

ESSAYS ON HYBRID BUNDLE PRICING

A Dissertation

by

JEFFREY DEAN MEYER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2010

Major Subject: Marketing

Essays on Hybrid Bundle Pricing

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ABSTRACT

Essays on Hybrid Bundle Pricing. (August 2010)

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Increasingly, firms are offering hybrid bundles — products that combine both good(s) and service(s). Some hybrid bundles, such as TiVo that combines a DVR and recording management are more visible, while some, such as GE's Powerplant System that includes a nuclear power plant and maintenance/project management are more obscure. While pricing strategies for a goods bundle have been well-studied, services bundles have been underexplored. Hybrid bundles, which are fundamentally different from bundles of goods or services, have received even less attention. In this dissertation, three essays offer important insights into different aspects of hybrid bundle pricing and provide important managerial implications and guidelines.

Essay I develops an analytic model of optimal pricing for hybrid bundles by a monopolist. My results show that an increase in quality variability of the service is generally associated with a higher optimal hybrid bundle price and a lower optimal price of the good, but lower overall bundle profit. They also reveal that the optimal price of the service (good) in a hybrid bundle is higher (lower) when the good has diminishing unit cost and the service has constant unit cost.

Essay II examines the effects of quality variability, independence, and complementarity on willingness-to-pay for hybrid bundle components using conjoint analysis experiments. The results show that higher quality variability of a service is associated with a wider distribution of willingness-to-pay, that independence between the good and the service has positive direct- and cross-effects on willingness-to-pay, that complementarity between components has a greater positive effect on the willingness-to-pay for the service than for the good, and that independence and complementarity interact to increase willingness-to-pay.

Essay III develops a general model for the pricing of hybrid bundles offered in a competitive setting. I estimate the model using empirical data of a hybrid bundle comprising carpet and installation. The results show that the price of the service plays a crucial role in the demands of both the good and service and that the service cross-price effect on the demand for the good can be substantially higher than the direct-price effect of the good on its own demand.

DEDICATION

I dedicate this to everyone who has supported me during this process, but most of all to my wife Glory. Without her love, support, and sacrifices throughout the years, none of this would have been possible. She has listened patiently when I needed to talk, offered advice when I needed guidance, and stood by my side when I needed someone to lean on.

ACKNOWLEDGEMENTS

I would first like to thank my dissertation committee co-chairs, Dr. Venkatesh Shankar and Dr. Leonard L. Berry. Each played an important role in my doctoral studies. Dr. Shankar guided me through the program from the very first semester, offering advice and encouragement along the way. His guidance became more pronounced when he graciously agreed to serve as my co-chair, and I am thankful for his support, expertise, and long hours spent guiding me throughout my studies. Dr. Berry was an inspiration and role model to me ever since attending his seminar in my second semester. His advice on balancing and managing the three facets of being a professor — research, teaching, and service — throughout one’s career will prove valuable for many, many years to come. I was very grateful he agreed to serve as my co-chair, and his support and guidance over the last three to four years has been invaluable. In addition to the professional support of Dr. Shankar and Dr. Berry throughout the doctoral program, they have shown their caring and nurturing side by taking a genuine interest in the health and happiness of me and my wife.

I would next like to thank my dissertation committee members, Dr. Ram Janakiraman and Dr. Oral Capps, Jr. Each has provided support and expertise when needed. In particular, Dr. Janakiraman has provided excellent feedback on the dissertation and during the job search phase, while the knowledge I gained from Dr. Capps’ class has proved priceless as I tackled the dissertation.

I would like to extend a special thanks to Dr. Alina Sorescu. Dr. Sorescu has been a great help during my doctoral studies, both as a professor during her seminar and as a mentor for teaching marketing research. In addition, her advice during presentations and during mock interviews is always beneficial. I would also like to thank her for the recommendation letter during the job search phase.

I would like to thank Dr. Kelly Haws for her help and support on my experimental studies. She was a great mentor for setting up experiments and her assistance with running my experiments was beyond the call of duty, and for that I am grateful.

I would also like to thank the many other professors and staff that provided support and encouragement throughout the doctoral program. In particular, I would like to thank Glenda Bessler, Theresa Morrison, Spring Robinson, and Dr. Paul Busch. Glenda was always there to help out when I needed something and was always a great listener. Theresa and Spring were always encouraging and helpful when I needed support. Dr. Busch was always a friendly face and great person to talk to about the Big 12.

I also thank Thomas Dotzel. Having known Thomas now for over seven years, he is not only a great colleague and officemate, but also a great friend. His advice during the dissertation and job search was invaluable and helped more than he probably realizes.

I would also like to thank Gautham Gopal Vadakkpatt and Reo Song. I thoroughly enjoyed having them as colleagues in my doctoral cohort. They were always there when I needed advice and support, and I will always be grateful for that.

I would also like to thank Ying Zhu and Sujana Dan. Ying has been a great listener and friend the past four years, and I am grateful for her advice and support. Sujana was a great officemate during my first three years, and continues to be a friend.

In addition to the doctoral students already mentioned, I would like to thank those doctoral students, both before me and after me, that have provided advice, support, and friendship over the past five years.

Finally, I would like to thank my parents and siblings. They have always been encouraging throughout my studies, and I am grateful for their love and support.

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CHAPTER I

INTRODUCTION

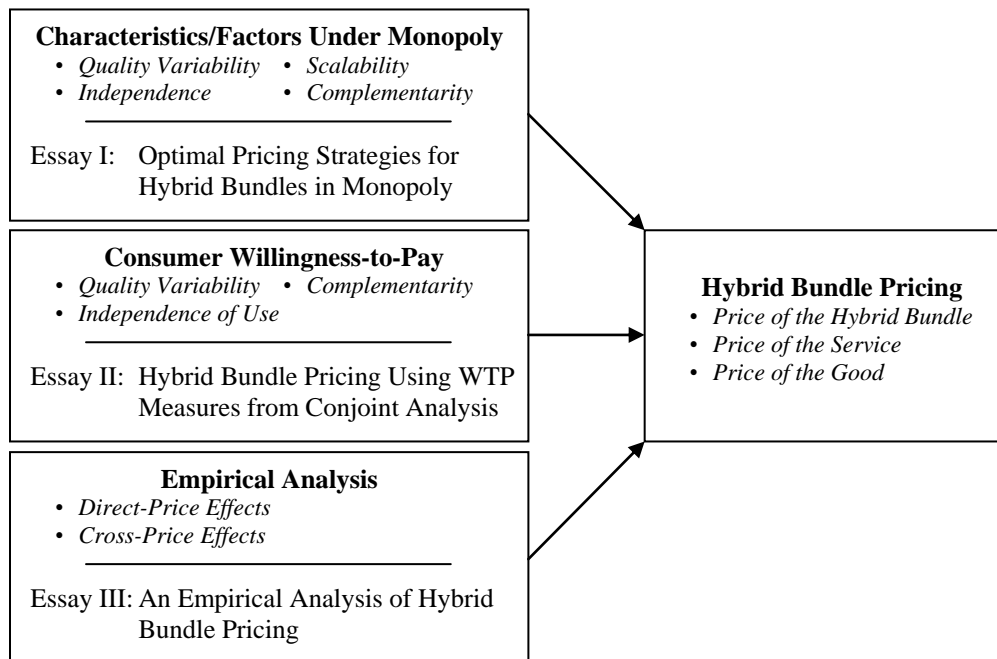
Increasingly, firms are developing and marketing hybrid bundles – products that combine both good(s) and service(s). Hybrid bundles are prevalent in both business-to-consumer (B2C) and business-to-business (B2B) industries. In the B2C space, for example, TiVo sells both the digital video recorder (DVR) and the program guide service as a hybrid offering. Similarly, in the B2B space, General Electric sells a power plant and a maintenance/project management service together in a single offering. Sales of such hybrid bundles have risen dramatically over the past 15 years. For example, from 1995 to 2004, sales of embedded services (i.e., services sold along with durable goods) grew nearly 200 percent, and the share of sales in the durable goods sector attributed to embedded services rose from 12 percent to 22 percent (Auguste et al. 2006). In addition, in many of the global manufacturing companies, services account for about 25 percent of total revenues and approximately 46 percent of total profits (Deloitte Research 2006).

I formally define a hybrid bundle as a single firm's offering that combines one or more goods and one or more services, creating more customer benefit than if the good and service were available separately, consistent with Shankar, Berry, and Dotzel (2009). My hybrid bundle definition contains two key criteria. First, the same firm must sell the good and the service. This ensures that the firm receives revenues from both the good and the service and eliminates simple complementary goods or services that are

sold by different parties. Second, when a customer uses the good and service together, the combined utility is superadditive. That is, the benefit a customer receives from the purchase and/or use of the good and service together is greater than the benefit a customer receives from the good and service separately.

My dissertation comprises three essays that examine multiple facets of hybrid bundle pricing, as shown in Figure 1-1. Each essay offers unique and important insights into different aspects of hybrid bundle pricing.

Figure 1-1 Facets of Hybrid Bundle Pricing



Essay I analyzes the effects of key hybrid bundle factors on its pricing in a monopolistic setting. Drawing from the bundling literatures in marketing, economics,

and operations management, I delineate four importance factors that impact pricing of hybrid bundles, namely quality variability, scalability, independence, and complementarity. My research questions focus on quality variability and scalability. First, how does greater variance in the quality of a service relative to that of a good affect the monopolist's optimal pricing strategies for hybrid bundles? Second, how does lower scalability of the service relative to that of the good influence the monopolist's pricing strategies for hybrid bundles?

I formulate a model of optimal hybrid bundle pricing by a monopolist, incorporating the four important pricing drivers. Using this model, I develop several useful and counter-intuitive propositions on optimal prices of the hybrid bundle, the good, and the service. My research extends the literatures on bundling in three important ways. First, existing literature focuses on the bundling of goods or the bundling of services, but not on the bundling of a good and a service together. My research offers important insights into the optimal pricing of hybrid bundles. Second, my research is the first to provide insights into the effects of the distinctive characteristics of services (namely, greater quality variability and lower scalability relative to goods) on optimal bundle pricing. Third, my research is the first to analyze the combined effects of quality variability and scalability in conjunction with independence and complementarity of the good and the service on the joint pricing decisions of these components in the hybrid bundle.

Essay II examines price sensitivity to three of the four pricing drivers explored in Essay I using willingness-to-pay measures extracted from choice-based conjoint (CBC)

experiments through hierarchical Bayesian methods. In this essay, the research questions focus on quality variability, independence, and complementarity. First, how does quality variability affect consumer willingness-to-pay? Second, how do independence and complementarity affect consumer willingness-to-pay, both individually and together?

To address these research questions, I complete three CBC studies. In the first study, I focus on quality variability. In the second study, I focus on independence and complementarity. In the third study, I focus on all three pricing drivers in one experimental setting. The results fill important gaps in the extant bundling literature. First, because the bundling of goods and services together has been largely ignored, my research examines how the inherent differences between goods and services affect consumer willingness-to-pay. Second, extant bundling literature focuses on the purchase of the bundle, not the usage of the components. That is, whether or not the components can be independently purchased. My research explores the concept of independence of usage versus independence of purchase, which can have important implications for the pricing of the hybrid bundle components.

Essay III studies the effects of the pricing of hybrid bundle components on the demand for the hybrid bundle in a competitive setting. I develop a general framework and model to answer important research questions on pricing of hybrid bundles. That is, what are the direct- and cross-effects of pricing of the good and service components on the demand for these components? Are these effects symmetric?

Empirical research on bundling is scarce. Drawing from literature in the cross-category purchasing literature marketing, I develop a general framework of hybrid

bundle pricing and demand. The framework is tested using data from a U.S. specialty retailer that markets a hybrid bundle comprising carpet (the good) and installation (the service). The results suggest that the effects of pricing in a hybrid bundle setting may be considerably different than the cross-category pricing effects.

CHAPTER II

OPTIMAL PRICING STRATEGIES FOR HYBRID BUNDLES IN MONOPOLY

2.1 INTRODUCTION

Increasingly, firms are developing and marketing hybrid bundles—products that combine both good(s) and service(s). Hybrid bundles are prevalent in both business-to-consumer (B2C) and business-to-business (B2B) industries. In the B2C space, for example, TiVo sells both the digital video recorder (DVR) and the program guide service as a hybrid offering. Similarly, in the B2B space, General Electric sells a power plant and a maintenance/project management service together in a single offering. Sales of such hybrid bundles have risen dramatically over the past 15 years. For example, from 1995 to 2004, sales of embedded services (i.e., services that include durable goods) grew nearly 200 percent, and the share of sales in the durable goods sector attributed to embedded services rose from 12 percent to 22 percent (Auguste et al. 2006).

I formally define a hybrid bundle as a single firm's offering that combines one or more goods with one or more services, creating greater customer benefit than if the good(s) and service(s) were available separately.¹ This definition is adapted from a definition of a hybrid innovation, which is essentially a hybrid bundle that is new to the firm introducing that bundle (Shankar et al. 2009). My hybrid bundle definition contains two key criteria. First, the same firm must sell both the good and the service. This criterion ensures that the firm receives revenues from both the good and the service. This

¹ For expositional ease, I use the terms, customer and consumer, interchangeably throughout the chapter.

criterion also eliminates from consideration simple complementary goods or services that are sold by different parties. Second, when a customer uses the good and service together, the combined utility is superadditive. That is, the benefit a customer receives from the purchase and/or use of the good and service together is greater than the benefit a customer receives from purchasing and/or using the good and service separately.

Hybrid bundles are different from bundles of goods or bundles of services in at least three important ways. First, from a demand or marketing standpoint, unlike goods, most services are people-intensive, so variability in quality, that is differences in expected quality among consumers, is typically greater for services than it is for goods. Second, from a supply, cost, or operations perspective, because most services' delivery involves people, services' scalability — the ability to sell high volumes at low unit cost — is lower than the scalability of goods. Thus, within a hybrid bundle, the levels of quality variability and scalability are mixed, whereas within a bundle of pure goods and a bundle of pure services, the levels of quality variability and scalability are similar. These differences have different pricing implications for hybrid bundles. Third, hybrid bundles are different from traditional bundles in the way the prices are presented to the consumer. For hybrid bundles, prices are often provided with separate prices for the good and the service. For example, in a hybrid bundle from TiVo, the price of the good (TiVo HD DVR) is presented as \$299.99, while the price of the service is listed separately as \$12.99 per month. In contrast, traditional bundles often give a single price for the bundle. For example, the price of a service bundle containing cable, Internet, and phone may be presented as \$147.99 per month, without a breakout of the prices of the

components. Therefore, determination of the optimal prices of the components is more relevant for hybrid bundles than for traditional bundles.

The pricing of a hybrid bundle is critical to its success. Consider TiVo's hybrid bundle that includes the TiVo DVR (the good) and the program guide (the service). Throughout its existence, TiVo has used different prices for the service component of the bundle in its quest to be successful. The frequent price changes beg the question: Is TiVo optimally pricing its hybrid bundles? Another example is Apple TV. Apple TV includes a set-top box (the good) that integrates with Apple's iTunes (the service). After an unsuccessful pricing attempt of Apple TV during its launch, Apple tweaked both the good and the service and reintroduced the set-top box at a price 25 percent lower than its initial price. Is Apple optimally pricing the set-top box and the iTunes service that is used with the set-top box? Like TiVo and Apple TV, many hybrid bundles are initially offered in a monopoly setting. Furthermore, many hybrid bundles such as home alarm and home improvement bundles are offered by marketers, who behave like monopolists in their local geographical markets. Therefore, it is important to determine the optimal pricing strategies for hybrid bundles in a monopoly.²

Despite the importance of pricing of hybrid bundles, little is known about it. The bundling literature in marketing has primarily examined bundles of goods, but some of this research considers factors relevant to quality variability (a critical dimension in a hybrid bundle) and complementarity (e.g., Balachander et al. 2010; Basu and Vitharana

² Although hybrid bundles are offered in monopoly and competitive contexts, because little is known about the pricing of hybrid bundles, a natural place to start is a monopoly setting. I do not have any reason a priori to believe my findings will be substantively different if applied in a competitive setting.

2009; Ghosh and Balachander 2007; Kopalle et al. 1999; Venkatesh and Chatterjee 2006; Venkatesh and Kamakura 2003). Basu and Vitharana (2009) examine a monopolist's bundle pricing when customers have different levels of knowledge about the usefulness of the bundle components such that the existence of a greater number of high-knowledge customers exhibits greater variability in reservation price—which is closely related to quality variability. They show that higher component prices are generally more profitable when there is greater variability in reservation price among consumers. Balachander et al. (2010) show that by offering a discount on the bundle, a firm can retain customers with low reservation prices, increasing the proportion of customers served and profits. Venkatesh and Kamakura (2003) consider optimal bundle pricing of goods under a monopoly and show that complementary components should typically be priced higher than independently valued components.

The bundling-related literature in operations management (e.g., Bala and Carr 2009; Bitran and Ferrer 2007; Rabinovitch et al. 2008) has also not examined hybrid bundles but addressed component cost that is germane to scalability (another key dimension in a hybrid bundle). Bitran and Ferrer (2007) propose an efficient solution procedure to determine the optimal composition and price of a hi-tech goods bundle and show that more attractive, lower cost bundles dominate less attractive, higher cost bundles. Bala and Carr (2009) analyze pricing of software in a context similar to bundling, in which the firm can offer just the upgrade (pure component) or the new upgraded software (bundle) at different levels of cost and upgrade quality. They show that a pure component pricing strategy is optimal when upgrade quality is either low or

high, but not in between. Rabinovich et al. (2008) assess the roles of cost mark-up and service quality in a retail setting where a good (e.g., CD) is offered with retail service. They find that higher service quality is associated with higher price mark-up.

However, research in both marketing and operations management has not explicitly addressed the pricing of a combination of goods and services. Importantly, the effects of differential quality variability and scalability across goods and services on optimal hybrid bundle pricing have not been explored. These effects have important implications for pricing the good, the service and the hybrid bundle.

To address these gaps in bundling research in marketing and operations management, I examine two main research questions. First, how does greater variance in the quality of a service relative to that of a good affect the monopolist's optimal pricing strategies for hybrid bundles? Second, how does lower scalability of the service relative to that of the good influence the monopolist's pricing strategies for hybrid bundles?

My research extends the literatures on bundling in marketing and operations management in three important ways. First, existing literature focuses on the bundling of goods or the bundling of services, but not on the bundling of a good and a service together. My research offers important insights into the optimal pricing of hybrid bundles. Second, my research is the first to provide insights into the effects of the distinctive characteristics of services (namely, greater quality variability and lower scalability relative to goods) on optimal bundle pricing. Third, it is the first to analyze the combined effects of quality variability and scalability in conjunction with

independence and complementarity of the good and the service on the joint pricing decisions of these components in the hybrid bundle.

2.2 CONCEPTUAL DEVELOPMENT AND RELATED RESEARCH

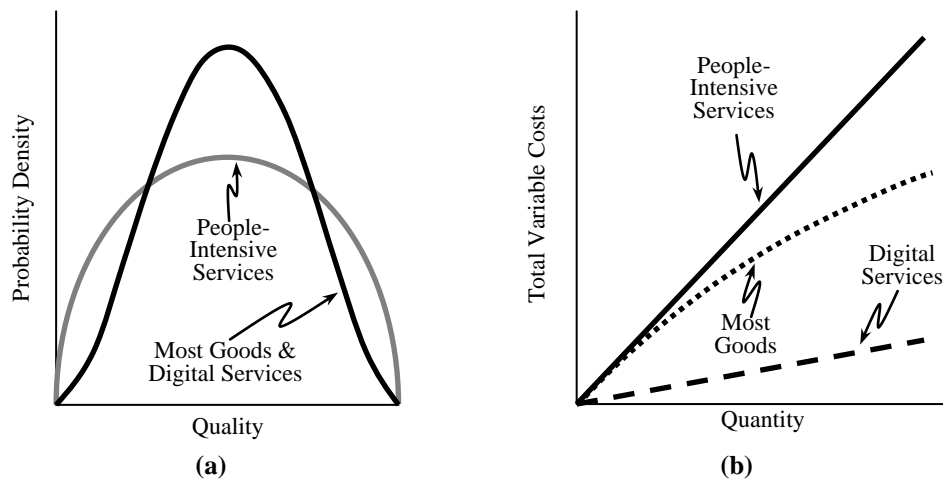
As outlined earlier, because hybrid bundles are unique combinations of services and goods, I must account for inherent differences between services and goods. These differences are key factors that drive hybrid bundle pricing (Shankar et al. 2009). The first main difference is from the demand perspective and is variability in quality. Customers' expectations of quality of a product influence their evaluation of it prior to purchase. Variability in the quality of a service may differ from that for a good. Many services are people-intensive and involve human actors in the production of the service. Thus, people-intensive services have greater variability in outcome than goods (Berry 1980; Murray and Schlacter 1990). Customers are aware of this aspect, so across customers, the expected quality for people-intensive services may vary widely. In contrast, for most goods, the variance around quality and customer expectations of quality should be considerably smaller. Figure 2-1a represents this scenario graphically.

The second major difference is from the operations standpoint and it is scalability. A key driver of the cost structure differences between services and goods is economies of scale or, more commonly referred to as the scalability of the services and goods.³ Economies of scale exist when unit production costs decrease as the number of units produced increases (Tirole 1988). Many services have lower economies of scale or lower scalability than goods (Johnson and Selnes 2004). Digital services, however, are

³ I use the terms scalability and economies of scale interchangeably. In my context, scalability does not refer to the ability to add new goods and/or services to a bundle.

exceptions. They are much more scalable than people-intensive services, and in some cases, more scalable than even goods as their marginal costs are close to zero. This situation results in very different cost structures for goods and services, both people-intensive and digital, as shown by the graph of total variable costs in Figure 2-1b. For the good in a hybrid bundle, the scalability is achieved in a straightforward manner through economies of scale. For the service in a hybrid bundle, however, scalability is not so clear cut. For people-intensive services, scalability may be hard to achieve because cost savings from serving an additional customer may be very small.

Figure 2-1 Differences in Quality Variability and Scalability between Goods and Services



Differences between components on the quality variability and scalability are not limited to the hybrid bundle context. However, because of the inherent differences between goods and services on these two dimensions, I argue that these two dimensions

are of increased importance in a hybrid bundle setting. Furthermore, these two dimensions have received little attention in extant bundling literature.

Two other factors, independence and complementarity, can also affect the revenue potential and optimal prices for the good, the service, and the hybrid bundle. While I include these factors in my model, they are not the focal dimensions in my research. I do not offer any formal propositions with respect to these factors but focus on quality variability and scalability in conjunction with independence and complementarity.

Independence is the extent to which the good and the service are available and can be used independent of each other. This factor is similar to bundling form that can be one of three: pure components, pure bundling, and mixed bundling (Stremersch and Tellis 2002). A focal question for prior research on bundling is which of these forms of bundling is optimal as it treats the choice of bundling form as a firm decision. However, this question is less relevant for hybrid bundles as customers typically decide whether to purchase or use the good and the service in a hybrid bundle separately or together. For example, in Sears' hybrid bundle comprising Sears Craftsman garage door opener (the good) and Sears professional installation (the service), the consumer determines the level of independence. That is, the consumer chooses either to purchase Sears professional installation or can do her own installation. Alternatively, the consumer can assemble a garage door opener herself and use Sears' professional installation. Thus, both the good and the service are independent within this hybrid bundle.

Full independence and mixed bundling are essentially equivalent, as are no independence and pure bundling. While independence and bundling form share some similarities, as argued earlier, they have important differences as well. First, bundling forms focus on only the purchase of the components, not their use. Independence considers both purchase and use. Thus, simply being able to purchase the good and service within a hybrid bundle separately does not necessarily mean the components are independent. Second, while much prior research treats form of bundling as a firm's decision, my concept of independence allows it to be exogenous to the firm, recognizing that consumers often decide whether to use the components independently or together. Third, independence allows for asymmetry between the components of the bundle. Thus, there can be good-only (service-only) independence in which the service (good) cannot be purchased and used separately. Finally, while bundling form is discrete (pure components, pure bundling, or mixed bundling), my conceptualization of independence allows it to be continuous in nature. That is, the level of independence could vary based on the hybrid bundle or even the consumer. For example, a hybrid bundle could consist of a good that has full functionality when used with the service, but only partial functionality when not used with the service. This example would create a situation where the good is somewhere between full independence and no independence. Similar to mixed bundling's profitability advantage, I expect profitability to be higher with greater independence.

Complementarity is the degree to which the good and service combination increases customer utility of the purchase and/or use. The effect of complementarity of

like components (that is, two goods or two services) of a bundle on its pricing has been studied. Tesler (1979) argues that complementarity can be a major reason for bundling because it yields a superadditive valuation. Venkatesh and Kamakura (2003) show that optimal prices are monotonically increasing in degree of complementarity under both pure components and pure bundling conditions. They also find that the optimality of mixed bundling depends on the degree of complementarity and the ratio of marginal costs to maximum reservation prices. As complementarity increases, mixed bundling becomes less attractive and pure bundling becomes more attractive. As relative marginal costs increase, the marketer is forced to raise prices. This action makes mixed bundling less attractive than pure components under low complementarity and less attractive than pure bundling under high complementarity.

Consider a representative example of hybrid bundle—flooring (the good) and installation (the service) from national home improvement stores such as Lowe's and Home Depot. In this bundle, the quality variability is likely greater for the service than the good because of the people-intensive nature of the installation process. In addition, consumers' expectations of quality will also likely be more variable for the service than the good because prior to purchase, consumers are generally unfamiliar with the skill and attitude of the people who would install the flooring. In contrast, consumers can touch and feel the actual quality of the flooring, the good. For the home improvement store, the flooring is highly scalable, whereas the installation service is not. The home improvement store can only perform a limited number of installations in a given time period as the pool of qualified installers is not big. With respect to independence,

because the flooring can be installed by the user, it is independent of the installation service. However, the installation service can be used only if the flooring is also purchased, and therefore, it is not independent of the good. Finally, consumers view the flooring and its installation service as highly complementary.

Prior research offers some guidance on pricing of bundles in general. Much work focuses on the conditions under which bundling improves profitability of goods bundles or services bundles (e.g., Schmalensee 1984; Stigler 1968). Models of bundling argue that the profitability of bundling depends on consumer reservation prices and costs. From the marketing or demand viewpoint, consumer reservation prices drive the profitability of bundling form and the optimal bundle price. Several researchers (McAfee et al. 1989; Venkatesh and Kamakura 2003; Venkatesh and Mahajan 1993) find that mixed bundling generally has a profitability advantage over pure bundling or pure components. However, Ghosh and Balachander (2007) find that generalists can gain by offering pure bundles to avoid head-to-head competition with specialists. Kopalle et al. (1999) also show that as the scope for marketing expansion decreases, a pure components strategy becomes the optimal bundling strategy. Subramaniam and Venkatesh (2009) find that pure bundling is best in an auction context when the components have strong individual demand. Salinger (1995) concludes that if costs are not subadditive, bundling can only be profitable if demand is superadditive (i.e., the demand for the bundle is greater than the combined demand of the individual products). Balachander et al. (2010) find that bundle discounts increase profits through endogenous loyalty because it lowers the reservation prices of switchers for competing products.

From the operations perspective, Bitran and Ferrer (2007) consider costs and argue that more attractive, lower cost bundles dominate less attractive, higher cost bundles. This finding is consistent with Hanson and Martin (1990), who argue that bundling is optimal when costs of components are subadditive (i.e., the cost of producing the bundle is lower than the sum of the costs of the individual products). Bala and Carr (2009) analyze a software upgrade or new bundle decision context for different levels of cost and upgrade quality and show that that a pure component pricing strategy is optimal at extreme levels of upgrade quality (low or high). On the service quality front, Rabinovich et al. (2008) find high quality service allows a marketer to charge higher prices for the good.

While the analytical models of bundling in marketing and operations do not address hybrid bundles, an empirical analysis by Bharadwaj and Ter Hofstede (2006) of pricing in the context of services that augment goods provides some related insights. Their findings show that reducing the price of services encourages customers to spend those savings on the good and that customers purchase more goods if they spend more on services. They further show that service margin affects the purchase of the good more than the opposite, and that customers who spend more on the service are more sensitive to the price of the good. However, this study did not examine the optimal pricing of the good and the service within a bundle.

A summary of relevant related research on the pricing of bundles listed in chronological order appears in Table 2-1. Taken together, prior bundling research in marketing and operations management shows that reservation prices, costs and

Table 2-1 Comparison of Selected Relevant Research on Pricing of Bundles

Reference	Focus	Model (Perspective)	Key Findings/Insights	Limitations
Hanson and Martin (1990)	Optimal product line breadth and pricing	Analytical (Marketing)	<ul style="list-style-type: none"> • Costless increase in reservation prices of all customer segments can lower profits. • Lowering costs on any bundle can never reduce profits. • If marginal costs are subadditive, bundling may be necessary to make profit. 	<ul style="list-style-type: none"> • Bundled products need not be complements
Venkatesh and Mahajan (1993)	Bundle pricing under pure bundling, mixed bundling, and pure components	Empirical (Marketing)	<ul style="list-style-type: none"> • Mixed bundling is better than pure bundling or pure components, but the size of advantage is determined by price of bundle relative to components. • Suboptimal pricing leads to extensive cannibalization of one product by another. 	<ul style="list-style-type: none"> • No marginal costs
Venkatesh and Kamakura (2003)	Pricing of bundles for complements and substitutes	Analytical (Marketing)	<ul style="list-style-type: none"> • Pure components, pure bundling, and mixed bundling all have areas of optimality depending on complementarity, substitutability, and costs. 	<ul style="list-style-type: none"> • Equal marginal costs • Reservation prices drawn from same distribution
Kopalle et al. (1999)	Bundling strategy amid market expansion	Analytical (Marketing)	<ul style="list-style-type: none"> • As the scope for marketing expansion decreases, pure components strategy becomes the optimal bundling strategy. 	<ul style="list-style-type: none"> • Differences in quality variability not considered
Bharadwaj and Ter Hofstede (2006)	Joint pricing of augmented products relative to pricing goods and services separately	Empirical (Marketing)	<ul style="list-style-type: none"> • Reducing price of services encourages customers to spend savings on goods. • Customers purchase more goods after spending more on services. • Service margins affect purchase of goods more than the opposite. • Customers spending more on services are more sensitive to goods pricing. 	<ul style="list-style-type: none"> • Services need not be complements to the augmented good
Bala and Carr (2009)	Pricing of bundles for multiform products	Analytical (Operations)	<ul style="list-style-type: none"> • A pure component (upgrade) strategy is optimal at extreme levels of quality. 	<ul style="list-style-type: none"> • Context restricted to adding components
Ghosh and Balachander (2007)	Conditions under which competitors resort to bundling	Analytical (Marketing)	<ul style="list-style-type: none"> • Generalists can gain by offering a pure bundle to avoid head-to-head competition. • Intense price competition can prevent a specialist from forming alliance and bundling when differences between brands are low. 	<ul style="list-style-type: none"> • Bundled products need not be complements
Bitran and Ferrer (2007)	Composition and price of bundles to maximize profit under competition	Analytical (Operations)	<ul style="list-style-type: none"> • More attractive, lower cost bundles dominate less attractive, higher cost bundles. • An efficient solution procedure can be used to optimize bundle composition and prices to maximize profits. 	<ul style="list-style-type: none"> • Bundled products need not be complements

Table 2-1 Continued

Reference	Focus	Model (Perspective)	Key Findings/Insights	Limitations
Bitran and Ferrer (2007)	Composition and price of bundles to maximize profit under competition	Analytical (Operations)	<ul style="list-style-type: none"> • More attractive, lower cost bundles dominate less attractive, higher cost bundles. • An efficient solution procedure can be used to optimize bundle composition and prices to maximize profits. 	<ul style="list-style-type: none"> • Bundled products need not be complements
Rabinovich et al. (2008)	Service quality and goods mark-ups	Empirical (Operations)	<ul style="list-style-type: none"> • Higher levels of service quality are associated with higher markups on goods in an Internet retailer setting. 	<ul style="list-style-type: none"> • Good and service need are not complements
Basu and Vitharana (2009)	Bundling strategy with different levels of customer knowledge	Analytical (Marketing)	<ul style="list-style-type: none"> • High knowledge customer exhibit greater variation in valuations. • With a greater number of high knowledge customers, higher component prices are generally more profitable. 	<ul style="list-style-type: none"> • Bundled products need not be complements • Equal marginal costs
Balachander et al. (2010)	Profitability of bundle discounts in a competitive setting	Analytical (Marketing)	<ul style="list-style-type: none"> • Bundle discounts can increase profits in a competitive market through endogenous loyalty. 	<ul style="list-style-type: none"> • Bundled products need not be complements • Equal marginal costs
This essay (2010)	Optimal pricing of hybrid (good+service) bundles	Analytical (Marketing & Operations)	<ul style="list-style-type: none"> • An increase (decrease) in quality variability for the service (good) is associated with higher (lower) optimal hybrid bundle price and lower optimal price for the good, but lower (higher) overall bundle profit. • Optimal prices for the service (good) in a hybrid bundle are higher (lower) when the good is more scalable than the service. 	<ul style="list-style-type: none"> • Competition not modeled

complementarity affect bundling form as well as optimal bundle pricing. Although each study makes an important contribution to the bundle pricing literature, none addresses a hybrid bundle. Quality variability and scalability, the unique dimensions of a hybrid bundle's optimal pricing, are not addressed by the bundling literature. In the hybrid bundle context, I expect quality variability and scalability, together with independence and complementarity, to affect optimal pricing.

2.3 MODEL

To address the research questions, I develop an analytic model that is based on three distinct segments in a market of size N : (1) consumers who buy the hybrid bundle (size N_{HB}); (2) consumers who buy only the good (size N_G); and (3) consumers who buy only the service (size N_S).⁴ The sizes of the three customer segments depend on a variety of factors, including: the prices of the hybrid bundle, service, and good, (P_{HB}, P_S, P_G) ; the reservation prices for the good and service for consumer i , (R_G^i, R_S^i) , which are a function of their quality levels;⁵ the degree of complementarity for consumer i , (θ^i) ; the independence of the good and service; and the number of potential consumers in the market, (N) .

In traditional bundling, a single reservation price is assumed for consumer i for the bundle (R_B^i) . Consistent with Venkatesh and Kamakura (2003), the degree of

⁴ A fourth segment, consumers that buy nothing, also exists. Its size is simply $N - (N_{HB} + N_G + N_S)$.

⁵ Reservation prices can be shown to be a linear function of quality expectations. Let consumer i 's utility be $V_i = \alpha + \beta Q_i - P_i$, where Q_i is quality expected by the consumer. Consumer i purchases if $(\alpha + \beta Q_i - P_i) > 0$. In terms of reservation price, consumer i purchases if $(R_i - P_i) > 0$. By equating the probabilities of purchase from these two perspectives, it can be shown that $\kappa_i(\alpha + \beta Q_i - P_i) = R_i - P_i$, where κ_i is a linear multiplier. Without loss of generality, assume $\kappa_i = 1$. Then $R_i = \alpha + \beta Q_i$, making R_i a linear function of Q_i . Therefore, as quality expectations widen, so does the distribution of reservation prices across consumers.

complementarity affects the bundle reservation price. Hybrid bundles are different from traditional bundles with regard to how the price is presented. Thus, consumer i will have a reservation price for the good given that the service will be purchased/used and a reservation price for the service given that good will be purchased/used ($R_{G|S}^i, R_{S|G}^i$). The degree of complementarity for consumer i is given by

$$\theta^i = \frac{(R_{G|S}^i + R_{S|G}^i) - (R_G^i + R_S^i)}{R_G^i + R_S^i} \quad (2.1)$$

From this expression, the combined reservation prices of consumer i for the hybrid bundle is given by

$$R_{G|S}^i + R_{S|G}^i = (1 + \theta^i)(R_G^i + R_S^i) \quad (2.2)$$

As stated earlier, the consumer has a reservation price for each component, the good and the service. The consumers' reservation prices will, in part, be determined by the quality expectations of the good and the service. To model this difference, I use the distribution of reservation prices. I argue that the distribution of reservation prices for people-intensive services has a wider variance than the distribution of reservation prices for goods or digital services.

In the traditional bundling literature, costs are often assumed to be linear (i.e., constant unit cost) and the same for each item in the bundle (e.g., Venkatesh and Chatterjee 2006; Venkatesh and Kamakura 2003). The assumption of equality of component costs is more realistic in a goods bundle or a services bundle than in a hybrid bundle. However, as described earlier, the cost structures of goods and services are quite

different, and an equality of component costs assumption may not be appropriate for a hybrid bundle due to differences in scalability of goods and services.

Returning to the three segments that purchase, I can now define the size of each segment for each independence condition. For example, under full independence, consumer i purchases the hybrid bundle if she gets a positive surplus from the hybrid bundle and if the surplus derived from purchasing the hybrid bundle is greater than the surplus generated from buying the good only or the service only. At the aggregate level, the sales of the hybrid bundle segment are given in Equation 2.3.

$$N_{HB} = N \times \Pr \left[\begin{array}{l} (1 + \theta)(R_G + R_S) \geq P_{HB} \cap \\ (1 + \theta)(R_G + R_S) - P_{HB} \geq R_G - P_G \cap \\ (1 + \theta)(R_G + R_S) - P_{HB} \geq R_S - P_S \end{array} \right] \quad (2.3)$$

In the segment of consumers purchasing only the good (service), $N_G(N_S)$, a consumer i purchases the good (service) if the surplus from purchasing the good (service) is positive and is greater than the surplus from purchasing the service (good) or the hybrid bundle. In this case, the sales of the good and service are given by Equations 2.4 and 2.5, respectively.

$$N_G = N \times \Pr \left[\begin{array}{l} R_G \geq P_G \cap R_G - P_G > R_S - P_S \cap \\ R_G - P_G > (1 + \theta)(R_G + R_S) - P_{HB} \end{array} \right] \quad (2.4)$$

$$N_S = N \times \Pr \left[\begin{array}{l} R_S \geq P_S \cap R_S - P_S > R_G - P_G \cap \\ R_S - P_S > (1 + \theta)(R_G + R_S) - P_{HB} \end{array} \right] \quad (2.5)$$

The monopolist sets the optimal price of the hybrid bundle, the good, and the service to maximize profits using the following objective function.

$$\max_{P_{HB}, P_G, P_S} \Pi = \left[\begin{array}{l} P_{HB} \times N_{HB} + P_G \times N_G + P_S \times N_S \\ -C_G(N_{HB}, N_G) - C_S(N_{HB}, N_S) \end{array} \right] \quad (2.6)$$

where N_{HB} , N_G , and N_S are as defined in Equations 2.3, 2.4, and 2.5 and Π represents profits.

The same procedure can be done for each independence condition. Knowing the size of each segment, I can define the objective function for each independence condition. The size of each segment and the objective function for each independence condition are shown in Table 2-2. I drop the superscript for consumer i for expositional clarity. For the first three independence conditions in Table 2-2, within each $Pr [\cdot]$, the first term guarantees that the individual participation (IP) constraint is met, while the

Table 2-2 Segment Size and Objective Function for Each Independence Condition

1. FULL INDEPENDENCE (i.e., hybrid bundle, good, or service can be purchased/used)

$$1.1 \quad N_{HB} = N \times \Pr \left[\begin{array}{l} (1 + \theta)(R_G + R_S) \geq P_{HB} \cap (1 + \theta)(R_G + R_S) - P_{HB} \geq R_G - P_G \cap \\ (1 + \theta)(R_G + R_S) - P_{HB} \geq R_S - P_S \end{array} \right]$$

$$1.2 \quad N_G = N \times \Pr [R_G \geq P_G \cap R_G - P_G > R_S - P_S \cap R_G - P_G > (1 + \theta)(R_G + R_S) - P_{HB}]$$

$$1.3 \quad N_S = N \times \Pr [R_S \geq P_S \cap R_S - P_S > R_G - P_G \cap R_S - P_S > (1 + \theta)(R_G + R_S) - P_{HB}]$$

$$1.4 \quad \max_{P_{HB}, P_G, P_S} \Pi = [P_{HB} \times N_{HB} + P_G \times N_G + P_S \times N_S - C_G(N_{HB}, N_G) - C_S(N_{HB}, N_S)]$$

2. GOOD-ONLY INDEPENDENCE (i.e., hybrid bundle or good can be purchased/used)

$$2.1 \quad N_{HB} = N \times \Pr [(1 + \theta)(R_G + R_S) \geq P_{HB} \cap (1 + \theta)(R_G + R_S) - P_{HB} \geq R_G - P_G]$$

$$2.2 \quad N_G = N \times \Pr [R_G \geq P_G \cap R_G - P_G > (1 + \theta)(R_G + R_S) - P_{HB}]$$

$$2.3 \quad \max_{P_{HB}, P_G} \Pi = [P_{HB} \times N_{HB} + P_G \times N_G - C_G(N_{HB}, N_G) - C_S(N_{HB})]$$

3. SERVICE-ONLY INDEPENDENCE (i.e., hybrid bundle or service can be purchased/used)

$$3.1 \quad N_{HB} = N \times \Pr [(1 + \theta)(R_G + R_S) \geq P_{HB} \cap (1 + \theta)(R_G + R_S) - P_{HB} \geq R_S - P_S]$$

$$3.2 \quad N_S = N \times \Pr [R_S \geq P_S \cap R_S - P_S > (1 + \theta)(R_G + R_S) - P_{HB}]$$

$$3.3 \quad \max_{P_{HB}, P_S} \Pi = [P_{HB} \times N_{HB} + P_S \times N_S - C_G(N_{HB}) - C_S(N_{HB}, N_S)]$$

4. NO INDEPENDENCE (i.e., only hybrid bundle can be purchased/used)

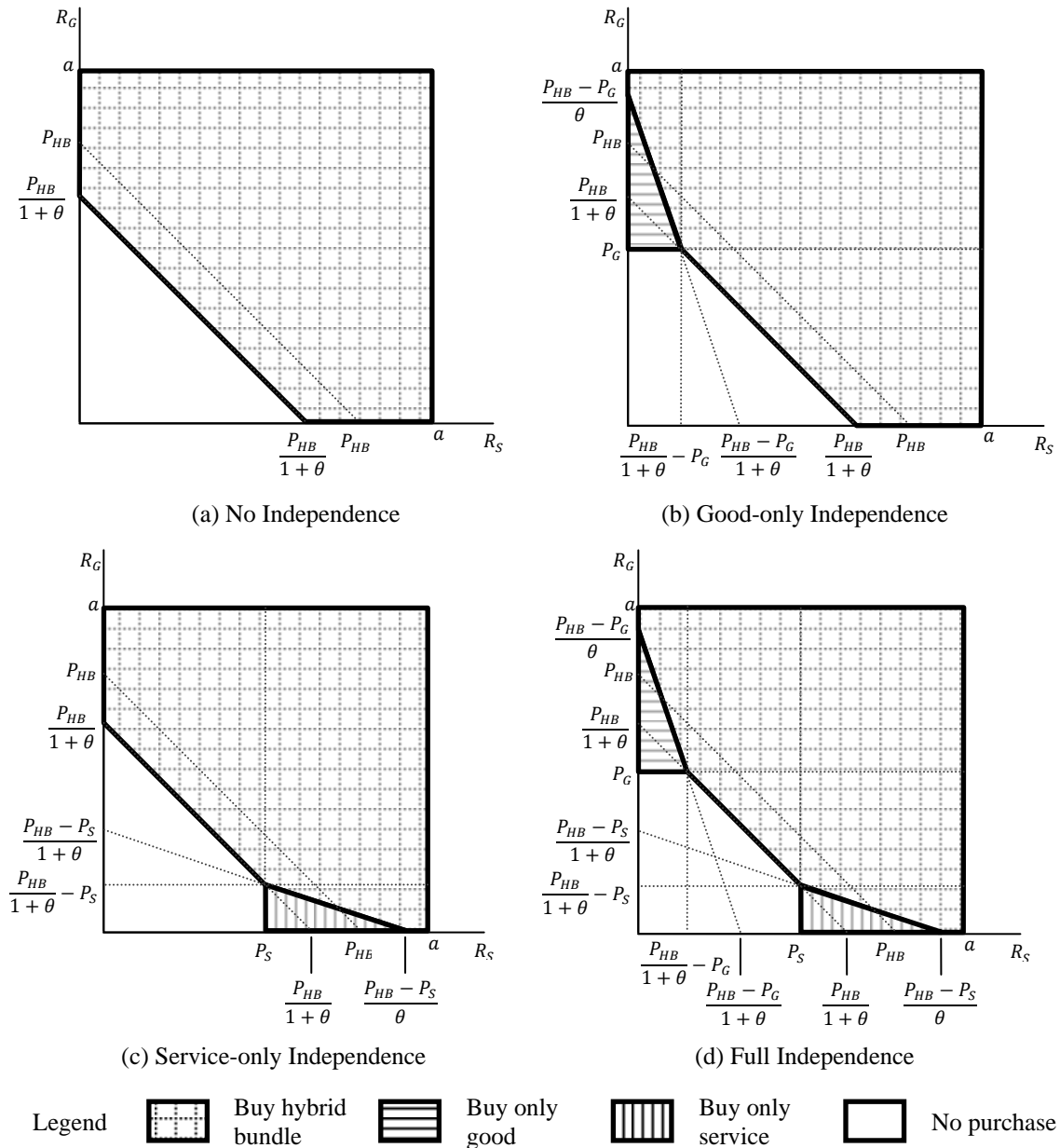
$$4.1 \quad N_{HB} = N \times \Pr [(1 + \theta)(R_G + R_S) \geq (P_{HB})]$$

$$4.2 \quad \max_{P_{HB}} \Pi = [(P_{HB}) \times N_{HB} - C_G(N_{HB}) - C_S(N_{HB})]$$

second and third terms guarantee incentive compatibility (IC). In the objective functions found in Table 2-2, the costs for the good and the service are left as generic functions of the size the various segments. As described earlier, complementarity affects the size of each segment through the reservation prices for the good and the service within a hybrid bundle. For simplicity, and consistent with past research (e.g., Venkatesh and Kamakura 2003), I assume that the degree of complementarity is the same for all consumers.

Figure 2-2 shows a graphical depiction of the basic framework for each independence condition. For this illustration, the reservation prices, (R_G, R_S) , are drawn from the joint uniform distribution such that $f(x, y) = 1/a^2$ for $0 \leq R_G, R_S \leq a$, where a represents the maximum reservation price. Thus, the service and good have the same quality variability. Complementarity is also restricted, such that $0 \leq \theta \leq 1$. A complementarity value of less than zero would represent substitutability, which is not relevant to hybrid bundles. A complementarity value equal to zero represents no complementarity, which while contrary to my definition of a hybrid bundle, is an apt representation of very low complementarity. A complementarity value of greater than one becomes unrealistic. The simplest condition is the no independence condition (2-2a). Here, the monopolist can only serve one segment, and the size of that segment is determined by the price of the hybrid bundle and the degree of complementarity between the good and the service. With good-only independence (2-2b) or service-only independence (2-2c), the monopolist can serve two segments. The size of the segments are determined by the price of the hybrid bundle, the price of the good (or service), and the degree of complementarity between the good and service. Finally, under full

Figure 2-2 Graphical Depictions of Reservation Price Regions for Good, Service and Hybrid Bundle Purchases under Different Levels of Independence

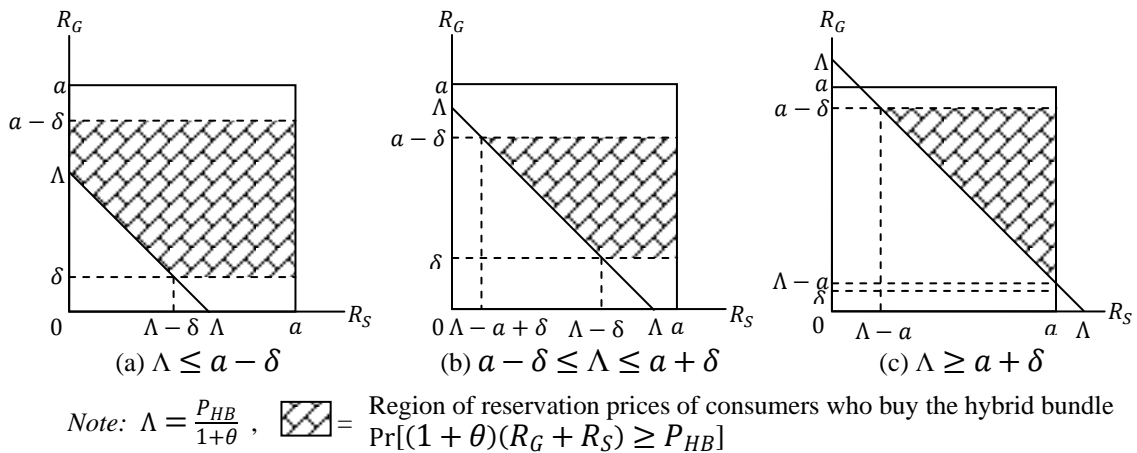


independence (2-2d), the monopolist can serve all three purchasing segments. Here, the

sizes of the segments are determined by all three prices (hybrid bundle, good, and service) and the degree of complementarity between the good and service.

This framework offers closed-form solutions under certain conditions. As mentioned earlier, full independence, good-only independence, and service-only independence are forms of mixed bundling. While prior research does not provide any closed-form solutions for mixed bundling, I can derive closed-form solutions for the no independence condition, where the monopolist only sells the hybrid bundle, serving only the N_{HB} segment. The size of the segment depends on a number of factors and, as shown in Figure 2-3, can be represented in three distinct ways. To allow for differences in quality variability for the service and good, I draw reservation prices, (R_G, R_S) , from the joint uniform distribution such that $f(x, y) = 1/(a^2 - 2a\delta)$ for $0 \leq R_S \leq a$ and $\delta \leq R_G \leq a - \delta$, where δ represents the quality variability differential between the

Figure 2-3 Graphical Depictions of Closed-Form Solutions for Hybrid Bundle Pricing under No Independence



service and the good. Thus, the service and good have the same quality variability when $\delta = 0$, while the good has less quality variability than the service when $\delta > 0$. The size of the segment served is given by Equation 4.1 in Table 2-2. Assuming a constant unit cost function for both the good and the service, the monopolist's problem can be defined as in Equation 2.7.

$$\max_{P_{HB}} \Pi = [(P_{HB} - C_G - C_S) \times N_{HB}] \quad (2.7)$$

Solving for P_{HB} , I find (see Appendix 1 for a derivation):

$$\begin{aligned} P_{HB}^* &= \left(\frac{2\delta(1+\theta) + C_S + C_G + \sqrt{(1+\theta)^2(6a^2 - 2\delta^2 - 12a\delta) - 2\delta(C_S + C_G)(1+\theta)}}{2\delta(C_S + C_G)(1+\theta)} \right) / 3 \quad \text{for } \frac{C_G + C_S}{1+\theta} \leq \frac{(a-3\delta)^2}{2(a-2\delta)} \\ &= [3a(1+\theta) + 2(C_S + C_G)]/4 \quad \text{for } \frac{(a+4\delta)}{2} \leq \frac{C_G + C_S}{1+\theta} \leq \frac{(a-3\delta)^2}{2(a-2\delta)} \\ &= [(2a - \delta)(1+\theta) + 2(C_S + C_G)]/3 \quad \text{for } \frac{C_G + C_S}{1+\theta} \geq \frac{(a+4\delta)}{2} \end{aligned} \quad (2.8)$$

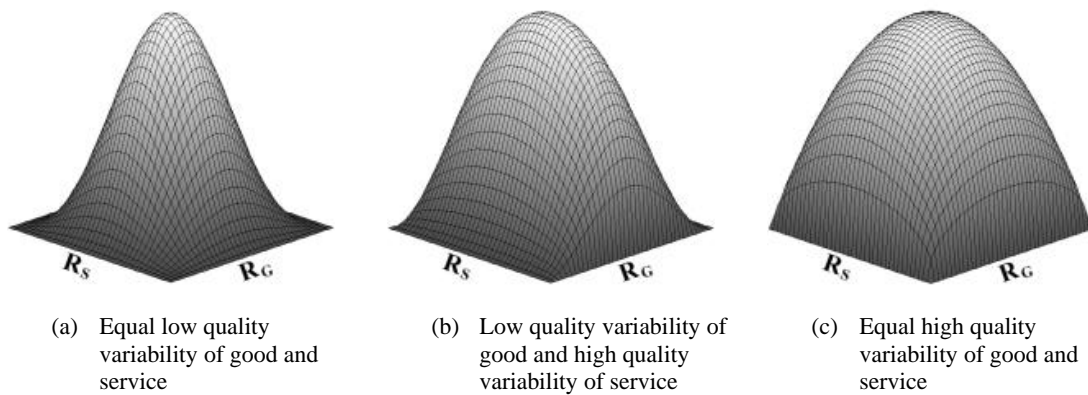
Broadly speaking, the three conditions that produce optimal prices can be viewed as low costs, medium costs, and high costs conditions. When $\delta = 0$, the middle costs condition disappears and the low and high costs conditions are equal to those found in Venkatesh and Kamakura (2003). Consistent with Venkatesh and Kamakura (2003), the optimal price of the hybrid bundle is increasing in complementarity and costs of the good and/or service. I can also examine the effects of changes in the quality variability of the good using δ . Interestingly, the middle costs condition is not affected by δ . When $\delta > 0$, the quality variability of the good is lower than the quality variability of the service. For both the low and high costs conditions, the optimal price of the hybrid bundle is lower when $\delta > 0$.

Aside from the no independence case, the monopolist's objective function does not lend itself to closed-form solutions in other cases, which represent a form of mixed bundling. Consistent with previous research on mixed bundling (Adams and Yellen 1976; Kopalle et al. 1999; Schmalensee 1984; Venkatesh and Chatterjee 2006; Venkatesh and Kamakura 2003), I adopt a numerical method to solve for the optimal good and service prices. For each scenario involving service quality variability, scalability, complementarity, and independence, I follow the method of Venkatesh and Chatterjee (2006) by creating 40,401 synthetic consumers in a two-dimensional, $(R_G \times R_S)$, grid representing consumer reservation prices. Each consumer in the grid has a unique combination of good and service valuations, (R_G, R_S) , ranging from (0,0) to (1,1) based on the particular joint beta distribution used for that scenario.

I capture the differences in quality variability between goods and services by drawing consumers' reservation prices from a joint beta distribution. While past research has often used a joint uniform distribution (e.g., Venkatesh and Chatterjee 2006; Venkatesh and Kamakura 2003), I require a distribution that allows me to manipulate the variance in reservation prices, while keeping the mean reservation price the same for the good and the service. The joint beta distribution fits this need nicely. Moreover, the uniform distribution is a special case of the beta distribution, so past research results can be nested within my research results. Higher service quality variability, and thus expectations in quality, can be reflected in two cases. First, the quality variability for the service can increase relative to a base case of equal good and service quality variability. To explore this situation, I consider an equal quality

variability condition, where quality variability for the good and the service follow a beta $B(1.5,1.5)$ distribution, while I examine an unequal quality variability condition in which the good follows a beta $B(3,3)$ distribution and the service follows a beta $B(1.5,1.5)$ distribution. Second, the quality variability for the good can decrease relative to a base case of equal good and service quality variability. To explore this situation, I consider an equal quality variability condition with the good and service following a $B(3,3)$ distribution, while I investigate an unequal quality variability condition similar to the first case. Figure 2-4 provides a visual representation of these three conditions.

Figure 2-4 Distributions of Reservation Prices of the Good and Service under Equal and Unequal Quality Variability Conditions



To operationalize the different degrees of scalability for the good and the service that lead to the different cost structures, I consider two different conditions. The first condition, equal scalability, is where both the good and the service have equal, constant variable costs of $0.25 \times (N_{HB} + N_G)$ for goods and $0.25 \times (N_{HB} + N_S)$ for services. The

second condition, unequal scalability, is where the good enjoys economies of scale while the service does not. Here, I assume that the good's total variable costs follow an exponential distribution function, while the service's unit costs are constant as before.

Along with the quality variability and scalability conditions, I also take into account the four independence conditions mentioned earlier (i.e., full independence, good-only independence, service-only independence, and no independence). Thus, based on different levels of service scalability, quality variability, and independence, there are $4 \times 2 \times 3 = 24$ scenarios to consider. For each of these scenarios, complementarity ranges from 0 to 1 in steps of 0.1, creating 11 complementarity conditions for each scenario. Therefore, I consider $24 \times 11 = 264$ different scenarios.

To determine the optimal prices and profits for each scenario, I use a grid search procedure. Within each scenario, I vary the appropriate prices of the hybrid bundle, the good, and the service, P_{HB} , P_G and P_S , over the feasible range in increments of 0.001. For each combination of prices, I determine if synthetic consumer i purchases the hybrid bundle (under all independence conditions), only the good (under full independence and good-only independence), only the service (under full independence and service-only independence), or does not purchase at all. With this set up, I determine the size of each segment served for the given independence condition by summing across all 40,401 synthetic consumers. I substitute these segment sizes into the appropriate objective function from Table 2-2 to calculate the profit under the specific service scalability and independence conditions for each scenario. I then identify the prices for which the profits are maximized.

2.4 PROPOSITIONS ON OPTIMAL PRICES, PROPORTION OF BUYERS, AND PROFIT

In this section, I derive a series of propositions on the optimal prices and profits associated with hybrid bundles. I focus on the effects of quality variability and scalability on the optimal prices, proportion of buyers, and profits across the various levels of independence and complementarity.

2.4.1 Demand Side Effects: The Effects of Quality Variability of Good and Service

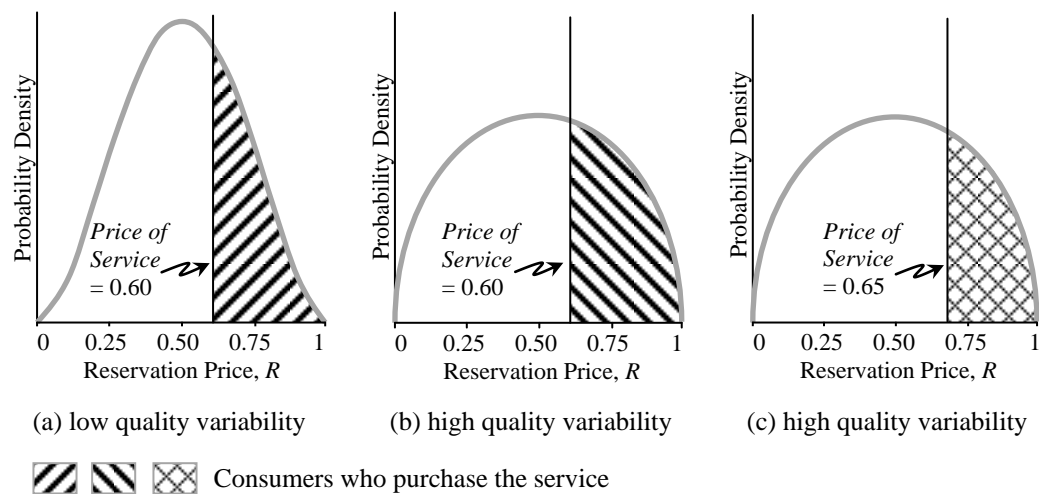
Proposition 1: Compared to a base case of equal quality variability for the good and the service,

- a. an increase (a decrease) in quality variability for the service (good) is associated with a higher (lower) optimal price for the hybrid bundle;*
- b. an increase (a decrease) in quality variability for the service (good) is associated with a lower optimal price for the good;*
- c. an increase (a decrease) in quality variability for the service (good) is (generally) associated with a higher optimal price for the service;*
- d. an increase (a decrease) in quality variability for the service (good) is associated with lower (higher) optimal proportion of buyers; and*
- e. an increase (a decrease) in quality variability for the service (good) is associated with lower (higher) optimal profit.*

From the demand standpoint, higher service quality variability can be reflected by two cases. First, the quality variability for the service can increase relative to a base case of equal quality variability for the good and service. To explain what happens in this case, consider Figure 2-5. The curve in 2-5a represents the distribution of service reservation prices under low service quality variability, while the curves in 2-5b and 2-5c represent the distribution of reservation prices under high service quality variability. Under low service quality variability (2-5a), suppose that for the given conditions, the optimal service price is 0.60. At this price, the firm maximizes profits while serving approximately 32 percent of the customer base. Now, suppose that service

quality variability increases. In the high quality variability condition, with a service price of 0.60, the firm would now serve approximately 37 percent of the customer base (Figure 2-5b). However, this is not the profit-maximizing optimal service price for the high quality variability condition. In this case, the firm should increase the service price such that it can extract higher margins from serving fewer customers with higher reservation prices than in the case of low quality variability. That is, higher quality variability means there is greater customer heterogeneity, so the firm can raise prices. This result is shown in 2-5c, where the optimal service price is higher than in 2-5a under lower service quality variability. Generally, fewer customers served at higher margins result in lower overall firm profits.

Figure 2-5 Distributions of Service Quality for Different Levels of Variability



The second situation where higher service quality variability can occur is when the quality variability of the good decreases relative to a base case of equal quality

variability for the good and service. In this case, the opposite result occurs. The firm lowers the price, serving more customers at lower margins to maximize profits, which are higher.

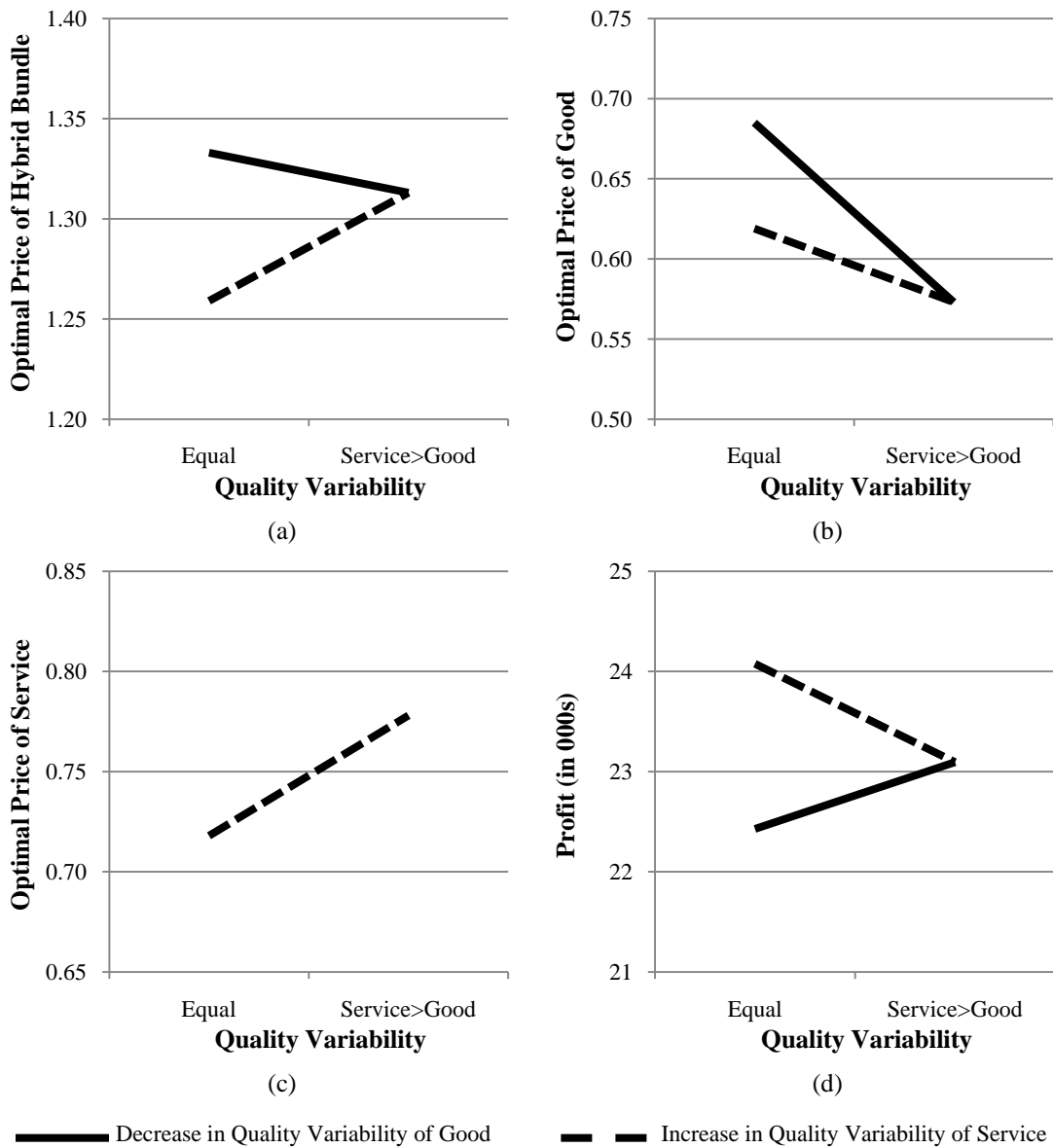
With respect to the optimal hybrid bundle price (*Proposition 1a*), opposite effects occur depending on whether the service has an increase in quality variability or the good has a decrease in quality variability. When the quality variability for the service increases, it is optimal for the firm to have higher hybrid bundle prices. However, when the quality variability for the good decreases, it is optimal for the firm to have lower hybrid bundle prices. The intuition for the difference is as follows. With an increase in quality variability for the service, the reservation price for the service is more variable. Because the hybrid bundle reservation price is the sum of the good and service reservation prices (multiplied by a complementarity factor), it also is more variable. Therefore, more consumers are located at the high and low ends of the distribution of reservation prices for the hybrid bundle. Under these conditions, the firm prices the hybrid bundle higher to maximize profit from the greater customer heterogeneity. The opposite occurs with a decrease in quality variability for the good. The distribution of reservation prices for the hybrid bundle is more clustered around the mean, and the firm lowers the hybrid bundle price to attract more customers around the mean and maximize profit. Figure 2-6a shows the effects of changes in quality variability for the service/good on the optimal hybrid bundle price through a representative example. These effects occur across all independence and complementarity conditions.

Regarding the optimal price for the good (*Proposition 1b*), it is optimal for the firm to decrease the price of the good both when the quality variability of the service increases and when the quality variability of the good decreases. This result can be explained by the following reasoning. An increase in service quality variability is associated with higher hybrid bundle prices (*Proposition 1a*). When this outcome occurs, the firm is faced with fewer consumers purchasing the hybrid bundle. However, some of these consumers who no longer purchase the hybrid bundle, adequately value the good alone. To capture some of these consumers and recoup some of the losses when the good is available separately (i.e., full independence and good-only independence), it is optimal for the firm to lower prices for the good. A decrease in quality variability for the good has a more direct effect on the optimal price for the good when it is available separately. Here, more consumers are clustered around the center of the distribution due to the lower customer heterogeneity. This situation allows the firm to lower the price of the good to capture a greater proportion of customers without sacrificing margin much. Figure 2-6b shows a representative example. As mentioned, these effects occur under full independence and good-only independence and across all complementarity conditions. Prices for the good are less important under service-only independence and no independence than under the full independence and good-only independence conditions.

With respect to the optimal price for the service (*Proposition 1c*), it is generally optimal for the firm to increase the price of the service both when the quality variability of the service increases and when the quality variability of the good decreases. The intuition behind this proposition is as follows. With an increase in quality variability for

the service, the reservation price for the service is more variable. Therefore, more consumers are located at the high and low ends of the distribution of reservation prices for the service. Under these conditions, the firm prices the service higher to maximize

Figure 2-6 Effects of Changes in Quality Variability of the Good and Service on Optimal Prices and Overall Firm Profits



profit from the greater customer heterogeneity. With a decrease in quality variability for the good, I know from Proposition 1a that the optimal price for the hybrid bundle decreases. When this happens, some consumers that previously only valued the service sufficiently for purchase now purchase the hybrid bundle. The remaining consumers who only adequately value the service for purchase have even higher reservation prices for the service than the previous set of service-only consumers, and it is optimal for the firm to raise the price of the service to take advantage of this. Consider Ecolab, a leading provider of cleaning supplies and service to restaurants. Because its restaurant customers are more heterogeneous in size, type of cuisine and style of dining in large metros than in small towns, their expectations of service quality also vary considerably more in metros than in small towns. Consistent with this proposition, Ecolab charges higher prices for its services in larger cities than in smaller towns. Figure 2-6c shows a representative example. As mentioned, these effects occur under full independence and service-only independence and across all complementarity conditions. Prices for the service are less important under good-only independence and no independence than under the full independence and service-only independence conditions.

With regard to the proportion of buyers and overall firm profit (*Propositions 1d and 1e*), opposite effects occur depending on whether the service has an increase in quality variability or the good has a decrease in quality variability. When the quality variability for the service increases, fewer customers purchase and the firm has lower profits. However, when the quality variability for the good decreases, more customers purchase and the firm has a higher profit. I can explain this result for each of the four

independence conditions. Under full independence, an increase in quality variability for the service causes more consumers to be located at the high and low ends of the distribution of reservation prices for the hybrid bundle and the service. Therefore, the firm raises prices on the hybrid bundle and service to serve fewer customers at a higher margin but a lower profit compared to when the quality variability of the service was lower. At the same time, the firm lowers prices on the good to capture more of the good-only customers, serving more customers at a lower margin but a higher profit. The decrease in consumers purchasing the hybrid bundle and the service only overshadows the increase in consumers purchasing the good only. The end result of serving fewer consumers is lower profit. The opposite occurs with a decrease in quality variability of the good. More consumers purchasing the hybrid bundle and good-only due to lower prices overshadow the fewer consumers purchasing the service. The end result of serving more consumers is higher profit.

Under good-only independence, a decrease in quality variability for the good decreases both the hybrid bundle price and the price of the good. The lower prices attract customers with lower reservation prices and lead to a higher profit. An increase in service quality variability increases hybrid bundle prices, but decreases the price of the good. However, the net effect is fewer customers purchasing and lower profit.

Under service-only independence, an increase in service quality variability increases both the hybrid bundle price and the service price. The higher prices dissuade customers with lower reservation prices from purchasing and contribute to a lower profit. A decrease in quality variability for the good decreases hybrid bundle prices and

generally increases the price of the service. The increase in consumers purchasing the hybrid bundle overshadows the decrease in consumers purchasing only the service, yielding a higher profit.

Finally, under no independence, only the hybrid bundle can be purchased. An increase in quality variability for the service raises hybrid bundle prices, attracting fewer consumers and resulting in lower profit. A decrease in quality variability for the good lowers hybrid bundle prices, attracting more consumers and resulting in higher profit. Figure 2-6d shows a representative example for profit.

2.4.2 *Supply Side Effects: The Effects of Scalability of Good and Service*

Proposition 2: Compared to a base case of constant and equal unit cost for the good and the service, when the good has diminishing costs and the service has constant unit cost,

- a. optimal hybrid bundle price is lower;*
- b. optimal price of the service (good) is higher (lower);*
- c. optimal proportion of buyers is higher; and*
- d. optimal profit is higher.*

From the supply perspective, I represent the scalability of the service relative to the good using two different cost function conditions. The first condition assumes that both the good and the service have equal, constant unit costs. The second condition assumes that the good has diminishing unit costs and the service has constant unit costs as before.

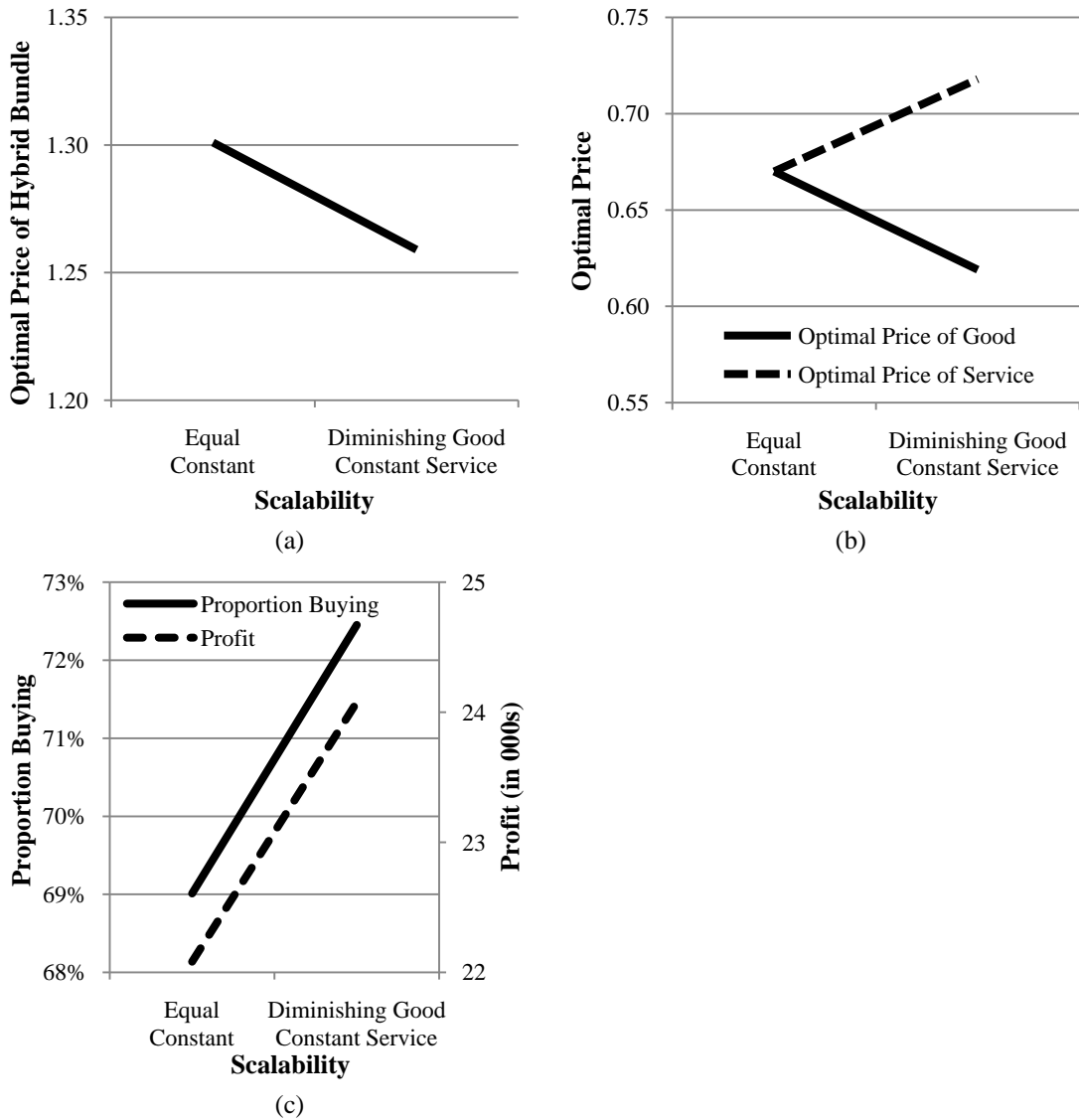
Optimal hybrid bundle prices are lower when the good has diminishing unit costs than when it has constant unit costs (*Proposition 2a*). The intuition for this proposition is as follows. Because the hybrid bundle costs are additive in the component costs, the lower costs for the good directly lower the cost of the hybrid bundle. By lowering the

price of the good, the firm can increase demand and serve more customers at similar margins. Figure 2-7a shows a representative example. These effects occur under all independence and complementarity conditions.

With respect to optimal prices for the good and service (*Proposition 2b*), diminishing unit costs for the good compared to constant unit costs for the good has opposite effects for the good and service. While the optimal price of the good decreases in this situation, the optimal price of the service increases. This proposition's intuition is as follows. For the good, the diminishing unit costs of the good have a direct effect of lowering the optimal price for the good because the firm leverages the lower costs by lowering prices to capture more of the good-only market under the full independence and good-only independence conditions. For the service, the diminishing unit costs of the good have a more indirect effect of increasing the optimal price for the service. Service prices are only optimized under the full independence and service-only independence conditions. As shown in *Proposition 2a*, diminishing unit costs for the good lowers the optimal hybrid bundle price. A lower hybrid bundle price induces some consumers who previously only purchased the service to now purchase the hybrid bundle. The service valuations of the remaining consumers who buy only the service are higher than those of the consumers who bought only the service prior to the decrease in the hybrid bundle price. Thus, by increasing the price of the service to serve these remaining service-only customers, the firm can obtain a higher margin. TiVo's pricing change in 2006 validates this proposition. During this period, even as TiVo's DVR price dropped due to improved scalability offered by technological advance, TiVo raised the

price of its subscription service. Figure 2-7b shows representative examples for the good and the service.

Figure 2-7 Effects of Changes in Scalability of the Good on Optimal Prices, Proportion of Buyers, and Overall Firm Profits



With respect to the proportion of buyers and overall firm profits (*Proposition 2c and 2d*), when the good has diminishing unit costs compared to constant unit costs, both the proportion of buyers and overall firm profit is higher. Again, I can provide the intuition for each independence condition. Under full independence, the lower costs for the good lead to lower hybrid bundle prices, lower prices for the good, and higher prices for the service. Thus, I have more customers purchasing the hybrid bundle and the good, but fewer purchasing the service, although at a higher margin. The increase in the number of consumers purchasing the hybrid bundle and the good only eclipses the decrease in the number of consumers purchasing the service, resulting in higher overall profits.

Under good-only independence, the lower costs for the good lead to lower hybrid bundle prices and lower prices for the good. This situation leads directly to more consumers purchasing and higher firm profit.

Under service-only independence, the lower costs for the good lead to lower hybrid bundle prices, but higher prices for the service. Thus, I have more consumers purchasing the hybrid bundle, but fewer consumers purchasing the service, although at a higher margin. The number of consumers being added to the hybrid bundle segment is greater than the number leaving the service-only segment. The net effect is a higher proportion of buyers and higher firm profit.

Lastly, under no independence, the lower costs for the good lead to lower hybrid bundle prices. Thus, there are more consumers purchasing the hybrid bundle and higher firm profit. Figure 2-7c shows a representative example for profit and proportion buying.

2.4.3 *The Effects of Independence and Complementarity*

Although I offer no formal propositions on the effects of independence and complementarity on optimal prices and profit, I briefly discuss them. I find that the optimal hybrid bundle price and profit are highest under full independence and lowest under no independence. The results in the full independence condition are consistent with those in mixed bundling form. Similarly, the results in the no independence are consistent with those in pure bundling form. That is, *ceteris paribus*, full independence has a profitability advantage over no independence. However, decreasing the quality variability for either the good or the service can remove the profitability advantage. That is, no independence with low quality variability can be more profitable than full independence with high quality variability. Low quality variability allows the firm to lower prices, increase demand and serve a greater proportion of the market. Furthermore, I find that optimal prices for the hybrid bundle, the good, and the service, along with profits, increase with complementarity. Interestingly, at the highest levels of complementarity, I find that the effects of independence are greatly diminished.

2.4.4 *Results Summary and Contributions Relative to Literature*

A summary of the key results from the propositions appears in Table 2-3. The key results relate to the effects of quality variability and scalability on optimal prices and profits. When quality variability is higher for the service than for the good, the optimal hybrid bundle and/or service price is higher. Although the bundle and service-only buyers have higher margins, they are not able to offset the loss in revenue from the overall lower proportion of buyers, resulting in lower profits. The greater scalability of

the good over the service, however, allows for a lower optimal price for the hybrid bundle and/or the good, but a higher service price. In this case, the monopolist serves a higher proportion of buyers at approximately equal or higher margins, with a net effect of higher profits.

Table 2-3 Summary of Key Analytical Results on Hybrid Bundle Pricing

Conditions	Optimal Prices			Proportion of Buyers and Profit
	Hybrid Bundle	Service	Good	
<i>QUALITY VARIABILITY</i>				
Quality variability of service increases	Higher	Higher	Lower	Lower
Quality variability of good decreases	Lower	Higher*	Lower	Higher
<i>SCALABILITY</i>				
From equal, constant unit costs for the good and the service to diminishing unit costs for the good	Lower	Higher	Lower	Higher
* Generally true except for a few extreme values of quality variability of the good in some simulation scenarios. This relationship is always true for low complementarity between the good and the service. However, for high levels of complementarity, the optimal price of the service does not always increase in some conditions. However, these situations are rare and inconsequential as with higher levels of complementarity, very few customers purchase the service alone, so the focus is on the price of the hybrid bundle.				

My results extend findings from the bundle pricing literature in marketing (e.g., Ghosh and Balachander 2007; Kopalle et al. 1999; Venkatesh and Chatterjee 2006; Venkatesh and Kamakura 2003) in many ways. First, to my knowledge, my research is the first to examine the effects of different levels of quality variability of the components within a bundle. Because of the inherent differences between a good and a service,

differences in quality variability between the components in a bundle are more likely in a hybrid bundle than in a goods-only or a services-only bundle. Consumers are aware of this variability and form their expectations accordingly prior to purchase. My findings suggest that typically when quality variability of the service is greater than that for the good, counter-intuitively, the optimal hybrid bundle price is higher, but overall profit is lower.

Second, my results also expand on the bundling-related research in operations management. While some prior studies have included costs in their analysis (e.g., Bala and Carr 2009; Bitran and Ferrer 2007), they assume costs to be the same for all the components in a bundle, so they do not consider different levels of scalability between the components. My findings show that the higher scalability of the good over the service in a bundle leads to lower optimal prices of the good and the hybrid bundle, but higher optimal price for the service and a greater overall profit.

Third, although not a primary focus of my research, my results on independence and complementarity reinforce and extend prior bundling research (e.g., Balachander et al. 2010; Venkatesh and Kamakura 2003). Full independence of the components within a bundle yields optimal profit similar to mixed bundling generally having a profitability advantage. Similarly, consistent with prior bundling research, I find that price and profit increase with complementarity. I extend prior research by showing that at the highest levels of complementarity, the level of independence has little effect as the optimal prices and profits converge as consumers naturally want to purchase and use the

components of the hybrid bundle together. I also show that low quality variability is more critical than independence from a profitability standpoint.

2.5 DISCUSSION AND MANAGERIAL IMPLICATIONS

I now discuss the answers to the two main research questions and outline their managerial implications. The focus in the first research question was the difference in quality variability between goods and services. My findings on optimal prices on this dimension are counter-intuitive. Compared to a base case of equal quality variability for the good and service, the findings suggest that a profit-maximizing monopolist should increase the price of the hybrid bundle and the price of the service as service quality variability increases. However, while this strategy is optimal, an increase in service quality variability leads to fewer consumers purchasing and lower overall firm profit than that when service quality variability is low. Similarly, optimal prices for the hybrid bundle and good decrease with a decrease in quality variability of the good, leading to more consumers purchasing and a higher overall firm profit. Therefore, managers should carefully consider the differences in quality variability for the good and the service within a hybrid bundle. For hybrid bundles that include people-intensive services, service quality has a wider variation than the quality of the good, leading to a wider distribution of reservation prices for the service than the good. To account for this situation, managers should consider pricing the service and the hybrid bundle relatively higher, while pricing the good relatively lower.

Managers must also be mindful about how quality variability affects profits. While higher service quality variability is associated with higher optimal prices for the

hybrid bundle and the service, firm profit is lower. Therefore, executives may want to lower service quality variability as higher optimal price of the service and the bundle is counter-productive to overall firm profit. Although quality variability is exogenous in the model, over a long period of time, firms do try to influence it. Thus, over the years, fast food restaurants such as McDonald's, which offer food (the good) and service, have been able to reduce quality variability in service by following standardized practices (e.g., consistent method of greeting, order-taking, cleaning, fulfilling orders across customers). The lowered variability in the quality of service and the good has enabled such restaurants lower the bundle price, attract more customers, and boost overall profit.

In the second research question, the focus was on the scalability of the service relative to the good. Consistent with my expectation, I find that, *ceteris paribus*, the optimal prices for the hybrid bundle and the good are lower when the good has diminishing costs than when it has constant costs. The optimal price for the service, however, is less straightforward. My results suggest that, *ceteris paribus*, the optimal price for the service is higher when the good has diminishing costs than when it has constant costs.

In setting hybrid bundle prices, managers must take into account the interaction between scalability and independence of the good and the service within a hybrid bundle. When the service is less scalable than the good and when the service is available independent of the good, managers should consider pricing the service higher to maximize profits. Increased scalability of the good generally leads to relatively lower prices for the hybrid bundle and the good. Managers can thus increase the price of the

service to extract a higher margin on the service-only customers without sacrificing the total number of customers served. For example, suppose an outdoor spa hot tub marketer, who is a monopolist in a local market, offers a hybrid bundle of a spa hot tub and lifetime maintenance service, but also sells the hot tub and maintenance service separately. Suppose this marketer has developed a highly scalable manufacturing process for hot tubs. In this case, the more scalable component (hot tub) should lead to lower prices for both the hybrid bundle and the hot tub. When this outcome occurs, more consumers will purchase the hybrid bundle or the hot tub. This situation allows the manufacturer to increase the price of the maintenance-only service contracts without sacrificing overall profit. While the marketer may be serving fewer maintenance-only customers, in doing so, it derives a higher margin.

2.6 LIMITATIONS AND EXTENSIONS

My research is a first attempt at developing a pricing model for hybrid bundles. Naturally, it has limitations, offering opportunities for future research. The limitations in my research relate mostly to the assumptions I made for parsimony and tractability of simulations. First, I assume that the degree of complementarity between the good and the service in a hybrid bundle is the same for all consumers. Future research could relax this assumption by allowing complementarity to vary by consumer. For example, in addition to the good and service reservation prices following a beta distribution, one could allow the complementarity to also follow a beta distribution.

Second, in my simulations, I assume that independence between the good and service is dichotomous, creating four independence conditions. However, independence

could be continuous or be a consumer level parameter. For example, for some hybrid bundles, technologically savvy consumers may be able to use a good (service) more independently from the service (good) than consumers who are not technologically savvy.

Third, I explored scalability by varying the cost structure of the good. I did not explore the possibility of highly-scalable digital services. In addition, I only considered two different cost conditions to keep the number of simulations reasonable. Future research could explore highly-scalable digital services as well as look at the effects under different levels of good and service marginal costs.

Fourth, my research focus is limited to a monopoly. This setting is realistic for many new-to-the-market hybrid bundles and is a useful start in the analysis of all hybrid bundles. The analysis could be extended to duopoly and other competitive settings for greater generalizability and extend bundling research in competitive contexts (e.g., Chen 1997; Ghosh and Balachander 2007).

Finally, my research looks at a single time period. Many hybrid bundles involve a single purchase of a good with a subscription-based service. Over multiple time periods, the good may be replaced and prices of the subscription-based service may change. A model that allows for multiple time periods would also provide more valuable insights.

2.7 CONCLUSION

Hybrid bundles are and will continue to be a vehicle of growth for traditional goods firms and conventional service companies in both B2C and B2B industries. In this

essay, I conceptually outlined how hybrid bundles differ from traditional bundles of goods or bundles of services and how these differences have implications for bundle pricing. I formulated a model of optimal hybrid bundle pricing by a monopolist and developed several useful and counter-intuitive propositions on optimal prices of the bundle, the good and the service under varying conditions of quality variability and scalability, while also accounting for independence and complementarity of the components. My results show that an increase (decrease) in quality variability for the service (good) is generally associated with higher (lower) optimal prices for the hybrid bundle and lower optimal price for the good, but lower (higher) overall firm profits. They also reveal that the optimal service (good) price in a hybrid bundle is higher (lower) when the good has a diminishing unit cost and the service has a constant unit cost (i.e., the good is more scalable than the service).

CHAPTER III
HYBRID BUNDLE PRICING USING WILLINGNESS-TO-PAY
MEASURES FROM CONJOINT ANALYSIS

3.1 INTRODUCTION

Many traditional manufacturing companies and traditional service companies are increasingly selling hybrid bundles—bundles comprising one or more goods and one or more services. By some estimates, sales of embedded services (i.e., services sold along with durable goods) grew nearly 200 percent from 1995 to 2004, and the share of sales in the durable goods sector attributed to embedded services rose from 12 percent to 22 percent in the same period (Auguste et al. 2006). In addition, in many of the global manufacturing companies, services account for about 25 percent of total revenues and approximately 46 percent of total profits (Deloitte Research 2006).

The pricing of such hybrid bundles is critical to the success and profitability of firms selling these bundles. In particular, three factors, quality variability, independence, and complementarity are important determinants of pricing (Meyer and Shankar 2010). While some theoretical insights about the effects of these factors on pricing are known, empirical or experimental evidence on their effects is sparse. In particular, little is known about the effects of these three important factors on consumer willingness-to-pay for the hybrid bundle and its components. This research aims to fill this void by estimating these effects using consumers' willingness-to-pay measures extracted in an experimental setting.

Consider the hybrid bundle of flooring (the good) and installation (the service) offered by Lowe's, a home improvement retailer. While the good is tangible and is homogenous in quality, the service is intangible and considerable heterogeneity exists in the quality of the installation. How does this difference in quality variability between the good and the service affect consumers' willingness-to-pay for the installation? As another example, consider U-Haul's hybrid bundle consisting of the sale of a truck hitch and the rental of a pull-behind trailer. Are consumers willing to pay more for the hitch because it can be used with a multitude of trailers instead of only with U-Haul's trailers? Similarly, would consumers be willing to pay less for the pull-behind trailer rental if it could only be used with a U-Haul hitch? Finally, consider TiVo's hybrid bundle offering of the digital video recorder (DVR) and program guide service. Does the increased benefit consumers receive from using the DVR with the program guide service increase their willingness-to-pay for the DVR? These are the other types of questions that this research will help answer.

The bundling literature has a long history in marketing and economics. Unfortunately, the bulk of this literature focuses on the bundling of similar components; that is, a bundle consisting only of goods or a bundle consisting only of services. The bundling of goods and services has been largely ignored. There are inherent differences between goods and services that suggest that consumer willingness-to-pay for hybrid bundles and the pricing of such bundles may be inherently different from those for bundles with similar components. This research helps fill this important gap.

Similarly, the bundling literature has often focused on the *purchase* of bundle components, not on their *usage*. The changes in consumer utility when components are purchased together differ from those when the components are used together. TiVo's DVR and program guide are often purchased together and must be used together. However, an Otis elevator and Otis' maintenance service need not be purchased together nor used together as an Otis elevator can be serviced by a third party, and Otis services competitive elevator brands. These differences have significant implications for the willingness-to-pay for hybrid bundles and the purpose of this research is to examine these differences as well.

The rest of the essay is organized as follows. I start with conceptual development and propose several hypotheses, focusing on the topics of bundling, willingness-to-pay, quality variability, independence, and complementarity. I follow with three experimental studies that examine the effects of quality variability, independence, and complementarity on willingness-to-pay both separately and together. I then present and discuss the results. I discuss the managerial implications and close by highlighting the key limitations and future research avenues.

3.2 CONCEPTUAL DEVELOPMENT AND HYPOTHESES

A hybrid bundle is a single firm's offering that combines one or more goods with one or more services, creating greater customer benefit than if the good(s) and service(s) were available separately. This definition is consistent with the definition in Meyer and Shankar (2010). This hybrid bundle definition contains two key criteria. First, the same firm must sell both the good and the service, ensuring that the firm receives revenues

from both. Second, when a customer uses the good and service together, the benefit a customer receives from the use of the good and service together is greater than the benefit a customer receives from using the good and service separately.

3.2.1 Bundling

Stremersch and Tellis (2002, p. 55) define bundling as “the sale of two or more separate products in a package.” When a firm decides to bundle products or services together, it must choose its strategy along two dimensions: bundle focus and bundle form (Stremersch and Tellis 2002). The bundle focus decision reduces to a decision between product bundling and price bundling. Product bundling and price bundling differ in two main ways. First, price bundling requires the sale of the bundle at a discount compared to the sum of the individual components, whereas product bundling does not. Second, product bundling requires integration among the components of the bundle, whereas price bundling does not. Put into the context of hybrid bundles, which requires that the use of the service and good together *increase* consumer benefit, hybrid bundles are product bundles and not price bundles.

The bundle form decision reduces to a decision about how the components of the bundle are offered to consumers. If the components are only offered in a bundle, the bundle form is called pure bundling. If the components are not offered in a bundle at all, the bundle form is called pure components. However, if the components are offered both in a bundle and separately, the bundle form is called mixed bundling. In hybrid bundles, bundle form is deemphasized in favor of independence. Independence is the extent to which the good and service are available and can be used separately from each other

(Shankar, Berry, and Dotzel 2009). Important differences exist between independence and bundling form. First, bundling form is focused on the purchase of the components, but not necessarily on the use. That is, in pure bundling, a consumer may still be able to use the components separately. However, in hybrid bundles with no independence, not only may the consumer not be able to purchase the components separately, the consumer will not be able to use one of the components without the other. Another important difference is the discrete nature of bundle form: pure components *or* pure bundling *or* mixed bundling. Contrary to this conceptualization, independence is more continuous in nature and can vary based on the components of the hybrid bundle or vary by consumer. Consider a Sirius satellite radio. Without the Sirius service, the radio may have partial functionality in that it can play land-based radio stations, whereas with the Sirius service, the radio has full functionality.

Bundling research has a long history in economics and marketing. The extant research can be placed in two major buckets. The first bucket typically uses normative models to provide guidance on the optimal pricing and/or design of bundles on a variety of topics. For example, bundling can be used as a price discrimination tool to extract greater consumer surplus (e.g., Adams and Yellen 1976; Schmalensee 1984; Venkatesh and Mahajan 1993). Complementarity increases consumer reservation prices for the bundle versus the sum of the individual components (e.g., Tesler 1979; Venkatesh and Kamakura 2003). Increased profitability due to bundling can come from component cost sub-additivity (e.g., Hanson and Martin 1990). Mixed bundling, pure bundling, and pure components all have areas of optimality depending on factors such as cost and demand

(e.g., Adams and Yellen 1976; Schmalensee 1984; Venkatesh and Kamakura 2003). Bundling can reduce competition through tie-in sales and by deterring entry (e.g., Carbajo, De Meza, and Siedman 1990).

The second bucket is more behavioral in nature and explores consumers' perceptions of bundling on a variety of topics. For example, consumers form subjective evaluations for each component within a bundle, which are then combined to form an overall evaluation (Gaeth et al. 1990). The authors use a tie-in context where the tie-in has a much lower monetary value than the primary product and find that the tie-in can have an effect on bundle attractiveness equally as high as the primary product, even though the monetary value is much lower. Bundling also induces consumers to purchase more than if the products were offered individually (Drumwright 1992). Building on Thaler's (1985) transaction utility, Yadav and Monroe (1993) find that consumer's transaction value is largely influenced by the additional savings offered by purchasing the bundle; however, savings on individual items are also important. When consumers evaluate bundles, they start with an anchor of the most important attribute and make adjustments throughout the evaluation (Yadav 1994). With respect to bundle evaluation and pricing, a discount on the more preferred bundle component results in a higher bundle evaluation (Yadav 1995). In terms of complementarity, the greater the functional complementarity between components of a bundle, the greater the likelihood of purchasing the bundle (Herrmann, Huber, and Coutler 1999).

3.2.2 *Willingness-to-Pay*

The value of a product offering has been called “the cornerstone of marketing strategy” (Anderson, Jain, and Chintagunta 1993, p. 3). Therefore, it is not surprising that willingness-to-pay and reservation price⁶ have received much attention in marketing and economics. However, as pointed out by Wang, Venkatesh, and Chatterjee (2007), there is inconsistency in the literature with respect to the definition. Extant literature has considered: (1) the minimum price at which a consumer will no longer purchase (Hauser and Urban 1996); (2) the price at which a consumer is indifferent between purchasing and not purchasing (Moorthy, Ratchford, and Talukdar 1997); and (3) the maximum price at which a consumer will purchase (Varian 1992). Jedidi and Jagpal (2009) call these the ceiling reservation price, indifference reservation price, and floor reservation price, respectively. I define willingness-to-pay as the indifference reservation price; that is, the price at which a consumer is indifferent between purchasing and not purchasing a product. I treat a consumer’s willingness-to-pay as a monetary measure of a product’s utility. At the consumer’s willingness-to-pay price, the surplus extracted for the consumer is the same with or without purchase — zero.

Estimating consumers’ willingness-to-pay can be done using data from one of five sources: market or purchase data; laboratory or field experiments; experimental auctions; direct surveys; and indirect surveys. Each method has its own advantages and disadvantages. For example, observational methods using market or purchase data are not subject to hypothetical bias and are incentive compatible because they are based on

⁶In this chapter, I use the terms willingness-to-pay and reservation price interchangeably.

actual purchases. However, such methods are limited in the number of price points that can be studied (Jedidi and Jagpal 2009). While laboratory or field experiments allow for additional control, they are typically associated with higher costs. Experimental auctions, such as the Vickrey (1961) and the Becker, DeGroot, and Marshak (1964) procedure, are incentive compatible using real money, but lack realism with the purchase situation. Direct surveys elicit consumers' self-stated willingness-to-pay and are the easiest to implement, but perhaps are the most likely to lead to inaccurate results due to consumers' increased likelihood to overstate willingness-to-pay for more well-known brands and understate for less well-known brands (Jedidi and Jagpal 2009). Indirect surveys cover the many varieties of conjoint analysis, including choice-based conjoint analysis. Conjoint analysis has a long history in marketing and is discussed in more detail later in this essay.

3.2.3 Quality Variability

Hybrid bundles are unique combinations of services and goods. The common differences of services compared to goods — intangibility, perishability, heterogeneity, and simultaneous production and consumption — are well documented (e.g., Zeithaml, Parasuraman, and Berry 1985). While each of these differences likely affects a consumer's willingness-to-pay, one of particular importance to the pricing of hybrid bundles is heterogeneity. Zeithaml, Parasuraman, and Berry (1985, p. 34) sum up the fundamental nature of heterogeneity in services as follows.

The quality and essence of a service ... can vary from producer to producer, from customer to customer, and from day to day. Heterogeneity in service output is a particular problem for labor intensive services.

A key part of this description of heterogeneity of services is the variability in quality. Whereas the production of goods is often standardized and quality control is tightly contained, the production or performance of a service often lacks standardization and tightly constrained quality control, especially for labor-intensive services. Even prior to purchasing, consumers expect services to have greater variability in quality than goods (Murray and Schlacter 1990). However, it is unknown how this will affect consumers' willingness-to-pay for services, either in a bundle or stand-alone services.

In a normative model on hybrid bundle pricing, Meyer and Shankar (2010) assume that greater quality variability is associated with a wider distribution of reservation prices across consumers. Using this association, the authors find that the optimal price for the service in a hybrid bundle increases with an increase in quality variability of the service. However, the assumption of the association between greater quality variability and a wider distribution of reservation prices is not tested. This leads to the following hypothesis.

H1: When the quality variability of the service is high versus low, the variance of consumers' willingness-to-pay for the service is wider.

No formal hypotheses are made regarding the effect of the quality variability of the service on the average willingness-to-pay for the service or the average and distribution of the willingness-to-pay for the good. However, no significant differences in any of these three measures are expected.

3.2.4 Independence

As mentioned previously, bundle form is deemphasized in hybrid bundles in favor of independence, which is the extent to which the good and service can be used

separately from each other (Shankar, Berry, and Dotzel 2009). Therefore, many of the findings in extant literature with respect to the optimality of mixed bundling over pure bundling or pure components are not entirely instructive with respect to independence. However, the ability to use the good or the service separate from the other component in the hybrid bundle should increase the consumer's utility. An increase in utility should be reflected with a higher willingness-to-pay. Anecdotal evidence suggests that businesses may be pricing information goods to reflect this. Take Amazon.com, which offers e-books in two formats: a propriety format that can only be used with the Kindle (or compatible hardware running Kindle software) and a portable document format that can be used on a wide variety of hardware. A quick browsing of the books at Amazon.com that are available in both formats routinely shows that the more independent format is higher priced than the less independent format. This leads to the second hypothesis.

H2a: When the service is independent from the good, consumers are willing to pay more for the service.

H2b: When the good is independent from the service, consumers are willing to pay more for the good.

Independence of one component can also have an effect on the willingness-to-pay for the other component. For example, if the service is independent, consumers may be willing to pay more for the good than if the service is not independent. In essence, this is a cross-demand effect. Consumers' expertise with products increase as they become more familiar with them. The increased familiarity and expertise can lead to automaticity, which frees up recourses to be used on other tasks (Alba and Hutchinson 1987). In a hybrid bundle setting, increased usage of the service (or good) due to its

independence from the good (or service) increases the consumer's familiarity and, thus, expertise with the service (or good). When this occurs, consumers have more resources to devote to the usage of the good (or service), increasing their utility and leading to higher willingness-to-pay measures. This leads to the third hypothesis.

H3a: When the service is independent from the good, consumers are willing to pay more for the good.

H3b: When the good is independent from the service, consumers are willing to pay more for the service.

3.2.5 Complementarity

Both the normative models and behavioral research streams have looked at complementarity. Complementarity is central in the very definition of hybrid bundles. Shankar, Berry, and Dotzel (2009, p. 96) define complementarity as “the degree to which the value to the customer increases when the product and the service are used together.” This is similar to the concept of super-additivity of reservation prices found in the normative models research stream (e.g., Venkatesh and Kamakura 2003). By definition, the normative models require that willingness-to-pay is higher with increased complementarity. Research in the behavioral research stream focuses on whether the components of a bundle are functionally related or not functionally related (e.g., Herrmann, Huber, and Coutler 1999); that is, complementary or not complementary, respectively. Gaeth et al. (1990) show that complementary bundles are evaluated differently than non-complementary bundles. Herrmann, Huber, and Coutler (1999) show that consumers are more willing to purchase functionally related bundles versus bundles not functionally related. However, little research has looked at the effect of

complementarity on the willingness-to-pay for components in a bundle. Thus, I hypothesize as follows.

H4: When complementarity between the good and the service is high versus low, consumers are willing to pay more for (a) the service and (b) the good.

3.2.6 Independence – Complementarity Interaction

It is reasonable to believe that independence and complementarity interact to significantly alter consumers' willingness-to-pay for the good or the service within a hybrid bundle. Independence affects whether the consumer *can* use the good and service separately. Complementarity affects whether the consumer *wants* to use the good and service together. Although independence is conceptually different from bundling form, extant research in the normative models stream provides some guidance. Venkatesh and Kamakura (2003) show that with strong complements, pure bundling can be optimal versus mixed bundling or pure components. With strong complementarity, consumers are more likely to want to purchase the bundle, and optimal prices increase and converge to the pure bundling prices. Similarly, Meyer and Shankar (2010) show that although full independence typically has higher optimal prices, the optimal prices converge to the no independence prices at the highest levels of complementarity. Based on this, one might expect that the difference in consumers' willingness-to-pay between independence and no independence is significantly *smaller* with high complementarity versus low complementarity. On the other hand, one could argue the effects of independence and complementary are multiplicative. That is, the difference in consumers' willingness-to-pay between independence and no independence is significantly *larger* with high

complementarity versus low complementarity. Thus, the fifth and sixth hypotheses do not indicate a direction of the interaction. H5 focuses on the direct effects, while H6 focuses on the cross effects due to familiarity and expertise as in H3.

H5a: Differences in consumers' willingness-to-pay for the *service* under high and low complementarity are moderated by the independence of the service from the good.

H5b: Differences in consumers' willingness-to-pay for the *good* under high and low complementarity are moderated by the independence of the good from the service.

H6a: Differences in consumers' willingness-to-pay for the *good* under high and low complementarity are moderated by the independence of the service from the good.

H6b: Differences in consumers' willingness-to-pay for the *service* under high and low complementarity are moderated by the independence of the good from the service.

3.2.7 Conjoint Analysis

As alluded to earlier, the studies described below rely on conjoint analysis to elicit consumer willingness-to-pay. Conjoint analysis is defined as “any decompositional method that estimates the structure of a consumer's preferences ... given his/her overall evaluations of a set of alternatives that are prespecified in terms of levels of different attributes” (Green and Srinivasan 1978, p. 104). Many types of conjoint analysis exist, from full profile to self-explicated to adaptive to choice-based to incentive-aligned (Ding, Grewal, and Liechty 2005). Common among these methods is the use of multiple attributes and levels within attributes to create product profiles. The preferences for all or some of these profiles are measured using one of the many conjoint analysis techniques. From this, each respondent's preference structure is created based on the

attributes and levels. For each attribute-level combination, respondents' part-worths are estimated. A part-worth is a measure of a respondent's marginal utility for that attribute level. By combining the attributes and levels in different ways to form the different profiles, the respondent's utility for a given profile can be determined.

Conjoint analysis is not without its limitations. For example, it is assumed that the part-worths for each respondent are stable throughout the conjoint analysis. However, it is possible that within-task learning occurs and respondents' preferences change as the task continues (Bradlow 2005). Other criticisms relate to the number and levels of attributes. Many products have a large number of attributes, but typical conjoint tasks only evaluate a small subset of these attributes. Similarly, the attributes and levels within the attributes must be the important or salient attributes to provide accurate part-worth estimates (Bradlow 2005).

Extracting consumers' willingness-to-pay from conjoint analysis began in earnest with the ground-breaking work of Kohli and Mahajan (1991). The authors assume a status quo product against which consumers compare other concepts. The willingness-to-pay that is calculated is the ceiling price for a particular concept in which the consumer would switch away from the status quo product. Wübker and Mahajan (1999) extend the work of Kohli and Mahajan (1991) and estimate willingness-to-pay for product bundles where the one non-price attribute is either an individual item (e.g., French fries) or a bundle of individual items (e.g., French fries, Big Mac, and drink). This research was one of the first forays extracting willingness-to-pay from conjoint analysis in a bundling setting. Jedidi and Zhang (2002) also build off of Kohli and Mahajan (1991), but depart

from the requirement of a status quo product. This method is the one used in this essay, and will be discussed in more detail in a later section. Sichtmann and Stingel (2007) also use a status quo product; however, the authors select the status quo product for each individual through a limit-conjoint procedure, where the concept with the lowest utility that a consumer would actually purchase is set as the status quo product. More recently, Sonnier, Ainslie, and Otter (2007) directly specify respondents' willingness-to-pay using Bayesian analysis.

3.3 STUDY 1

The first study focuses only on the effects of quality variability on willingness-to-pay within a hybrid bundle setting, without directly considering either independence or complementarity. Thus, it tests H1. 129 undergraduate students at a U.S. university participated in a laboratory experiment for class credit. Of the 129 responses, 19 incomplete responses were discarded, keeping 110 usable responses for final analysis. The average respondent age was 20.5 years and 57.3 percent of respondents were female.

3.3.1 Conjoint Design

Study 1 uses a hybrid bundle comprising a portable multimedia device (the good) and a streaming multimedia service (the service) for the conjoint experiment. I selected this hybrid bundle based on a pretest ($n = 84$) in which subject interest and knowledge about portable multimedia players (similar to Apple iPod) and streaming or on-line multimedia services was high. For simplicity, I limited the hybrid bundle to no

independence. That is, the portable music player could not be used without the streaming music service, and vice versa.

Both the good and the service had one non-price attribute and one price attribute. Therefore, each hybrid bundle profile consisted of four attributes that were presented to the respondents. The portable multimedia device was described as a device that “plays audio and video, such as music and TV shows.” For the good, the non-price attribute was the weight of the portable multimedia device using two levels: 3 ounces and 10 ounces. The price attribute for the good comprised three levels (\$25, \$100, and \$175) with a sufficiently broad range to cover reasonable prices (Haaijer and Wedel 2007). The streaming multimedia service was described as a service that “sends wireless audio and video signals, such as music and TV shows, to a compatible player so you can listen or watch.” For the service, the non-price attribute was the number of different music channels from which the user can choose, again using two levels: 50 channels and 150 channels. The price attribute for the service also consisted of three levels with a sufficiently wide range: \$5 per month, \$10 per month, and \$15 per month.

To manipulate quality variability, the following scenario was presented to the respondents:

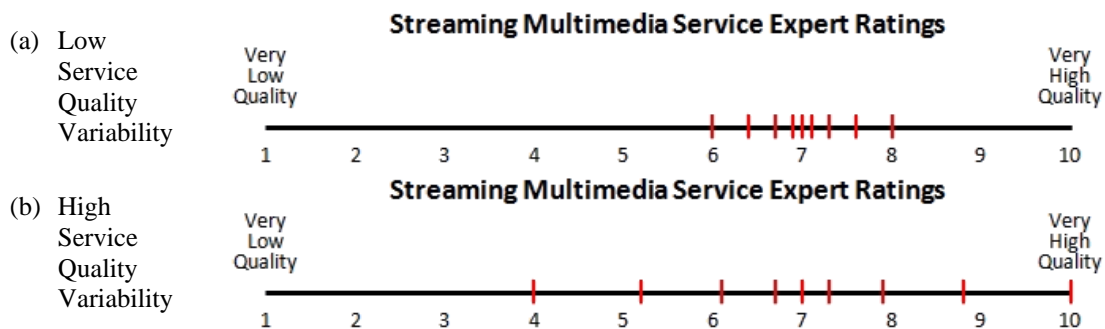
Consumer Reports had nine experts rate the quality of the portable multimedia device and the streaming multimedia service. After using the combination for one month, the experts rated the quality using a scale between 1 and 10, where 1 is Very Low Quality and 10 is Very High Quality.

Under the low (high) service quality condition, respondents were then presented with the following:

The expert ratings for the streaming multimedia service were consistent (inconsistent), with a narrow (wide) range between 6 and 8 (4 and 10). The overall average rating was 7. The graph below shows each expert's rating for the streaming multimedia service. Each red tick-mark represents an expert's rating.

As indicated, the respondents were also presented with a visual scale to reinforce the narrow or wide distribution of service quality ratings, as shown in Figure 3-1.

Figure 3-1 Service Quality Variability Manipulation



A choice-based conjoint design was selected and administered using Sawtooth Software. Choice-based conjoint designs are often considered to better simulate the actual choice decision consumers must make (DeSarbo, Ramaswamy, and Cohen 1995). Each respondent was presented with twelve random choice tasks and two fixed choice tasks. Each choice task consisted of three choices. The twelve random choice tasks were selected using the balanced overlap method instead of minimal overlap. In minimal overlap, an attribute level repeats itself within a choice task as little as possible (e.g., a portable multimedia music player price of \$100 shown in more than one of the three concepts). This method attempts to ensure that the choices made contribute information

about the value of that attribute (Rao 2008). The balanced overlap method allows level overlap within a single choice task, but does not allow for duplicate concepts in a single choice task. If concepts with a particular attribute level are always selected by a respondent, the choices made will not contribute much information. The balanced overlap method is effective by allowing additional overlap to account for these situations (Sawtooth Software 2008).

3.3.2 *Estimation of Willingness-to-Pay*

As mentioned above, willingness-to-pay can be estimated from conjoint analysis data in a variety of ways. For this study, I followed the method of Jedidi and Zhang (2002). The first step is to obtain the part-worth utilities for each respondent from the choice-based conjoint data. Unfortunately, obtaining individual-level estimates is often difficult because of the limited number of observations per respondent (DeSarbo, Ramaswamy, and Cohen 1995). However, hierarchical Bayesian methods allow for the recovery of the individual-level part-worth utilities with such limited observations (Allenby, Arora, and Ginter 1995).

I implemented the hierarchical Bayesian model using Sawtooth Software (2009). The attribute levels are coded using effects coding versus dummy coding. To begin, at the higher level, individual part-worths are assumed to follow a multivariate normal distribution,

$$\beta_i \sim \text{Normal}(\alpha, \sigma^2) \quad (3.1)$$

where β_i is a vector of part-worths for individual i , α is a vector of part-worth means across individuals, and σ^2 is a matrix of variances and covariances of part-worths across individuals.

Within each choice task, a respondent chooses one of the concepts. The probability of individual i choosing a concept follows a multinomial logit model,

$$p_k = e^{x'_k \beta_i} / \sum_j e^{x'_j \beta_i} \quad (3.2)$$

Where p_k is the probability of individual i choosing concept k in a choice task and x_j is a vector of values describing concept j in a choice task, for j from 1 to 3.

I used Gibbs sampling and Monte Carlo Markov Chain method to estimate β , α , and σ^2 . The estimation process consisted of 40,000 iterations. Within each iteration, I used an adaptive Metropolis Hastings algorithm to draw each new set of β values, attempting to keep the acceptance rate near 0.30 (Sawtooth Software 2009). I used the first 20,000 iterations for burn-in until the process converges. I used the next 20,000 iterations for the actual estimation and obtained the final values of β , α , and σ^2 by averaging across the final 20,000 iterations.

With the part-worth utilities in hand, I use the method of Jedidi and Zhang (2002) to estimate each individual's willingness-to-pay. The willingness-to-pay extracted through this method is the indifference reservation price, or "the price at which the consumer is indifferent between buying and not buying the product, given the consumption alternatives available to the consumer" (Jedidi and Zhang (2002, p. 1352). Individual i gets some utility for the consumption of product profile \mathcal{P} and consumption of the composite product y_i , given by the expression $U_i(\mathcal{P}, y_i)$. If individual i has an

income of m_i , the budget constraint is given by $p_i^y y_i + p = m_i$, where p is the price of product profile \mathcal{P} . Thus, the individual utility function of individual i is given by:

$$\begin{aligned} U_i \left(\mathcal{P}, \frac{m_i - p}{p_i^y} \right) & \text{ if product profile } \mathcal{P} \text{ is purchased} \\ U_i \left(0, \frac{m_i}{p_i^y} \right) & \text{ otherwise} \end{aligned} \quad (3.3)$$

Thus, the reservation price, $r_i(\mathcal{P})$, is the price at which the following expression holds:

$$U_i \left(\mathcal{P}, \frac{m_i - r_i(\mathcal{P})}{p_i^y} \right) - U_i \left(0, \frac{m_i}{p_i^y} \right) \equiv 0. \quad (3.4)$$

Using a quasi-linear utility function and a multiattribute utility model, the utility for product profile \mathcal{P} can be written as:

$$U_i(\mathcal{P}) = \beta_{i0} + \sum_{k=1}^N \beta_{ik} A_k - \beta_{ip} p \quad (3.5)$$

where β_{i0} is $\alpha(m_i/p_i^y)$ and α is a positive constant, $\beta_{ik} A_k$ is the utility from non-price attribute k and A_k is the value of the k th non-price attribute, and $\beta_{ip} p$ is equal to α/p_i^y and α is a positive constant.

From equations 3.4 and 3.5, the reservation price for individual i can be recovered as follows:

$$r_i(\mathcal{P}) = \frac{1}{\beta_{ip}} \sum_{k=1}^N \beta_{ik} A_k \quad (3.6)$$

However, because conjoint analysis, including choice-based conjoint analysis, is often performed with indicator variables, the following transformation is required:

$$r_i(\mathcal{P}) = \frac{\Delta p}{\beta_{ip}^c} \sum_{k=1}^N \frac{\beta_{ik}^c}{\Delta A_k} A_k \quad (3.7)$$

With this transformation, $\Delta p/\beta_{ip}^c$ can be computed as a dollar-metric exchange rate of dollars for utiles. The summation in the second part of equation 3.7 is the sum of the

utilities for the non-price attributes at their given levels for product profile \mathcal{P} . Thus, the willingness-to-pay for individual i is obtained by multiplying the dollar-metric exchange rate by the total utility of the non-price attributes.

As mentioned earlier, the conjoint design for Study 1 involves a hybrid bundle with four attributes: one non-price attribute each for the good and the service and one price attribute each for the good and the service. When calculating the willingness-to-pay for the good (the service), the price attribute for the service (the good) is treated as a non-price attribute. For example, when calculating the willingness-to-pay for the service in this study, the exchange rate – the first part of equation 3.7 – is calculated using the price attribute for the service. The utility of the product profile \mathcal{P} – the second part of equation 3.7 – is the sum of the part-worths for the number of channels attribute for the service, the weight attribute for the good, and the price attribute for the good. I calculated the willingness-to-pay for each respondent.

3.3.3 Results

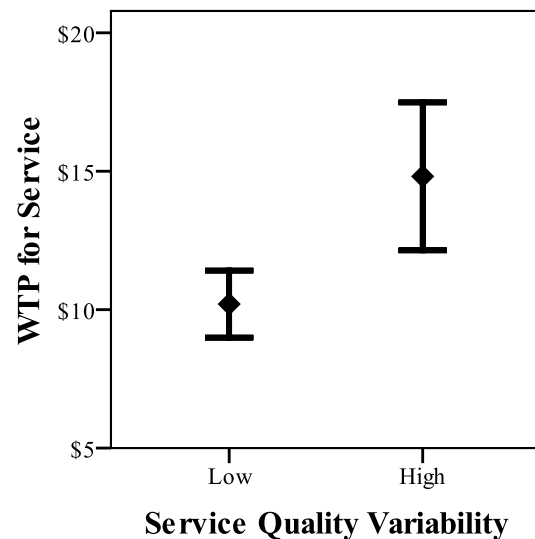
To begin analyzing the results, it is informative to examine the aggregate conjoint results for both the low and high service quality variability conditions. These results appear in Table 3-1. Within each attribute, for both the low quality variability and the high quality variability conditions, the aggregate part-worth utilities are in the expected directions. That is, consumers prefer spending less money to more money, prefer a lighter good to a heavier good, and prefer more channels for the service to fewer channels. Interestingly, the price of the good seems to be more important under a high quality variability condition than under a low quality variability condition.

Table 3-1 Aggregate Conjoint Results for Study 1

Hybrid Bundle Component	Attribute	Level	Part-Worth Utilities		Average Importance	
			Low Service Quality Variability	High Service Quality Variability	Low Service Quality Variability	High Service Quality Variability
Portable Media Player	Price	\$25	0.731	0.810	30.4	36.7
		\$100	0.085	-0.082		
		\$175	-0.816	-0.728		
	Weight	3 ounces	0.320	0.186	12.6	8.9
		10 ounces	-0.320	-0.186		
Streaming Multimedia Service	Price	\$5/month	0.890	0.687	35.0	35.1
		\$10/month	-0.002	0.098		
		\$15/month	-0.888	-0.785		
	Channels	150	0.561	0.406	22.1	19.4
		50	-0.561	-0.406		

While the aggregate analysis is an interesting starting point, it does little to shed light on the distribution of willingness-to-pay measures for the service under low and high service quality variability. To test H1, I use a one-way ANOVA with the Levene (1960) test for equality of variances. Figure 3-2 provides an error bar chart for the willingness-to-pay for the service under low and high service quality variability conditions. The distribution of willingness-to-pay measures for the service is considerably wider under the high service quality variability condition than the low service quality variability condition. The Levene test for homogeneity of variance confirms that the distribution under high service quality variability is significantly wider ($F_{1,108} = 23.14; p < .001$). Although not a focus, the ANOVA results show a surprisingly significant main effect in which the willingness-to-pay for the service is actually higher under a high service quality variability condition than in a low service quality variability condition ($\mu_{WTP}^{HIGH} = 14.81; \mu_{WTP}^{LOW} = 10.20; F_{1,108} = 10.42; p = .002$).

Figure 3-2 Study 1 Error Bar Chart



3.3.4 Discussion

The purpose of Study 1 was to explore H1. That is, when the quality variability of the service is higher, does consumers' willingness-to-pay have a wider variance for the service? As hypothesized, the distribution of consumers' willingness-to-pay is significantly wider under high service quality variability than under low service quality variability. To my knowledge, this research is the first to examine the effects of service quality variability on willingness-to-pay for a service, whether the service is part of a hybrid bundle or not. The intuition behind this finding is as follows. When a service has a wider distribution of quality, but the same mean quality, this means an individual consumer is more likely to get both a high and a low quality service than when the distribution of quality is narrow. Some consumers will be willing to pay more on the chance they will get the high quality service, while some consumers will be willing to

pay less on the chance they will get the low quality service. This initial finding has important implications for academic research and marketing practice.

The finding offers valuable insights into an important factor that can affect the pricing of hybrid bundles and services. Because quality variability has been largely ignored in the normative models research stream for bundle pricing, it is important that future research include this factor when researching hybrid bundles or traditional bundles whose components differ in quality variability. Managerially, this finding can help provide guidance in the pricing of high quality variability services within a hybrid bundle. The wider distribution of reservation prices for high quality variability services means there is greater customer heterogeneity in pricing of the service than that of the good. This finding suggests that managers may actually have greater latitude in pricing the high quality variability components within a hybrid bundle. Indeed, a higher price for the service with high quality variability can actually be more profitable (Meyer and Shankar 2010).

3.4 STUDY 2

The second study focuses on the effects of independence and complementarity on willingness-to-pay within a hybrid bundle setting. Thus, it tests H2a, H3a, H4, H5a, and H6a. To help test these hypotheses, 91 undergraduate students at a U.S. university participated in a laboratory experiment for class credit. Of the 91 responses, eight incomplete responses were discarded, resulting in 83 responses for final analysis. The average respondent age was 20.9 years and 52.4 percent of respondents were female.

3.4.1 Conjoint Design

Study 2 uses a hybrid bundle containing a digital video recorder (the good) and an online music service (the service) for the conjoint experiment. I chose this hybrid bundle based on a pretest ($n = 84$) of subject interest and knowledge about DVRs and online music services.

Both the good and the service had two non-price attributes and one price attribute. Therefore, each hybrid bundle profile consisted of six attributes that were presented to the respondents. The DVR was described as a device that “records television in a digital format to an internal disk drive or other memory medium.” For the good, the first non-price attribute was the number of recording hours, which had two levels: 50 hours and 300 hours. The second non-price attribute was the satisfaction/reliability rating with the DVR, which had two levels: 50% satisfaction and 90% satisfaction. The price attribute for the good consisted of three levels (\$100, \$300, and \$500) with a sufficiently wide range to cover reasonable prices (Haaijer and Wedel 2007). The online music service was described as “a service that works with a DVR that allows a subscriber to search for and listen to a vast number of songs, search for specific artists, listen to themed music channels, and create playlists.” For the service, the first non-price attribute was whether the music service allowed the user to listen to the service on any Internet-connected device, which had two levels: No Web Listening and Web Listening. For the purpose of the study, this attribute determined if the service was independent from the good. If the online music service did not allow web listening, the service was not independent; if the online music service did allow web listening, the

service was independent. The second non-price attribute was the satisfaction/reliability rating with the online music service, which had two levels: 50% satisfaction and 90% satisfaction. The price attribute for the service also consisted of three levels with a sufficiently wide range: \$5 per month, \$15 per month, and \$25 per month.

A choice-based conjoint design was selected and administered using Sawtooth Software. Each respondent was presented with 14 random choice tasks and two fixed choice tasks. Each choice task consisted of three choices. As with Study 1, the 14 random choice tasks were selected using the balanced overlap method.

I measured complementarity between the good and the service for each respondent following the completion of the choice tasks. Respondents were asked:

How much additional benefit do you think you would get from using a DVR and a Music Subscription together? Please rate the additional benefit from 1 (Low Additional Benefit) to 7 (High Additional Benefit). If you do not think you would get any additional benefit, please select the No Additional Benefit option.

3.4.2 Estimation of Willingness-to-Pay

I estimated the part-worth utilities and willingness-to-pay measures as in Study 1. As mentioned earlier, the conjoint design for Study 2 involves a hybrid bundle with six attributes: two non-price attributes each for the good and the service and one price attribute each for the good and the service. When calculating the willingness-to-pay for the good (the service), I treat the price attribute for the service (the good) as a non-price attribute. I calculated a willingness-to-pay measure for each respondent.

3.4.3 Results

As in Study 1, it is informative to begin with an examination of the aggregate conjoint results. These results appear in Table 3-2. Within each attribute, the aggregate part-worth utilities are in the expected direction, showing that consumers prefer spending less money to more money, more recording hours to fewer hours, a higher satisfaction rating to a lower satisfaction rating, and service independence to no service independence. Given the wide range of prices for the good, it is not surprising to see it have the highest importance at the aggregate level.

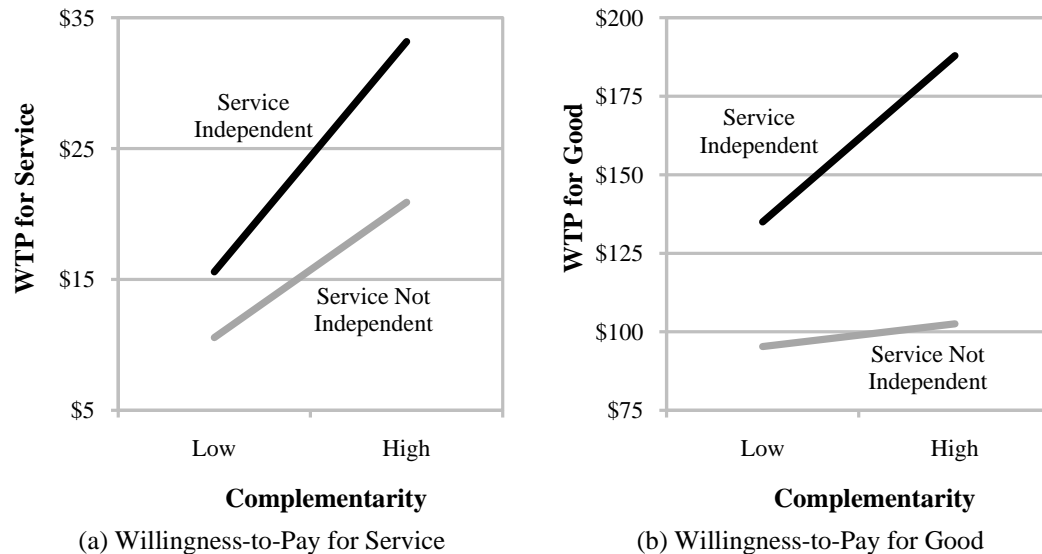
Table 3-2 Aggregate Conjoint Results for Study 2

Hybrid Bundle Component	Attribute	Level	Part-Worth Utilities	Average Importance
Digital Video Recorder	Price	\$100	0.804	33.3
		\$300	0.109	
		\$500	-0.912	
	Recording Hours	300 hours	0.344	13.3
		50 hours	-0.344	
	Satisfaction/Reliability	90%	0.403	15.6
50%		-0.403		
Online Music Service	Price	\$5/month	0.547	20.2
		\$15/month	-0.055	
		\$25/month	-0.492	
	Independence (Web Listening)	Yes	0.310	12.0
		No	-0.310	
	Satisfaction/Reliability	90%	0.143	5.6
50%		-0.143		

To test the relevant hypotheses, I use a repeated measures design in which more than one measure is obtained from each respondent. For this study, I obtain two willingness-to-pay measures from each respondent: one willingness-to-pay measure when the service is independent and one willingness-to-pay measure when the service is

not independent. Figure 3-3 provides a graphical depiction of the results for both the good and the service in the hybrid bundle.

Figure 3-3 Study 2 Results



Hypotheses 2a and 3a state that when the service is independent from the good, consumers are willing to pay more for the service (2a) and for the good (3a). To test these hypotheses, I use a repeated measures MANOVA. The results support both hypotheses. Respondents' willingness-to-pay measures are significantly higher for both the service ($F_{1,81} = 91.45; p < 0.001$) and for the good ($F_{1,81} = 58.83; p < 0.001$) when the service is independent from the good versus not independent. These results are represented in Figure 3-3 by the vertical separation between the *Service Independent* and *Service Not Independent* lines.

Hypotheses 4a and 4b state that consumers are willing to pay more for both the service (4a) and the good (4b) when complementarity between the good and service is high versus low. The results support hypothesis 4a, but not hypothesis 4b. Respondents' willingness-to-pay measures are significantly higher for the service ($F_{1,81} = 6.36; p = .014$) when they perceived the complementarity between the service and the good to be high versus low, but willingness-to-pay measures are not significantly higher for the good ($F_{1,81} = 2.30; p = .133$). These results are represented in Figure 3-3 by the slope of the lines. A steeper slope is more likely to be significant.

Hypotheses 5a and 6a state that there is an interaction between independence of the service from the good and complementarity on consumers' willingness-to-pay for both the service (5a) and the good (6a). The results support hypothesis 6a, but not hypothesis 5a. The difference in respondents' willingness-to-pay measures between an independent service and non-independent service is significantly higher under high complementarity than under low complementarity for the good ($F_{1,81} = 8.72; p = .004$), but not for the service ($F_{1,81} = 0.44; p = .509$). These results are represented in Figure 3-3 by the difference in slopes between the *Service Independent* and *Service Not Independent* lines. For the good, the slopes are much more different than they are for the service.

3.4.4 Discussion

The purpose of Study 2 was to explore several hypothesis regarding independence, complementarity, and the interaction of the two. As hypothesized, consumers' willingness-to-pay for both the service and the good is significantly greater

when the service is independent from the good. For willingness-to-pay for the service, this finding follows basic intuition. Consumers receive more direct benefit from the service if they can use it separately from the good. From an academic research perspective, bundling literature has addressed mixed bundling versus pure bundling and pure components. However, this finding extends previous research in an important way. While the hybrid bundle in this study was presented in a pure bundle setting, having the service independent from the good increases the willingness-to-pay for the service even within a pure bundle setting. This finding is also useful for practitioners. Managers of hybrid bundles need to be cognizant of consumers' higher willingness-to-pay for an independent service. For example, if TiVo's program guide also allowed consumers to record programs on their personal computer in addition to their TiVo DVR, TiVo could likely charge a price premium for this added independence.

The increased willingness-to-pay for the good when the service is independent is not quite as intuitive. One possible explanation is that increased familiarity and expertise with the service due to the ability to use it in more situations increases the utility a consumer receives from the good. From an academic research perspective, this finding suggests some spillover effects of independence of the service on the utility received from the good. This has not received attention in the traditional bundling literature, and is ripe for normative modeling. From a marketing practitioner perspective, this finding is just as important as the willingness-to-pay finding for the service. Managers of hybrid bundles should consider having higher prices for the good when the service is independent from the good.

With respect to complementarity, the findings are mixed. While consumers' willingness-to-pay for the service is significantly higher with higher complementarity, the same cannot be said for the good. Complementarity has received considerable attention in the bundling literature, so the significant finding for the service is not surprising. While the finding for the good is not significant, the willingness-to-pay difference was in the expected direction. From a practitioner's perspective, these findings provide further support for having components within a hybrid bundle with high complementarity, as highly complementary components allow a price premium to be extracted. The asymmetric findings for the service and the good may be a function of how consumers perceive the service and the good. For example, consumers may consider the service more specialized and the good more commoditized. Complementarity may be of more importance for the specialized component.

A central part of Study 2 was to look at the interaction between complementarity and independence. While a direction was not hypothesized, the hypotheses receive mixed support from Study 2. While other research has suggested that higher levels of complementarity would dampen the effect of independence (Meyer and Shankar 2010) or the optimality of mixed bundling (e.g., Venkatesh and Kamakura 2003), the findings from Study 2 show the opposite. The difference in willingness-to-pay for the good when the service is independent versus not independent is significantly higher under high complementarity than under low complementarity. However, the same is not true for willingness-to-pay for the service. This finding offers new and unique insights into how complementarity and independence interact. Increased independence of the good or

service allows the consumer to use the good or service in more situations, increasing the familiarity and expertise with the bundle component. This increased familiarity may contribute to increased complementarity between the components. Further research in this area for both hybrid bundles and traditional bundles is warranted. If managers of hybrid bundles want to extract an even higher price premium for the good, both service independence and high complementarity are important.

3.5 STUDY 3

The third study focuses on the effects of quality variability, independence and complementarity on willingness-to-pay within a hybrid bundle setting. This study examines many of the hypotheses already tested in Study 1 and Study 2 (i.e., H1, H2a, H3a, H4, H5a, and H6a), as well as testing those hypotheses not yet explored (H2b, H3b, H5b, and H6b). To examine these questions, 132 undergraduate students at a U.S. university participated in a laboratory experiment for class credit. Of the 132 responses, 14 were discarded as incomplete or unusable questionnaires, leaving 118 respondents available for final analysis. The average respondent age was 21.0 years and 54.7 percent of respondents were male.

3.5.1 Conjoint Design

As in Study 1, a hybrid bundle of a portable multimedia device (the good) and a streaming multimedia service (the service) was selected as the conjoint context. Once again, this hybrid bundle was selected for study because of subject interest and knowledge about portable multimedia players (similar to Apple iPod) and because of

subject interest in streaming or on-line multimedia services from a separate pretest ($n = 84$).

Both the good and the service had two non-price attributes and one price attribute. Therefore, each hybrid bundle profile consisted of six attributes that were presented to the respondents. The portable multimedia device was described as a device that “plays audio and video, such as music and TV shows.” For the good, the first non-price attribute was the screen size of the portable multimedia device, which had two levels: 2 inches and 4 inches. The second non-price attribute for the good was whether the portable multimedia device allowed for the use of the device with multiple streaming services, which also had two levels: *Yes, the device can be used with other streaming multimedia services* and *No, the device cannot be used with other streaming multimedia services*. For the purpose of the study, this attribute determined if the good was independent from the service. The price attribute for the good consisted of three levels (\$25, \$100, and \$175) with a sufficiently broad range to cover reasonable prices (Haaijer and Wedel 2007). The streaming multimedia service was described as a service that “sends wireless audio and video signals, such as music and TV shows, to a compatible player so you can listen or watch.” For the service, the first non-price attribute was the number of different music channels from which the user can choose, which had two levels: 50 channels and 150 channels. The second non-price attribute for the service was whether the streaming multimedia service could be used on other types of devices, which also had two levels: *Yes, the streaming multimedia service can be used with other devices* and *No, the streaming multimedia service cannot be used with other devices*. For

the purpose of the study, this attribute determined if the service was independent from the good. The price attribute for the service also consisted of three levels with a sufficiently wide range: \$5 per month, \$10 per month, and \$15 per month.

Quality variability was manipulated in the exact same way as Study 1, where respondents were once again presented with a visual scale (shown previously in Figure 3-1) to reinforce the narrow or wide distribution of service quality ratings.

A choice-based conjoint design was selected and administered using Sawtooth Software. Each respondent was presented with twelve random choice tasks and two fixed choice tasks. Each choice task consisted of three choices. As in Study 1 and Study 2, the random choice tasks were selected using the balanced overlap method.

Similar to Study 2, complementarity between the good and the service was measured for each respondent following the completion of the choice tasks.

Respondents were asked:

Please rate how much additional benefit you think you would get from using the portable multimedia device and a streaming multimedia service together. Please rate the additional benefit from 1 (Low Additional Benefit) to 7 (High Additional Benefit). If you do not think you would get any additional benefit, please select the No Additional Benefit option.

3.5.2 Estimation of Willingness-to-Pay

The part-worth utilities and willingness-to-pay measures are estimated as in Study 1 and Study 2. As discussed earlier, the conjoint design for Study 3 involves a hybrid bundle with six attributes: two non-price attributes each for the good and the service and one price attribute each for the good and the service. When calculating the willingness-to-pay for the good (the service), the price attribute for the service (the

good) is treated as a non-price attribute. A willingness-to-pay measure is calculated for each respondent in the study.

3.5.3 Results

The aggregate conjoint results appear in Table 3-3. Within each attribute, the aggregate part-worth utilities are in the expected direction, as consumers prefer spending less money to more money, prefer larger screen sizes and more channels, and prefer good and service independence to no good and service independence. Using the fixed tasks as a holdout sample, the respondent choice was correctly selected in 59 percent of the cases.

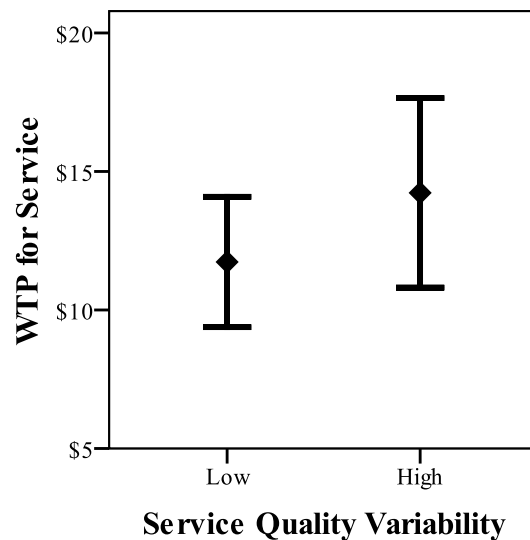
Table 3-3 Aggregate Conjoint Results for Study 3

Hybrid Bundle Component	Attribute	Level	Part-Worth Utilities		Average Importance	
			Low Service Quality Variability	High Service Quality Variability	Low Service Quality Variability	High Service Quality Variability
Portable Media Player	Price	\$25	0.553	0.697	19.9	27.7
		\$100	-0.001	0.079		
		\$175	-0.552	-0.776		
	Independence from Service	Yes	0.585	0.617	21.1	23.2
		No	-0.585	-0.617		
Screen Size	4 inches	0.502	0.414	18.1	15.6	
	2 inches	-0.502	-0.414			
Streaming Multimedia Service	Price	\$5/month	0.475	0.402	17.6	15.6
		\$10/month	0.025	0.023		
		\$15/month	-0.500	-0.425		
	Independence from Good	Yes	0.373	0.264	13.5	9.9
		No	-0.373	-0.264		
Channels	150	0.271	0.212	9.8	8.0	
	50	-0.271	-0.212			

As in Study 1, H1 is tested using a one-way ANOVA with the Levene (1960) test for equality of variances. Figure 3-4 provides an error bar chart for the willingness-to-

pay for the service under low and high service quality variability conditions. Although not as pronounced as in Study 1, the distribution of willingness-to-pay measures for the service is considerably wider under the high service quality variability condition versus the low service quality variability condition. The Levene test for homogeneity of variance confirms that the distribution under high service quality variability is significantly wider ($F_{1,116} = 5.77; p = .018$). Thus, as in Study 1, H1 is supported.

Figure 3-4 Study 3 Error Bar Chart



To test the remaining hypotheses, I use a repeated measures design as in Study 2. For this study, I obtain many willingness-to-pay measures from each respondent based on the independence of the good and the service.

Hypothesis 2 is concerned with the willingness-to-pay measures of the service (2a) or the good (2b) when the service or good is independent, respectively. The results

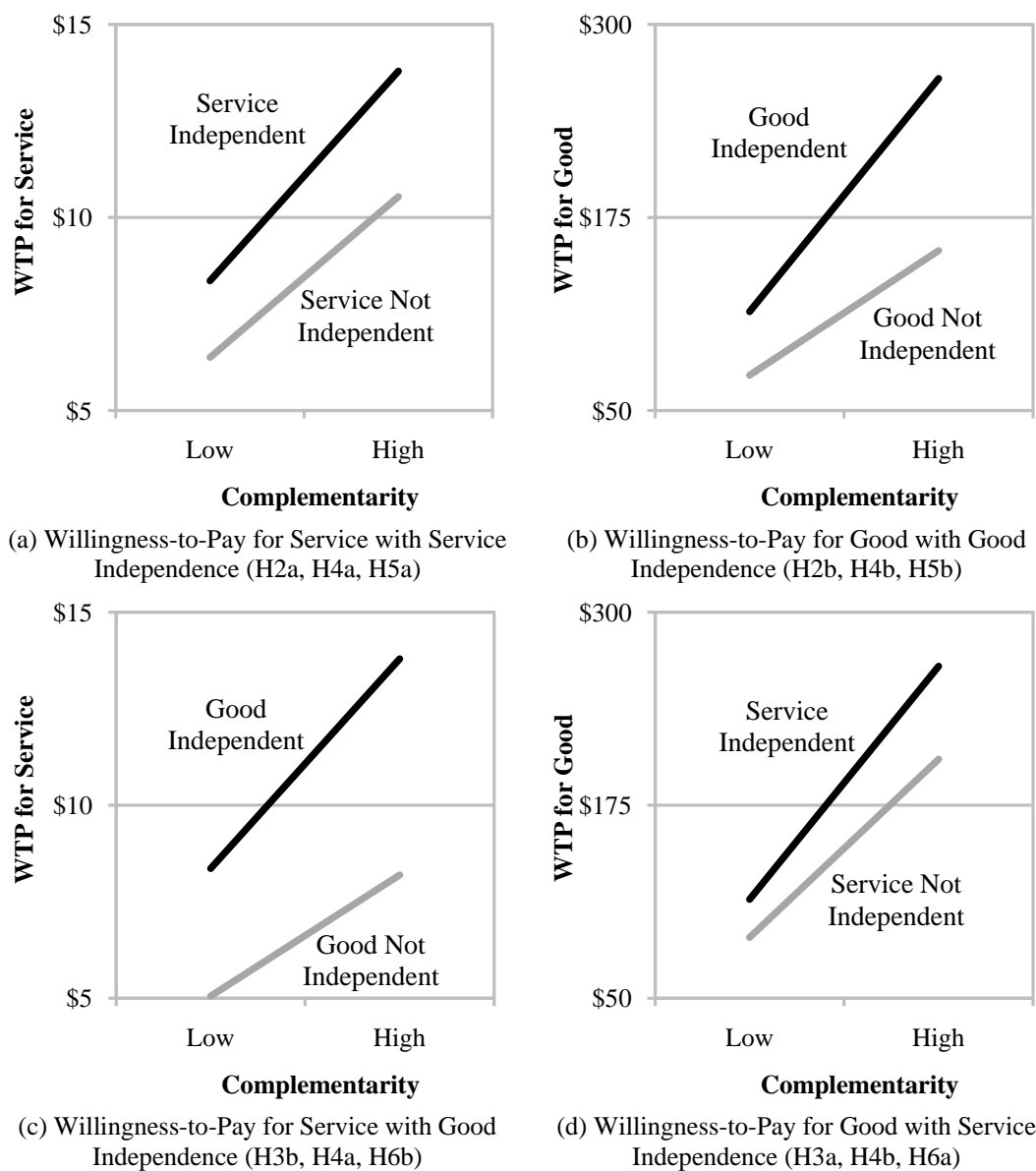
support both hypotheses. Respondents' willingness-to-pay measures are significantly higher for the service when it is independent from the good ($F_{1,115} = 27.82; p < .001$) and for the good when it is independent from the service ($F_{1,115} = 17.05; p < .001$). These results are represented in Figure 3-5a by the vertical separation between the *Service Independent* and *Service Not Independent* lines (for H2a) and in Figure 3-5b by the vertical separation between the *Good Independent* and *Good Not Independent* lines (for H2b).

Hypothesis 3 is similar to H2, but focuses on the cross-effects of independence: the willingness-to-pay for the good when the service is independent (H3a) and the willingness-to-pay for the service when the good is independent (H3b). The results support both hypotheses. Respondents' willingness-to-pay measures are significantly higher for the good when the service is independent from the good ($F_{1,115} = 15.98; p < .001$) and for the service when the good is independent from the service ($F_{1,115} = 36.88; p < .001$). These results are represented in Figure 3-5d by the vertical separation between the *Service Independent* and *Service Not Independent* lines (for H3a) and in Figure 3-5c by the vertical separation between the *Good Independent* and *Good Not Independent* lines (for H3b).

Hypothesis 4 states that consumers are willing to pay more for both the service (4a) and the good (4b) when they consider the hybrid bundle to have high complementarity versus low complementarity. In Study 2, this result is supported for the service, but not the good. In Study 3, both the hypotheses are supported. Respondents' willingness-to-pay measures are significantly higher for the service ($F_{1,115} = 5.02; p =$

.027) and for the good ($F_{1,115} = 2.91$; $p = .091$) when they perceive the complementarity between the service and the good to be high rather than low. These results are represented in Figure 3-5 by the slope of the lines. A steeper slope suggests higher likelihood of significance.

Figure 3-5 Study 3 Results



Hypothesis 5 states that there is an interaction effect of independence and complementarity on consumers' willingness-to-pay. H5a examines the willingness-to-pay for the service under an interaction between service independence and complementarity. H5b examines the willingness-to-pay for the good under an interaction between good independence and complementarity. The results support H5b, but not H5a. The difference in respondents' willingness-to-pay for the good between an independent good and non-independent good is significantly higher under high complementarity than under low complementarity ($F_{1,115} = 3.10$; $p = .081$). However, the difference in respondents' willingness-to-pay for the service between an independent service and non-independent service is not significantly different under high complementarity than under low complementarity ($F_{1,115} = 1.63$; $p = .204$). These results are represented in Figure 3-5a and 3-5b by the difference in slopes between the *Service (Good) Independent* and *Service (Good) Not Independent* lines. When the good is independent, the slopes are less parallel than they are for when the service is independent.

Hypothesis 6 is similar to H5, but is concerned with the cross-effects of independence and its interaction with complementarity. H6a (H6b) examines the willingness-to-pay for the good (service) under an interaction between service (good) independence and complementarity. The results support H6b, but not H6a. The difference in respondents' willingness-to-pay for the service between an independent good and non-independent good is significantly higher under high complementarity than under low complementarity ($F_{1,115} = 2.92$; $p = .090$). However, the difference in respondents' willingness-to-pay for the good between an independent service and non-

independent service is not significantly different under high complementarity than under low complementarity ($F_{1,115} = 2.50; p = .117$). These results are represented in Figure 3-5c and 3-5d by the difference in slopes between the *Service (Good) Independent* and *Service (Good) Not Independent* lines. As before, when the good is independent, the slopes are less parallel than they are for when the service is independent.

3.5.4 Discussion

The purpose of Study 3 was to explore all of the hypotheses in one, combined study. Of the 11 hypotheses, seven are tested in Study 1 or Study 2 and repeated in Study 3. Of these seven, only two (H4b and H6a) have different results. The focus of this discussion will be on these two hypotheses and the four hypotheses not yet tested (H2b, H3b, H5b, and H6b).

In Study 2, higher complementarity does not significantly increase respondents' willingness-to-pay for the good. However, in Study 3, I found marginal significance. This finding is consistent with extant literature. Nonetheless, it is interesting to find differential effects of complementarity on willingness-to-pay for a good and a service within a hybrid bundle.

Furthermore, in Study 2, the effect of the interaction of service independence and complementarity on the willingness-to-pay for the good is significant. However, in Study 3, this effect is not significant ($p > .10$). A possible explanation for the mixed results across studies relates to the ratio of the prices of the good and service within the hybrid bundles. In Study 3, the ratios ranged from 1.67:1 to 35:1, whereas in Study 2, the

ratios ranged from 4:1 to 100:1. These different ratios could be affecting respondents' perceptions of the value of service independence under high and low complementarity.

As hypothesized, consumers' willingness-to-pay for both the service and the good is significantly greater when the good is independent from the service. The results mirror the results from Study 2 and Study 3, in which consumers' willingness-to-pay for both the service and the good is significantly greater when service is independent from the good than vice-versa. The intuition behind the results is also a mirror image of that for Study 2. Consumers receive more direct benefits from the good if they can use it separately from the service. The increased willingness-to-pay for the service when the good is independent is not quite as intuitive, but it suggests some spillover effects of independence of one component on the utility received from the other component.

As in Study 2, a key focus in Study 3 is the interaction between complementarity and independence, particularly when the good is independent from the service. The findings show that the difference in willingness-to-pay for both the good and the service when the good is independent versus not independent is significantly higher under high complementarity than under low complementarity. As mentioned in Study 2, this finding offers new and unique insights into how complementarity and independence interact.

3.6 SYNTHESIS OF THE STUDIES AND THEORETICAL AND MANAGERIAL IMPLICATIONS

Table 3-4 shows a summary of the hypotheses and the findings across all three studies. I find full support for eight of the 11 hypotheses, partial support for two hypotheses, and no support for one hypothesis. The three studies covered three factors:

service quality variability, independence, and complementarity. I offer a summary of the findings and provide theoretical and managerial implications for the effects of these factors.

Table 3-4 Summary of Results

<i>Focus</i>	<i>Hypothesis</i>	<i>Study 1</i>	<i>Study 2</i>	<i>Study 3</i>
Quality Variability	1: $\sigma_S^{HSQV} > \sigma_S^{LSQV}$	***	—	**
	2a: $\mu_S^{SI} > \mu_S^{SNI}$	—	***	***
Independence	2b: $\mu_G^{GI} > \mu_G^{GNI}$	—	—	***
	3a: $\mu_S^{SI} > \mu_S^{SNI}$	—	***	***
	3b: $\mu_S^{GI} > \mu_S^{GNI}$	—	—	***
Complementarity	4a: $\mu_S^{HC} > \mu_S^{LC}$	—	**	**
	4b: $\mu_G^{HC} > \mu_G^{LC}$	—	N.S.	*
Interaction of Independence and Complementarity	5a: $\mu_S^{SI,HC} - \mu_S^{SNI,HC} \neq \mu_S^{SI,LC} - \mu_S^{SNI,LC}$	—	N.S.	N.S.
	5b: $\mu_G^{GI,HC} - \mu_G^{GNI,HC} \neq \mu_G^{GI,LC} - \mu_G^{GNI,LC}$	—	—	*
	6a: $\mu_S^{SI,HC} - \mu_S^{SNI,HC} \neq \mu_S^{SI,LC} - \mu_S^{SNI,LC}$	—	***	N.S.
	6b: $\mu_S^{GI,HC} - \mu_S^{GNI,HC} \neq \mu_S^{GI,LC} - \mu_S^{GNI,LC}$	—	—	*

*** = $p < 0.01$ ** = $p < 0.05$ * = $p < 0.1$ N.S. = Not Significant ($p > 0.1$) — = Not Applicable
 σ = variance μ = mean S = service G = good H = high L = low QV = quality variability
 I = independent NI = not independent C = complementarity

Heterogeneity in service quality is an overlooked aspect of pricing of hybrid bundles in particular, and pricing of services in general. The quality variability of services within hybrid bundles can have important implications on consumers' willingness-to-pay for hybrid bundles and firms' pricing of hybrid bundles. I hypothesized that higher quality variability of a service within a hybrid bundle is associated with a wider distribution of willingness-to-pay measures across consumers. My findings support this hypothesis. This finding is significant for several reasons. First, it extends pricing research on bundles and services in a direction that has not previously been explored, opening avenues for additional research that can have a meaningful

impact on academic research and marketing practice. Second, it provides guidance to managers of hybrid bundles that contain high quality variable services. Specifically, the wider willingness-to-pay distribution of services with high quality variability may offer managers a high level of latitude in the pricing of the service within a hybrid bundle.

Independence is the extent to which the good and service can be used separately from each other (Shankar, Berry, and Dotzel 2009). I argued that the ability to use the components within a hybrid bundle separately should increase the consumer's utility, resulting in higher willingness-to-pay. The results support this argument for both the good and the service when either the good or the service is independent from the other. The direct-effects (e.g., higher willingness-to-pay for the good when the good is independent) are intuitive and straightforward, while the cross-effects (e.g., higher willingness-to-pay for the good when the service is independent) are not as straightforward. Both the findings are important. First, previous literature focuses only on the purchase aspect of independence, not on the usage aspect. My research extends prior literature and sheds light on a previously unexplored aspect of bundling—the usage of the components. Second, managers who market hybrid bundles must be mindful that in addition to purchase situation, the independence of components in their use is important in pricing. Third, managers should be aware of the cross-effects of independence on pricing and can charge a price premium on a component when the other component in the hybrid bundle is independent. However, the level of competition also influences the ability of managers of hybrid bundles to charge a price premium for independent components. For example, if a competitor offers a similar service that can

be used with the good, it may be more difficult for the manager to charge a price premium.

Complementarity is the degree to which the utility to the customer increases when the product and the service are used together (Shankar, Berry, and Dotzel 2009). I argued that willingness-to-pay increases with complementarity. This hypothesis is partially supported by the findings. Complementarity has a greater positive effect on the willingness-to-pay for the service than for the good. This asymmetric effect has significant theoretical implications. Prior research has largely assumed the effects to be the same for each component in the bundle. My findings suggest that a richer theory needs to be developed. My results also imply that to extract a price premium, managers of hybrid bundles may want to find ways of increasing complementarity between the good and the service components.

I also explored the interaction between independence and complementarity. This interaction is an aspect that has received little attention in extant literature, so the findings open up an exciting new aspect of bundling. I argued that the interactive effects could be either positive or negative. In other words, the difference in willingness-to-pay between independence and no independence could be either greater or smaller with high complementarity relative to low complementarity. While the findings are mixed with respect to significance, all the results point to a positive moderation. This finding is especially true when the good is independent from the service. For marketers of hybrid bundles, having goods independent from the service can enable the company to extract an even higher price premium when the components are highly complementary.

3.7 LIMITATIONS, FUTURE RESEARCH, AND CONCLUSION

3.7.1 Limitations and Future Research

The limitations of the research presented in this essay all suggest future research directions. First, the conjoint designs used in this essay are not incentive-aligned. Ding (2007), Ding, Grewal, and Liechty (2005) and Voelckner (2007) show that under certain conditions, estimates from incentive aligned approaches provide more precise results than those from other methods. It would be worthwhile to retest the hypotheses using incentive aligned approaches.

Second, I measured complementarity for each respondent using a scale question, and it may be fruitful to consider other methods of measuring complementarity. For example, it may be possible to measure and compare the willingness-to-pay for the hybrid bundle to the sum of the willingness-to-pay for each component within the hybrid bundle. This ratio would be similar to a measure of complementarity that has been used in the analytical models of bundling (e.g., Meyer and Shankar 2010; Venkatesh and Kamakura 2003).

Third, the conjoint designs used in the studies were of pure bundling form, regardless of whether the components were independent or not. My finding that independence increases willingness-to-pay is significant because it is true in pure bundling. Allowing for other bundling forms, such as mixed bundling or pure components would be a useful extension. This will also allow for examining if the service attributes are perceived differently than the goods attributes by some respondents.

Fourth, I did not examine the quality variability of the good. While it is reasonable to assume that the findings related to quality variability of the good would be similar to that of service, it would be worthwhile to test it. Similarly, I did not address the effect of quality variability on the mean willingness-to-pay. However, the results from Studies 2 and 3 suggest that there is perhaps an optimism bias where respondents believe they are less likely to get a service with poor quality (Tanner and Carlson 2008). Therefore, higher quality variability with equal mean quality results in higher willingness-to-pay measures. This is an interesting avenue for future research and can have important implications for the pricing of goods and services.

Fifth, I found asymmetric effects for independence and complementarity for the willingness-to-pay for the good and the service. My results show that complementarity is more important for the service than for the good, but the interaction between complementarity and independence is more important when the good is independent than when the service is independent. These asymmetric effects deserve a deeper examination by future research.

Sixth, in real life purchase situations, consumers have the option of not purchase. However, the choice-based conjoint studies used in this research did not allow respondents to select a “No Purchase” option. Research on conjoint analysis has shown that the inclusion of a “No Purchase” option can increase the model fit and decrease the bias in estimates (e.g., Haaijer, Kamakura, and Wedel 2001).

Seventh, all three studies use hi-tech bundles of a good and a service. Consumers’ perceptions of hi-tech goods and services may be different from perceptions

of a hybrid bundle with a “low-tech” good and people-intensive service, such as carpeting and installation. Further exploration of the effects of quality variability, independence, and complementarity is warranted in other bundle settings.

Finally, prior research, especially analytic models, suggest that high complementarity can reduce the optimality of mixed bundling relative to pure bundling (Venkatesh and Kamakura 2003) and the optimality of independence relative to no independence (Meyer and Shankar 2010). However, the findings from this essay suggest otherwise. Future research could identify the conditions under which these different results can be obtained.

3.7.2 Conclusion

Many traditional manufacturing companies and traditional service companies are increasingly selling hybrid bundles—bundles comprising one or more goods and one or more services. The pricing of such hybrid bundles—critical to success and profitability of firms selling these bundles—hinges on a better understanding of consumer willingness-to-pay for the bundle and its components. I examined the effects of three important factors, quality variability, independence, and complementarity, on willingness-to-pay using choice based conjoint experiments estimated through hierarchical Bayesian analysis. The results show that higher quality variability of a service within a hybrid bundle is associated with a wider distribution of willingness-to-pay, independence between the good and the service in the bundle has positive direct- and cross-effects on willingness-to-pay, complementarity between the good and the service has a greater positive effect on the willingness-to-pay for the service than for the

good, and independence and complementarity interact to increase willingness-to-pay.

These results offer important guidelines for managers to develop premium-priced hybrid bundles.

CHAPTER IV

AN EMPIRICAL ANALYSIS OF HYBRID BUNDLE PRICING

4.1 INTRODUCTION

In both the business-to-consumer (B2C) and business-to-business (B2B) sectors, a growing number of firms are offering bundles of goods and services together in competitive settings. These hybrid bundles can be seen across a variety of manufacturing and retailing settings. BMW offers a hybrid bundle comprising a new vehicle and a total maintenance program. Best Buy offers hybrid bundles comprising home theater components and professional home theater setup. GE Medical Systems offers hybrid bundles comprising medical imaging machines with training and maintenance services. Together with its suite of network products, 3Com offers many services ranging from installation and assessment, maintenance, and training.

A hybrid bundle is a “a single firm’s offering that combines one or more goods with one or more services, creating greater customer benefit than if the good(s) and service(s) were available separately” (Meyer and Shankar 2010). Within this definition lie two key criteria. First, the offering comes from a single firm, essentially ensuring that the firm gets revenue from both the good(s) and the service(s). Second, the use of the good(s) and service(s) together creates greater customer benefit. In other words, a customer’s utility from purchasing or using the components together is greater than the sum of the utilities from purchasing or using each component separately.

Although data on the size of the market for all hybrid bundles is unavailable, it is evident market opportunity is growing. One estimate is that the sales of services sold together with durable goods increased by nearly 200 percent from 1995 to 2004 (Auguste, Harmon, and Pandit 2006). Added profits from joining services with goods – or vice versa – can be considerable. Otis Elevators claims that 90 percent of its operating profits from 2002 to 2008 were generated by repair and maintenance services even though Otis is known as a manufacturer (Shankar, Berry, and Dotzel 2009).

Although hybrid bundles are here to stay and grow, research on hybrid bundles is in its infancy. There is conceptual (Shankar, Berry, and Dotzel 2009), analytical (Meyer and Shankar 2010), and experimental (Meyer, Shankar, and Berry 2010) research on hybrid bundles. However, little *empirical* research exists on the factors that drive the demand of the hybrid bundle components. This essay aims to fill this gap in the literature. Specifically, this essay seeks to answer the following questions: What are the direct- and cross-effects of pricing of the good and service components on the demand for these components? Are these effects symmetric?

I organize the remainder of the essay as follows. I begin with conceptual development, including a discussion of the relevant literature on bundling, contingent products, and cross-selling. I then discuss the data and context. I present the model and the results of the estimation. I discuss the implications, highlight the key limitations and areas for future research, and conclude with the takeaways.

4.2 CONCEPTUAL DEVELOPMENT AND RELATED RESEARCH

Bundling, defined as “the sale of two or more products in a package” (Stremersch and Tellis 2002), has a rich history in marketing and economics. Bundles can be classified as either product bundles or price bundles. Product bundle components are integrated and are sold at any price, while price bundle components are not integrated and are sold at a discount (Stremersch and Tellis 2002). By definition, hybrid bundles are product bundles as the purchase or use of their components adds additional customer benefit. Product bundles can further be classified into three forms: pure bundles (i.e., components only sold together), pure components (i.e., components only sold separately), and mixed bundles (i.e., components sold both together and separately).

Hybrid bundles differ from traditional bundles of goods or bundles of services. First, many services are labor-intensive. The labor-intensive nature means that the components of the bundle often vary widely in quality variability and scalability, with the service being higher in quality variability and lower in scalability. Second, hybrid bundles are often presented to consumers with separate prices for each component, contrasting with traditional bundles, which are usually presented at a single price. For example, TiVo’s hybrid bundle offering lists separate prices for the digital video recorder and the program guide, whereas Time Warner Cable’s bundle of cable television, internet, and digital phone has a single list price. Third, many hybrid bundles involve a good that is used continuously and a service that is used intermittently. For example, Best Buy’s home theater and professional setup bundle consists of a home theater that is used regularly and a service that is often used only once. Fourth, hybrid

bundles expand on the idea of bundle form to consider the independence of the good and the service. Independence is “the extent to which the good and service are available and can be used independent of each other” (Meyer and Shankar 2010). Independence is at the component level, meaning that both the good and the service can be independent or not independent. For example, TiVo’s digital video recorder has little functionality without the program guide, and vice versa, and both components would be classified as having no independence. However, Best Buy’s home theater can be purchased and used without the professional setup, while the professional setup cannot be used without the purchase of the home theater. In this case, the home theater is independent, but the professional setup is not.

Much of the extant research on bundling is either analytical or experimental. Researchers have looked at bundling as a price discrimination tool (e.g., Venkatesh and Mahajan 1993), complementarity among bundle components (e.g., Venkatesh and Kamakura 2003), mixed bundling optimality (e.g., Venkatesh and Kamakura 2003), component costs (e.g., Hanson and Martin 1990), and perceptions of savings (e.g., Yadav and Monroe 1993). Although empirical research on bundling is scarce, researchers have empirically examined topics that share similarities with bundling, such as cross-category purchasing.

In cross-category purchasing, if lowering the price of one product increases the demand for another product, then the two products are considered complements. If two products in different categories are complements, one would expect cross-category correlations to be positive. Much research in this area has used market basket analysis.

Russell and Petersen (2000) develop a global utility model where consumer preference for a product can be contingent on the consumption of items in other product categories. Using four household paper goods categories, they find small cross-price effects. Manchanda, Ansari, and Gupta (1999) develop a multivariate probit model applied to a consumer's shopping basket, allowing for both complementarity and co-incidence. Applying their model to two sets of complementary categories, they also find small cross-price elasticities. Song and Chintagunta (2006, 2007) add brand into the mix and find higher negative cross-price elasticities for certain brand combinations, but also highlight the asymmetries between categories where the price effect of brand A on brand B is different than the price effect of brand B on brand A. Mehta (2007) also looks at brand and category purchase incidence and finds much smaller cross-price effects than direct-price effects. Finally, Niraj, Padmanabhan, and Seetharaman (2008) use a two stage bivariate logit model that allows for cross-category correlations in both incidence and quantity. Using bacon and eggs as the complementary categories, they find that the cross-price effects on incidence are negative and significant. However, while bacon's cross-price effect on quantity of eggs purchased is significant, the same is not true for eggs' cross-price effect on quantity of bacon purchased. A comparison of the relevant research is shown in Table 4-1.

One commonality across the cross-category purchase stream of research is the use of frequently purchased consumer packaged goods. There is a dearth of empirical research on cross-category effects in durable goods or services. Many hybrid bundles

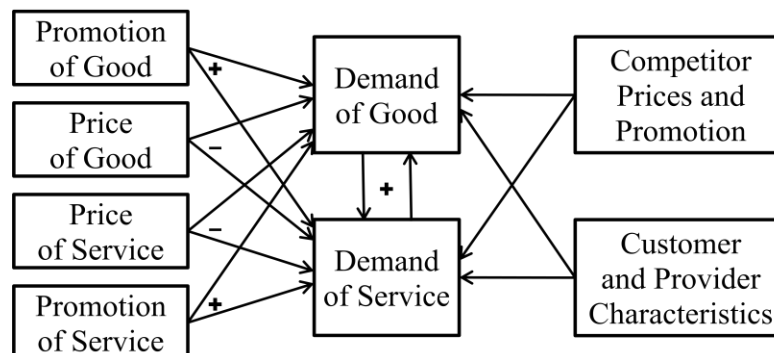
Table 4-1 Comparison of Relevant Research

Reference	Focus	Key Findings/Insights	Limitations
Manchanda, Ansari, and Gupta (1999)	Complementarity and co-incidence within shopping baskets	Separating complementarity from co-incidence shows small cross-price and cross-promotion effects	Uses frequently purchased consumer packaged goods
Russell and Petersen (2000)	Market basket analysis accounting for store traffic and brand	Cross-category price elasticities are small and store traffic patterns may be more important than consumer-level demand interdependence	Uses frequently purchased consumer packaged goods
Song and Chintagunta (2006)	Estimating cross-category effects at store-level while accounting for price endogeneity and customer heterogeneity	Size of cross-category elasticities are small, but often asymmetric based on brand	Aggregate data at the store-level using frequently purchased consumer packaged goods
Song and Chintagunta (2007)	Incidence, brand choice, and quantity choice allowing for complementarity and substitutability	Cross-category effects are small and mostly due to joint purchase incidence	Uses frequently purchased consumer packaged goods
Mehta (2007)	Effect of the market mix of brands in one category on incidence in another category	Cross-price effects much smaller than direct-price effects	Uses frequently purchased consumer packaged goods
Niraj, Padmanabhan, and Seetharaman (2008)	Incidence and quantity decisions across categories	Cross-category promotional effects are asymmetric	Uses frequently purchased consumer packaged goods
This essay (2010)	Direct- and cross-effects of price in a hybrid bundle setting	Cross-effects are of service price on good quantity larger than direct-effects of good price	Model not estimated simultaneously

would not be classified as frequently purchased items. Therefore, there is little guidance on the expected cross-category effects of components within a hybrid bundle.

The general model for pricing of hybrid bundles is shown in Figure 4-1. I expect the direct-price effect on the demand of a component within a hybrid bundle to be negative. Given that hybrid bundles contain complementary components, and consistent with findings in cross-category research, I also expect the cross-price effect of one component on the demand of another component within a hybrid bundle to be negative. Similarly, I expect both the direct- and cross-promotion effects on demand of components within a hybrid bundle to be positive. Next, provided that the hybrid bundle allows for independence between the good and the service, I expect the demand of the good to have a positive effect on the demand of the service, and vice versa. Finally, competitor price and promotion, along with customer and provider characteristics, affect the demand for the good and the service within a hybrid bundle.

Figure 4-1 Factors Affecting Demand of Hybrid Bundles



4.3 CONTEXT AND DATA

To answer the research questions using the model in Figure 4-1, I obtained data from a major U.S. specialty retailer that markets a hybrid bundle comprising carpet (the good) and installation (the service). The retail carpet industry offers an excellent context to empirically study pricing of hybrid bundles. It is a huge industry that pervades nearly all the households in the U.S. In 2007, U.S. carpet and rug mills had an estimated \$13.5 billion in revenue (Rajakumar 2010), and carpet laying and removal contractors had combined revenues of about \$5.7 billion (Kelly 2010). Furthermore, total industry shipments of carpet were 14.4 billion square feet, and carpet covers nearly 70 percent of the flooring in the U.S. (CRI 2010).

Hybrid bundles where the service is an installation are common in many retail settings. Electronics retailers offer installation on a variety of goods, such as home theater components, automobile audio and video components, and computers and home networking. Major home improvement retailers often offer installation services for appliances, garage door openers, doors and windows, window treatments, and many other goods. Some of the goods in these hybrid bundles are similar to carpeting in which the quantity of the good purchased can vary from customer to customer. For example, one customer may purchase a window treatment for only one window, whereas another customer may purchase window treatments for the whole house.

The carpet and installation data are transactional over a 15 month period starting in January 2009. The data set is a random sample of approximately 3,700 household transactions involving the purchase of at least 100 square feet of carpet during the 15

month period. For this retailer's hybrid bundle, the installation is not independent, but the carpet is. In other words, consumers can purchase the carpet and not the installation, but they cannot purchase the installation without purchasing the carpet. The data set includes the quantity of carpet purchased (in square feet), the incidence of installation purchases, the price and cost per square foot for the carpet, the price and cost of basic installation, the brand and type of carpet purchased, and a variety of household demographics such as distance to store, distance to nearest competitor, home value, marital status, and number of children.

Table 4-2 reports basic descriptive statistics. Note that 86 percent of transactions include the purchase of installation. For this retailer, the installation is priced at a flat rate. However, consumers typically view this figure against the quantity of carpet they buy, so implicitly they have a mental estimate of the installation price in terms of price per square foot. Both forms of installation prices (absolute and per unit square foot) are available in the data.

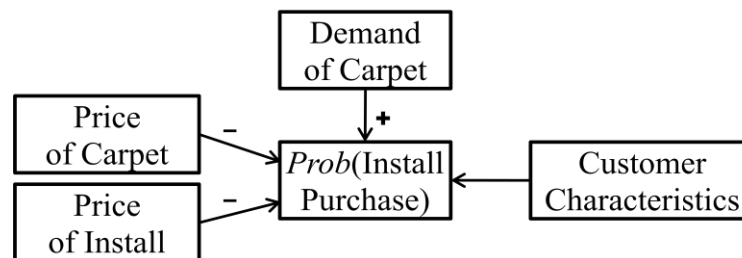
4.4 MODEL DEVELOPMENT

Due to limitations in the available data, I could not fully estimate the model presented in Figure 4-1. However, I estimated two subsets of the models in Figure 4-1, which are shown in Figure 4-2. Table 4-3 provides the correlation matrix for the relevant variables used to model both the installation purchase decision and the carpet demand quantity decision.

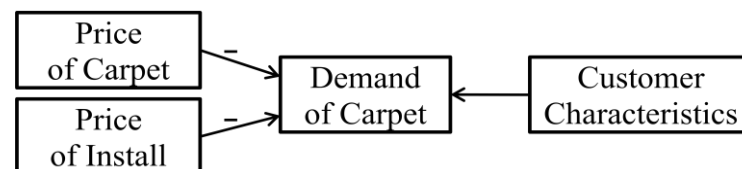
Table 4-2 Descriptive Statistics

		Install Purchase	
		Yes	No
Household Transactions	N	3170	523
Carpet Quantity (Ft²)	Mean (St. Dev.)	633 (348)	454 (416)
Carpet Price (\$ per Ft²)	Mean (St. Dev.)	2.11 (.73)	2.00 (.71)
Total Install Price (\$) ^a	Mean (St. Dev.)	105 (39)	107 (20)
Install Price (\$ per Ft²) ^a	Mean (St. Dev.)	.24 (.19)	.39 (.27)
Home Value (\$ 000s) ^b	Mean (St. Dev.)	229 (184)	199 (169)
Nearest Competitor(Miles)	Mean (St. Dev.)	8.76 (11.29)	9.42 (11.42)

^a Install price when no installation is purchased is estimated based on weekly average installation prices.
^b Home value is based on the mid-point of 19 home value ranges.

Figure 4-2 Factors Affecting Demand of Installation and Carpet

(a) Installation Demand for All Purchasers



(b) Carpet Demand for Installation Purchasers

Table 4-3 Correlation Matrix

	<i>Carpet Quantity</i>	<i>Install Purchase</i>	<i>Carpet Price per Ft²</i>	<i>Install Price</i>	<i>Install Price per Ft²</i>	<i>Nearest Comp.</i>	<i>Home Value</i>
<i>Carpet Quantity</i>	1	0.152 *	-0.028	0.117 *	-0.633 *	-0.002	0.097 *
<i>Install Purchase</i>		1	0.051 *	-0.014	-0.246 *	0.005	0.058 *
<i>Carpet Price per Ft²</i>			1	-0.136 *	-0.041 *	-0.002	0.072 *
<i>Install Price</i>				1	0.344 *	-0.059 *	0.063 *
<i>Install Price per Ft²</i>					1	-0.033 *	-0.010
<i>Nearest Competitor</i>						1	-0.092 *
<i>Home Value</i>							1

* $p < .05$

4.4.1 Installation Purchase Decision

The purchase decision for installation, as shown in Figure 4-2a, is modeled first. A household decides to purchase either one unit of installation or no installation at all. Therefore, the installation purchase decision is a binary choice and must be modeled appropriately using a latent variable model:

$$INSTALL_i^* = \beta_0 + \beta_1 ISTPRICE_i + \beta_2 CPTPRICE_i + \beta_3 CPTQNTY_i + \beta_4 NRCMP_i + \beta_5 HMVAL_i + \sum_{m=1}^{M-1} \beta_{6m} MONTH_{mi} + \epsilon_i \quad (4.1)$$

$$\Pr(INSTALL_i = 1) = \Pr(INSTALL_i^* > 0) \quad (4.2)$$

where i is household transaction, $INSTALL$ is a binary variable equal to 1 if installation was purchased, $ISTPRICE$ is the basic installation price, $CPTQNTY$ is the quantity of carpet purchased in square feet, $CPTPRICE$ is the carpet price per square feet, $NRCMP$ is the distance from the household to the nearest competitor, $HMVAL$ is the estimated home value for the household, $MONTH$ is a vector of 11 dummy variables denoting the month of the year of the household's transaction (with December as the base month), β

are parameter vectors, and ϵ is an *i.i.d.* error term. Thus, Equation 4.1 is the probit model.

However, both installation price and carpet price are endogenous. Therefore, an instrumental variable approach can be used as in Rivers and Vuong (1988) and Wooldridge (2002). In this approach, there are two instrumental variable regressions:

$$\begin{aligned}
 ISTPRICE_i = & \delta_{10} + \delta_{11}ISTCST_i + \delta_{12}CPTCST_i + \delta_{13}CPTQNTY_i \\
 & + \delta_{14}NRCMP_i + \delta_{15}HMVAL_i + \sum_{j=1}^{J-1} \delta_{16j}TYPE_{ji} \\
 & + \sum_{k=1}^{K-1} \delta_{17k}BRAND_{ki} + \sum_{l=1}^L \delta_{18l}PL_{li} \\
 & + \sum_{m=1}^{M-1} \delta_{19m}MONTH_{mi} + v_i
 \end{aligned} \tag{4.3}$$

$$\begin{aligned}
 CPTPRICE_i = & \delta_{20} + \delta_{21}ISTCST_i + \delta_{22}CPTCST_i + \delta_{23}CPTQNTY_i \\
 & + \delta_{24}NRCMP_i + \delta_{25}HMVAL_i + \sum_{j=1}^{J-1} \delta_{26j}TYPE_{ji} \\
 & + \sum_{k=1}^{K-1} \delta_{27k}BRAND_{ki} + \sum_{l=1}^L \delta_{28l}PL_{li} \\
 & + \sum_{m=1}^{M-1} \delta_{29m}MONTH_{mi} + u_i
 \end{aligned} \tag{4.4}$$

where *ISTCST* is the basic installation cost, *CPTCST* is the carpet cost per square foot, *TYPE* is a vector of six dummy variables denoting the product type of carpet (with type *other* set as the base), *BRAND* is a vector of eight dummy variables denoting the brand of carpet (with brand *unknown* set as the base), *PL* is a vector of two dummy variables denoting if the carpet is part of two retailer specific product lines, δ are parameter vectors, v and u are error terms, and the other terms are as defined earlier. Equations 4.3 and 4.4 are estimated separately, with the residuals, \hat{v}_i and \hat{u}_i , calculated and saved. These are then added to the probit model in equation 4.1 to get consistent coefficient estimates. In addition, the price of the carpet is observable, but the price of the installation is only observable for those who purchase the installation. For those

transactions that an installation is not purchased, an estimated installation price is used by averaging across all install rates for the given week.

4.4.2 Carpet Demand

In the general model presented in Figure 4-1, I expect the demand for the service to have a positive effect on the demand for the good. However, not all hybrid bundles behave in this manner. In particular, some hybrid bundles consist of a focal component and a secondary component. The carpet and installation hybrid bundle behaves in the manner, with the carpet being the focal component and the installation the secondary component. Therefore, there is no expected cross-demand effect where the installation purchase drives the quantity of carpet purchased. This reasoning leads to the model in Figure 4-2b.

As in the estimation for installation demand, I observe the installation price only for those transactions for which installation is purchased. While I use the average weekly installation price in the installation demand estimation, I perform the estimation for carpet demand using only those transactions where an installation was purchased.

I expect carpet demand to follow a multiplicative functional form model as shown in Equation 4.5. Multiplicative models are commonly used to model sales response and a key benefit of such models is that the relevant parameters can be interpreted as elasticities (Hanssens, Parsons, and Schultz 2003).

$$CHQNT_i = e^{\alpha_0} CHNDPRC_i^{\alpha_1} IHNDPRC_i^{\alpha_2} NRCMP_i^{\alpha_3} \cdot HMVAL_i^{\alpha_4} e^{\sum_{m=1}^{M-1} \alpha_{5m} MONTH_{mi}} e^{\epsilon_i} \quad (4.5)$$

As shown in equation 4.6, I use the log-log form of the multiplicative model,

$$\begin{aligned} \ln(CHQNT_i) = & \alpha_0 + \alpha_1 \ln(CHNDPRC_i) + \alpha_2 + \ln(IHNDPRC_i) \\ & + \alpha_3 \ln(NRCMP_i) + \alpha_4 \ln(HMVAL_i) \\ & + \sum_{m=1}^{M-1} \alpha_{5m} MONTH_{mi} + \epsilon_i \end{aligned} \quad (4.6)$$

where $CHQNT$ is the quantity of carpet purchase in 100 square feet, $CHNDPRC$ is the carpet price per 100 square feet, $IHNDPRC$ is the basic installation price per 100 square feet, α are parameter vectors, ϵ is the error term, and the remaining terms are as defined earlier.

As before, the carpet price and installation price are endogenous. To account for their endogeneity, I use the two-stage least squares (2SLS) approach. In addition to the exogenous variables in equation 4.6, the instruments for the first stage regressions are the carpet type, brand, and product line dummy variables, as in the installation demand equation, along with the log of the carpet and installation cost per 100 square feet.

4.5 EMPIRICAL RESULTS

4.5.1 Installation Purchase Decision

The estimation results (minus the monthly dummies) are shown in Table 4-4. The direct effect of installation price on the probability of installation purchase is significant and in the expected direction ($\beta_1 = -.0193; p < .001$). Based on the change in probability for installation price, a \$10 increase in the price of installation at the sample means results in a .040 decrease in the probability of purchasing the installation. The cross-effect of carpet price on the probability of installation purchase is also significant ($\beta_2 = -.1221; p = .026$). The quantity of carpet purchased has a significant effect in the expected direction ($\beta_3 = .0009; p < .001$). At the sample means, a 100 square foot increase in carpet purchased increases the probability of installation purchase by .02.

Table 4-4 Installation Purchase Estimation Results

Variable	Coefficient (Std. Error)	p > z	Change in Probability
Installation Price	-.0193 (.0036)	<.001	-.0040
Carpet Quantity	.0009 (.0001)	<.001	.0002
Carpet Price per ft ²	-.1221 (.0549)	.026	-.0254
Nearest Competitor	-.0044 (.0025)	.073	-.0009
Home Value	.0006 (.0002)	<.001	.0001
INTERCEPT	2.5564 (.4051)	<.001	

$\chi^2_{18} = 176.03$ $p < .001$ $R^2 = .058$
 * 4 of the 11 monthly dummies are significant

Based on the estimation results, the expected effects of Figure 4-2a are confirmed. The direct- and cross-price effects on the probability of installation purchase are both negative and significant. The biggest driver of the probability of installation purchase appears to be carpet quantity. Intuitively, this makes sense. The more carpet a household purchases, the less likely the customer would want to personally install the carpet. The distance to the nearest competitor is marginally significant ($\beta_4 = -.0044$; $p = .073$). The further a customer is from a major competitor, the less likely they are to purchase the installation. Closeness to a major competitor allows the customer to more easily compare prices. Because the focal retailer and major competitor often have similar installation prices, the customer is better able to judge the value of the installation, inducing installation purchase. Home value has a significant positive effect on the probability of installation purchase ($\beta_5 = .0006$; $p < .001$). Intuitively, this is expected. Higher home values are likely associated with higher disposable incomes and

a greater ability to pay for the installation. In addition, four of the 11 monthly dummy variables are significant, indicating some moderate seasonality. The significant seasonality occurs during the peak home buying months of May through August. During these months, customers are moving into existing homes and want to replace the carpet to match their preferences for color and type.

4.5.2 *Carpet Demand*

The results of the estimation appear in Table 4-5. As expected, the direct carpet price elasticity of carpet demand is negative and significant ($\alpha_1 = -.3852; p < .001$). A one percent decrease (increase) in the price of carpet per 100 square feet leads to a .38 percent increase (decrease) in the quantity of carpet purchased. The cross installation price elasticity of carpet demand is also negative and significant ($\alpha_2 = -.8462; p < .001$). A one percent decrease (increase) in the price of installation per 100 square feet leads to a .85 percent increase (decrease) in the quantity of carpet purchased. The distance to the nearest competitor has a significant negative effect on carpet demand ($\alpha_3 = -.0310; p = .002$). A one percent increase (decrease) in distance to nearest competitor decreases (increases) carpet quantity purchased by .03 percent. As in the installation purchase, closeness to a major competitor allows customers to better evaluate the value of the carpet purchase, inducing them to purchase more carpet. The home value has a significant positive effect on carpet demand ($\alpha_4 = .0433; p < .001$). A one percent increase (decrease) in home value leads to a .04 percent increase (decrease) in quantity of carpet purchased. Intuitively, this is as expected. Higher home values are associated with larger homes and greater disposable income, leading to

greater quantities of carpet purchased. Ten of the 11 monthly dummy variables are significant, indicating much seasonality.

Table 4-5 Carpet Demand Estimation Results

Variable	Coefficient (Std. Error)	<i>z</i>	<i>p</i> > <i>z</i>
<i>ln(Carpet Price per 100 ft²)</i>	-.3852 (.0368)	-10.45	<.001
<i>ln(Installation Price per 100 ft²)</i>	-.8462 (.0314)	-26.91	<.001
<i>ln(Nearest Competitor)</i>	-.0310 (.0100)	-3.10	.002
<i>ln(Home Value)</i>	.0433 (.0123)	3.52	<.001
INTERCEPT	5.6466 (.2509)	22.50	<.001

$\chi^2_{15} = 757.27$ $p < .001$ $R^2 = .278$
 *10 of the 11 monthly dummies are significant

4.6 DISCUSSION AND MANAGERIAL IMPLICATIONS

4.6.1 Installation Purchase

The results show that the decision to purchase installation is largely driven by the amount of carpet purchased, with higher quantities of carpet purchased resulting in a higher likelihood of purchasing installation. Intuitively, this makes sense on two fronts. First, the more carpet a household purchases, the more difficult it would be for the household to install it on their own, and the more expensive it might be for the household to hire a third party to install. Second, households purchasing higher quantities of carpet spend more money on the carpet. As this phenomenon occurs, the firm can allocate to the good a higher percentage of the hybrid bundle's cost to the consumer. Consequently, the service appears more attractive than the good as the price

of the service is mostly fixed. Marketers of hybrid bundles that follow this pricing scheme (i.e., per unit pricing on the good, flat pricing on the service) should highlight the enhanced price-value for the service with higher quantities of good purchased.

While the purchase installation decision is negatively affected by the price of the installation and the price of the carpet, the direct effect of installation price is greater. At first glance, this may not seem to be the case. However a \$1 increase in installation price is a very small increase, while a \$1 increase in carpet price per square foot is a very large increase. At the sample means, a 10 percent increase in carpet price would decrease the probability of installation purchase by only .0053, whereas a 10 percent increase in installation price would decrease the probability of installation purchase by .0423. For marketers of hybrid bundles of this type, the price of the good should be considered, but should be secondary to the price of the service as the latter has a much larger effect on the decision to purchase the service and the quantity of carpet purchased, as I show in the following sub-section.

4.6.2 Quantity of Carpet Demanded

The results from the carpet quantity estimation are interesting. While both the direct- and cross-price effects are significant and in the expected directions, the magnitude of the cross-price effect is much higher than past research on cross-category price elasticities suggests. The cross-price elasticity of the service on the demand of the good is more than twice as large as the direct-price elasticity. This difference is significant ($\chi^2_1 = 147.1$; $p < .001$) and has important managerial implications. When consumers convert their flat installation price to an installation price per square foot, it

can have a dramatic effect on the quantity of carpet purchased. Marketers of such hybrid bundles should highlight the low installation price per square foot when appropriate, and emphasize that additional carpet purchased reduces the overall square foot price. The price of the service in this hybrid bundle has a great deal of leverage.

4.7 LIMITATIONS, FUTURE RESEARCH, AND CONCLUSION

4.7.1 Limitations and Future Research

The limitations of the research are largely data related and suggest future research directions as better data are obtained. First, lack of data on the price and cost of basic installation for transactions that do not purchase installation creates problems in the analysis. The installations are normally flat priced, but vary over time and location. With data on the flat pricing for a given time and location, it would be possible to generate a better estimate of the installation price for non-installation purchasers and result in more accurate estimation results.

Second, the installation service is very labor-intensive. The quality variability of this component could have important pricing implications (Meyer and Shankar 2010; Meyer, Shankar, and Berry 2010). Information on the quality variability of the installation would be helpful in isolating its pricing implications. This information may be available at the store or transaction level, but was not available for the current research.

Third, the model could not be estimated simultaneously. The carpet quantity and installation purchase decision may be made either simultaneously or recursively. However, given the binary installation purchase decision, simultaneous estimation is not

appropriate. Future research may explore similar settings using a simultaneous system that allows equations with binary dependent variables.

Fourth, this research is for one specific type of hybrid bundle. Additional empirical research on other similar and dissimilar types of hybrid bundles should be undertaken to enhance the generalizability of the findings.

Finally, to fully estimate the model in Figure 4-1, additional information is needed on competitive pricing and promotion, as well as direct promotion. With these data, a more complete model of pricing hybrid bundles in a competitive setting can be constructed.

4.7.2 Conclusion

The marketing of hybrid bundles—bundles comprising both goods and services—is becoming more prevalent as firms seek to gain additional revenue streams. It is critical for marketers of hybrid bundles to understand the pricing implications of the good and the service within the bundle. This essay proposed a general framework and model for pricing of hybrid bundles in a retail setting with competition. Portions of this framework were tested using empirical data on one such hybrid bundle – carpet (the good) and installation (the service). The results show that for both the installation purchase decision and the carpet quantity decision, the price of the installation plays a crucial role. Past research on cross-category pricing effects often shows negative cross-price elasticities smaller than .10 percent. However, the cross-price effect of installation on carpet quantity was much higher, with a cross-price elasticity larger than the direct-

price elasticity. The results suggest it is crucial for marketers of such hybrid bundles to effectively price the service.

CHAPTER V

SUMMARY

The three essays in my dissertation examine the different facets of hybrid bundle pricing as shown previously in Figure 1-1. Although hybrid bundles are here to stay and continue to grow, research on hybrid bundles is scarce. In this dissertation, I provide important and useful insights into the pricing of hybrid bundles using a variety of methods.

Using an analytic model of hybrid bundle pricing by a monopolist, Essay I shows the considerable effects of quality variability and scalability, while accounting for independence and complementarity of the components. My results show that an increase (decrease) in quality variability for the service (good) is generally associated with higher (lower) optimal prices for the hybrid bundle and lower optimal price for the good, but lower (higher) overall firm profits. When marketers of hybrid bundles with high variability in the quality of the service, they should consider pricing the service and the hybrid bundle relatively higher, while pricing the good relatively lower. The results also reveal that the optimal service (good) price in a hybrid bundle is higher (lower) when the good has a diminishing unit cost and the service has a constant unit cost (i.e., the good is more scalable than the service). These findings have important implications for managers of hybrid bundles. While increased scalability of the good should naturally lead to lower prices for the good and the hybrid bundle, marketers of hybrid bundles should

also consider increasing the price of the service if it is available independently from the good.

Using CBC experimental analysis across three studies, Essay II tests the effects of quality variability, independence, and complementarity on price sensitivity through willingness-to-pay measures and hierarchical Bayesian estimation. The results show that higher quality variability of a service within a hybrid bundle is associated with a wider distribution of willingness-to-pay, independence between the good and the service in the bundle has positive direct- and cross-effects on willingness-to-pay, complementarity between the good and the service has a greater positive effect on the willingness-to-pay for the service than for the good, and independence and complementarity interact to increase willingness-to-pay. The results also offer important guidelines for managers. As in Essay I, managers should consider higher relative service prices for hybrid bundles with services high in quality variability. In addition, the cross-effects of independence on willingness-to-pay highlights that managers of hybrid bundles should strive for components that are independent of the other component in usage.

Through an empirical analysis of prices of hybrid bundles of a large specialty retailer data set, Essay III models the direct- and cross-effects of component prices on demand for the components in a hybrid bundle offered in a competitive setting. The empirical analysis uses data set of approximately 3,700 household transactions involving the purchase of a hybrid bundle comprised of carpet (the good) and installation (the service). The results show that for both the installation purchase decision and the carpet quantity decision, the price of the installation plays a crucial role. Past research on cross-

category pricing effects often shows very small cross-price elasticities. However, the cross-price effect of installation on carpet quantity was much higher, with a cross-price elasticity larger than the direct-price elasticity. The results suggest it is crucial for marketers of such hybrid bundles to effectively price the service.

Many interesting observations permeate the three essays collectively. First, Essay II showed how quality variability affects the willingness-to-pay for the service, while Essay I showed that it is optimal for a monopolist to increase the price of the service if its quality variability increases. Next, the independence of purchase, as used in Essay I, is much different than the independence of use, as used in Essay II, which leads to different implications across the two essays. Finally, all three essays showed that either a pricing driver or the price of one component can have significant effects on the other component. Essay I showed that service quality variability affects the optimal price of the good, and that the scalability of the good affects the optimal price of the service. Essay II showed that the independence of the good (service) affects consumer willingness-to-pay for the service (good). Essay III showed that the cross-elasticity of installation price on carpet demand is higher than own-elasticity of carpet price. Together, these three essays make important contributions to theoretical modeling of and substantive insights on the pricing of hybrid bundles and their component goods and services.

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APPENDIX I

DERIVATION OF CLOSED-FORM SOLUTION FOR OPTIMAL PRICE OF HYBRID BUNDLE UNDER NO INDEPENDENCE

With no independence, the monopolist sells only the hybrid bundle, serving only the N_{HB} segment. The size of this segment is given by:

$$N_{HB} = N \times \Pr [(1 + \theta)(R_G + R_S) \geq P_{HB}] \quad (A1.1)$$

Assuming a constant unit cost function for both the good and the service, the monopolist's problem can be defined as:

$$\max_{P_{HB}} \Pi = [(P_{HB} - C_G - C_S) \times N_{HB}]. \quad (A1.2)$$

I draw reservation prices, (R_G, R_S) , from the joint uniform distribution such that

$$f(x, y) = 1/(a^2 - 2a\delta) \text{ for } 0 \leq R_S \leq a \text{ and } \delta \leq R_G \leq a - \delta. \quad (A1.3)$$

I now derive the optimal price of the hybrid bundle in three cases.

Case 1: $\frac{P_{HB}}{1+\theta} \leq a - \delta$

The size of N_{HB} is given by:

$$N_{HB} = N \times \frac{2(1+\theta)^2(a^2 - 2a\delta - \delta^2) + 2P_{HB}(1+\theta) - P_{HB}^2}{2a(a-2\delta)(1+\theta)^2}. \quad (A1.4)$$

The monopolist's problem is given by:

$$\max_{P_{HB}} \Pi = \left[(P_{HB} - C_G - C_S) \times N \times \frac{2(1+\theta)^2(a^2 - 2a\delta - \delta^2) + 2P_{HB}(1+\theta) - P_{HB}^2}{2a(a-2\delta)(1+\theta)^2} \right] \quad (A1.5)$$

First Order Condition (simplified):

$$\frac{d\Pi}{dP_{HB}} = 0 = \frac{\left(\frac{2(1+\theta)^2(a^2-2a\delta-\delta^2)+2P_{HB}(1+\theta)}{-P_{HB}^2+(P_{HB}-C_G-C_S)(2\delta(1+\theta)-2P_{HB})} \right)}{2a(a-2\delta)(1+\theta)^2} \quad (\text{A1.6})$$

Second Order Condition (simplified):

$$\frac{d^2\Pi}{dP_{HB}^2} = \frac{-3P_{HB}+2\delta(1+\theta)+C_G+C_S}{a(a-2\delta)(1+\theta)^2} < 0 \quad (\text{A1.7})$$

Solving for P_{HB} :

$$P_{HB}^* = \left(\frac{2\delta(1+\theta) + C_S + C_G + \sqrt{(C_S + C_G)^2 + (1+\theta)^2(6a^2 - 2\delta^2 - 12a\delta) - 2\delta(C_S + C_G)(1+\theta)}}{2\delta(C_S + C_G)(1+\theta)} \right) / 3 \quad (\text{A1.8})$$

This solution holds for “low costs”:

$$\frac{C_G+C_S}{1+\theta} \leq \frac{(a-3\delta)^2}{2(a-2\delta)} \quad \text{and} \quad \delta < \frac{5a}{11} \quad (\text{A1.9})$$

Case 2: $a - \delta \leq \frac{P_{HB}}{1+\theta} \leq a + \delta$

The size of N_{HB} is given by:

$$N_{HB} = N \times \frac{3a(1+\theta)-2P_{HB}}{2a(1+\theta)}. \quad (\text{A1.10})$$

The monopolist’s problem is given by:

$$\max_{P_{HB}} \Pi = \left[(P_{HB} - C_G - C_S) \times N \times \frac{3a(1+\theta)-2P_{HB}}{2a(1+\theta)} \right] \quad (\text{A1.11})$$

First Order Condition (simplified):

$$\frac{d\Pi}{dP_{HB}} = 0 = \frac{3a(1+\theta)-4P_{HB}+2(C_G+C_S)}{2a(1+\theta)} \quad (\text{A1.12})$$

Second Order Condition (simplified):

$$\frac{d^2\Pi}{dP_{HB}^2} = \frac{-2}{a(1+\theta)} < 0 \quad (\text{A1.13})$$

Solving for P_{HB} :

$$P_{HB}^* = \frac{3a(1+\theta)+2(C_S+C_G)}{4} \quad (\text{A1.14})$$

This solution holds for “medium costs”:

$$\frac{(a+4\delta)}{2} \leq \frac{C_G+C_S}{1+\theta} \leq \frac{(a-3\delta)^2}{2(a-2\delta)} \text{ and } \delta < \frac{a}{2} \quad (\text{A1.15})$$

Case 3: $\frac{P_{HB}}{1+\theta} \geq a + \delta$

The size of N_{HB} is given by:

$$N_{HB} = N \times \frac{(1+\theta)^2(\delta-2a)^2 + P_{HB}(1+\theta)(2\delta-4a) + P_{HB}^2}{2a(a-2\delta)(1+\theta)^2}. \quad (\text{A1.16})$$

The monopolist’s problem is given by:

$$\max_{P_{HB}} \Pi = \left[\frac{(P_{HB} - C_G - C_S) \times N \times ((1+\theta)^2(\delta-2a)^2 + P_{HB}(1+\theta)(2\delta-4a) + P_{HB}^2)}{2a(a-2\delta)(1+\theta)^2} \right] \quad (\text{A1.17})$$

First Order Condition (simplified):

$$\frac{d\Pi}{dP_{HB}} = 0 = \frac{\left((1+\theta)^2(\delta-2a)^2 + P_{HB}(1+\theta)(2\delta-4a) + P_{HB}^2 \right) + (P_{HB} - C_G - C_S)((1+\theta)(2\delta-4a) + 2P_{HB})}{2a(a-2\delta)(1+\theta)^2} \quad (\text{A1.18})$$

Second Order Condition (simplified):

$$\frac{d^2\Pi}{dP_{HB}^2} = -\frac{-3P_{HB}+4a(1+\theta)-2\delta(1+\theta)+C_G+C_S}{a(a-2\delta)(1+\theta)^2} < 0 \quad (\text{A1.19})$$

Solving for P_{HB} :

$$P_{HB}^* = \frac{(2a-\delta)(1+\theta)+2(C_S+C_G)}{3} \quad (\text{A1.20})$$

This solution holds for “high costs”:

$$\frac{C_G+C_S}{1+\theta} \geq \frac{(a+4\delta)}{2} \quad \text{and} \quad \delta < \frac{a}{3} \quad (\text{A1.21})$$

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