delta \text{ is big.} \\ - & \text{otherwise.} \end{cases}$		$+$	$+$
p_1	$\begin{cases} +/- & \text{if } \alpha_2 \text{ is big.} \\ - & \text{otherwise.} \end{cases}$		$+$	$-$
p_2	$-$		$+$	$-$
$p_1 - p_{1n}$	$\begin{cases} +/- & \text{if } \alpha_2 \text{ is big.} \\ - & \text{otherwise.} \end{cases}$		$+$	$-$
$p_2 - p_{2n}$	$-$		$+$	$-$
$p_2 - p_1$	$-$		$+$	$+$
Π ^{b}	$-$		$+$	$-$
$\Pi - \Pi_n$ ^{c}	$-/+$		$+$	$-$

---

^{a} "$-/+$" shows U-shaped pattern and "$+/-$" shows inverted U-shaped pattern as the substitutability goes close to 1

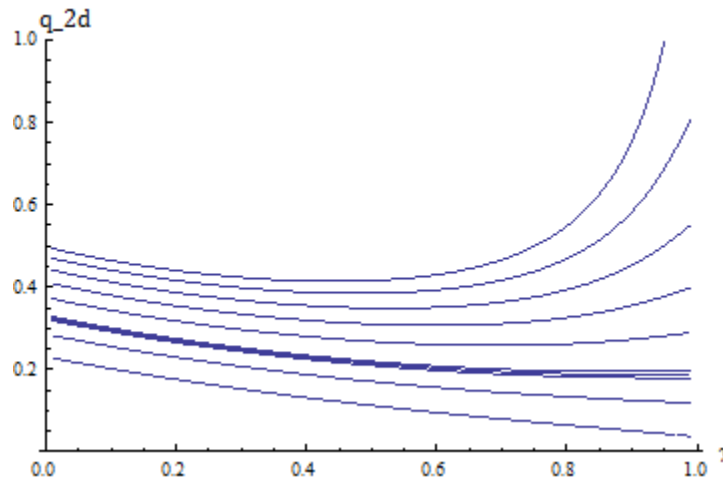^{b} $\Pi \equiv \pi_1 + \pi_2$.

^{c} $\Pi_n \equiv \pi_{1n} - \pi_{2n}$.

Figure 3.4: Delayed Purchases with respect to Product Substitutability with Discounting Factor
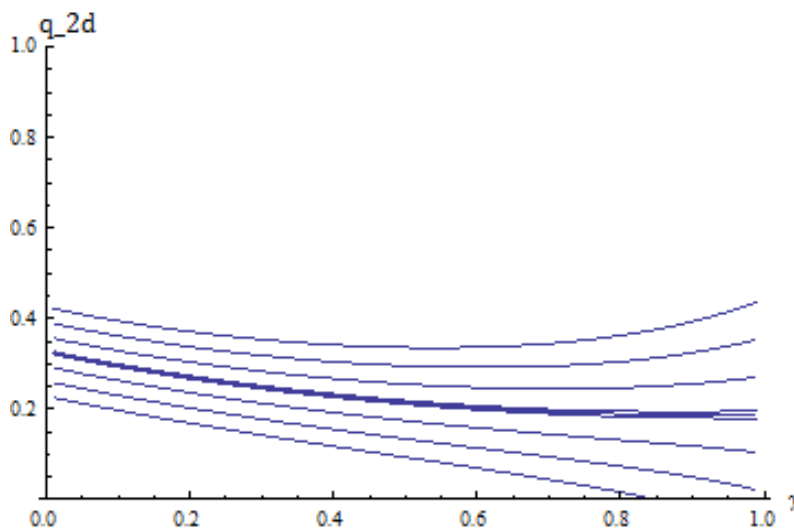
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \le \gamma < \beta, \delta = 0.485, \alpha_2 = 0.7$
(Lowest), $0.8, 0.9, 0.99, 1, 1.01, 1.1, 1.2, 1.3$ (Highest)

Figure 3.5: Delayed Purchases with respect to Product Substitutability with Fixed New Model Quality

(Parameter values used: $\alpha_1 = \alpha_2 = 1, \beta = 1, 0 \leq \gamma < \beta, 0 < \delta \leq 1, \delta = 0.3(\text{Lowest}), 0.4, 0.475, 0.495, 0.6, 0.7, 0.8, 0.9, 0.99$ (Highest)

However, delayed purchases do not show a U-shaped pattern for all the parameter space. See Figure 3.6 which presents the parameter range of a U-shaped pattern of the delayed purchases with respect to the substitutability between the old and new model. To guarantee that the delayed purchases have a U-shaped pattern, I first require that $\alpha_2 \geq 0.789$. If the quality level of the new model is smaller than 0.789, then the delayed purchases monotonically decrease as the substitutability of the two models increases. In other words, if the quality of the new product is even lower than the old product under a certain level, then delayed purchases shrink as the difference between the old and new models become smaller. Finally, if the discounting factor is too big over a certain level ($\delta \geq 0.129$), then delayed purchases might decrease as the substitutability increases. It is clear to see that the discounting factor can be a disincentive for consumers to wait for the new model by the next period. In Figure 3.6, the shaded region shows the parameter pairs that give U-shaped pattern of delayed purchases.
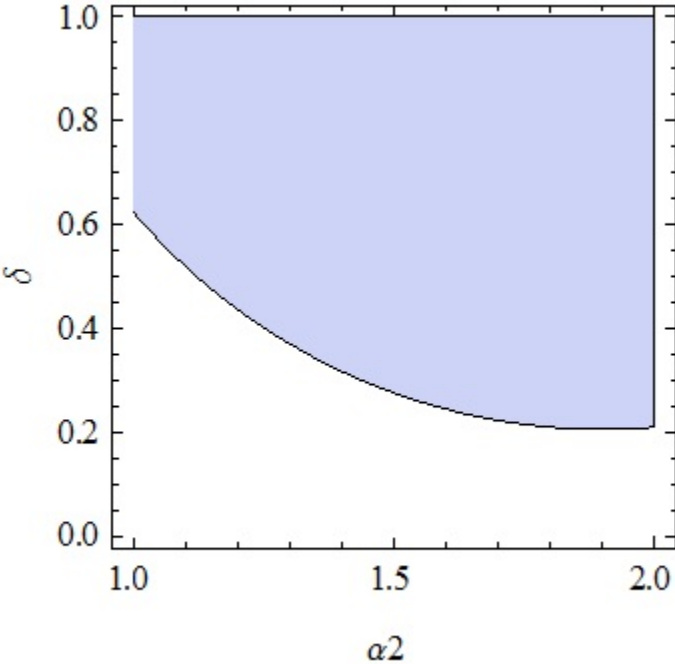
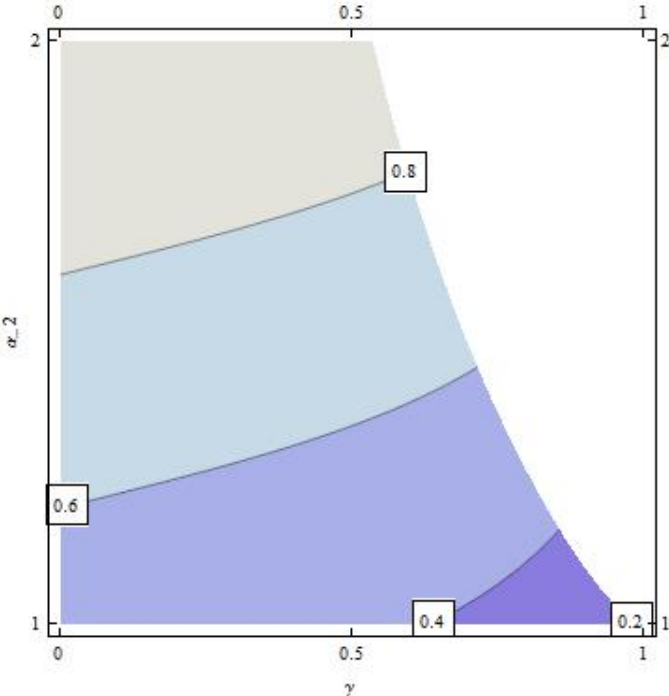Figure 3.6: The Parameter Range of U-Shaped Delayed Purchases with respect to substitutability

Figure 3.7: New Model Price (p_2^*)
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)

3.4.2 New Model Price

I first explain how the three consumer parameters (the new product quality, the substitutability, and the discounting factor) affect the prices of the old and new models when the firm demonstrates the new model concept in period 1. I then compare the impact of these three consumer parameters between two cases – that is where firms do and do not have a new model concept demonstration.

First, let's focus on the new model's price with respect to three parameters. Note that from Table 3.2 the price of the new product (p_2) decreases as the substitutability of the old and new product increases ($\frac{\partial p_2}{\partial \gamma} < 0$) because of the cannibalization of customers between the old and new models; moreover, note that the more similar the two models, the more cannibalization occurs. Next, the quality effect of a new model is positive ($\frac{\partial p_2}{\partial \alpha_2} > 0$) (See Appendix B for the Proofs). Also, the price of the new model (p_2) decreases as the discounting factor (δ) increases ($\frac{\partial p_2}{\partial \delta} < 0$). It is easy to understand that if the cost of waiting for the new model (δ) decreases, then the manufacturer can set the price lower to attract the consumers who want to wait.

For the comparison between cases with and without having a new concept demonstration, note that the closed form solutions in Table 3.1 indicate that the new model price (p_2) with a demonstration is always lower than the new model price without a demonstration. This result may seem counter-intuitive because after giving more alternatives to consumers the firm still charges less than the new model without having a concept demonstration. To gain a deeper understanding of why the price of the new model with a demonstration can be lower than the price of new model without a demonstration, I rearrange the demand equation for a new model. From Equation (3.8) and Equation (3.9),

$$Q_2 = q_2 + q_{2D} = \frac{\beta^2 \delta \alpha_2 - \beta \delta \gamma (\alpha_1 - p_1) + \alpha_2 \delta (\beta^2 - \gamma^2 \delta)}{\beta \delta (\beta^2 - \gamma^2 \delta)} - \frac{\beta^2 + \delta (\beta^2 - \gamma^2 \delta)}{\beta \delta (\beta^2 - \gamma^2 \delta)} p_2 \qquad (3.14)$$

Lets call the constant term A such as $A = \dfrac{\beta^2 \delta \alpha_2 - \beta \delta \gamma (\alpha_1 - p_1) + \alpha_2 \delta (\beta^2 - \gamma^2 \delta)}{\beta \delta (\beta^2 - \gamma^2 \delta)}$ and the

slope B such as $B = \dfrac{\beta^2 + \delta(\beta^2 - \gamma^2\delta)}{\beta\delta(\beta^2 - \gamma^2\delta)}$ respectively. Then Equation (3.14) becomes $Q_2 = A - Bp_2$. Note that $\dfrac{\partial A}{\partial \gamma} > 0$, $\dfrac{\partial B}{\partial \gamma} > 0$, $\dfrac{\partial A}{\partial \alpha_2} > 0$ and $\dfrac{\partial B}{\partial \alpha_2} = 0$. These comparative statics for the total demand for the new model are shown in Figure 3.8. The total demand line for the new model rotates clockwise as substitutability increases close to 1 (or β) and shifts upward from the origin as the new model quality increases. Even though the demand curve rotates clockwise, the intercept moves on a much higher level than before as the new model differs from the old model. Hence, if the new model is less horizontally differentiated (or if the new model has higher substitutability), then the demand for the new model expands. In Figure 3.8, I confirm these effects of vertical and horizontal differentiation. Points on each demand line in the Figure 3.8 show equilibrium price and quantity respectively, so I can precisely observe what is happening while the demand line is shifting or rotating. For the new model, if the firm demonstrates a new concept model, then the new model price decreases no matter at what level the firm sets the price. In Figure 3.9, I used a higher quality ($\alpha_2 = 1.2$) to contrast the differences and I confirm that all the demand lines shift upward compared to Figure 3.8 when the new model is not different from the old model vertically ($\alpha_1 = 1$); however, both traces of equilibrium sets show a U-shaped pattern as well. Note that this U-shaped pattern is driven from the delayed purchases and the total quality of the new model is the sum of the new model quantity and the delayed purchases.

Furthermore, it is important to note that the new model price can be lower than the old model price ($p_2 < p_1$) if the firm demonstrates the concept model. I already showed that the quality effect of the new model is positive ($\dfrac{\partial p_2}{\partial \alpha_2} > 0$) and the price of the new model (p_2) decreases as the discounting factor for the new model (δ) increases ($\dfrac{\partial p_2}{\partial \delta} < 0$). The substitution effect of the new model, however, is negative. Therefore, if the substitutability is high enough to dominate the quality effect and discounting factor effect, then the new model can be cheaper than the old model. I summarize these results here as follows:

Result 2 *(New Model Price)*
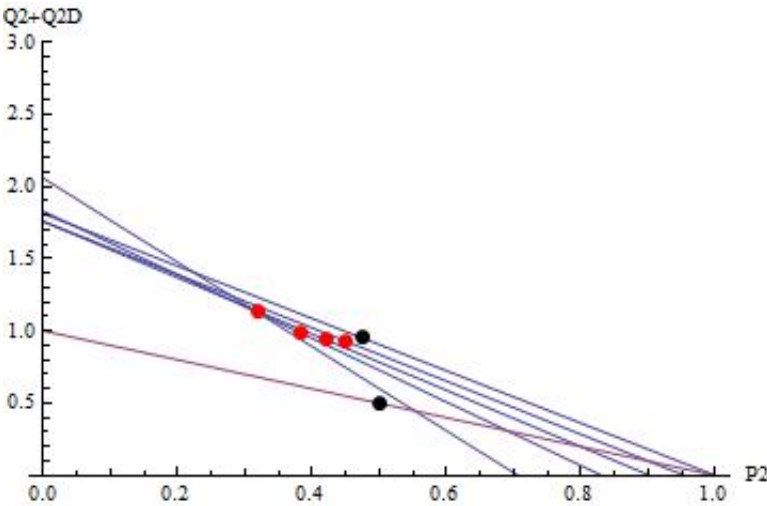
Figure 3.8: New Model Demand $(q_2^* + q_{2d}^*)$, $\alpha_2 = 1$
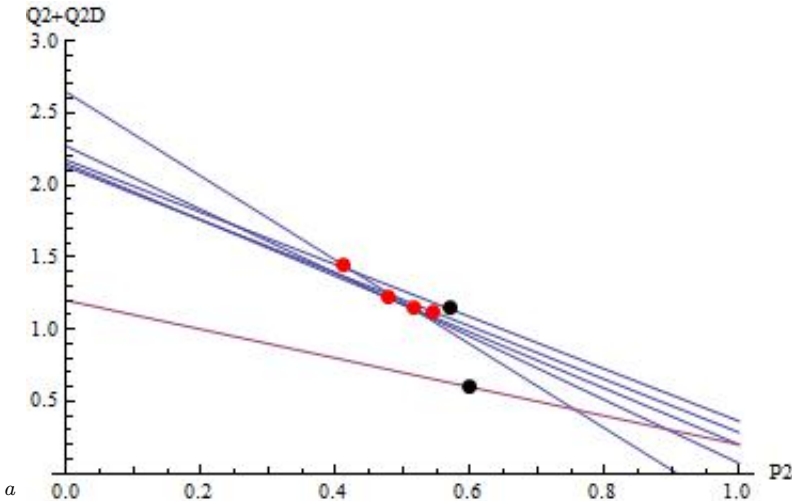
Figure 3.9: New Model Demand $(q_2^* + q_{2d}^*)$, $\alpha_2 = 1.2$

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[a] The lowest line is the demand line for the new model when the firm does not have a new concept demonstration. Among five points, the black one indicates an equilibrium with $\gamma = 0$, while the next three dots show equilibriums of $\gamma = 0.2, 0.4, and 0.6$. The farthest red point indicates an equilibrium of $\gamma = 0.8$.

(a) The new model price with a demonstration is lower than the new model price without a demonstration for all new model quality levels, hence, the total new model quantity with a demonstration is greater than that with out a demonstration.

(b) The new model price with a demonstration is lower than the old model price with a demonstration at some parameter ranges where the new model quality is still higher than the old model quality (price puzzle). However, if the vertical differentiation dominates the horizontal differentiation, then the new model price is higher than the old model price.

I graphically capture these results in Figure 3.10. Figure 3.10 shows the price difference of the new model between cases with and without a demonstration. All feasible range of the new model price are negative; hence, the new model price with a demonstration is always lower than that without a demonstration. Moreover, as the two old and new models get more similar, the difference between new model prices in cases with and without a demonstration becomes larger. This happens because as two models become more similar ($\gamma \to 1$), the difference between the new model price with a demonstration and that without a demonstration becomes larger. Because two models become more similar in these cases, then the price competition between them would intensify.

From Figure 3.11, I find that the old model price when having a concept demonstration is higher than the old model price without having a concept demonstration. When the old and new models get horizontally closer, the price difference gets smaller. Note that even though the new model quality is higher than the old model quality, there are still parameter ranges where the new model price is lower than the old model price. The price difference of the old and new model is plotted with respect to substitutability and the new model's quality level (see Figure 3.12). This is a counterintuitive result given that the higher quality new product is cheaper than the old lower quality product and the degree of difference gets larger as the substitutability between the old and new model shrinks (as $\gamma \to 1$). However, when the new model is vertically differentiated enough from the old model, the price of the new product

is greater than that of the old product with relatively low discounting factor ($\delta \geq .6$). This is consistent with common knowledge that the better the quality of a product, the higher the price the market will bear. Thus, if the vertical differentiation dominates the horizontal differentiation, then this pricing puzzle can be resolved.

Furthermore, when there is no vertical differentiation (when the new model quality is also 1), the price of the new product is always smaller than that of the old model. Also, notice that the higher new model quality, the greater the price difference between the old and new models. If the discounting factor gets closer to 1, then the price difference between the two also becomes larger.

3.4.3 Old Model Price

I find that the old model price (p_1) shows an inverted U-shaped pattern as the substitutability of the old and new model increases. See Figure 3.13. In other words, there exists a parameter range where the old model price is higher than the new one ($\frac{\partial p_1}{\partial \gamma} > 0$) as the substitutability of two models increases. See Figure 3.14 and 3.15. At the same time, as the new model gets more similar to the old one, the old model quality decreases, which is not consistent with economic theory. The old model price, however, decreases as the two models get horizontally closer. Note that there are two different strategic forces working here. First, the competitive pricing makes the old model price lower as the substitutability gets higher.[1] The second strategic force is the substitution effect in the new model, which occurs when decreases in the old model even though the old model price is cheaper. This shows that the old model is also affected by the negative substitution effect between old and new models as far as there is no dominating vertical differentiation of the new model.

Second, the price of the old model (p_1) increases as the quality of the new model (α_2)

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[1] Strictly speaking, a cannibalization is not a competition in a monopoly market; however, I use the term, 'competitive pricing' here because there are two different models competing with each other to attract more consumers from each other's demand. This happens even though the monopolist maximizes the total profits from both old and new models.
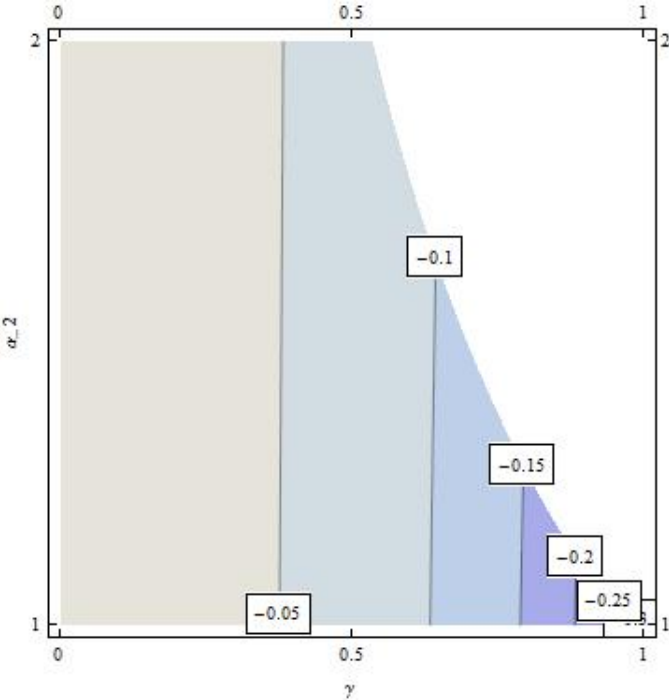
Figure 3.10: The Price Difference of the New Model between the Demonstration Case and No Demonstration Case $(p_2^* - p_{2n}^*)$
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)
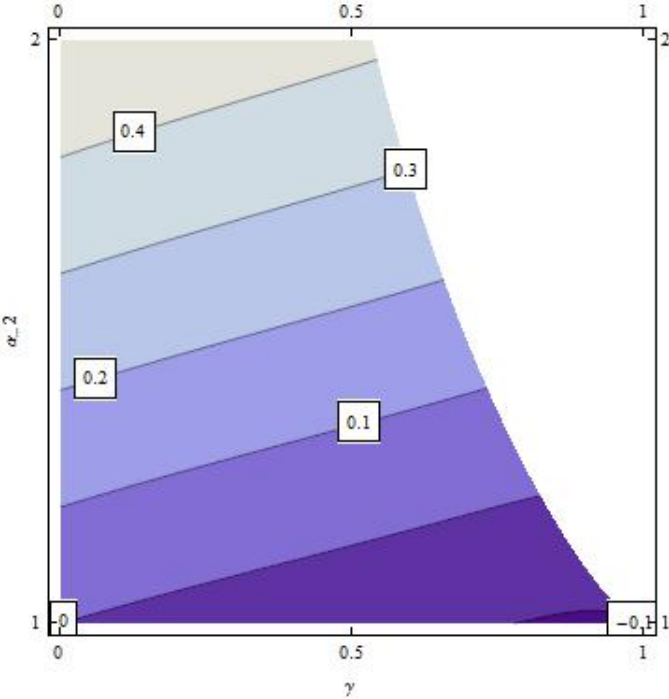
Figure 3.11: The Price Difference of the Old Model between the Demonstration Case and No Demonstration Case $(p_1^* - p_{1n}^*)$
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)
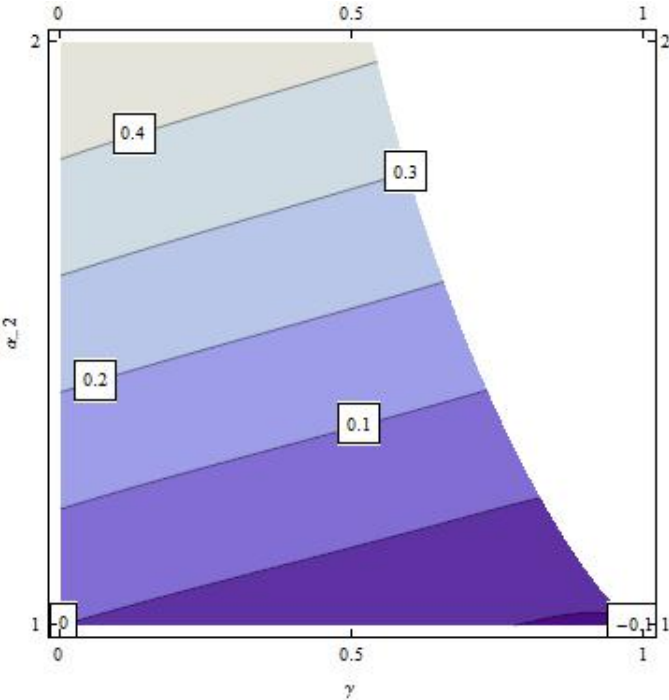
Figure 3.12: The Price Difference between the New and Old Model $(p_2^* - p_1^*)$
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)
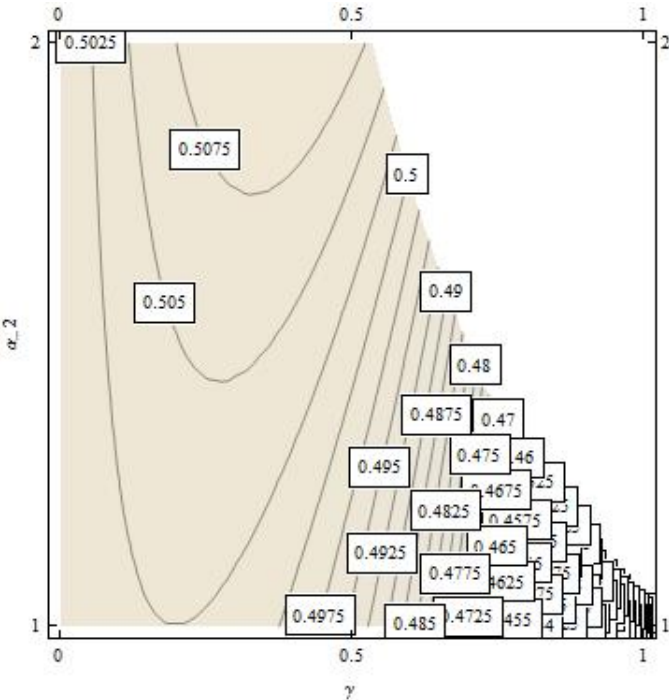
Figure 3.13: Old Model Price (p_1^*)
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)
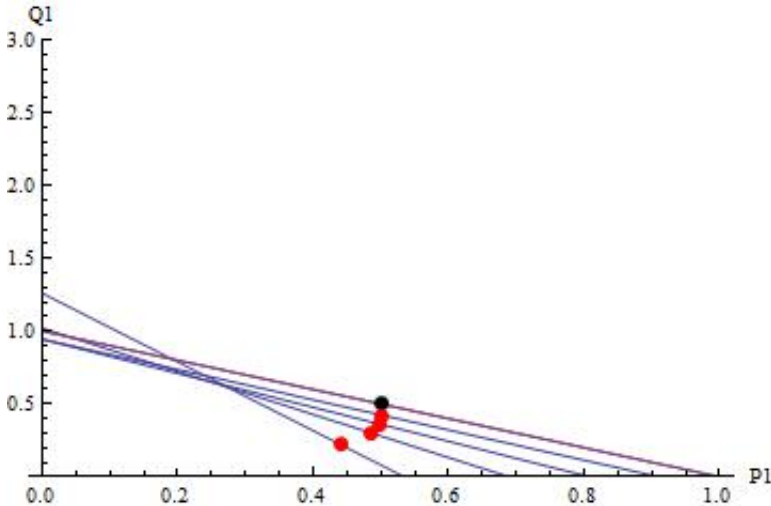
Figure 3.14: Old Model Demand (q_1^*), $\alpha_2 = 1$
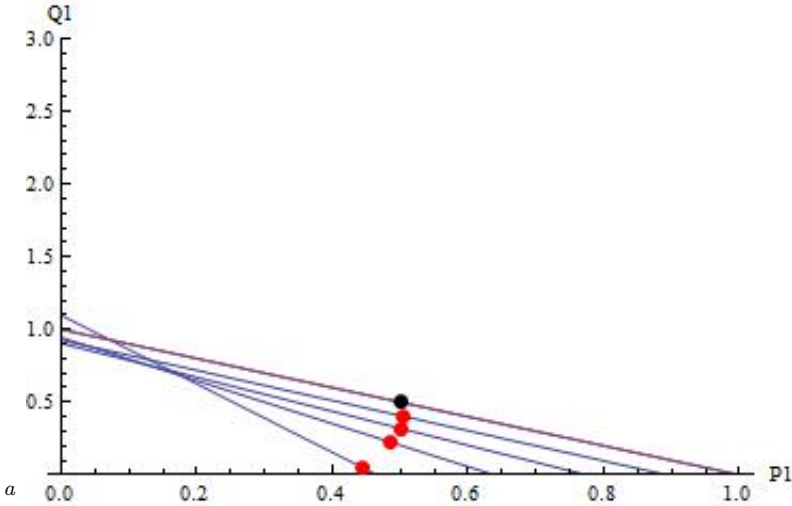
Figure 3.15: Old Model Demand (q_1^*), $\alpha_2 = 1.2$

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[a] The least stiff line is the demand line for the old model when the firm does not have a new concept demonstration, while the black point indicates an equilibrium with $\gamma = 0$ and the next three dots show equilibria of $\gamma = 0.2, 0.4, and 0.6$. The lowest red point indicates an equilibrium of $\gamma = 0.8$.

gets higher; thus, $\dfrac{\partial p_1}{\partial \alpha_2} > 0$ because of the lower rate of cannibalization between the old and new models. Prior research shows that when the quality of a new model has been increased, two strategic forces occur: demand force and strategic force (Vandenbosch and Weinberg 1995). Based on the demand force, if the new model is superior to the old model in terms of vertical differentiation, then the demand for the old model decreases. On the other hand, due to the strategic force, if the quality difference of the old and new model diminishes price competition, then the price of the old model rises.

Third, the price of the old model (p_1) decreases as the discounting factor for the new model (δ) decreases, $\dfrac{\partial p_1}{\partial \delta} < 0$. Note that the higher the discounting factor, the smaller the parameter (δ). It is easy to see that if the cost of waiting for the new model (δ) decreases, then more consumers are willing to wait because the new model will give consumers higher utility than before. Hence, if the discounting factor decrease, then the price of the old model (p_1) decreases.

Note that from a product concept demonstration, downward effects of substitutability and discounting factors on the old model price are greater with a demonstration than that of the old model without a demonstration (See Figure 3.11). At the same time, if the new model is of a better quality than the old model, the price of the old model increases because relative price competition between the old and new models weakens. These insights lead to Result 3.

Result 3 *(Old Model Price)*

(a) The old model price with a demonstration shows an inverted U-shaped pattern as the substitutability of the old and new product increases. However, the negative pricing effect, $\dfrac{\partial p_1}{\partial \gamma}$ *is much stronger where the new model is slightly horizontally differentiated than the positive pricing effect,* $\dfrac{\partial p_1}{\partial \gamma} > 0$ *where the new model is sufficiently horizontally differentiated.*

(b) The old model price with a demonstration increases as the new model quality increases due to the less competitive pricing pressure between old and new models.

3.4.4 Profit

In this subsection, I focus on the total profit of the monopolistic firm and summarize results describing how total profit is changed when the three parameters change: substitutability between the old and new model, the quality of the new model, and the discount factor. See also Table 3.2.

First, Figure 3.16 indicates that the profit from the old model decreases as the new model is less horizontally differentiated and the new model quality gets higher. Figure 3.17 shows that the profit from the new model increases as the new model quality gets higher. The profit from the new model is the greatest at very low or very high levels of product substitutability, exhibiting a U-shaped pattern.

Second, the firm's total profit increases as the two products become more horizontally differentiated, as indicated in Table 3.2. This effect is also graphically shown in the example in Figure 3.18. The new model, when sufficiently differentiated from the old model, can attract those consumers who do not find the old model to fit their taste to wait for the new model. In this aspect, distinctive alternatives pay off in the two-period market when there is a product concept demonstration.

I also find from the closed form solution in Table 3.1 that a product concept demonstration does not always give the monopolistic firm a positive profit impact when the discounting factor gets too large. In other words, only when two models are horizontally differentiated and discounting factors are not too high can the firm experience a positive profit effect by demonstrating a new product concept in period 1. On the other hand, if the new model is vertically differentiated from the old model, then the firm has a wider range of horizontal differentiation between old and new models and a wide range in the discounting factor (i.e., a positive total profit effect is more likely). I summarize these insights below.

Result 4 *(Total Profit)*

Engaging in a pre-launch product concept demonstration is not an optimal strategy if the new
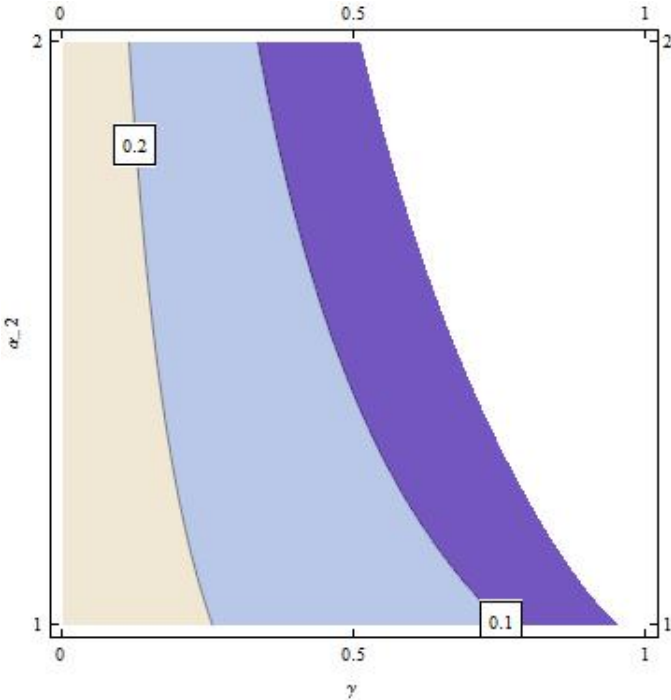
Figure 3.16: Profit from Old Model (π_1^*)
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)
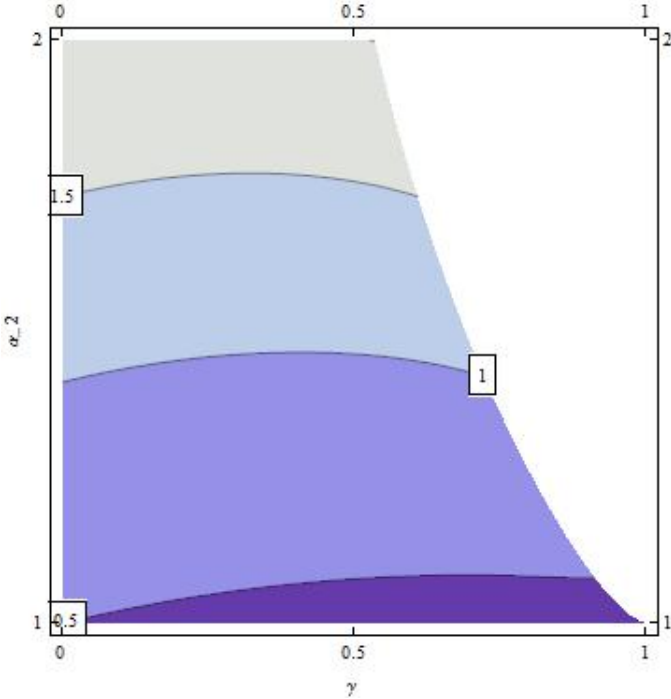
Figure 3.17: Profit from New Model (π_2^*)
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)
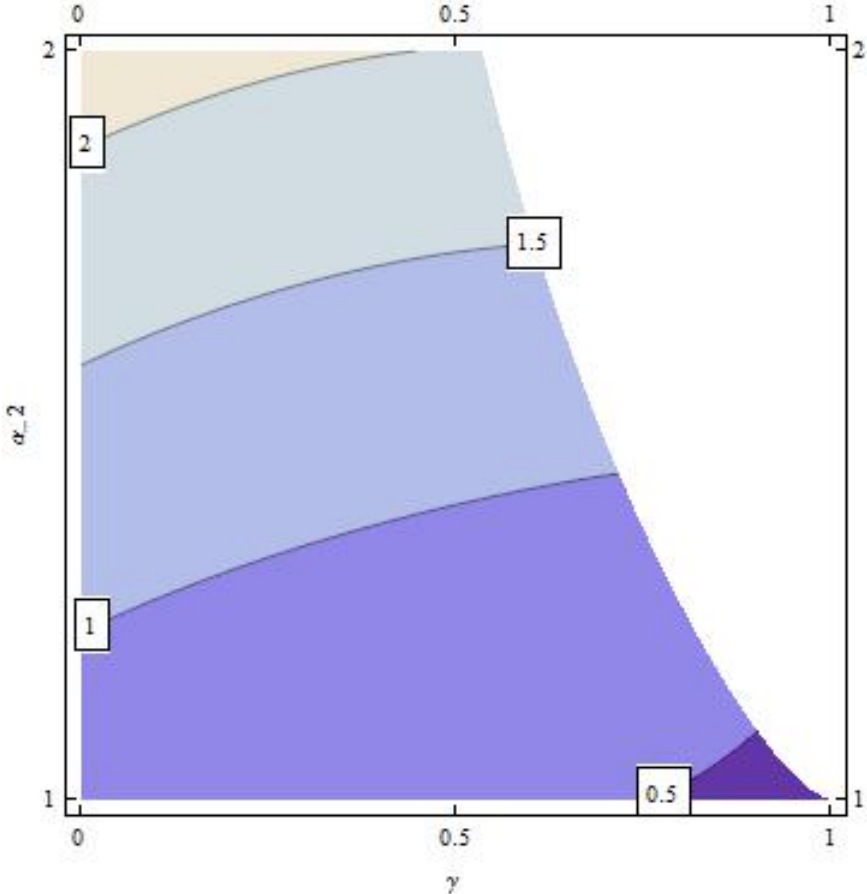
Figure 3.18: Total Profit $(\pi_1^* + \pi_2^*)$
(Parameter values used: $\alpha_1 = 1, \beta = 1, 0 \leq \gamma < \beta, \delta = .9$)

model is not sufficiently differentiated from the old model. Only sufficiently differentiated (either horizontally or vertically, or both) new models can create a positive profit effect with a demonstration.

3.5 Extensions

Remember that I assume that the monopolist sells the old model only in period 1. I now generalize this assumption, and consider the case where an old product is still available for purchase in the second period market. In such a market, the firm has two different pricing strategies for the old model. The first strategy is that the firm sells the old model at the same price in the first period. I call this '*Simple Pricing Strategy*'. In this case, the firm in period 2 maximizes the profit by controlling only the new model price and the new model quality since the old model quality is fixed in period 1. The second pricing strategy is that the firm charges lower price for the old model in the second period because of two reasons: the firm has incentives to clear its inventory holdings or to increase customer trials for market expansion in the near future.[2] I call this '*Complex Pricing Strategy*'. This reduced old model price affects the new model demand in period 2 due to the cheaper price of the old model especially if the new model is not differentiated enough to attract consumers. In this situation, it would be meaningful to check whether the new model price with a concept demonstration can go lower than that of the old model. If so, the price puzzle of the new product – that the new model price is lower than the old model price – can be explained.

---

[2] Even though I analyze the monopoly market, to attract consumers who are less willing to pay for the old model, the firm achieves market expansion through increasing customer trials. For example, apply reduces the price of existing models when they launch a new iPhone version.

3.5.1   Model

For the simple pricing model, Equation 3.3 becomes Equation 3.15 for period 1 and Equation 3.4 becomes Equation 3.16 for period 2, as follows:

$$U(q_{11}, q_{2D}) = (\alpha_1 - p_1)q_{11} - \frac{\beta_1 q_{11}^2}{2} + (\alpha_2 - p_2)q_2 - \frac{\beta_2 q_2^2}{2} - \gamma q_{11}q_2 \qquad (3.15)$$

$$U(q_{12}, q_2) = (\alpha_1 - p_1)q_{12} - \frac{\beta_1 q_{12}^2}{2} + (\alpha_2 - p_2)q_2 - \frac{\beta_2 q_2^2}{2} - \gamma q_{12}q_2 \qquad (3.16)$$

Remember that consumers in period 1 have no incentive to wait and purchase the old model in period 2 (e.g., $q_{1d} = 0$ in simple pricing model) because the old model price will be the identical to the old model price in period 1, quality and design of the old model will be the same, and there is positive waiting cost (e.g., discounting factor, $\delta > 0$).

For the complex pricing model, I have

$$
\begin{aligned}
U(q_{11}, q_{1D}, q_{2D}) \;=\; & (\alpha_1 - p_1)q_{11} - \frac{\beta_1 q_{11}^2}{2} \\
+ \; & \delta \Big\{ (\alpha_1 - p_{12})q_{1D} - \frac{\beta_1 q_{1D}^2}{2} + (\alpha_2 - p_2)q_{2D} - \frac{\beta_2 q_{2D}^2}{2} \\
- \; & q_{11}q_{1D} - \gamma q_{11}q_{2D} - \gamma q_{1D}q_{2D} \Big\}
\end{aligned}
\qquad (3.17)
$$

$$U(q_{12}, q_2) = (\alpha_1 - p_1)q_{12} - \frac{\beta_1 q_{12}^2}{2} + (\alpha_2 - p_2)q_2 - \frac{\beta_2 q_2^2}{2} - \gamma q_{12}q_2 \qquad (3.18)$$

I distinguish the old model demand between period 1 and period 2 by using a two-digits subscript: q_{1k} denotes the old model quantity in period k and prices have consistent subscripts. q_{1D} denotes the old model quantity sold in period 2 from the delayed purchases from period 1. The only difference between Equation 3.16 and 3.18 is the old model price (p_1 vs.p_{12}), and this is what makes Equation 3.17 so complicated. Note that the substitutability measure is only meaningful for two different models so that the fifth term inside of the square bracket does not have γ.

3.5.2 Demand

Demand derivation of these two different models is consistent with the baseline model. When the firm demonstrates a new concept model, I have the following demand system for the simple pricing model:

$$q_{11} = \frac{\beta(1 - p_1) + (p_2 - \alpha_2)\gamma\delta}{\beta^2 - \gamma^2\delta} \tag{3.19}$$

$$q_{12} = \frac{\beta(1 - p_1) + (p_2 - \alpha_2)\gamma}{\beta^2 - \gamma^2} \tag{3.20}$$

$$q_2 = \frac{\beta(\alpha_2 - p_2) + (p_1 - 1)\gamma}{\beta^2 - \gamma^2} \tag{3.21}$$

$$q_{2D} = \frac{\beta(\alpha_2 - p_2) + (p_1 - 1)\gamma}{\beta^2 - \gamma^2\delta} \tag{3.22}$$

For the complex pricing model with having a new concept model demonstration, I have

$$q_{11} = \frac{\beta^2(1 - p_{11}) + \beta(-1 + p_{12} + p_2\gamma - \alpha_2\gamma\delta) + \gamma\{(-p_2 + \alpha_2)\delta + \gamma(-1 + p_{11} + \delta - p_{12}\delta)\}}{\beta^3 + \gamma^2\delta - \beta\{\delta + \gamma^2(1 + \delta)\}} \tag{3.23}$$

$$q_{1D} = \frac{\beta^2(1 - p_{12}) + \beta(-1 + p_{11} + p_2\gamma - \alpha_2\gamma) + \gamma\{(-p_2 + \alpha_2)\delta - \gamma(-1 + p_{11} + \delta - p_{12}\delta)\}}{\beta^3 + \gamma^2\delta - \beta\{\delta + \gamma^2(1 + \delta)\}} \tag{3.24}$$

$$q_{12} = \frac{\beta(1 - p_{12}) + (p_2 - \alpha_2)\gamma}{\beta^2 - \gamma^2} \tag{3.25}$$

$$q_2 = \frac{\beta(\alpha_2 - p_2) + (p_{12} - 1)\gamma}{\beta^2 - \gamma^2} \tag{3.26}$$

$$q_{2D} = \frac{\alpha_2(\beta^2 - \delta) + p_2(-\beta^2 + \delta) + \gamma\{1 + p_{11}(-1 + \beta) + (-2 + p_{12})\beta + \delta - p12\delta\}}{\beta^3 + 2\gamma^2\delta - \beta\{\delta + \gamma^2(1 + \delta)\}} \tag{3.27}$$

By solving this inter-temporal two-period game using backward induction, I have sets of equilibrium solutions for the two pricing models, respectively. See Table 3.3. More than anything else, I focus on checking whether these two extended models satisfy my major findings from Result 1 through Result 5. Both simple and complex pricing models satisfy all the results from Result 1 (the delayed purchases), Result 2 (the new product price), Result 3 (the old model price), Result 4 (total profit), and Result 5 (welfare).

Figure 3.19: Extension: Total Quantity of Old Model

(a) Simple Pricing ($q_{11}^* + q_{12}^*$)   (b) Complex Pricing ($q_{11}^* + q_{12}^* + q_{1d}^*$)
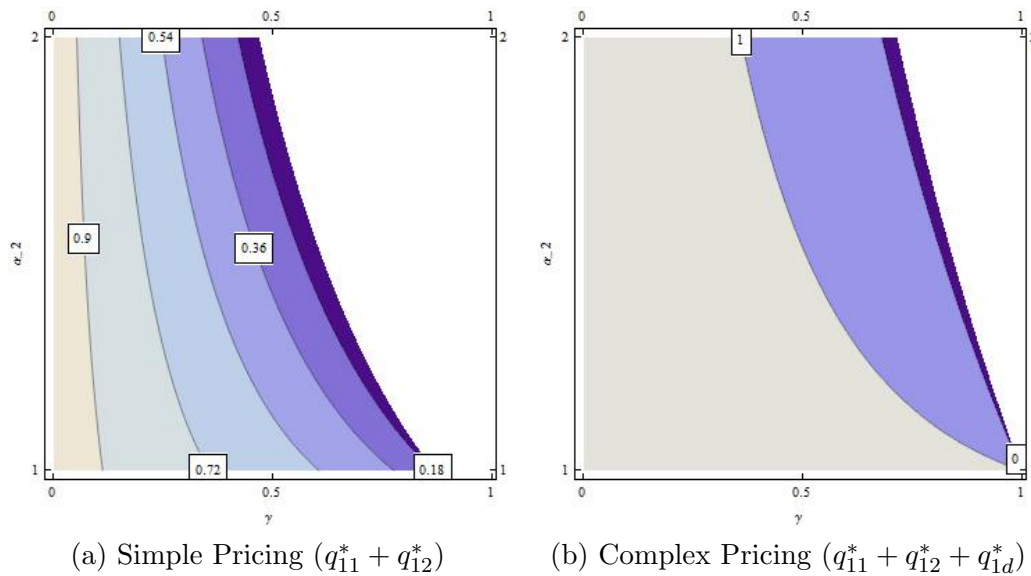
For the following six subsections I compare these two extended models to the baseline model.

3.5.3   Equilibrium Quantity

Figure 3.19a and 3.19b show the total quantity of the old model for both simple and complex pricing strategies. By definition, the old model price of complex pricing strategy is lower than that of simple pricing strategy. Therefore, the quantity of complex pricing strategy is greater than that of simple pricing strategy.

Figure 3.20a and 3.20b show the total quantity of the new model for both simple and complex pricing strategy. The new model total quantity of simple pricing strategy is slightly greater than that of complex pricing strategy. This is a sequential outcome of a cheaper old model price in the complex pricing strategy. The strategic force working in here is price competition force. As I mentioned previously, even though there is no competition in a monopoly market, 'competitive pricing' can exist because two different models compete with each other to attract more consumers from each other's demand.

Figure 3.20: Extension: Total Quantity of New Model

(a) Simple Pricing $(q_2^* + q_{2d}^*)$ (b) Complex Pricing $(q_2^* + q_{2d}^*)$
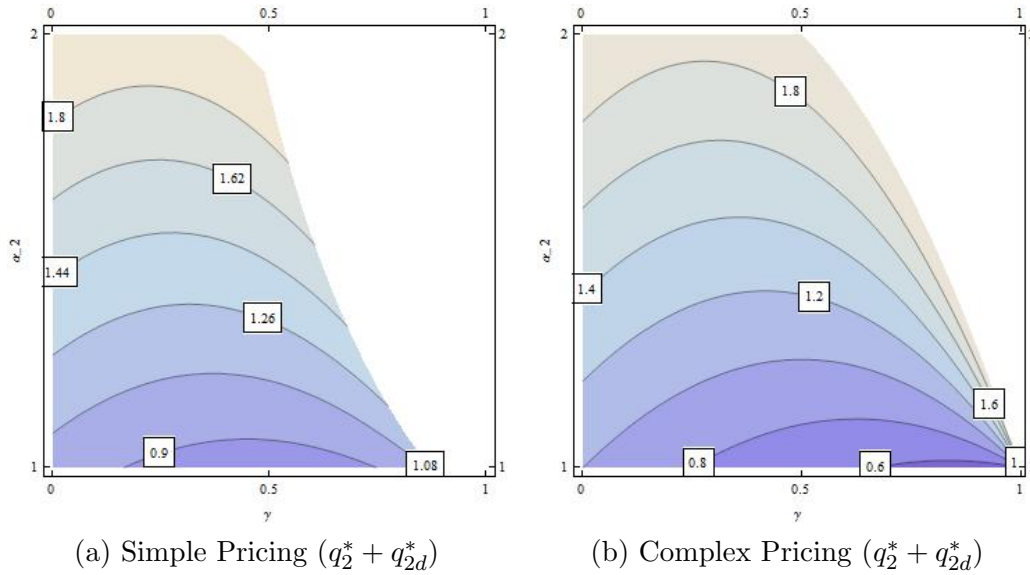
3.5.4   Delayed Purchases

Figure 3.21a and 3.21b show delayed purchases for both simple and complex pricing strategies. Figure 3.21c shows the difference between the two. Both Figure 3.21a and 3.21b are consistent to the figure of delayed purchases of baseline pricing strategy. From Figure 3.21c, the difference between simple and complex pricing strategy is either positive or negative, depending on the parameter values. Specifically, if the vertical differentiation is dominant to the horizontal differentiation, then the delayed purchases of simple pricing strategy is greater than that of complex pricing strategy.

3.5.5   New Model Price

Figure 3.22a and 3.22b show the new model prices for both simple and complex pricing strategies. Overall, the new model price of simple pricing strategy is higher than that of complex pricing strategy because the old model price of complex pricing strategy is lower than that of simple pricing strategy by definition. As I explained before in Result 6, the competitive pricing effect makes this happen $(p_2^{Simple} > p_2^{Complex})$.

Figure 3.21: Extension: Delayed Purchases (q^*_{2d})
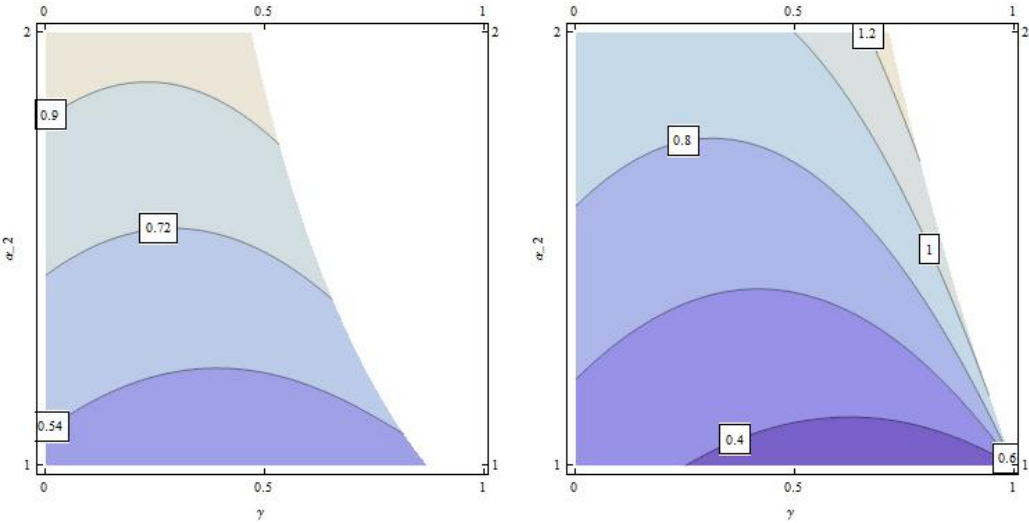
(a) Simple Pricing

(b) Complex Pricing
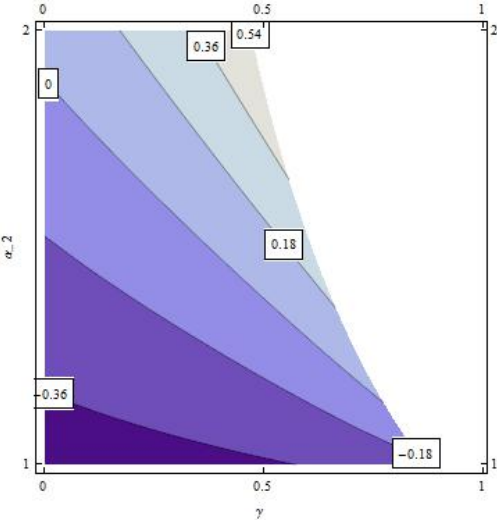
(c) Simple $-$ Complex

Figure 3.22: Extension: New Model Price

(a) Simple Pricing   (b) Complex Pricing
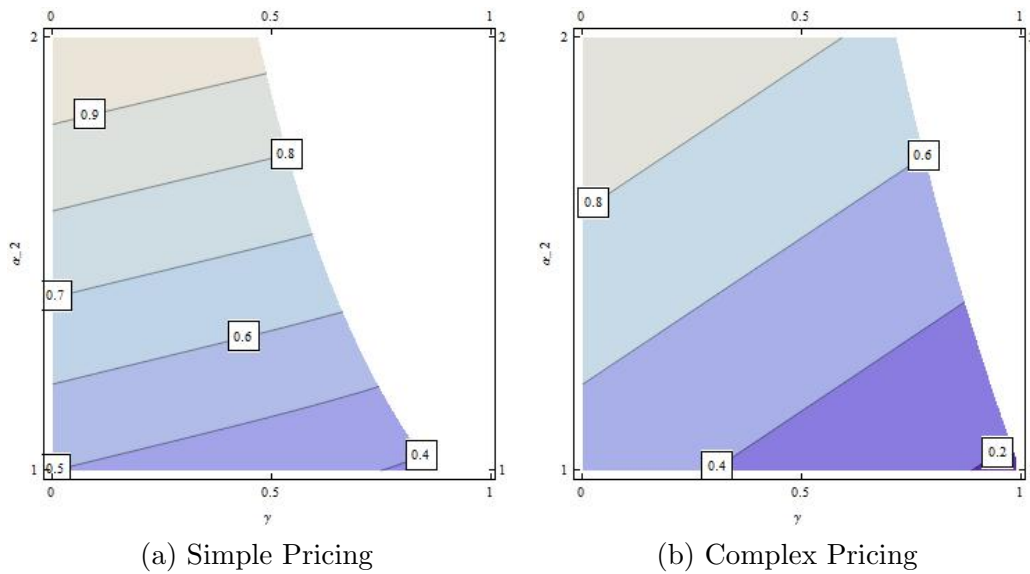
3.5.6   Old Model Price

Figure 3.23a, 3.23b, and 3.23c show the old model prices for both simple and complex pricing strategies. Consistent to the old model price, p_1 in Figure 3.13, Figure 3.23a shows a U-shaped pattern as substitutability between old and new model increases. However, Figure 3.23b and 3.23c show a fixed old price for all the parameter ranges of substitutability and the new model quality. This shows that price setting for the old model neither depends on the new model quality nor on the substitutability between the old and new models. See Table 3.3. The old model price is just function of discount rate, δ. This suggests that the old model price is solely determined by the volume of the demand shift from the old model to the new model in the complex pricing strategy.

3.5.7   Profit

Figure 3.24a and 3.24b show the profit from the old model for both simple and complex pricing strategies. For the simple pricing strategy, the profit from the old model is consistent to the baseline model output. However, the profit from the old model of complex pricing strategy looks quite different and is negative for all the parameter values. This shows that

Figure 3.23: Extension: Old Model Price
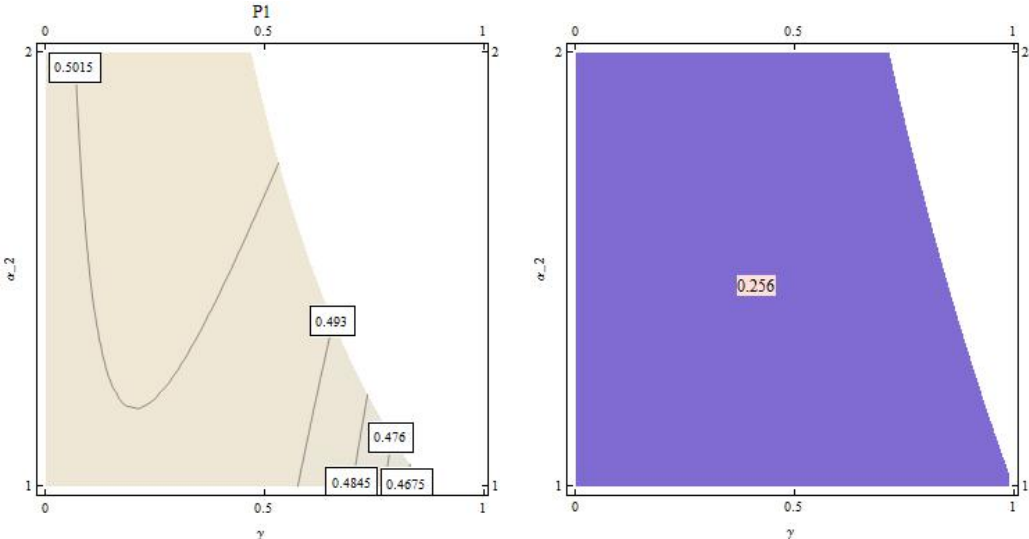
(a) Simple Pricing

(b) Complex Pricing, p_{11}
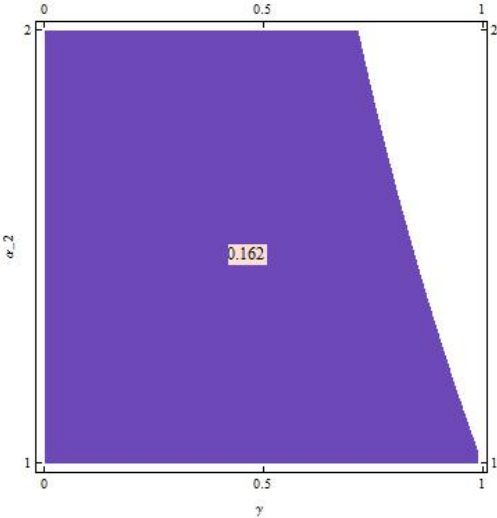
(c) Complex Pricing, p_{12}

Figure 3.24: Extension: Profit from Old Model

(a) Simple Pricing   (b) Complex Pricing
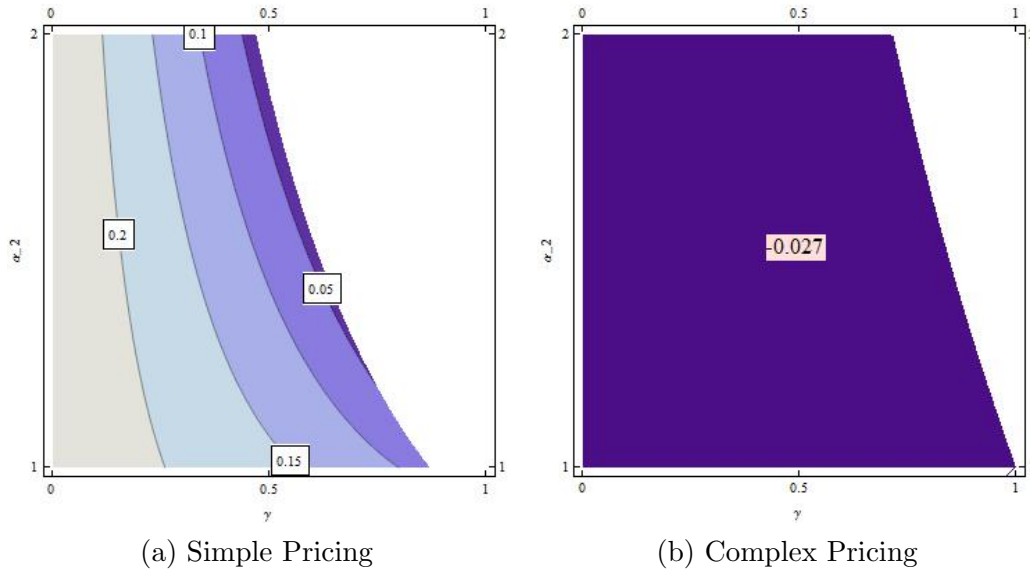
lowering the old model price in period 2 makes the firm worse off in terms of profit from the old model.

Figure 3.25a and 3.25b show the profit from the new model for both simple and complex pricing strategies. These two – Figure 3.25a and 3.25b – are consistent to baseline model. The profit from the new model of simple pricing strategy is slightly greater than that of complex pricing strategy.

Figure 3.26a and 3.26b show the total profit from both the new and old models. These show are also consistent with the baseline model, showing a U-shaped pattern.

Figure 3.27a and 3.27b show the net total profit from the old and new models for both simple and complex pricing strategies. Net total profit is defined as the total profit subtracted by the total profit of the no demonstration case ($\Pi - \Pi_n \equiv \pi_1 + \pi_2 - \{\pi_{1n} + \pi_{2n}\}$). Figure 3.27d shows that the simple pricing strategy dominates the baseline model. In other words, selling the old model in period 2 makes the firm better off than discontinuing the old model in period 2. Furthermore, lowering the old model price in period 2 reduces the total profit; hence, the complex pricing strategy is inferior to the simple pricing strategy.

Figure 3.25: Extension: Profit from New Model

(a) Simple Pricing

(b) Complex Pricing

(c) Baseline Model

(d) Baseline −Complex
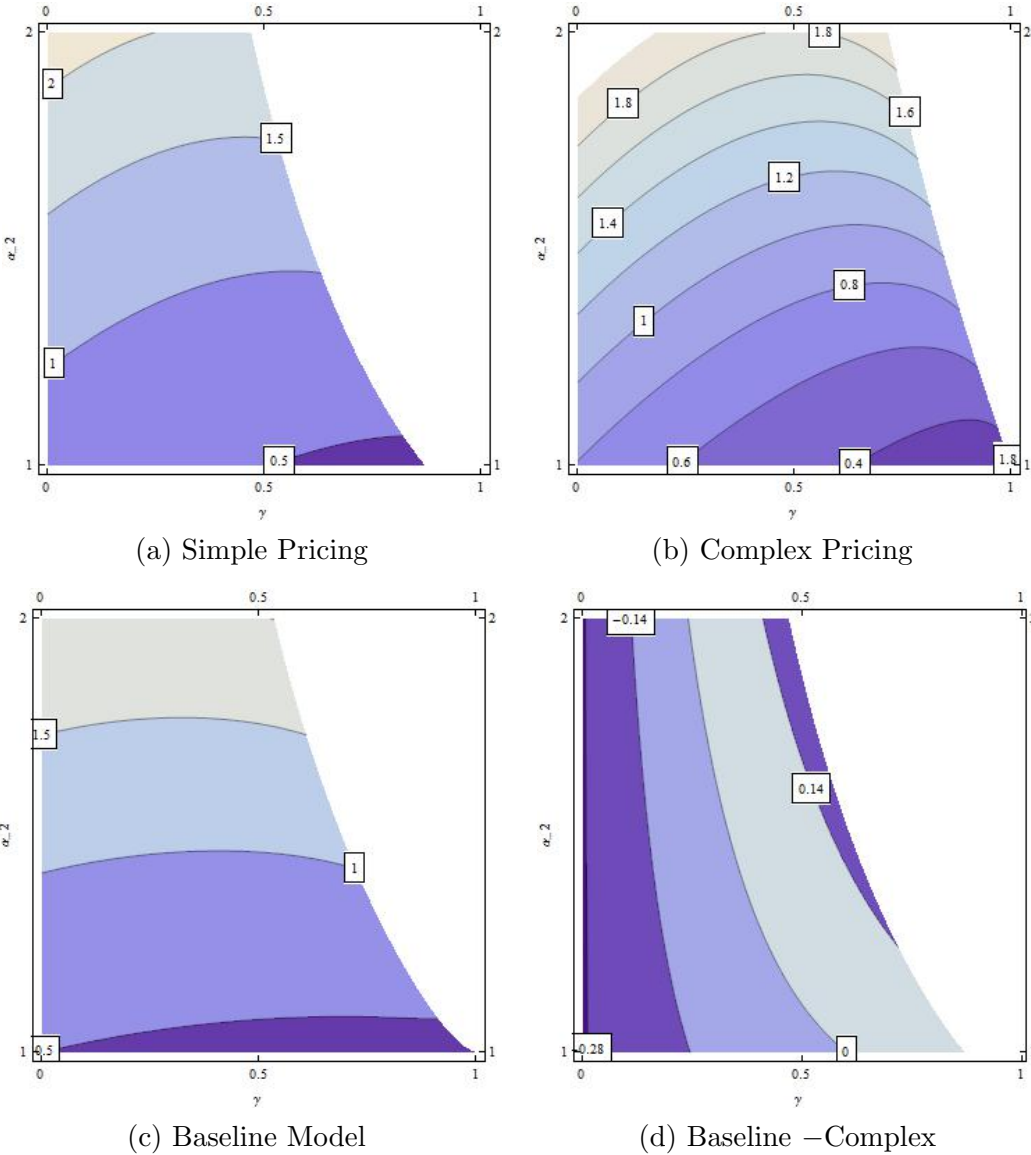
Figure 3.26: Extension: Total Profit

(a) Simple Pricing   (b) Complex Pricing
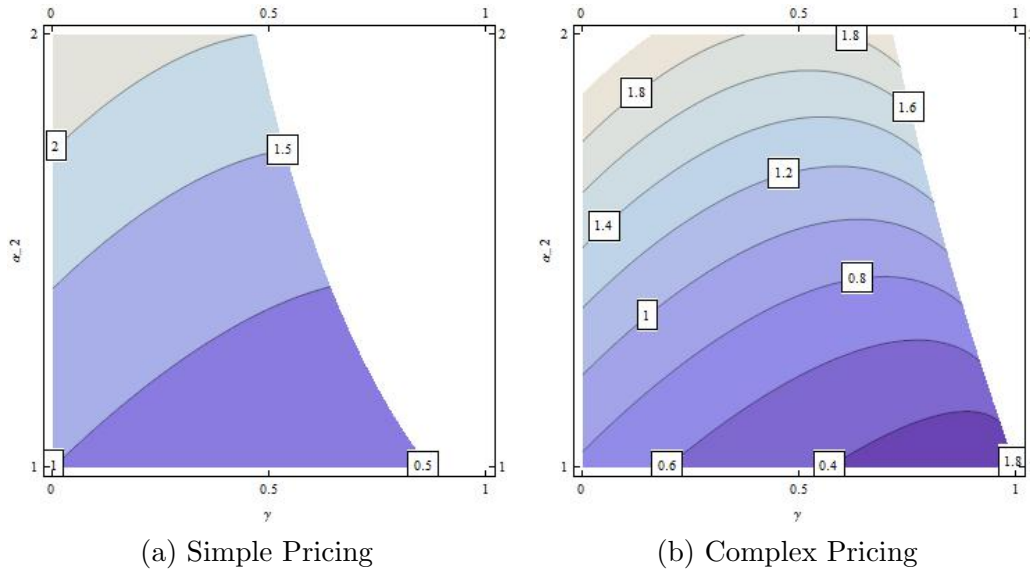
3.5.8   Summary of the Comparison

Now, I compare the equilibrium set of two different pricing models to the baseline model. All the results of the comparison among three models are summarized at Table 3.4. First of all, the delayed purchase of the complex model is greater than that of the simple model where the quality of new model is relatively low and the substitutability between old and new model is relatively high (e.g., $q_{2d}^S < q_{2d}^C$ where low α_2 and low γ, also see Table 3.23a). This supports the real world phenomenon that Apply systematically price down on old generation of iPhone when the firm launches the new iPhone. Next, the old model price of the complex model is lower than that of the simple model by definition of two pricing model (e.g., $p_{11}^C < p_{12}^C$). Furthermore, the old model price of the simple pricing model is lower than that of the baseline case (no old model available in period 2). Third, the new model profit of the complex pricing model is greater than that of the baseline model only when the substitutability between old and new model is low (e.g., $\pi_2^N < \pi_2^C$ only when γ is small). Under other parameter ranges, the complex pricing model is inferior than both the baseline model and the simple pricing model in terms of profit. Lastly, the simple pricing strategy is the most superior strategy among three strategies even when we considering the

Figure 3.27: Extension: Net Total Profit from Old and New Model

(a) Simple Pricing

(b) Complex Pricing

(c) Baseline Model

(d) Baseline − Simple
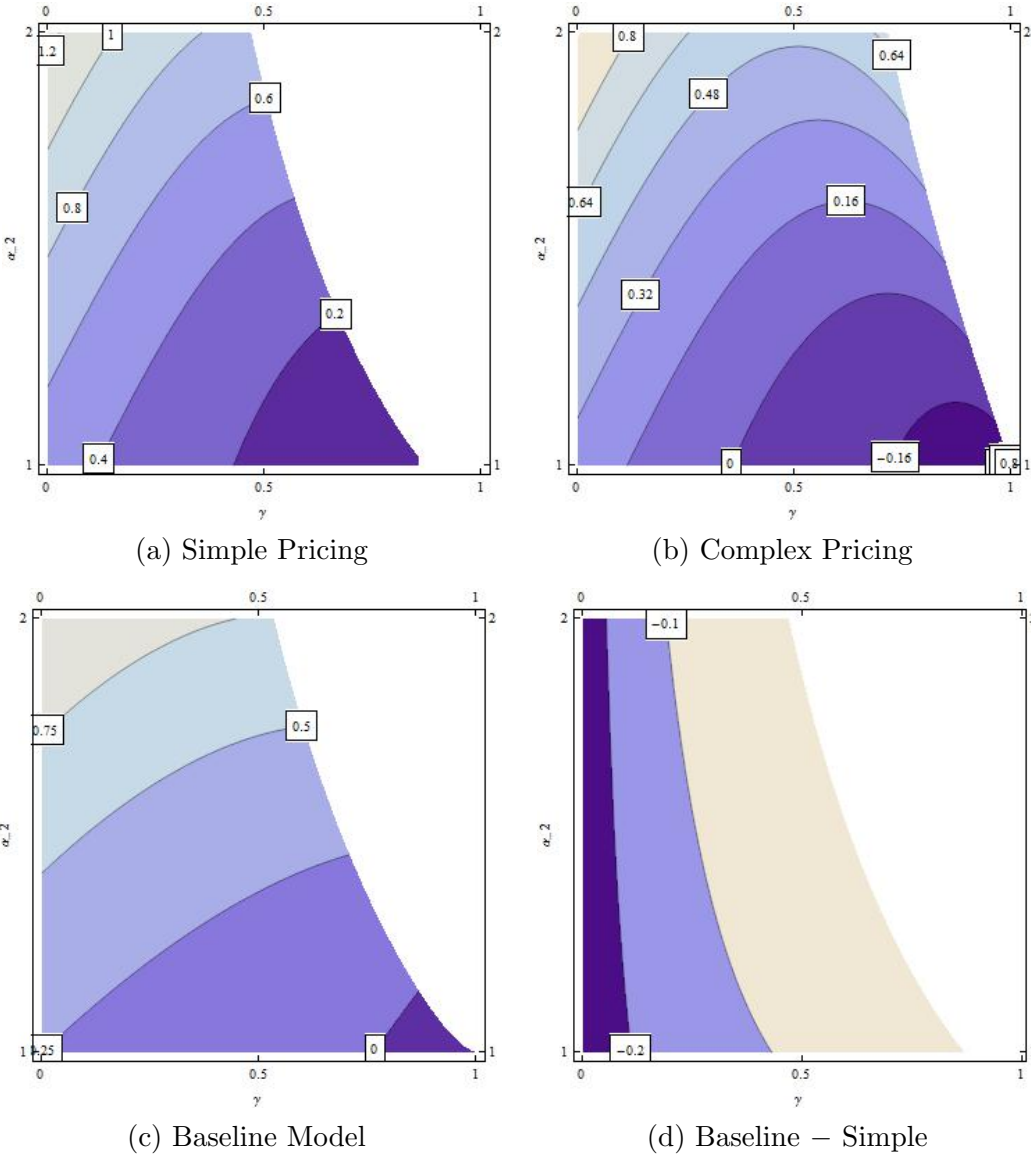
net benefit of product concept demonstration.

3.6   Discussion

My analysis provides new insights into the interplay between product positioning and a product concept demonstration that induces varying degrees of purchase delay while shaping the firms inter-temporal pricing strategy. Interestingly, I find that a product concept demonstration can bring the new product's price lower than that without a demonstration, and that the amount of delayed purchases induced by the product concept demonstration is greatest at very low or high levels of product substitutability, exhibiting a U-shaped pattern. My results indicate that engaging in a pre-launch product concept demonstration is the optimal strategy for the monopolistic firm with either horizontal or vertical differentiation. Product concept demonstration is beneficial not only for the firm but also consumers. By giving consumers higher utility when waiting for a period, the firm can increase the total profit and the consumers can have a boost in their utility.

3.6.1   Future Research Directions

It is worthwhile to consider the uncertainty of quality, price, or possible delays in the launch date. There are many possible scenarios for the firm to increase (or decrease) the price of a new product (i.e., realized demand is much greater than expected, consumers feedback or experts reviews are extremely favorable).

Researchers can extend this paper by analyzing a duopoly market with a product concept demonstration. To have a closed form solution for such a case, one might need to assume that only one firm demonstrates its product concept. One can solve the duopoly model for a Nash game and for a Leader-Follower game. In the later case, only a leading firm can demonstrate and set the retail price first and then smaller, follower firms can observe the publics uptake of the price point and decide their retail price. Inter-temporal strategic

interactions in the duopoly market might be different from those in the monopoly market.

Finally, I assume that all products experience diminishing marginal utility uniformly, by setting $\beta_1 = \beta_2 = \beta = 1$. It will be interesting to consider the case of asymmetric diminishing marginal utility, such as $\beta_1 < \beta_2$ (i.e., that the marginal utility decline of the new model is steeper than that of the old model). The afore-mentioned scenario could create a set of puzzling results concerning pricing and positioning in the two-periods monopoly market.

Table 3.3: Comparison of the Equilibrium Solutions

	Simple Pricing Strategy	Complex Pricing Strategy
p_1^* [a]	$\dfrac{\{-2+\gamma^2(1+\delta)\}[-4+\gamma\{\gamma+\alpha_2(-1+\delta)+3\gamma\delta\}]}{16-\gamma^2(9+22\delta)+\gamma^4(1+6\delta+8\delta^2)}$	
p_{11}^* [b]		$\dfrac{(-5+\delta)(-1+\delta)}{7-6\delta}$
p_{12}^* [c]		$\dfrac{12-19\delta+7\delta^2}{28-38\delta+12\delta^2}$
p_2^*	$\dfrac{1}{2}\left\{\alpha_2+(-1+2p_1)\gamma+\dfrac{p_1\gamma(1-\gamma^2)}{-2+\gamma^2(1+\delta)}\right\}$	$\dfrac{1}{2(-2+\delta)}\left\{\alpha_2(-2+\delta)+\dfrac{\gamma(-2+\delta^2)}{-7+6\delta}\right\}$
q_{11}^*		$\dfrac{-1+p_{11}+\delta-p_{12}\delta}{-1+\delta}$
q_{1D}^*		$\dfrac{-1+p_{12}+\delta-p_2\gamma+\alpha\gamma}{-1+\gamma^2}$
q_{12}^*	$\dfrac{-1+p_1-p_2\gamma+\alpha_2\gamma}{-1+\gamma^2}$	$\dfrac{-1+p_{12}-p_2\gamma+\alpha_2\gamma}{-1+\gamma^2}$
q_2^*	$\dfrac{p_2-\alpha_2\gamma-p_1\gamma}{-1+\gamma^2}$	$\dfrac{p_2-\alpha_2\gamma-p_{12}\gamma}{-1+\gamma^2}$
q_{2D}^*	$\dfrac{p_2-\alpha_2\gamma-p_1\gamma}{-1+\gamma^2\delta}$	$\dfrac{p_2-\alpha_2\gamma-p_{12}\gamma}{-1+\gamma^2}$
π_1^*	$\dfrac{\left[\{-2+\gamma^2(1+\delta)\}A\left\{B+\alpha_2\gamma[4+12\delta+\gamma^4\delta\{2+\delta(7+6\delta)\}-\gamma^2\{2+\delta(12+17\delta)\}]\right\}\right]}{2(-1+\gamma^2\delta)C^2}$ [d]	$-\dfrac{(-5+\delta)(-1+\delta)\{8+3(-4+\delta)\delta\}}{2(7-6\delta)^2(-2+\delta)}$
π_2^*	$D\left\{(\alpha_2-\gamma)^2-\dfrac{2(-1+\gamma^2)\{-2+\gamma(-\alpha_2+\gamma+2\gamma\delta)\}A}{C}+\dfrac{(-1+\gamma^2)A^2E}{C^2}\right\}$	$\dfrac{1}{3600}\left\{\dfrac{25(49+72\alpha_2^2-144\alpha_2\gamma+23\gamma^2)}{1-\gamma^2}-\dfrac{2645}{(7-6\delta)^2}+\dfrac{1564}{7-6\delta}+\dfrac{144}{-2+\delta}\right\}$ [e]

[a] $p_1^*\equiv p_{11}^*\equiv p_{12}^*$ by definition of Simple Pricing Strategy.
[b] p_{11}^* denote old model price in period 1.
[c] p_{12}^* denote old model price in period 2.
[d] $A\equiv-4+\gamma\{\gamma+\alpha_2(-1+\delta)+3\gamma\delta\}$,
$B\equiv-16+\gamma^2[6+\delta\{28+\gamma^4\delta(1+2\delta)-3\gamma^2(2+5\delta)\}]$,
$C\equiv16-\gamma^2(9+22\delta)+\gamma^4(1+6\delta+8\delta^2)$
[e] $D\equiv\dfrac{2-\gamma^2(1+\delta)}{4(-1+\gamma^2)(-1+\gamma^2\delta)}$,
$E\equiv8+\gamma^2\{-5-12\delta+(\gamma+2\gamma\delta)^2\}$

Table 3.4: Result Summary for Model Extensions

q_{11} [a]	$C < S$ [b]
q_{12}	$S < C$
q_1 [c]	$N < S < C$
q_2	$C < S < N$
q_{2D}	$C < S < N$ or $S < C < N$ [d]
p_1	$C < S < N$ [e]
p_2	$C < N < S$
π_1	$C < N < S$
π_2	$\begin{cases} C < N < S & \text{if } \gamma \text{ is big.} \\ N < C < S & \text{otherwise.} \end{cases}$
Π [f]	$C < N < S$
$\Pi - \Pi_n$ [g]	$C < N < S$

[a] I assume the new product quality is weakly superior to the old product one ($\alpha_2 \geq 1$).

[b] N: No old model available in period 2, S: Simple pricing strategy ($p_1 = p_{11} = p_{12}$), C: Complex pricing strategy ($p_{11} > p_{12}$).

[c] For simple pricing strategy, $q_1 \equiv q_{11} + q_{12}$ and for complex pricing strategy, $q_1 \equiv q_{11} + q_{1d} + q_{12}$.

[d] See Figure 3.21c for detail parameter ranges.

[e] $C(p_{12}) < C(p_{11}) < S(p_1) < N(p_1)$

[f] $\Pi \equiv \pi_1 + \pi_2$.

[g] $\Pi_n \equiv \pi_{1n} + \pi_{2n}$.

Appendix A

Comparative Statics

Appendix B shows the details for Table 3.2 Comparative Statics. First, I show how I get the signs for each cell in Table 3.2 by demonstrating analytical approach. Next, if it is too complicated to tell the sign with analytical approach, I show the results of the chosen set of points by using a numerical method.

Assumption 1. $0 \leq \gamma \leq 1$

Assumption 2. $0 \leq \delta \leq 1$

Assumption 3. $1 \leq \alpha_2 \leq 2$

- $\dfrac{\partial p_1}{\partial \alpha_2}$

  Proof. From Table 3.1, $\dfrac{\partial p_1}{\partial \alpha_2} = \dfrac{\gamma(\gamma^2\delta - 2)(1 - \delta)}{\gamma^2(6\delta + 1) - 8}$. Since $\gamma^2(6\delta+1)-8 < 0$, $(\gamma^2\delta-2) < 0$, and $(1 - \delta) \leq 0$ by Assumption 1,2, and 3, both the numerator is weakly positive and the denominator is positive. Hence, $\dfrac{\partial p_1}{\partial \alpha_2} > 0$. **Q.E.D.**

- $\dfrac{\partial p_2}{\partial \alpha_2}$

  Proof. From Table 3.1, $\dfrac{\partial p_2}{\partial \alpha_2} = \dfrac{7\gamma^2\delta - 8)}{2(\gamma^2(6\delta + 1) - 8)}$. Since the numerator is negative and the denominator is negative. Therefore, $\dfrac{\partial p_2}{\partial \alpha_2} > 0$. **Q.E.D.**

- $\dfrac{\partial q_1}{\partial \alpha_2}$

  Proof. From Table 3.1, $\dfrac{\partial q_1}{\partial \alpha_2} = \dfrac{\gamma(\delta(\gamma^2(3\delta + 4) - 4) - 4) - 4)}{2(\gamma^2\delta - 1)(\gamma^2(6\delta + 1) - 8)}$. Note that $\delta(\gamma^2(3\delta + 4) - 4) \leq 3$ when $\delta = 1$ and $\gamma + 1$. This implies that the numerator is negative. Since $(\gamma^2\delta - 1) < 0$ and $(\gamma^2(6\delta + 1) - 8) < 0$, the numerative is weakly positive. This proves $\dfrac{\partial q_1}{\partial \alpha_2} \leq 0$. **Q.E.D.**

- $\dfrac{\partial q_2}{\partial \alpha_2}$

  Proof. From Table 3.1, $\dfrac{\partial q_2}{\partial \alpha_2} = \dfrac{5\gamma^2\delta + 2\gamma^2 - 8)}{(2(\gamma^2(6\delta + 1) - 8)}$. Since both the numerator and the denominator are negative. Therefore, $\dfrac{\partial q_2}{\partial \alpha_2} > 0$. **Q.E.D.**

- $\dfrac{\partial q_{2D}}{\partial \alpha_2}$

  Proof. From Table 3.1, $\dfrac{\partial q_2}{\partial \alpha_2} = \dfrac{2\gamma^4\delta(\delta - 1) + \gamma^2(2 - 9\delta) + 8)}{2(\gamma^2\delta - 1)(\gamma^2(6\delta + 1) - 8)}$. I note that $-0.5 \leq 2\gamma^4\delta(\delta - 1) \leq 0$ and $1 \leq \gamma^2(2 - 9\delta) + 8 \leq 10$. Hence, the numerator is always positive. Since $(\gamma^2\delta - 1) \leq 0$ and $(\gamma^2(6\delta + 1) - 8) < 0$, the denominator are weakly positive for all values of γ and δ. Therefore, $\dfrac{\partial q_{2D}}{\partial \alpha_2} > 0$. **Q.E.D.**

- $\dfrac{\partial(\pi_1 + \pi_2)}{\partial \alpha_2} \geq 0$ if $\alpha_2 > \dfrac{\gamma(\delta\gamma^2(4 + 3\delta) - 4(\delta + 1))}{(\gamma^2\delta - 2)(8 + \gamma^2\delta^2 - 8\gamma^2\delta)}$

  Proof. $\dfrac{\partial(\pi_1 + \pi_2)}{\partial \alpha_2} = \dfrac{2\gamma(\gamma^2\delta - 2)(\delta(\gamma^2(4 + 3\delta) - 4) - 4) - 2\alpha_2(\gamma^2\delta - 2)^2(8 + \gamma^2(-8 + \delta)\delta)}{4(\gamma^2(1 + 6\delta) - 8)(2 + \gamma^2\delta(\gamma^2\delta - 3))}$

  Note that the denominator is always negative because $\gamma^2(1 + 6\delta) - 8 < 0$ and $2 + \gamma^2\delta(\gamma^2\delta - 3) = \gamma^4\delta^2 - 3\gamma^2\delta + 2 = (\gamma^2\delta - 1)(\gamma^1\delta - 2) \geq 0$ since $\gamma^2\delta \leq 0$. Now, the sign of $\dfrac{\partial(\pi_1 + \pi_2)}{\partial \alpha_2}$ depends on the numerator. If the first term is greater than the second, $\alpha_2 > \dfrac{\gamma(\delta\gamma^2(4 + 3\delta) - 4(\delta + 1))}{(\gamma^2\delta - 2)(8 + \gamma^2\delta^2 - 8\gamma^2\delta)}$, then the numerator is negative, hence, $\dfrac{\partial(\pi_1 + \pi_2)}{\partial \alpha_2} \geq 0$.

For the signs with respect to the substitutability, γ, we investigate the numerical results because the expressions for $\dfrac{\partial p_1}{\partial \gamma}$, $\dfrac{\partial p_2}{\partial \gamma}$, $\dfrac{\partial q_1}{\partial \gamma}$, $\dfrac{\partial q_2}{\partial \gamma}$, $\dfrac{\partial q_{2D}}{\partial \gamma}$, and $\dfrac{\partial (\pi_1 + \pi_2)}{\partial \gamma}$ have very complex forms to tell the sign. ("+/−" denotes inverted U-shaped pattern and "−/+" shows U-shaped pattern as the substitutability goes to 1.)

- $\dfrac{\partial p_1}{\partial \gamma}$ shows overall inverted U-shaped pattern of old model price with respect to the substitutability except only one with $\alpha_2 = 1.5$ and $\delta = 0.6$.

- $\dfrac{\partial p_2}{\partial \gamma}$ shows overall negative sign of new model price with respect to the substitutability. See Table A.2

- $\dfrac{\partial q_1}{\partial \gamma}$ shows overall negative sign of old model quantity with respect to the the substitutability when the new model quality is higher than the old model, such as $\alpha_2 > \alpha_1$. See Table A.3

- $\dfrac{\partial q_2}{\partial \gamma}$ shows overall positive sign of new model quantity with respect to the the substitutability. See Table A.4

- $\dfrac{\partial q_{2D}}{\partial \gamma}$ shows overall a U-shaped pattern of delayed purchases with respect to the substitutability. See Table A.5

- $\dfrac{\partial (\pi_1 + \pi_2)}{\partial \gamma}$ shows overall negative sign of total profit with respect to the substitutability. See Table A.6

Similarly, for the signs with respect to the discounting factor, δ, we investigate the numerical results because the expressions for $\dfrac{\partial p_1}{\partial \delta}$, $\dfrac{\partial p_2}{\partial \delta}$, $\dfrac{\partial q_1}{\partial \delta}$, $\dfrac{\partial q_2}{\partial \delta}$, $\dfrac{\partial q_{2D}}{\partial \delta}$, and $\dfrac{\partial (\pi_1 + \pi_2)}{\partial \delta}$ have very complex forms to tell the sign.

- $\dfrac{\partial p_1}{\partial \delta}$ shows overall negative sign of old model price with respect to the discounting factor. See Table A.7

Table A.1: Comparative Statics for $\dfrac{\partial p_1}{\partial \gamma}$

$\dfrac{\partial p_1}{\partial \gamma}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
δ	0.6	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+$
	0.7	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$
	0.8	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$
	0.9	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$
	1	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$	$+/-$

Table A.2: Comparative Statics for $\dfrac{\partial p_2}{\partial \gamma}$

$\dfrac{\partial p_2}{\partial \gamma}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
δ	0.6	$-$	$-$	$-$	$-$	$-$	$-$	$-$
	0.7	$-$	$-$	$-$	$-$	$-$	$-$	$-$
	0.8	$-$	$-$	$-$	$-$	$-$	$-$	$-$
	0.9	$-$	$-$	$-$	$-$	$-$	$-$	$-$
	1	$-$	$-$	$-$	$-$	$-$	$-$	$-$

Table A.3: Comparative Statics for $\dfrac{\partial q_1}{\partial \gamma}$

$\dfrac{\partial q_1}{\partial \gamma}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
δ	0.6	$-/+$	$-/+$	$-$	$-$	$-$	$-$	$-$
	0.7	$-/+$	$-/+$	$-$	$-$	$-$	$-$	$-$
	0.8	$-/+$	$-/+$	$-/+$	$-$	$-$	$-$	$-$
	0.9	$-/+$	$-/+$	$-/+$	$-$	$-$	$-$	$-$
	1	$-/+$	$-/+$	$-/+$	$-$	$-$	$-$	$-$

Table A.4: Comparative Statics for $\dfrac{\partial q_2}{\partial \gamma}$

$\dfrac{\partial q_2}{\partial \gamma}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
δ	0.6	$+$	$+$	$+$	$+$	$+$	$+$	$+$
	0.7	$+$	$+$	$+$	$+$	$+$	$+$	$+$
	0.8	$+$	$+$	$+$	$+$	$+$	$+$	$+$
	0.9	$+$	$+$	$+$	$+$	$+$	$+$	$+$
	1	$+$	$+$	$+$	$+$	$+$	$+$	$+$

Table A.5: Comparative Statics for $\dfrac{\partial q_{2D}}{\partial \gamma}$

$\dfrac{\partial q_{2D}}{\partial \gamma}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
δ	0.6	−	−	−/+	−/+	−/+	−/+	−/+
	0.7	−	−	−/+	−/+	−/+	−/+	−/+
	0.8	−	−	−/+	−/+	−/+	−/+	−/+
	0.9	−	−	−/+	−/+	−/+	−/+	−/+
	1	−	−	−/+	−/+	−/+	−/+	−/+

Table A.6: Comparative Statics for $\dfrac{\partial(\pi_1+\pi_2)}{\partial \gamma}$

$\dfrac{\partial(\pi_1 + \pi_2)}{\partial \gamma}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
δ	0.6	−/+	−	−	−	−	−	−
	0.7	−/+	−	−	−	−	−	−/+
	0.8	−/+	−	−	−	−	−	−/+
	0.9	−/+	−	−	−	−	−	−/+
	1	−/+	−	−	−	−	−	−/+

- $\dfrac{\partial p_2}{\partial \delta}$ shows overall negative sign of new model price with respect to the discounting factor. See Table A.8

- $\dfrac{\partial q_1}{\partial \delta}$ shows overall negative sign of old model quantity with respect to the discounting factor. See Table A.9

- $\dfrac{\partial q_2}{\partial \delta}$ shows overall positive sign of old model price with respect to the discounting factor. See Table A.10

- $\dfrac{\partial q_{2D}}{\partial \delta}$ shows overall positive sign of delayed purchases with respect to the discounting factor. Note that four pairs of parameter values in Table A.11 are outside of feasible range of this analysis.

- $\dfrac{\partial(\pi_1 + \pi_2)}{\partial \delta}$ Note that four pairs of parameter values in Table A.12 are outside of feasible range of this analysis.

Table A.7: Comparative Statics for $\dfrac{\partial p_1}{\partial \delta}$

$\dfrac{\partial p_1}{\partial \delta}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
γ	0.01	−	−	−	−	−	−	−
	0.2	−	−	−	−	−	−	−
	0.4	−	−	−	−	−	−	−
	0.6	−	−	−	−	−	−	−
	0.8	−	−	−	−	−	−	−
	0.99	−	−	−	−	−	−	−

Table A.8: Comparative Statics for $\dfrac{\partial p_2}{\partial \delta}$

$\dfrac{\partial p_2}{\partial \delta}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
γ	0.01	−	−	−	−	−	−	−
	0.2	−	−	−	−	−	−	−
	0.4	−	−	−	−	−	−	−
	0.6	−	−	−	−	−	−	−
	0.8	−	−	−	−	−	−	−
	0.99	−	−	−	−	−	−	−

Table A.9: Comparative Statics for $\dfrac{\partial q_1}{\partial \delta}$

$\dfrac{\partial q_1}{\partial \delta}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
γ	0.01	−	−	−	−	−	−	−
	0.2	−	−	−	−	−	−	−
	0.4	−	−	−	−	−	−	−
	0.6	−	−	−	−	−	−	−
	0.8	−	−	−	−	−	−	−
	0.99	−	−	−	−	−	−	−

Table A.10: Comparative Statics for $\dfrac{\partial q_2}{\partial \delta}$

$\dfrac{\partial q_2}{\partial \delta}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
	0.01	+	+	+	+	+	+	+
	0.2	+	+	+	+	+	+	+
γ	0.4	+	+	+	+	+	+	+
	0.6	+	+	+	+	+	+	+
	0.8	+	+	+	+	+	+	+
	0.99	+	+	+	+	+	+	+

Table A.11: Comparative Statics for $\dfrac{\partial q_{2D}}{\partial \delta}$

$\dfrac{\partial q_{2D}}{\partial \delta}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
	0.01	+	+	+	+	+	+	+
	0.2	+	+	+	+	+	+	+
γ	0.4	+	+	+	+	+	+	+
	0.6	+	+	+	+	+	+	+
	0.8	+	+	+	+	+	+	+
	0.99	−	−	+	+	+	+	+

Table A.12: Comparative Statics for $\frac{\partial(\pi_1+\pi_2)}{\partial \delta}$

$\dfrac{\partial(\pi_1 + \pi_2)}{\partial \delta}$		α_2						
		0.5	0.7	0.9	1	1.1	1.3	1.5
	0.01	−	−	−	−	−	−	−
	0.2	−	−	−	−	−	−	−
γ	0.4	−	−	−	−	−	−	−
	0.6	−	−	−	−	−	−	−
	0.8	−	−	−	−	−	−	−/+
	0.99	−	−	−	−	−/+	−/+	−/+

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