Essays on Extended Service Contracts

Tao Chen
Defense
May 1st, 2008
Abstract

Extended service contracts have been the major profit generator for many consumer electronics retailers as they contribute to half of the retailers’ profit. My dissertation studies how consumers make purchase decisions of extended service contracts and how the ESC purchase decisions are related to the product purchase decisions.

Essay 1: “Why Do Consumers Buy Extended Service Contracts?”

The first essay in my dissertation examines factors that influence consumer purchases of ESCs for electronic products in a retail setting. ESCs are essentially insurance products. The major insurance purchase determinants are the perceived probability of loss, the extent of loss, risk aversion, and the amount of the insurance premium. This essay examines how product characteristics (hedonic/utilitarian) and retailer actions (promotions and contract coverage) influence the purchase of ESCs. It also investigates the impact of consumer characteristics (sex, income, and prior usage) on these purchase determinants. The predictions are tested using revealed preferences from panel data of electronic purchases covering several product categories.

Essay 2: An Empirical Investigation of Consumer Purchases and Inter-Temporal Pricing of Retailers’ Extended Service Contracts

The second essay examines consumers’ inter-temporal pattern of product adoption and ESC purchases across product shelf lives. Recognizing the fact that consumers strategically delay their product adoption, this paper focuses on how fast declining product prices affect consumer purchase
propensity of ESCs and whether the decreasing ESC prices help the electronics retailers to sell more ESCs. The results show that consumers are more likely to purchase ESCs during the early stages of the product’s shelf life because of the higher risk associated with replacement costs and uncertainty. Quickly declining product prices significantly decrease consumers’ propensity of purchasing ESCs. The current decreasing trend of ESCs further destroys ESC value by encouraging consumers to delay product adoptions. The simulation results show that sometimes an increasing ESC price trend helps encourage consumers to adopt the product earlier, which increases their propensities to purchase ESCs, because it is more aligned with consumers’ strategic behavior.
Essay 1

Why Do Consumers Buy Extended Service Contracts?

TAO CHEN
AJAY KALRA
BAOHONG SUN
1. INTRODUCTION

Examining how consumers make decisions under uncertainty is a fertile field of research in several domains. The purchase of extended service contracts provides an excellent opportunity to understand consumer behavior under uncertainty in a field setting. Extended Service Contracts (ESCs) are usually offered by retailers and sometimes by manufacturers to lengthen the coverage provided by the manufacturer’s basic warranty. They are also sometimes referred to as Extended Warranties or Extended Service Plans. Technically, ESCs are insurance products which require consumers to pay premiums up front for protection against possible failures or problems in later periods. Usually, the salesperson or the checkout staff recommends the purchase of the ESC immediately after the consumer buys a product.

Extended service contracts, first introduced by large electronics stores in the late 1980s, have become a core product for many retailers and cover a wide range of categories. The cost of the extended contract usually ranges between 10% and 50% of a product’s original price (Business Week 2004). Typically, ESCs are priced at a fixed amount for certain product price tiers. For example, the price of ESC for TVs below $199 is $39.99, the price of ESC for TVs between $200 and $499.99 is $59.99, and so on. This creates variations of ESC prices across price tiers but not products or brands within a tier. The terms typically last from one to three years, depending on the product category. ESCs generate approximately $15 billion dollars a year for retailers (Warranty Weeks, January 19, 2005) and are extremely profitable. For example, even though extended service contracts accounted for only 3-4% percent of the revenue, they contributed more than 50% of Best Buy’s profit and almost 100% (amounting to $194.5m) of Circuit City’s profits in 2003 (Business Week, 2004). Some analysts estimate that the average margin for the ESCs is 50-60% which is about 18 times the margin for regular products.
Selling service contracts has become a dominant profit growth strategy for retailers of durable products (Warranty Week, 2004). Even Wal-Mart, which initially resisted recommending ESCs has started exploiting this profit generator (Business Week, 2005, Consumer Affairs, 2005).

Although most consumer magazines and experts advocate consumers should not buy extended service contracts, because they provide little value, it is intriguing that the demand for service contracts remains high. Many consumers purchase extended service contracts because they say the plans provide them with “peace of mind” (ABC News, 2006). Given the financial stake of ESCs to retailers and costs for consumers, understanding what factors affect consumer purchase decisions of ESCs and whether the process can be influenced is both theoretically and substantively important.

Literature on extended service contracts is sparse and mainly uses an analytical paradigm (e.g., Padmanabhan and Rao 1993). While this stream of analytical research significantly advances our understanding of the function of extended warranties from manufacturer’s perspective and/or in a competitive setting, the mechanism(s) underlying consumer behavior regarding the purchase of insurance products such as extended service contracts in a retail environment are not well understood.

Insurance literature identifies the major determinants of purchasing insurance as being the probability of loss, the extent of loss, the insurance premium charged and buyer’s risk aversion (Mossin 1968; Schlesinger 1999). These determinants have been shown to influence purchase of flood (Browne and Hoyt 2000), life (Hammond,Houston, and Melander 1967) and health (Cameron et al 1988; Feldman et al 1989) insurance. With very few exceptions, the empirical literature in insurance considers these determinants to be objective. From the consumer
decision making perspective, it is important to note that these determinants are not always objective but can be subjective. For example, different consumers may have very different perceptions of the probability that the same model of a TV will fail. Most insurance literature also assumes risk aversion to be consumer specific rather than product or context specific. Our focus in this paper is on understanding how the likelihood of purchasing ESC can be influenced by product characteristics and the marketing actions taken by retailers. In addition, consumer characteristics can accentuate or attenuate the effect of these insurance purchase determinants.

We examine how differences in consumer characteristics impact ESC purchases.

More specifically, first, we examine the product categories in which consumers purchase extended service contracts. We use the categorization of hedonic versus utilitarian products and investigate whether consumer purchase patterns differ based on this product characteristic.

Second, we examine retail influences on perceptions of ESCs. Retail environment and retailer controlled decisions potentially can impact ESC sales. For example, there is evidence in the literature that product price and the length of a manufacturer’s warranty coverage signal quality (Boulding and Kirmani 1993). We examine whether such findings hold for ESC purchases as well. Furthermore, because retailers decide on price promotions and whether to advertise these promotions, we investigate whether advertised and unadvertised promotions alter consumers’ risk attitudes and hence their propensity to purchase extended service contracts. Third, we examine whether consumers with certain demographic variables (e.g. gender, income, past experience of ESCs) are more likely to purchase extended service contracts. The predictions are tested using a panel data provided by the electronic department of a retailer on the consumer purchase histories of ESCs across several categories. Thus, our predictions are tested using consumers’ revealed preferences.
To the best of our knowledge, this is the first attempt to examine consumers’ purchase of extended service contract in a retail environment using field data. We thus depart from existing research in several important ways. First, in contrast to the empirical testing in the existing literature where the main objective was to verify analytical models, we are interested in understanding the consumer decision making under uncertainty and how their purchase propensities of ESC are influenced by product, retail, and consumer factors. Second, unlike prior research which has been primarily survey based and covers only one (automobile) category, this study uses purchase history data across several categories. Third, unlike most previous research where risk attitudes are self-reported and probability of loss is objective, we infer these factors from consumers’ revealed preferences. Fourth, while prior literature largely views the ESC purchase decision as exogenous and based primarily on consumers’ inherent risk aversion and usage patterns, this research demonstrates that the purchase likelihood can be influenced by marketing actions. Fifth and finally, we provide some interesting insights into why the ESC purchase process differs across demographics (e.g., between high- and low-income consumers).

2. LITERATURE REVIEW

As the literature on ESCs is fairly small, we summarize the key findings. The early literature rationalizes the use of extended service contracts based on consumer segmentation variables such as risk aversion, demographics and usage rates. Using an agency theory framework, Padmanabhan and Rao (1993) examine optimal manufacturer warranty policies in a market characterized by the moral hazard problem and consumers with heterogeneous risk aversions. They conclude that manufacturers should offer a menu of warranties in light of the
heterogeneity in risk aversion and suggest that extended warranties be offered as a part of the menu for risk averse consumers. Padmanabhan (1995b) argues that since products bought by heavy users are more likely to fail, they have a stronger incentive to purchase the optional extended warranty compared to consumers who are light users. In a heterogeneous market where the relative number of heavy users is high, the profitability for the manufacturers to offer ESCs reduces. He concludes that extended warranties should not be offered in such a market or if it is, then consumers with high usage rates must be expressly excluded.

One set of papers investigate manufacturer strategies for extended service plans in the presence of competition from third-party insurers. Lutz and Padmanabhan (1995) propose that manufacturers should not offer extended warranties when third-party insurers compete with them. They provide two reasons: first, manufacturers have to consider the increased expected costs of both the basic warranty and the extended warranty. Second, if consumers buy the extended warranty from the third-party insurers, the consumers are more likely to reduce their maintenance effort in the product during the warranty period. They suggest that the manufacturers are better off altering their pricing strategy and withdrawing the extended warranty. Lutz and Padmanabhan (1998) also show that the manufacturers will limit the range of extended warranty menus when third-party insurers enter the market. Desai and Padmanabhan (2004) pose the question on whether the extended warranty should be sold by the manufacturer or the retailer. They find that, even in the presence of third-party insurers, it is either equally or more profitable to sell extended warranties through retailers.

Despite the rich analytical literature, empirical research on ESCs is limited. In a qualitative study using focus groups, Day and Fox (1985) find that while general attitudes towards ECSs are negative, consumers are more favorably inclined to extended warranties that
provide insurance against catastrophic loss or those that provided regular maintenance. They also conjecture that income levels, risk attitude, product usage and product experience may relate to attitude towards ESCs. They also find that ESCs could impact product quality perceptions but the direction is not clear.

Based on automobile purchase data where risk attitude is measured through a survey, Padmanabhan and Rao (1993) reveal that demand for ESCs is higher for consumers who are more risk averse, who are single and who have higher income levels. However, they find no support for an effect of high product usage on ESCs purchase. They also find that consumers who buy more expensive cars and cars with shorter manufacturer warranty coverage are more likely to buy ESCs.

Padmanabhan (1995b) tests the relationship between high product usage rate and ESC purchases. Using data of automobiles with 3-year/3600-mile base warranties, he finds support for the model as consumers with higher usage rates (business versus non-business) and those who intended to keep the cars longer are more likely to buy extended warranties. Another factor that explains the purchases is marital status (singles were more likely) but risk attitude and income do not.

3. CONCEPTUAL DEVELOPMENT

3.1. Product Characteristics:

3.1.1 Hedonic and Utilitarian Products

A robust finding in the insurance literature is that the relationship between the monetary value of the object and likelihood of purchase of insurance is positive (e.g., Browne and Hoyt 2000). Therefore, given the same price of any two products and equal probability of breakdown,
consumers should be equally likely to insure both products. This argument does not take into account that equally priced products may be valued quite differently by consumers. Products are characterized by a combination of utilitarian and hedonic attributes (Dhar and Wertenbroch 2000; Okada 2005). Utilitarian products provide consumers with functional benefits that are useful, practical and necessary whereas hedonic products are associated with fantasy, fun and pleasure. Dhar and Wertenbroch (2000) show that equivalently priced hedonic products are valued more than utilitarian products in forfeiture situations but both are equally valued in acquisition decisions. This finding is qualified by Okada (2005) who finds that even in the acquisition decision, the purchase context impacts the relative consumer valuations of hedonic and utilitarian products (Okada 2005). Okada finds that in acquisition decisions, where consumers evaluate products one at a time, hedonic items are valued higher than utilitarian item.

The typical scenario in the purchase of durables (e.g., TV, cameras) is that the consumer decides the category prior to the store visit and then makes a brand or model selection within the store. After the purchase decision, a salesperson suggests the purchase of the extended service contract. When deciding on the ESC purchase, the consumer must elaborate on the possibility of losing the product which is a state that approximates the forfeiture situation. Dhar and Wertenbroch (2000) suggest that hedonic items are valued more than utilitarian products in forfeiture situations for two reasons. First, the attributes of hedonic products are more sensory and image evoking and therefore consumers are more likely to imagine and elaborate on (MacInnis and Price 1987). Second, they suggest that forfeiture scenarios lead to upward prefactual thinking that could lead consumers to minimize their emotional loss by valuing the hedonic items more (Sanna 1999).
Given the same price of a product, consumers are more likely to purchase a service contract for a product they value more as compared with a product that is ascribed lower value. In a series of interesting experiments, Hsee and Kunreuther (2000) manipulate the emotional value of an identical object (e.g., a painting) by asking participants in one condition to imagine that they “fell in love” with the product. They find that, holding the level of expected compensation the same, people are more willing to purchase insurance for products for which they are more fond. They argue that when valuation increases due to higher affection for the product, the pain of loss is higher and the compensation from the insurance serves as a consolation for the loss. Given equivalent prices, since consumers attach greater worth to hedonic products than to utilitarian products, we predict they are more likely to buy extended service contracts for hedonic products.

Another set of argument for why consumers are more likely to purchase extended service contracts for hedonic products is that very often, compared to utilitarian products, the purchase of hedonic goods involves self gratification which is accompanied by feelings of guilt (Khan, Dhar and Wertenbroch 2005). Consumers use coping mechanisms to reduce or minimize their feelings of guilt such as finding reasons to support or justify the purchase. For example, consumers justify the purchase of a hedonic product as a reward to themselves or categorize income spent on the purchase as being obtained from a windfall (Strahilevitz and Myers 1998). The justification routes identified in the literature mainly address the reasoning that consumers use prior to their purchase decision. An alternative route to such post purchase justification is to take actions after purchase that serve the guilt reduction objective. One such sequential action is insuring the product by the purchase of an ESC – a behavior that is very prudent. Additionally and more directly, there is evidence that guilt is associated with risk averse behavior (Mancini
and Gangemi 2004). In summary, given the same price, the extent of loss for hedonic products is more than for utilitarian products and since the purchase is more guilt inducing, it could lead to greater risk aversion. We therefore predict that, holding all else constant, consumers are more likely to purchase extended service contracts for products with relatively higher hedonic value than for those with relatively lower hedonic value.

_Hypothesis 1: Consumers are more likely to purchase ESCs for products which have relatively higher hedonic value as compared to products that have relatively higher utilitarian value._

3.1.2 Manufacturer Warranty.

When the purchase decision is made, consumers do not have perfect knowledge about the reliability of the product and therefore of the likelihood of product failure in the future. There is large body of evidence that when decisions need to be made under uncertainty, consumers look for cues which help them infer product reliability (Dodds, Monroe and Grewal 1991). Prior research has documented product price and terms of the manufacturer’s basic warranty as important sources of information regarding product reliability. The literature on warranties shows that warranty terms impact consumer perceptions of product quality (Shimp and Bearden 1982) and purchase intentions (Boulding and Kirmani 1993). Warranty terms include the length and scope of the warranty while product quality dimensions cover overall quality, probability of breakdown and specific attribute quality. A generalizable finding from this stream of research is that the length and scope of the manufacturer’s warranty indicate higher quality and more specifically lower perceptions of product failure (Boulding and Kirmani 1993). The positive effect of warranties has been found to be moderated by brand name (Price and Dawar 2002),
manufacturer reputation (Boulding and Kirmani 1993, Purohit and Srivastava 2001) and retailer reputation (Purohit and Srivastava 2001), and consumer expertise (Srivastava and Mitra 1998).

Hypothesis 2: Consumers are less likely to purchase ESCs for products which have relatively longer manufacturer warranties because they perceive a lower probability of failure.

3.2 Retail Factors:

3.2.1 Promotions.

Price promotions are ubiquitous and retailers spend considerable amount of money communicating the promotions. While there is considerable research examining promotions (see Neslin 2002 for an excellent review), the relationship between price promotions offered on products and purchase of service contracts is not obvious.

A line of reasoning suggests that there could be a positive relationship between buying a product on promotion and buying an extended service contract. The savings accrued by buying a discounted product results in the income effect. There is considerable evidence that the income effect resulting from a promotion can lead to the purchase of more expensive brands (e.g. Allenby and Rossi 1991; Blattberg and Wisniewski 1989). The increase in income from a promotion can also induce consumers to spend the extra money on the ESC. We therefore hypothesize that when a product is purchased at a discount, consumers are more likely to purchase ESCs.

Hypothesis 3: Consumers are more likely to purchase ESCs for products purchased on promotion.
3.2.2 Unadvertised Promotions.

Very often, retailers offer price promotions on products but do not advertise those promotions. The literature has identified two benefits of this strategy. First, using an analytical framework, Rao and Syam (2001) show that unadvertised price cuts is an equilibrium strategy for retailers as it helps them retain customers who frequent the store. Heilman et al (2002) find that unexpected in-store coupons cause consumers to increase their expenditures by making more unplanned purchases. One account for this behavior is due to the consumers’ unexpected psychological increase in income. More important, they also argue that the unexpected windfall gain makes people feel good resulting in an elevated positive mood.

Mood can affect risk taking behavior. Isen and her colleagues have demonstrated that a positive mood causes people to become more risk averse. When the situation is in the domain of gains, positive mood effect leads to risk seeking, but in the domain of losses, people become risk averse (Dunegan et al 1992; Isen and Patrick 1983). Isen, Nygren and Ashvy (1988) also show that positive mood makes people become more sensitive to losses and that they prefer to minimize their losses rather than maximize their gains. In a business decision making context too, Mittal and Ross (1998) also show that positive mood causes low risk taking. The underlying mechanism is that the positive mood affects the subjective utility value of the potential outcomes. As compared with a neutral mood, a positive mood causes potential losses to appear worse. The reasoning is that besides the negative financial outcome, the loss also leads to the demolishing of the positive mood. Interestingly, Isen and Geva (1987) find that people carefully elaborate about negative outcomes when they are in a happy mood. In summary, anticipating a loss is more unpleasant for those are in a relatively happy mood compared with those who are in a neutral mood.
As compared to consumers who expect a promotion, consumers who purchase a product on an unadvertised promotion are likely to have an elevated mood due to the unexpected positive surprise. When faced with the decision to make an ESC purchase, this elevated mood, in turn, is likely to make them more risk averse.

*Hypothesis 4: Unadvertised promotions are more likely to increase consumers’ risk aversion and therefore increase their propensity to purchase ESCs.*

### 3.3 Consumer Characteristics

We now discuss how consumer characteristics influence the ESC purchase decisions. The consumer characteristics we examine are gender, income, and prior experience with ESCs.

#### 3.3.1 Gender

The role of gender in risk taking has received considerable interest in both the economics (Dekel and Scotchmer 1999) and psychology literature (Magnan and Hinsz 2005). In a meta-analysis of research that uses an experimental paradigm, Byrnes, Miller and Schafer (1999) conclude that females are less prone to risk taking than male participants. This result is reinforced by empirical studies that females are less risk taking in their allocation of retirement savings plans (Sunden and Surette 1998), in the selection of term life insurance (Halek and Eisenhauer 2001) and buying health insurance (Feldman et al 1989). As ESC is essentially an insurance product, we therefore expect to confirm that females are more likely to purchase extended service contracts.
Hypothesis 5: Females are more likely to purchase ESCs than males because they are more risk averse.

3.3.2 Income.

A decreasing absolute risk aversion which implies that income is negatively related to insurance purchase is widely accepted in theoretical analysis of insurance demand. (Mossin 1968). However, the empirical findings in the insurance literature find mixed results where some studies show a positive relationship between income and purchase of insurance (e.g., Browne and Hoyt, 2000 for flood insurance), while others find a negative relationship (e.g., Cicchetti and Dubin, 1994 for telephone line service contracts). Padmanabhan and Rao (1993) find that higher income consumers are more likely to buy ESCs in the automobile category. We therefore view the effect of income as an empirical question.

3.3.3 Past Usage of ESCs.

As extended service contracts are insurance products, two segments emerge post purchase after buying an ESC in any category. The first segment does not experience product failure in the category purchased and therefore does not avail of any benefits from the purchase of the ESC. The second segment does face a problem with the product and has to exercise the contract. We argue that consumers who do face a product failure problem, regardless of the category where they experience product failure, are more likely to view purchasing the ESC more favorably on any subsequent purchase occasions. There is evidence that consumer purchase of insurance is prone to biases due to past claims (Johnson et al 1993). The past product failure is likely to increase the potential perceived probability of future related and even unrelated product category breakdowns. Therefore, if ESCs have been used in the past,
consumers’ perceived probability of failure will increase which, in turn, increases their propensity to purchase ESCs for other related or unrelated products.

Hypothesis 6: Prior usage of a service contract increases consumers’ perceptions of product failure rates and therefore makes it more likely for them to purchase ESC for other products.

In summary, we conceptualize that product characteristics, retailer actions and consumer characteristics influence the purchases of ESCs. The mechanisms include either altering the perceptions of the probability of loss, the extent of loss and risk aversion or through the psychological income effect. We now test the predictions of the outcomes using data on observed choices made by consumers and the mechanisms permitted by the available data.

4. DATA DESCRIPTION

We use data provided by the electronics department of one retailer. Some retailers, such as Circuit City, offer consumers a menu of ESC’s that vary in length and price whereas others, such as Best Buy and Target, provide only one plan. This retailer offers only one plan. We have access to the consumer purchase histories of ESC plans of 604 households from November 2003 to October 2004, who made a total of 1676 purchases of products and 553 purchases of service contracts during the observation period. More specifically, the data consists of the complete history of the households’ purchases of electronic durables and service contracts during these 12 months. It contains detailed information on both the purchased products and available service contracts such as product type, product price, promotion offered on the product, presence of a feature (i.e. advertised promotion), price and length of coverage of the service contracts, and time and location of the purchases. We also have access to consumer characteristics such as
income, gender and a dummy variable that identifies whether a consumer has used an ESC in the past (even before the starting of observation period). Since the number of product types is unmanageable, we follow the retailer’s practice and classify the products into seven product categories based on their general function. The seven product categories are video, audio, phone, camera, computer, game, and mobile audio.

Insert Table 1 about here

Table 1 presents the sample statistics. On average 31% of the consumers purchase an ESC at least once during the observation period. ESC purchases constitute about 33% of all purchase occasions. Among all the seven product categories, consumers are most likely to purchase service contracts for mobile-audio and cameras, and least for video and game systems. The average price of products purchased is $340.09 and that of the service contracts is $59.25. Thus, service contracts are priced at roughly 17.42% of the product price. The average length of coverage is 33 months, which varies from 24 to 48 months. The average price promotion depth is 6.41% of the product price. That of the advertised and unadvertised price promotion is 2.38% and 4.03% respectively. ESCs are used by 8% of consumers once during our observation period. The percentage of male consumers in the sample is 62%. In the dataset, income is provided as a 100 point index.

To determine the hedonic and utilitarian values of each product, we conducted a survey on a sample of 107 adults using the same methodology as Okada (2005). Respondents rated each product category on one hedonic scale anchored between “not at all hedonic (0)” and “extremely hedonic (6)” and one utilitarian scale anchored between “not at all utilitarian (0)”
and “extremely utilitarian (6).” Following Okada (2005), hedonic items were described as fun/pleasant/enjoyable and utilitarian products were described as useful/practical/functional. The results are reported in Table 2. We code $HEDONIC_j$ as the difference between the hedonic value and the utilitarian value of a category. We also note that the Plasma TV category features the highest price in the dataset ($4000$-$5000$). If we remove the observations for the plasma TV category, there is no significant correlation between product prices and the $HEDONIC_j$ variable. We analyzed the data excluding the Plasma TV category and find that it does not change the results. We therefore include it in the final estimation.

____________________

Insert Table 2 about here

5. EMPIRICAL ANALYSIS

5.1 Model

We consider consumers $i = 1, \ldots, I$ who bought electronic products in product categories $j = 1, \ldots, J$ during purchase occasion $t$ and therefore use $D_{ijt}$ to represent whether consumer $i$ purchases an ESC for product $j$ at occasion $t$:

$$D_{ijt} = \begin{cases} 1, & \text{if consumer } i \text{ buys ESC for product } j \text{ at time } t, \\ 0, & \text{otherwise}. \end{cases}$$

5.1.1 Perceived Failure Rate.

Because consumers buy ESCs to cover the risk of future replacement or repair cost incurred by product breakdowns, purchase decisions should depend on the likelihood of product failure. However, at the time of purchase, they suffer uncertainty regarding this precise
probability. Therefore, they often use the price of the product and the length of coverage of the manufacturer’s warranties as quality cues for assessing the probability (Boulding and Kirmani 1993; Erdem, Keane, and Sun 2007; Purohit and Srivastava 2001). Accordingly, we employ the following function to determine the consumer’s perceived product failure rate:

\[
V_{ij} = \beta_{i0} + \beta_{0j} + \beta_{1i}PRICE_j^P + \beta_{2i}COVER_j^M + e_{ij},
\]

where \(V_{ij} = \overline{V}_{ij} + e_{ij}\). This formulation is based on Erdem, Keane, and Sun’s (2007) empirical finding that price signals quality and Boulding and Kirmani’s (1993) determination that manufacturer warranty signals quality. Then, \(PRICE_j^P\) represents the price of product \(j\) within each product category, and \(COVER_j^M\) is the length of coverage of the manufacturer’s basic warranty, which comes free with the product. We include this latter variable to control for the potential association of a longer manufacturers’ warranty coverage with lower failure rates, which would affect ESC purchase propensities. Finally, \(e_{ij}\) refer to unobservable factors that affect consumers’ perceptions of breakdown rates.

The coefficient \(\beta_{0j}\) is consumer-specific constant that captures unobserved factors that may affect perceptions of failure rates across product categories. For example, consumers with children may perceive a higher probability of product failure. Next, \(\beta_{0j}\) is a category-specific constant term that captures different failure rates across categories. For example, product categories with the newest technology or multiple sophisticated features may be perceived as more likely to break down. Whereas \(\beta_{ii}\) captures the effect of product price on perceived failure probabilities, \(\beta_{2i}\) measures the effect of the length of the manufacturer’s basic warranty.
Assuming \( e_{ij} \) follows an independent and identically extreme value distribution, we derive the probability of product failure with a binary logit model:

\[
\rho_{ij} = \frac{e^{\eta_i}}{1 + e^{\eta_i}}.
\]  

5.1.2 Expected Benefit of Purchasing Service Contract.

The decision to purchase an ESC requires a comparison between the cost and benefit of owning it. Whereas the price represents the cost to the consumer, uncertainty surrounds the benefits, which accrue only if the product breaks down. If the product does not fail, an ESC purchase involves only cost; if the product fails, the ESC enables consumers to avoid out-of-pocket expenses to repair or replace the product.

At the time of purchase, consumers must assess the benefits according to the expected replacement or repair costs they may avoid. For simplicity, we assume that the terms of the ESC include replacing the failed product with a similar product at a similar price. Because we do not observe information about repair costs, the cost of replacement provides a reasonable surrogate; high labor costs mean many consumers simply elect to replace rather than repair their durable products. In addition, repair cost usually is proportional to replacement cost.

Because consumers’ perceived failure rate is \( \rho_{ij} \), we can identify the expected cost of replacement as \( \rho_{ij} \text{PRICE}_j^P \), where \( \text{PRICE}_j^P \) is the price for product \( j \) paid by consumer \( i \). Thus, the expected benefit of owning a service contract equals the replacement price, weighted by the perceived probability of product failure. According to the special property of binomial distribution, the variance of the expected replacement cost is \( \rho_{ij}(1-\rho_{ij}) \text{PRICE}_j^{P2} \).

5.1.3 Purchase Decisions.
Under uncertainty, consumers make purchase decisions on the basis of their expected utilities, given the perceived probability of failure $\rho_j$, which consumer $i$ develops for product $j$. We then assume that the expected utility that affects the ESC purchase decisions is given by

$$E[U_{ij} | \rho_j] = \alpha_0 + \alpha_h HEDONIC_j + \alpha_s \rho_j PRICE_{ij}^s + \alpha_i [1 - \rho_j] PRICE_{ij}^2 + \alpha_a PROM_{ij}$$

$$+ \alpha_i PRICE_{ij}^{ESC} + \alpha_s COVER_{ij}^{ESC} + \alpha_i PP_i + \alpha_i (1 - \rho_j) PRICE_{ij}^3 \cdot HEDONIC_j$$

$$+ \alpha_i \rho_j (1 - \rho_j) PRICE_{ij}^2 \cdot \text{UNADPROM}_{ij} + \alpha_i \rho_j (1 - \rho_j) PRICE_{ij}^{ADPROM} + \epsilon_{ij},$$

where $HEDONIC_j$ is the difference between the hedonic value and utilitarian value of product $j$. We include this variable to test whether a product with greater hedonic value makes consumers more likely to purchase ESC. The term $\rho_j$ refers to consumer $i$’s perceived failure rate for product category $j$, as described by equations 1–3, and $\rho_j PRICE_{ij}^s$ is the expected cost of replacement. In addition, $\rho_j(1 - \rho_j) PRICE_{ij}^2$ equals the variance of the expected cost of replacement, which contains information about the accuracy of consumers’ perceived failure rate, in line with Levy and Markowitz (1979), who allow the mean and variance to affect expected utility functions. As in standard marketing and economics literature, we interpret coefficient $\alpha_s$ as sensitivity to uncertainty, a measure of consumer risk attitude (Erdem and Keane 1996). We include $PROM_{ij}$, the depth of the price promotion on product $j$ that consumer $i$ receives, to test whether a price discount makes consumers more or less likely to purchase service contract. Then, $PRICE_{ij}^{ESC}$ is the price of the ESC charged by the retailer, as well as the cost for consumers to buy the ESC. The variable $COVER_{ij}^{ESC}$ refers to the length of coverage of ESC, which we include to determine whether longer length attracts consumers to ESCs. Finally, $PP_i$ captures consumer $i$’s ESC purchase history. Conceptually similar to Guadagni and Little’s (1983) loyalty index,
*PP*<sub>it</sub> is the weighted average of purchases of ESC prior to occasion *t*; it includes the purchase of an ESC in any product category. Therefore,

\begin{equation}
PP_{it} = \theta PP_{it-1} + (1 - \theta) \sum_{j=1}^{t-1} D_{ij-1},
\end{equation}

where \( \theta \) is the decay factor.

To test whether purchasing a hedonic product makes consumers more risk averse, we include the interaction term between hedonic value and the variance of the expected replacement cost, \( \rho_j (1 - \rho_j) PRICE_j^{P2} \ast HEDONIC_j \). In turn, \( UNADPROM_j \) indicates a price promotion not advertised to consumers, and its interaction with the variance in the expected replacement cost, \( \rho_j (1 - \rho_j) PRICE_j^{P2} \ast UNADPROM_j \), enables us to test the possibility that consumers become more risk averse with a surprise promotion. Similarly, \( ADPROM_j \) indicates if the promotion is advertised, and we again include its interaction with variance, \( \rho_j (1 - \rho_j) PRICE_j^{P2} \ast ADPROM_j \).

In the expected utility function of equation 4, parameter \( \alpha_{i0} \) indicates consumers’ intrinsic preference to buy ESCs; \( \alpha_i \) measures whether consumers are more likely to purchase ESCs for hedonic product categories; \( \alpha_{i2} \) measures sensitivity to the expected replacement cost; \( \alpha_{i3} \) indicates their level of risk aversion; \( \alpha_{i4} \) denotes the effect of a promotion on the purchase of a service contract; \( \alpha_{i5} \) measures price sensitivity with respect to the price of the ESC; \( \alpha_{i6} \) represents whether the length of ESC coverage affects ESC purchase; \( \alpha_{i7} \) indicates whether prior purchases of ESC’s increase the likelihood of purchasing ESCs; \( \alpha_{i8} \) measures whether a hedonic product purchase makes the consumer more risk averse; and \( \alpha_{i9} \) and \( \alpha_{i10} \) indicate the effects of unadvertised and advertised promotions on risk aversion.

We use the vector \( \Theta \) to represent parameters to be estimated, such that
\[ \Theta_i = (\beta_{i0}, \beta_{i1}, \alpha_i, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7, \alpha_8, \alpha_9, \alpha_{10}) \] for all \( j \). If \( \bar{U}_j = U_{ij} - \varepsilon_{ij} \) is the deterministic part of the utility functions, and assuming the error term \( \varepsilon_{ij} \) is independently and identically extreme value distributed, we obtain the probability of consumer \( i \) choosing ESC for product \( j \) conditional on \( \Theta_i \):

\[
\text{Prob}(D_{ij} = 1|\Theta_i) = \frac{e^\gamma \Theta_i}{1 + e^\gamma \Theta_i},
\]

In line with existing insurance literature, we allow consumers to make purchase decisions on the basis of perceived failure rates, expected replacement cost, and uncertainty associated with the future replacement costs.

5.1.4 Heterogeneity and Estimation.

To measure the effect of consumer heterogeneity on responses to the main variables (i.e., coefficients in the perceived failure rate and utility functions), we assume each parameter is a linear function of consumer demographic variables, such as income, gender, and experience with ESCs, and thereby characterize how the coefficients in the utility function differ across consumer demographics and past usage with ESCs:

\[
\Theta_i = \gamma_0 + \gamma_{1}\text{INCOME}_i + \gamma_{2}\text{MALE}_i + \gamma_{3}\text{USE}_i + \varepsilon_i,
\]

where \text{INCOME}_i and \text{MALE}_i refer to the income and gender of consumer \( i \) and \text{USE}_i is a dummy variable indicating whether consumer \( i \) has ever used a service contract. Their coefficients measure the impact of these factors on consumers’ perceptions of failure probability and ESC purchase probabilities. By modeling this heterogeneity, we introduce interaction terms among the three consumer demographic variables and all coefficients from the perceived failure rate and
utility functions in a parsimonious way. The coefficient estimates in the heterogeneity equation 7 reveal how consumer characteristics moderate the main effects. For example, if we estimate $\alpha_{2i}$ as positive and $\gamma_1$ as negative, consumers appear sensitive to expected replacement cost on average, but higher income consumers are less so.

We assume the unobserved part of equation 7 is distributed as multivariate normal, or $e_i \sim MVN[0, \Sigma]$. We use a hierarchical Bayesian approach to estimate the model. For identification, $\beta_{04}$ is fixed. Readers interested in the estimation procedure are referred to Gelfand and Smith (1990) and Allenby and Rossi (1999) for details.

5.2 Results

To explore the fit of our proposed model, we estimate three benchmark models. The first is a basic logit model, in which the utility function is a linear function of the category constants, price of the product, promotion, price of ESC, and coverage of ESC. This is our proposed model without perceived failure rate, expected replacement cost, variance of expected replacement cost, interaction terms, and heterogeneity. The second model matches our proposed model but without hedonic value and the three interaction terms with variance of expected replacement cost. Finally, in the third model, we exclude just heterogeneity from our proposed model. In table 3A, we provide the log-likelihood and Akaike information criterion (AIC) model comparison results; our proposed model fits the data better. That is, by taking into account consumer perceived failure rate, the modifying effects of product characteristics, advertising, promotion, and consumer characteristics, our model explains the observed data better than the benchmark models.
In table 3B, we compare the predicted ESC purchase probabilities with those from the sample for each product category and find an overall hit rate of 72%. We also calculate and compare the purchase probabilities for the seven product categories predicted from our model with the sample frequencies. Given the discrete nature of the dependent variable, the fit is quite good. Thus, our estimated consumer model approximates the data reasonably well.

---

Insert Table 3A and 3B about here

To further establish model validity, we obtain the available breakdown rates published by *Consumer Reports* and *PC Magazine* in the same period and compare them with the perceived probabilities of breakdown inferred from the model. The rank order of the calculated perceived failure rates is consistent with that indicated by the publications, and the magnitudes also are accurate. For example, the actual breakdown rates for video, game, and phone equipment are 9%, 18%, and 26%, respectively; our model produces perceived rates of 16%, 32%, and 39%.

In table 4, we focus on the parameter estimates in the perceived probability function; as expected, consumers tend to associate higher prices with a lower probability of product failure. We thus confirm the conventional wisdom that product price plays a significant role in signaling product reliability and reduces consumer concerns about product failure. However, the length of the manufacturer warranty has no significant impact on the perceived probability of failure. This result is inconsistent with prior experimental findings (Boulding and Kirmani 1993) and hypothesis 2. Unlike experimental research where the manufacturer warranty length is manipulated, our data feature manufacturers’ warranties that are similar in length for most electronic categories, we posit that these results may not contradict existing theory; rather, the data may lack sufficient variation to provide results consistent with experimental research.
In the purchase utility equation, the coefficient of the dummy variable $HEDONIC_j$ is positive and significant ($\alpha_1 = 0.21$); that is, consumers are more likely to purchase ESCs for hedonic products than for utilitarian products, in support of hypothesis 1. The $\alpha_2$ parameter also is significant and positive, which implies consumers are sensitive to the expected cost of replacement and increase their probability of purchasing ESCs when they estimate a higher replacement cost. This result is consistent with existing findings in insurance literature that consumers are more likely to purchase insurance for products where expected cost of replacement is high (Williamson, Ranyard, and Cuthbert 2000). The coefficient of the squared term of the expected replacement cost $\alpha_3$ also is positive and significant, which suggests that consumers are risk averse, and greater uncertainty about the replacement cost increases their propensity to purchase ESCs. The coefficient of price promotion is positive and significant—that is, if consumers receive a price discount, they are more likely to purchase an ESC. We find support for hypothesis 3. As anticipated, consumers also are sensitive to the price (insurance premium) of the ESCs ($\alpha_5 = -17.00$), though we find no impact of its length. This absence of effects may result from the lack of variation in the length of ESC, as we speculated for the manufacturer warranty. Finally, the coefficient for past purchase of ESC ($\alpha_7 = 5.23$) is significant, such that consumers who have purchased ESCs in the past are more likely to do so in the future.

The interaction of hedonic value and variance in the expected replacement costs is not significant ($\alpha_8 = 0.06$); therefore, we must reject the explanation that purchase guilt increases
risk aversion. In turn, consumers may be more likely to buy ESCs simply because they value hedonic items more, consistent with experimental results provided by Hsee and Kunreuther (2000).

In hypothesis 4, we predict that unadvertised promotions create a positive mood and increase risk aversion; the interaction between unadvertised promotion and variance of expected replacement cost is positive and significant ($\alpha_{ui} = 0.42$). Thus, when a retailer uses unadvertised promotions, consumers’ risk aversion increases, making them more likely to buy ESCs, in support of hypothesis 4. The interaction between advertised promotions and variance of expected replacement cost is not significant though ($\alpha_{io} = 0.04$), which confirms that only unadvertised promotions alter risk aversion levels.

We now turn to examine the coefficients in the heterogeneity equations reported in Table 5. These estimates describe how consumers with different characteristics respond differently to our focal variables; we discuss only significant estimates. The estimates in the heterogeneity equations can be interpreted as interactions between heterogeneity characteristics and the explanatory variables in the probability and utility equations. For example, the coefficient of men ($\beta_{h} = 0.77$) in the heterogeneity equation indicates that, relative to women, men are less likely to associate higher product price with lower probabilities of failure. Said differently, women are more likely to believe that high priced products are more reliable.

Income level does not affect perceived probabilities of product failure rate. However, as indicated by the negative coefficient of income in the heterogeneity equation for $\alpha_{zi} (-2.02)$, relative to low income consumers, higher income consumers are less sensitive to the expected cost of replacement. The higher-income consumers also are less sensitive to promotions ($\alpha_{4i} = -0.40$) and less likely to purchase ESCs even when the product is on promotion.
The overall effect implies that given everything else equal, lower income consumers are more prone to buying ESCs. Two explanations account for this finding: first, lower income consumers are more sensitive to the replacement cost which is not very surprising since the more limited disposable income makes it much harder for them to repurchase the product in event of product failure. Second and more interesting, the impact of price promotions on the purchase of extended service contracts is more for low income consumers. The conjecture that low income consumers are more prone to ESC purchases is inconsistent with the findings of Padmanabhan and Rao (1993) and Padmanabhan (1995b). These results can be accounted for by the differences in the automobile category examined in the earlier studies and the cheaper electronic product categories. In the relatively cheaper electronic categories, higher income consumers have the ability to self insure their purchases but the lower income consumers do not. Another possibility is that the insurance objective for automobiles and electronics products differs. In automobiles, the ESC objective is primarily repair and maintenance while for electronic products, it is replacement. Since higher income consumers have higher time costs, they may be more willing to purchase ESCs for automobiles rather than for electronic products where product replacement is the primary goal.

Gender also entails several differences. Compared with female consumers, men are less likely to rely on price to infer product reliability (0.77) and more sensitive to expected replacement costs (10.18). Consistent with prior findings, male consumers appear less risk averse than women (-6.72). However, it remains difficult to predict whether ESC purchases relate to gender overall. Although women are inherently more risk averse, they also rely more on product
price to infer product reliability. The raw data shows that across the purchase occasions, 33.46% of men and 32.23% of women purchase ESCs; thus, we cannot confirm hypothesis 5.

Finally and interestingly, if a consumer has previously exercised a service contract, they perceive a greater probability of product failure, regardless of the product category (2.02). As an explanation, we offer the availability bias (Tversky and Kahneman 1974) or posit that past failures may make consumers less confident about the way they handle products. No other parameters are significant. This result therefore points to the strong effect of past product failure on subsequent purchase of ESCs, in support of hypothesis 6 that consumers who have used an ESC earlier perceive increased probability of product failure and are more likely to purchase ESCs.

6. DISCUSSION

In this article, we use consumer decisions of purchasing extended service contracts to understand their decision making under uncertainty. The decision to purchase insurance requires consumers to assess the probability of loss and the extent of loss and make a decision based on their perceptions of risk and the premium charged. Our results suggest that this decision is context specific and can be influenced by marketing actions.

We conceptualize and demonstrate that the purchase of extended service contracts as being influenced by three major factors: hedonic/utilitarian value of products, price promotions and advertising, and consumer characteristics. We develop hypotheses on the impact of these three factors on consumers’ perceptions of product failure probability and likelihood of purchasing an extended service contract. We then test these predictions by applying a consumer
We hypothesize that consumers are more likely to purchase insurance provided by extended service contracts for products that have relatively higher hedonic value than utilitarian value for two reasons. First, given equal prices, consumers’ valuation for hedonic products is higher thereby increasing the perceived extent of loss. Second, the purchases of hedonic products also elicit feelings of guilt and heighten risk aversion. The results confirm that the perceived probability of purchasing extended service contracts is more for hedonic products. We do not find support for the guilt explanation. The results reinforce the findings of Dhar and Wertenbroch (2000) which show that valuation of hedonic products is more than for utilitarian products. The results also suggest that consumers are willing to pay a premium to protect the additional valuation.

Our results on the impact of retail environment demonstrate that retailer actions can influence ESC sales. Promotions increase likelihood of purchasing extended service contracts because there may be a psychological increased income effect realized from savings due to the price promotion. We also predict and find support that unadvertised promotions augment the effects of promotions. The unexpected gains from unadvertised promotions evoke positive moods in consumers (Heilman, Nakamoto and Rao 2002). This positive moods, in turn, increase their risk aversion and consequently the purchase of extended service contracts.

We confirm earlier empirical findings that product price serves as a cue of quality (Erdem, Keane and Sun 2007). Consumers use high price as an indicator of product quality and assign a lower chance of the product failing if it has a higher price. The results do not confirm that the basic manufacturer warranty length is an indicator of quality. We suspect however that this is an
artifact of the real world data where there is little variation in the length of warranty offered across brands. The results also suggest that state dependence in the purchased of extended service contracts. Consumers who have purchased service contracts in the past are also likely to do again in other product categories in the future.

The results from the heterogeneity analysis are intriguing. In contrast to the prior empirical findings (Padmanabhan and Rao 1993; Padmanabhan 1995b), our results show that low income consumers are more likely to purchase ESCs. The analysis reveals that they are likely to do so because they are more sensitive to the replacement costs in event of product failure. Unlike the case of automobiles where high income consumers buy ESCs to avoid maintenance because they have higher time costs, in the electronics product category, low income consumers buy insurance to hedge against out-of-pocket costs of replacing the product. Additionally, lower income consumers are also more predisposed to exercising the savings obtained from promotions to purchase ESCs.

If the extended service contracts do, in fact, offer little value, the results imply a perverse impact on consumer welfare. The lack of financial ability of low income consumers to replace products induces them to pay a potentially unnecessary and overpriced insurance premium. On the other hand, high income consumers for whom product replacement is not a cause for anxiety incur a lower total cost of product acquisition. This finding are somewhat ironic given the earlier observations that the poor sick patients unable to afford health insurance pay the highest prices for drugs (e.g., Frank 2001). In the health domain, poor patients are unable to afford insurance in a category where it is salubrious to but opt for insurance in an area where the investment is inexpedient.
The results of gender differences show that men and women have very different underlying motivations. We find evidence that women are more risk averse than men in the domain of purchasing extended service contracts and are inherently more prone to buy insurance. Women are more likely to use price as an indicator of product reliability but are less sensitive to expected replacement cost. But men are more sensitive to the expected replacement cost.

Finally, the analysis confirms that consumers who have encountered product failure and have utilized their ESC in the past increase their estimates of subsequent product failures. We conjecture that perceptions of risk are higher for these consumers due to the availability bias.

7. Future Research

With data based on revealed choices in a store environment, we focus primarily on examining outcomes of the decision process. Unlike experimental research, which can pinpoint causality by controlling all other factors, empirical research is more exploratory. The main advantage of conducting empirical research is that we have revealed preference data collected in real setting. Thus, we can investigate the simultaneous impact of many factors on the purchase decision. More important, it allows us to establish the external validity of the key effects. Consistent with the nature of our data though, we cannot test for all underlying processes, which represents an endemic limitation of empirical research. Although our primary objective has been predicting outcomes based on theoretical reasoning, when the data allow, we make the best possible attempt to gain an understanding of the processes.

It is important to point out that many of the effects in a realistic purchase setting, particularly for large-ticket items will be challenging to reproduce in an experimental setting. For example, reproducing the subjective valuations consumers assign to their possessions during the
acquisition process and their resultant actions would be difficult in an experimental setting is difficult. Similarly, replicating the positive mood evoked by an unexpected price promotion using hypothetical scenarios is likely a formidable undertaking.

The mechanisms that influence perceptions of value, perceived probability of failure, and risk aversion require more in-depth analysis, including through experimentation. For example, we find that consumers are more likely to purchase ESCs in response to unadvertised promotions, but we cannot determine post hoc whether consumers actually were unaware, so research in an experimental setting should confirm this effect. In addition, our data indicate that guilt following purchase of hedonic items does not account for ESC purchases, so research should examine our proposed explanation that high hedonic valuation prompts insurance purchase.

A key difference between ESCs and other insurance is that the purchase process for the latter is more deliberate. For most ESC purchases, decision making likely takes place quickly and with less deliberation. These differences suggest potential avenues for exploration. Such exploration also might consider the different ESC offers among retailers: some of them offer a single ESC option where the only decision a consumer faces is whether to buy or not buy. Other retailers offer menus of ESC contracts. It is interesting issue for future research to investigate how consumers choose among a menu of ESC plans.

We adopt a static approach for our analysis, whereas further research might model consumer dynamics explicitly in the choice of service contracts. Structural models in which consumers learn the benefits of ESCs, incorporate prior information to form their expectations of product reliability, develop expectations about future replacement costs, and are forward looking about risk might help investigate the dynamic nature of consumer decision processes. Finally,
additional consumer decisions, such as product returns, could be studied in conjunction with the ESC purchase decision.
REFERENCES


### TABLE 1. SAMPLE STATISTICS

<table>
<thead>
<tr>
<th>Variables</th>
<th>Explanations</th>
<th>Means or Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(D_{ijt})</td>
<td>Whether ESC was purchased</td>
<td>.33</td>
</tr>
<tr>
<td>Audio</td>
<td></td>
<td>.38</td>
</tr>
<tr>
<td>Video</td>
<td></td>
<td>.24</td>
</tr>
<tr>
<td>Phone</td>
<td></td>
<td>.31</td>
</tr>
<tr>
<td>Camera</td>
<td></td>
<td>.45</td>
</tr>
<tr>
<td>Computer</td>
<td></td>
<td>.34</td>
</tr>
<tr>
<td>Game</td>
<td></td>
<td>.30</td>
</tr>
<tr>
<td>Mobile Audio</td>
<td></td>
<td>.52</td>
</tr>
<tr>
<td>(PRICE^{ESC}_{jt})</td>
<td>Price of ESC</td>
<td>$59.25</td>
</tr>
<tr>
<td>(COVER^{ESC}_{jt})</td>
<td>Coverage period of ESC (years)</td>
<td>2.75</td>
</tr>
<tr>
<td>(COVER^{M}_{jt})</td>
<td>Coverage period of manufacturer’s basic warranties (years)</td>
<td>0.87</td>
</tr>
<tr>
<td>(PRICE^{P}_{jt})</td>
<td>Price of product</td>
<td>$340.09</td>
</tr>
<tr>
<td>(HEDONIC_{jt})</td>
<td>The difference between hedonic and utilitarian values of a product</td>
<td>-0.49</td>
</tr>
<tr>
<td>(PROM_{jt})</td>
<td>Depth of price promotion</td>
<td>6.41%</td>
</tr>
<tr>
<td>(ADPROM_{jt})</td>
<td>Depth of advertised price promotion</td>
<td>2.38%</td>
</tr>
<tr>
<td>(UNADPROM_{jt})</td>
<td>Depth of unadvertised price promotion</td>
<td>4.03%</td>
</tr>
<tr>
<td>(INCOME_{j})</td>
<td>Income level on a 100 point index</td>
<td>64.48</td>
</tr>
<tr>
<td>(GENDER_{j})</td>
<td>Whether the consumer is a male</td>
<td>62%</td>
</tr>
<tr>
<td>(USE_{j})</td>
<td>Whether a previous purchase of ESC was availed</td>
<td>7.94%</td>
</tr>
</tbody>
</table>

---

\(D_{ijt}\): Whether ESC was purchased

\(PRICE^{ESC}_{jt}\): Price of ESC

\(COVER^{ESC}_{jt}\): Coverage period of ESC (years)

\(COVER^{M}_{jt}\): Coverage period of manufacturer’s basic warranties (years)

\(PRICE^{P}_{jt}\): Price of product

\(HEDONIC_{jt}\): The difference between hedonic and utilitarian values of a product

\(PROM_{jt}\): Depth of price promotion

\(ADPROM_{jt}\): Depth of advertised price promotion

\(UNADPROM_{jt}\): Depth of unadvertised price promotion

\(INCOME_{j}\): Income level on a 100 point index

\(GENDER_{j}\): Whether the consumer is a male

\(USE_{j}\): Whether a previous purchase of ESC was availed

---

\(a\): The sample contains 604 households that purchased 553 service plans for 1,676 products between November 2003 and October 2004.
**TABLE 2. HEDONIC CATEGORIES vs UTILITARIAN CATEGORIES**

<table>
<thead>
<tr>
<th>Categories</th>
<th>Hedonic Value</th>
<th>Utilitarian Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio-visual receiver</td>
<td>3.92(.16)</td>
<td>4.02(.15)</td>
</tr>
<tr>
<td>Boom box</td>
<td>4.63(.15)</td>
<td>3.47(.20)</td>
</tr>
<tr>
<td>Car stereo</td>
<td>4.81(.16)</td>
<td>4.38(.19)</td>
</tr>
<tr>
<td>CD recorder</td>
<td>2.93(.31)</td>
<td>3.93(.29)</td>
</tr>
<tr>
<td>Cell phone</td>
<td>3.61(.31)</td>
<td>5.36(.16)</td>
</tr>
<tr>
<td>Computer peripheral</td>
<td>2.89(.33)</td>
<td>4.32(.23)</td>
</tr>
<tr>
<td>Desktop</td>
<td>2.50(.30)</td>
<td>4.88(.23)</td>
</tr>
<tr>
<td>Digital camcorder</td>
<td>4.56(.15)</td>
<td>4.42(.14)</td>
</tr>
<tr>
<td>DVD player</td>
<td>4.90(.16)</td>
<td>4.34(.17)</td>
</tr>
<tr>
<td>High end camera (&gt; $400)</td>
<td>4.51(.25)</td>
<td>3.06(.29)</td>
</tr>
<tr>
<td>High end speaker (&gt; $200)</td>
<td>4.11(.26)</td>
<td>3.03(.31)</td>
</tr>
<tr>
<td>Home CD changer</td>
<td>4.17(.19)</td>
<td>3.49(.18)</td>
</tr>
<tr>
<td>Home phone</td>
<td>1.75(.32)</td>
<td>4.57(.31)</td>
</tr>
<tr>
<td>Home theatre</td>
<td>4.66(.25)</td>
<td>3.83(.30)</td>
</tr>
<tr>
<td>IPOD</td>
<td>4.54(.24)</td>
<td>3.23(.28)</td>
</tr>
<tr>
<td>Low end camera (&lt; $400)</td>
<td>4.72(.15)</td>
<td>5.01(.12)</td>
</tr>
<tr>
<td>Low end speaker (&lt; $200)</td>
<td>2.53(.29)</td>
<td>3.63(.29)</td>
</tr>
<tr>
<td>Notebook</td>
<td>3.61(.28)</td>
<td>5.21(.16)</td>
</tr>
<tr>
<td>Pay phone</td>
<td>1.79(.29)</td>
<td>4.40(.35)</td>
</tr>
<tr>
<td>PDA</td>
<td>4.11(.16)</td>
<td>5.03(.14)</td>
</tr>
<tr>
<td>Portable CD player</td>
<td>4.91(.27)</td>
<td>4.17(.30)</td>
</tr>
<tr>
<td>Portable DVD player</td>
<td>3.97(.23)</td>
<td>2.76(.28)</td>
</tr>
<tr>
<td>Printer</td>
<td>2.25(.33)</td>
<td>5.06(.21)</td>
</tr>
<tr>
<td>Projection TV</td>
<td>4.77(.28)</td>
<td>3.21(.32)</td>
</tr>
<tr>
<td>Regular TV (&lt; $1000)</td>
<td>3.12(.25)</td>
<td>5.23(.24)</td>
</tr>
<tr>
<td>Shelf stereo system</td>
<td>4.46(.16)</td>
<td>3.99(.17)</td>
</tr>
<tr>
<td>Two way radio</td>
<td>3.13(.20)</td>
<td>4.15(.18)</td>
</tr>
<tr>
<td>VCR</td>
<td>2.65(.30)</td>
<td>3.91(.29)</td>
</tr>
<tr>
<td>Video game console</td>
<td>4.53(.30)</td>
<td>2.59(.31)</td>
</tr>
<tr>
<td>Video game controller</td>
<td>4.30(.31)</td>
<td>2.26(.32)</td>
</tr>
<tr>
<td>Voice recorder</td>
<td>3.06(.18)</td>
<td>4.46(.15)</td>
</tr>
</tbody>
</table>
### TABLE 3A. MODEL COMPARISON

<table>
<thead>
<tr>
<th></th>
<th>Benchmark Model 1</th>
<th>Benchmark Model 2</th>
<th>Benchmark Model 3</th>
<th>Proposed Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log-likelihood</td>
<td>-997.56</td>
<td>-965.74</td>
<td>-956.29</td>
<td>-899.88</td>
</tr>
<tr>
<td>AIC</td>
<td>1008.56</td>
<td>979.74</td>
<td>974.29</td>
<td>956.88</td>
</tr>
</tbody>
</table>

### TABLE 3B. COMPARISON WITH SAMPLE STATISTICS

<table>
<thead>
<tr>
<th>Predicted Purchase Probability</th>
<th>Sample</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio</td>
<td>.38</td>
<td>.37</td>
</tr>
<tr>
<td>Video</td>
<td>.24</td>
<td>.22</td>
</tr>
<tr>
<td>Phone</td>
<td>.31</td>
<td>.28</td>
</tr>
<tr>
<td>Camera</td>
<td>.45</td>
<td>.36</td>
</tr>
<tr>
<td>Computer</td>
<td>.34</td>
<td>.35</td>
</tr>
<tr>
<td>Game</td>
<td>.30</td>
<td>.34</td>
</tr>
<tr>
<td>Mobile audio</td>
<td>.52</td>
<td>.46</td>
</tr>
<tr>
<td>Hit Rate</td>
<td></td>
<td>.71</td>
</tr>
<tr>
<td>Efron's RSQ</td>
<td></td>
<td>.18</td>
</tr>
<tr>
<td>McFadden’s RSQ</td>
<td></td>
<td>.15</td>
</tr>
<tr>
<td>Parameters</td>
<td>Estimates (Standard Deviations)</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>---------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Perceived Probabilities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant Term</td>
<td>[\beta_{0j}]</td>
<td></td>
</tr>
<tr>
<td>Audio</td>
<td>-0.83 (.41)**</td>
<td></td>
</tr>
<tr>
<td>Video</td>
<td>-2.01 (.39)**</td>
<td></td>
</tr>
<tr>
<td>Phone</td>
<td>-0.90 (.67)</td>
<td></td>
</tr>
<tr>
<td>Camera</td>
<td>fixed</td>
<td></td>
</tr>
<tr>
<td>Computer</td>
<td>-1.40 (.25)**</td>
<td></td>
</tr>
<tr>
<td>Game</td>
<td>-1.15 (.39)**</td>
<td></td>
</tr>
<tr>
<td>Mobile audio</td>
<td>-0.73 (.70)</td>
<td></td>
</tr>
<tr>
<td>Price of the Product</td>
<td>[\beta_{1i}] - .95 (.23)**</td>
<td></td>
</tr>
<tr>
<td>Coverage of Manufacturer Warranty</td>
<td>[\beta_{2i}] .05 (.24)</td>
<td></td>
</tr>
<tr>
<td><strong>Utility Function</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant Terms</td>
<td>[\alpha_{0i}] -5.94 (2.96)**</td>
<td></td>
</tr>
<tr>
<td>Hedonic Product</td>
<td>[\alpha_{1i}] .21 (.11)**</td>
<td></td>
</tr>
<tr>
<td>Expected Replacement Cost</td>
<td>[\alpha_{2i}] 13.29 (6.27)**</td>
<td></td>
</tr>
<tr>
<td>Variance of Expected Replacement Cost</td>
<td>[\alpha_{3i}] 6.85 (3.12)**</td>
<td></td>
</tr>
<tr>
<td>Promotion</td>
<td>[\alpha_{4i}] 0.99 (0.57)*</td>
<td></td>
</tr>
<tr>
<td>Price of ESC</td>
<td>[\alpha_{5i}] -17.00 (1.96)**</td>
<td></td>
</tr>
<tr>
<td>Length of ESC</td>
<td>[\alpha_{6i}] 1.00 (0.77)</td>
<td></td>
</tr>
<tr>
<td>Past Purchases of ESC</td>
<td>[\alpha_{7i}] 5.23 (2.11)**</td>
<td></td>
</tr>
<tr>
<td>Variance * Hedonic</td>
<td>[\alpha_{8i}] 0.06 (.74)</td>
<td></td>
</tr>
<tr>
<td>Variance * Unadvertised Prom</td>
<td>[\alpha_{9i}] 0.42 (0.12)**</td>
<td></td>
</tr>
<tr>
<td>Variance * Advertised Prom</td>
<td>[\alpha_{10i}] 0.04 (0.11)</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at 0.10 level.
** Significant at 0.05 level.
### TABLE 5. HETEROGENEITY ESTIMATES

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Estimates (Standard Deviations)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Income</td>
</tr>
<tr>
<td>Perceived Probabilities</td>
<td></td>
</tr>
<tr>
<td>Constant Term</td>
<td>$\beta_{\alpha}$</td>
</tr>
<tr>
<td>Price of the product</td>
<td>$\beta_{\beta}$</td>
</tr>
<tr>
<td>Coverage of Manufacturer</td>
<td>$\beta_{\gamma}$</td>
</tr>
<tr>
<td>Utility Function</td>
<td></td>
</tr>
<tr>
<td>Constant Term</td>
<td>$\alpha_{\alpha}$</td>
</tr>
<tr>
<td>Expected Replacement Cost</td>
<td>$\alpha_{\beta}$</td>
</tr>
<tr>
<td>Variance of Expected Replacement Cost</td>
<td>$\alpha_{\gamma}$</td>
</tr>
<tr>
<td>Promotion</td>
<td>$\alpha_{\delta}$</td>
</tr>
<tr>
<td>Length of ESC</td>
<td>$\alpha_{\varepsilon}$</td>
</tr>
<tr>
<td>Price of ESC</td>
<td>$\alpha_{\rho}$</td>
</tr>
<tr>
<td>Past Purchases of ESC</td>
<td>$\alpha_{\iota}$</td>
</tr>
</tbody>
</table>
Essay 2

An Empirical Investigation of Consumer Purchases and Intertemporal Pricing of Retailers’ Extended Service Contracts

Tao Chen
Contracts on expensive digital TVs with liquid-crystal displays, plus plasma TVs, account for well over half of such income at both retailers, analysts figure. But deflation on high-priced electronics is accelerating: Prices now fall by 45% every 18 months, nearly twice the rate of five years ago. As prices decline, consumers become less willing to buy the service plans, figuring that if their gadget breaks, they’ll just buy a new one. The trend led to a fall last year in Circuit City’s contract revenues to 3.3% of sales, from 3.6% the year before.

—BusinessWeek, December, 2004

1 Introduction

Since the mid-1990s, extended service contracts (ESCs) have become a major profit engine for consumer electronics retailers (BusinessWeek 2004). ESC sales generated approximately $15 billion in 2004 and continue to grow at 7% a year (Warranty Weeks 2005). The average profit margin for ESCs is 50–60%, approximately 18 times the margin for regular products. BusinessWeek (2004) also reports that ESCs contributed to more than half of the total profits of major electronics retailers, such as Best Buy and Circuit City. This significant contribution to the bottom line makes ESCs increasingly important, visible marketing mix variables for retailers (Desai and Padmanabhan 2004).

Retailers usually provide ESCs as an insurance service for consumer electronics products, such that consumers pay a premium when they purchase the product and receive insurance for an extended period. If the product breaks down during the covered period, consumers can bring the product back to the retailers for repair or replacement for free or at a nominal fee. However, ESCs also can be provided by manufacturers and some third parties (e.g., credit cards), and in some cases, they can be purchased after purchasing the product. Most ESC purchases occur from the same retailers and at the same time as the consumers made product purchases though (Warranty Week 2007). Our paper therefore focuses on ESCs sold by the retailers at the point of product purchase.
In most situations, ESCs complement the manufacturers’ warranty that comes with most electronic products, which covers only manufacturer defects for a very limited period. Most manufacturer warranties cover only defective parts for a limited amount of time, such as one year, and labor for three months. Retailers’ ESCs offer much broader coverage, including normal wear and tear, surge, heat, and moisture protection. The length of coverage is usually two to four years. To some extent, ESCs are similar to manufacturers’ extended warranties but offer more and longer coverage, though ESCs also have a service component, because they create a repeated relationship between consumers and retailers. Because consumers generally visit the same retailer to purchase other products, the consumer cost of exercising the insurance policy with retailers is much lower than that with the manufacturer. In addition, if a service contract is exercised well, consumers may interpret it as good service and become more likely to purchase ESCs from the same retailer for other products. Thus, the insurance offered by retailers usually termed as an extended service contract, to differentiate it from manufacturers’ extended warranties.

On average, one-third of purchases of consumer electronics also include ESCs, which are attractive to consumers because they hold the promise of protection against the cost of mechanical failures and breakdowns after the manufacturers’ (basic or extended) warranties expire. By paying an insurance premium up front, consumers can avoid repair or replacement costs when the product breaks down in the future. Many consumers also purchase service contracts from the retailers because they want to protect their investment and gain peace of mind (ABC News 2006).

Insert Table 1 and Figure 1 about here
Currently, the most popular ESC pricing charges tiered prices proportional to product prices, such that the price of the ESC ranges around 10–30% of the product price, depending on the product categories. In Table 1, we list the ESC pricing schedule of a few major electronics retailers. Taking Best Buy’s digital camera as an example, retailers charge $29.99, $39.99, and $49.99 for cameras under $100, those between $100 and $199.99, and those that cost $200–$299.99. Some retailers vary the proportion across product categories, but other retailers, such as Target and Amazon, do not. The same ESC pricing schedule applies to all electronic products. With this pricing structure, whenever product prices decrease over the product’s shelf life, the ESC price also decreases. As we show in Figure 1, the Canon A75 Powershot digital camera was introduced to the market at $279.99 in February 2004. By August 2004, the product price fell to $249.99, an approximately 10% price cut in six months. The price of the product further was reduced to $179.99 in October 2004, an approximately 36% price cut from the initial price in only nine months. As a result of the product price reduction, the corresponding ESC price declined from $59.99 to $39.99, a 33% price cut.

Industry analysts argue that tiered pricing plans allow ESC pricing to fall in concert with the ticket sizes of electronic products and thus maintain traditional price-value ratios (TWICE 2007). The justification is straightforward: If the product becomes cheaper, the cost of repairing or replacing it should be less expensive, and therefore, it costs less for policy issuers to offer the insurance. In turn, the ESC price should be reduced. However, intuitively, when manufacturers reduce the product price, the expected repair or replacement cost also decreases, so the value of insurance should decline.

Given the increasing importance of ESCs as profit engines for retailers, it is important for electronics retailers to understand how, when, and why consumers purchase ESCs across a
product’s shelf life, as well as how they react to the inter-temporal pricing of ESCs. With greater understanding of these issues, consumer electronics retailers can evaluate their current ESC pricing. However, little existing research examines consumer purchase behavior with regard to ESCs offered by retailers. Moreover, little work considers whether and how ESC purchases interact with dynamic product adoption decisions or investigates its implications for the general design and pricing of ESCs. Therefore, we attempt to answer several interesting research questions.

First, we study how consumers’ propensity to purchase ESCs changes across the product shelf life and how that propensity relates to the time at which consumers adopt the product. Chen, Kalra, and Sun (2007) note that because it is an insurance product, the fundamental drivers of ESC purchases include risks associated with future repair or replacement costs.

Second, if product adoption and ESC purchases relate, how are ESC purchases affected by the declining product prices; alternatively, when does ESC pricing affect product adoption? Previous literature has established that for electronic products, consumers form expectations about future prices and make strategic decisions about when to adopt the product to balance their current consumption benefits with future lower prices (Melnikov 2001; Song and Chintagunta 2003). Intuitively, decreasing ESC prices should encourage consumers to delay their product adoption, because it is cheaper to hedge risk. We examine whether lower ESC prices across the product shelf life, as implied by current tiered ESC pricing, encourage consumers to delay their product purchases and decrease their risk.

Third, if current ESC pricing discourages consumers from purchasing ESCs, how can retailers improve ESC pricing to align it with consumer strategic decisions? This important issue can shed light on retailers’ evaluation of ESC pricing over a product’s shelf life (TWICE 2007),
which is particularly crucial because retailers usually have little control over product prices and must resort to ESC pricing to encourage consumers to purchase more ESCs.

We study the inter-temporal nature of the joint decisions about product adoption and ESC purchase. We propose a dynamic model to investigate consumer purchase decisions for ESCs along product shelf lives, as well as how those decisions depend on changes in the product and ESC prices. By forming expectations about future product price, consumers strategically adjust the timing of their product adoption; then, by adjusting the risks associated with expected replacement cost and uncertainty accordingly, they make product and ESC purchase decisions. On the basis of our estimation results, we run simulations to demonstrate how various intertemporal ESC pricing trends can affect the timing of product adoption and hence ESC purchases.

Our results indicate that consumers purchase ESCs as an insurance product to cover risks related to possible future replacement costs and uncertainty. Consumers who are more risk averse are more likely to adopt the product later. After a product purchase, a more rapid decrease in the product price makes consumers less likely to purchase an ESC. Our results therefore suggest that current ESC pricing does not align with consumer decision dynamics in the digital camera category. Offering discount for ESCs at earlier stages would lead to earlier product adoption and hence more ESC purchases.

Our analysis therefore shed lights on the dynamic choice decision about insurance products when risk factors and premium policies change over time, which is particularly important for retailers, because manufacturers constantly expedite R&D cycles and release newer models that make older models obsolete. This cycle causes product prices to decrease fast over
the produce shelf life. Furthermore, fierce competition leaves retailers little choice but to adjust their retail prices downwards.

The rest of this paper is organized as follows: We review the related literature in Section 2 and then describe the formal empirical model in Section 3. In Section 4, we discuss the data, estimation, and some simulation results. Finally, we provide some conclusions and further research ideas in Section 5.

2 Literature review

2.1. Manufacturer’s Basic Warranty and Extended Warranty

Manufacturers’ basic warranties have been studied in many disciplines, which document extensively that manufacturers provide basic warranties to signal the quality of the product, using experimental (e.g., Boulding and Kirmani 1993, Bearden and Shimp 1982) and analytical (e.g., Spence 1977, Grossman 1981) approaches. Other research studies the manufacturer’s warranty’s insurance role (e.g. Heal 1977). Murthy and Djamaludina (2002) offer a thorough review of existing literature on manufacturers’ basic warranties.

Unlike a basic warranty that usually comes free with the product, ESCs are offered for additional lengths of coverage and fees. Previous literature studies the use of ESCs on the basis of consumer heterogeneity in risk aversion and usage rates, and discusses the optimal design of warranty contracts when manufacturers face consumers with different risk aversion attitudes and usage rates. Padmanabhan and Rao (1993) examine the warranty menus when a manufacturer sells to consumers with heterogeneous risk aversion attitudes. Padmanabhan (1995b) also considers the optimal strategy when a manufacturer faces consumers with different usage rates.
Another set of studies investigate the industry structure of extended warranties. Lutz and Padmanabhan (1995) suggest manufacturers should not offer extended warranties when third-party competitors are present because manufacturers must balance the cost of both the basic warranty and the extended warranty. Lutz and Padmanabhan (1998) also show that the manufacturers limit the range of their extended warranty menu when third-party insurers enter the market. Desai and Padmanabhan (2003) find that selling extended warranties through retailers is either equally or more profitable for manufacturers.

Despite this rich analytical literature, scarce empirical research centers on extended warranties, and that which does is exploratory, based on survey data collected from respondents who bought automobiles from a manufacturer or its dealers. Specifically, using data collected from focus groups, Day and Fox (1985) suggest that consumers generally have negative attitude towards the extended warranty and they are more likely to buy extended warranty that covers catastrophic loss. From survey data, for which risk attitude represents a dummy variable that records consumers’ answers to a question about risk attitude, Padmanabhan and Rao (1993) find that consumers are more likely to buy ESCs for more expensive automobiles and that single consumers are more likely to buy ESCs. They also find consumers are less likely to buy ESCs as base warranty coverage increases, particularly for risk-averse consumers. Using a subset of automobiles with three-year/3600-mile base warranties, Padmanabhan (1995a) demonstrates that owners of extended warranties use their products for significantly more hours. Recently, Chen, Kalra, and Sun (2007) study consumers’ purchases of ESCs in a retail environment to determine how product characteristics, retailer environment factors, and demographic factors affect the choice context. They find that consumers are more likely to buy ESCs for hedonic products and when the product is on unadvertised promotion.
2.2. Perceived Risk and Consumer Purchases of Insurance

Pollatsek and Tversky (1970) develop the theory of perceived risk, in which they express the risk of an option as a linear combination of its mean and variance to show that it is consistent with expected utility based on quadratic utility theory. Levy and Markovitz (1979) show that the mean-variance utility function can approximate expected utility theory. For product insurance, Cicchetti and Dubin (1994) use the hyperbolic absolute risk aversion (HARA) utility function to estimate consumers’ risk preference from their decision regarding the purchase of telephone line failure insurance. They model consumers’ perceived probability of failure and find it is consistent with the true probability of failure. They also find that the most affluent buyers are less likely to buy insurance contracts, whereas those who use telephone lines more often are more likely to buy.

Although most existing studies focus on cross-sectional analyses of consumer purchase behavior regarding insurance, some studies model how consumers make insurance choice decisions in a dynamic setting. Israel (2005a) notes how consumers learn about their auto insurance company’s service quality through repeated contacts with the auto insurance company. Israel (2005b) also models how tenure-based price policies affect strategic consumers’ dynamic choices for automobile insurance. However, he does not directly model the risks that consumers face and instead uses a constant to represent risk.

2.3. Consumer Strategic Product Adoption
Recent literature explores how forward-looking consumers make durable goods adoption timing decisions. Melnikov (2001), Song and Chintagunta (2003), Carranza (2006), Gowrisankaran and Rysman (2007), Nair (2007), and Gordon (2007) adopt an optimal stopping framework to study how forward-looking consumers make purchase decisions for durable goods. They show consumers are strategic with respect to when they adopt the product. For example, Melnikov (2001) proposes a method based on Rust (1987) to examine how forward-looking consumers make strategic decisions about when to purchase printers to coincide with expected future prices. Song and Chintagunta (2003) incorporate consumer heterogeneity to study how forward-looking consumers purchase digital cameras with future expectations about prices and brand availability; specifically, they examine the impact of Sony’s entry into the market and how the consumer mix changes over the product life cycle. Gowrisankaran and Rysman (2007) and Gordon (2007) both study upgrade and repeated purchase decisions.


Our research extends existing literature by examining how the price expectation about an ESC modifies consumers’ strategic product adoption decision and hence ESC purchases.
Because ESCs are contracts that consumers can use to hedge against future product failure risk, it is natural to examine how forward-looking and risk-averse consumers make joint decisions about products and ESCs. Furthermore, we study how consumers make ESC purchase decisions in a dynamic setting by recognizing risk changes resulting from product failure and the ESC prices across time.

3. Model

Suppose there are $i = 1, ..., I$ consumers who makes periodical decisions about whether to adopt product $j$ at time $t = 1, ..., T$, as well as whether to purchase an ESC to insure the product. At each time period, consumer $i$ can choose to delay the purchase, purchase the product without an ESC, or purchase the product with ESC protection. Consumer $i$ faces the same set of choices until he or she decides to buy. Once the product is purchased (with or without ESC), he or she cannot make future decisions. We define $D_{ijt}$ as a dummy variable that equals 1 if customer $i$ chooses $k$ at time $t$. The three alternatives are denoted as follows:

$$
1 \Rightarrow \text{if consumer } i \text{ buys the product } j \text{ with an extended service contract}
$$

$$
2 \Rightarrow \text{if consumer } i \text{ buys the product } j \text{ without an extended service contract}
$$

$$
3 \Rightarrow \text{if consumer } i \text{ defers the decision for period } t + 1
$$

Thus,

$$
D_{ijt}^{k} = \begin{cases} 
1 & \text{if consumer } i \text{ chooses choice } k \text{ for product } j \text{ at time } t, \\
0 & \text{otherwise.}
\end{cases}
$$
We focus on the case when products and ESCs are purchased together. Accordingly, we model the consumer purchase decision for ESCs jointly with product adoption decisions.

### 3.1 Perceived Failure Rate

Consumers buy ESCs to cover the risk of future replacement or repair costs incurred by product breakdowns. Thus, their purchase decisions should be driven by the likelihood of breakdowns. However, at the time of the purchase decision, there is uncertainty regarding the precise probability of breakdown. Previous literature shows that consumers are likely to rely on cues to assess the probability of breakdown at purchase occasion $t$. Accordingly, we assume the consumer’s perceived product failure rate can be determined by the following function:

\[ V_{ij} = \beta_{0ij} + \beta_{1ij} \text{BRAND}_j + \beta_{2ij} \text{PRICE}^{ESC}_j + \beta_{3ij} \text{LENGTH}^{ESC}_j + e_{ij}, \]

where $\text{BRAND}_j$ represents whether product $j$ is a premium brand, and $\text{PRICE}^{ESC}_j$ and $\text{LENGTH}^{ESC}_j$ are the price and the length of coverage of the service contract associated with product category $j$, respectively. We include these two variables for consistency with existing literature (e.g., Bearden and Shimp 1982; Spence 1977; Monroe 1973), which shows that the product price and coverage length of a manufacturer’s basic warranty signal the product reliability. Following a similar logic, we test whether consumers believe the terms of service contracts contain any information about the product reliability. Therefore, $\beta_{0ij}$ is a category-specific constant, which captures intrinsic consumer perceived failure rates for category $j$; $\beta_{1ij}$ captures the effect of brand names on perceived probabilities of breakdown; $\beta_{2ij}$ and $\beta_{3ij}$ capture the effect of the price and the length of coverage of the service contract on perceived
probabilities of breakdown; and $e_{ijt}$ is the unobservable factors that affect consumer perceived breakdown rates.

Let $V_{ijt} = \tilde{V}_{ij} + e_{ijt}$. Assuming $e_{ijt}$ follows an independent and identically extreme value distribution, the perceived probability of product failure is given by the logit representation:

$$
\rho_{ijt} = \frac{e^{\tilde{V}_{ijt}}}{1 + e^{\tilde{V}_{ijt}}}.
$$

We assume the perceived failure rate is category specific and does not change over time.

### 3.2 Utility Function

If consumers decide to purchase the bundle (both the product and the ESC), they have to pay the prices for both the product and the ESC. With insurance, consumers enjoy the consumption benefit and do not face any risk of product failure during the period covered by the ESC. We assume the expected utility for consumer $i$ to purchase product $j$ with an ESC at time $t$ is given by

$$
E[U_{ijt}] = \alpha_0 + \alpha_l (PRICE_{ijt}^p + PRICE_{ijt}^{ESC}) + \sum_{t=1}^{\text{LENGTH}^{ESC}} \delta^t \alpha_{ijt} + e_{ijt}.
$$

In this utility function, $PRICE_{ijt}^p$ and $PRICE_{ijt}^{ESC}$ are the prices for the product and the ESC, respectively; $\alpha_0$ can be viewed as the per-period consumption benefit; $\alpha_l$ represents the consumer’s sensitivity to prices; and $\delta$ is the monthly discounting factor. Under the assumption that consumer $i$ uses the product for the length of the coverage $\text{LENGTH}^{ESC}_j$ defined by the ESC, and that consumer $i$ enjoys risk-free and cost-free consumption utility of the product for all the
periods he or she plans to use the product, the cumulative discounted consumption utility can be measured by
\[
\sum_{t=0}^{\text{LENGTH}^{\text{DISC}}} \delta^t \{ \alpha_{oij} \}. \quad \text{Finally, } \epsilon_{1ijt} \text{ measures unobserved random factors that also affect}
\]
consumer \(i\)'s purchase decision about product \(j\) at time \(t\).

When consumers decide to buy the product alone, they face the risk of product breakdowns in the future and of repair or replacement costs. For simplicity, we assume consumer \(i\) replaces the same product at the expected future price if the product breaks down at time \(t + \tau\), which is a reasonable assumption because many consumers choose to replace a product instead of sending it out for repair. At time \(t\), when consumer \(i\) makes decisions, he or she uses mental accounting to calculate how much the loss will be if the product breaks down in the future. This approach differs from modeling whether consumer \(i\) actually chooses to repair, replace, or upgrade the product in the future. \(PRICE^P_i\) is the price of product \(j\) paid by consumer \(i\). Because consumer’s perceived failure rate is \(\rho_y\), the expected cost of replacement can be given by \(\rho_y \times PRICE^P_i\). Thus, the expected benefit of owning a service contract equals the replacement price weighted by the perceived probability of product failure. The variance of the expected cost of replacement is \(\rho_y (1 - \rho_y) (PRICE^P_i)^2\). Then, consumers’ expected utility function can be given as follows:

\[
E[U_{2,ijt}] = \alpha_{oij} \times \alpha_{yj} (PRICE^S_{ijt}) + \sum_{t=1}^{\text{LENGTH}^{\text{DISC}}} \delta^t \{ \alpha_{oij} \times \alpha_{yj} \rho_y E(PRICE^P_{ijt+\tau}) + \alpha_{u'j} \rho_y (1 - \rho_y) E[(PRICE^P_{ijt+\tau})^2] \} + \epsilon_{2,ijt}
\]

\[\text{(6)}\]
In this utility function, $\gamma_i$ represents the consumer’s risk aversion attitude. When consumers decide to buy the product without the ESC at time $t$, they can avoid paying for the ESC. However, they must bear the uncertainty of product failure in all time periods in the future while consuming the product. The unobserved random impacts on consumer $i$ at time $t$ is denoted by $\varepsilon_{2,ijt}$.

If a consumer decides not to buy the product at time $t$, he or she reserves the option to make the decision at a later time. We use $EV_{ijt+1}$ to denote the value of the option to make decisions at a later time, which refers to the expected maximum value of all alternatives from time period $t+1$, conditional on the state $S_i$ at time $t$, which we illustrate in detail in Section 3.5.

\[
E[U_{3,ijt}] = \partial EV(S_{ijt+1} | S_{ijt}) + \varepsilon_{3,ijt}.
\]

At time $t$, consumer $i$ does not know the future product prices $PRICE^P_{ijt+1}$. However, he or she needs this information to estimate the expected replacement cost and make purchase decisions. We therefore next model the consumer price expectation process.

### 3.3 Price Expectation

Consumers have witnessed price declines, often for electronic products. Following Erdem, Keane, and Strebel (2005), and Erdem, Keane, and Sun (2007), we assume they can form expectations of future product prices at time $t$ according to a first-order autoregressive (AR(1)) process.
\begin{align}
(8a) \quad \ln(PRICE_{ijt+1}^P) &= r_{ij} + \gamma_{ij} \ln(PRICE_{ijt}^P) + \xi_{ijt}^P, \quad \text{and} \\
(8b) \quad \xi_{ijt}^P &\sim i.i.d. N(0, \sigma_{j, P}^2),
\end{align}

in which $r_{ij}$ captures the time-invariant part of the price process, $\gamma_{ij}$ captures the influence of the last period’s price, and $\xi_{ijt}^P$ captures the random shock of product $j$ and time $t$. We assume the random shocks follow i.i.d. normal distribution with mean 0 and variance $\sigma_{j, P}^2$.

The time-varying price of the product also implies a time-varying price of the ESC. Consumers are likely to form a relationship between the ESC price and the product price. We assume the consumer’s expectation of the price of the extended service contract has a log-linear relationship, such that

\begin{align}
(9a) \quad \ln(PRICE_{ijt+1}^{ESC}) &= \nu_{0j} + \nu_{1j} \ln(PRICE_{ijt}^P) + \xi_{ijt}^{ESC}, \quad \text{and} \\
(9b) \quad \xi_{ijt}^{ESC} &\sim i.i.d. N(0, \sigma_{j, ESC}^2).
\end{align}

Coefficient $\nu_{0j}$ captures the fixed part of the price of the product in category $j$. Coefficient $\nu_{1j}$ captures how fast ESC prices change with the price of the product. We expect a positive relationship between the price of the extended service contract and the price of the product.

The coefficients in the product and ESC price processes are estimated using the price information for each product in the data prior to the estimation of the model. They are then treated as known in the model estimation when we solve the consumer’s dynamic optimization problem.
3.4 Consumer Optimal Stopping Problem

Economic literature has established that forward-looking consumer models explain the observed patterns of electronic durable goods better than myopic models do (Melnikov 2001). Accordingly, we model the consumer's purchase and consumption decisions as a dynamic optimization problem under price uncertainty. The consumer's task is to decide when to adopt the product and when to buy the ESC. Consumer $i$ maximizes the sum of discounted expected future utility $U_{ijt}$ over the infinite horizon:

$$
\max_{D_{ij}^k} E_t \{ \sum_{\tau=t}^{\infty} \delta^{\tau-t} (U_{\tau} + \epsilon_\tau) \mid S_t \} .
$$

The operator $E_t$ denotes the conditional expectation, given the consumer's information at time $t$.

We model a forward-looking consumer who makes the ESC decision under price uncertainty. At each time $t$, consumers form expectations about the future prices of the product and the ESC. They decide whether to buy the product with an ESC, buy the product without an ESC, or delay the purchase until $t+1$, by optimally balancing purchasing earlier at a higher price and risk with delaying the purchase for a lower price and lower risk; they also balance paying an insurance premium with trading. The consumer optimization problem therefore is an optimal stopping problem.

We denote the maximum utility consumer $i$ can achieve from the three alternatives as $V_{ijt}(S_{ijt})$, which represents the maximum discounted utility for consumer $i$ entering time $t$ with state variables $S_{ijt}$. We then define $V_{ijt}(S_{ijt})$ as the following:
\[
V_{ijt}(S_{ijt}) = \max_{k \in \{1, 2, 3\}} (U_{ijt,k-1}(S_{ijt}), EU_{ijt,k-2}(S_{ijt}), EU_{ijt,k-3}(S_{ijt})).
\]

In Equation (3), we use \( EV_{ijt+1} \) to denote the value of the option to consider the problem in period \( t+1 \). Thus, \( EV_{ijt+1} \) is actually the expected maximum value of \( V_{ijt+1}(t+1) \), conditional on all the information the consumer has at time \( t \).

\[
V_{ijt}(S_{ijt}) = \max_{k \in \{1, 2, 3\}} (U_{ijt,k-1}(S_{ijt}), EU_{ijt,k-2}(S_{ijt}), \delta E(V_{ijt+1}(S_{ijt+1}) + \epsilon_{ij,t,3})).
\]

\[
E(V_{ijt+1}(S_{ijt+1})) = \\
\int \int \int V_{ijt+1}(PRICE_{ijt+1}^{p}, PRICE_{ijt+1}^{ESC}, \epsilon_{ij+1}) p\left(PRICE_{ijt+1}^{ESC}, PRICE_{ijt+1}^{ESC} \mid PRICE_{ijt+1}^{p}\right) p(\epsilon_{ij+1})
\]

In this optimal stopping problem with a dynamic discrete choice decision, the state variables are the expected prices of the product and ESC. The consumer’s current period decision depends on his or her expected maximum utility for future periods. The expected maximum utility depends on two state variables: the price of the product and the price of the ESC. If the prices of the product and ESC decrease over time, they affect the expected maximum utility for future periods in two ways. First, decreased future price expectations reduce the out-of-pocket expenses consumers will need to pay, which increases their expected utility in the future. Second, lower product prices reduce future expected replacement cost, which further increases the long-term expected utility and induces consumers to delay purchase. However, by delaying product purchase, consumer \( i \) sacrifices some consumption utility. Therefore, he or she must strategically
trade off consumption utility with savings from reduced prices if he or she delays the product adoption.

Expectation about the two state variables also affects the relative attractiveness of ESC. On the one hand, the declining product price expectation reduces the expected replacement cost and thus the relative attractiveness of the ESC. On the other hand, the declining price of the ESC may offset this impact.

3.5 Consumer Heterogeneity, Log-likelihood Function, and Estimation

We adopt a latent class approach to account for consumer heterogeneity. To help understand the profiles of consumers in each segment, we assume the parameters in the utility function can be written as a linear function of some consumer demographic variables:

\[ \Theta_m = \gamma_{0m} + \gamma_{1m} \text{AGE}_i + \gamma_{2m} \text{GENDER}_i + \gamma_{3m} \text{INCOME}_i + e_i, \]

where \( \text{AGE}_i, \text{GENDER}_i, \) and \( \text{INCOME}_i \) are the age, gender, and income of consumer \( i \). We include these consumer-specific variables to acknowledge consumer heterogeneity with respect to their sensitivities to variables that affect consumers’ perceived probability of breakdown and repurchase. Assuming \( e_i \) follows an extreme value distribution, the probability of consumer \( i \) belonging to segment \( m \) can be written as:

\[ \pi_{im} = \frac{\exp(\gamma_{0m} + \gamma_{1m} \text{AGE}_i + \gamma_{2m} \text{GENDER}_i + \gamma_{3m} \text{INCOME}_i)}{1 + \sum_{s=1}^{M-1} \exp(\gamma_{0s} + \gamma_{1s} \text{AGE}_i + \gamma_{2s} \text{GENDER}_i + \gamma_{3s} \text{INCOME}_i)}, \]
Following Rust (1987), we assume the distribution of the unobserved random component is independent of the state variable transition process. The likelihood function of the choice problem is specified in Equations (13) and (14).

\[
Prob(D_{ijt} = 1|D_{ij31} = 1, ..., D_{ij3t-1} = 1, m) = \frac{\exp(EU_{ijt}^k | m)}{\sum_{k=1}^{l} \exp(EU_{ijt}^k | m)}.
\]

\[
Likelihood
\]

\[
= \prod_{t=1}^{T} \prod_{i=1}^{I} \prod_{m=1}^{M} \prod_{j=1}^{J} \prod_{t=1}^{T} \prod_{k=1}^{K} \left[ \prod_{j=1}^{J} \left[ \prod_{i=1}^{I} \left[ \prod_{m=1}^{M} \left[ \prod_{t=1}^{T} \left[ \prod_{k=1}^{K} \left[ \prod_{ijkt} \left[ Prob(D_{ijt} = 1|D_{ij31} = 1, ..., D_{ij3t-1} = 1, m) \right]^{D_{ijt}} \right] \right] \right] \right] \right] \right]
\]

We follow the convention and set \( \delta = 0.98 \). For normalization, we set the constant perceived probability function in the digital camera category to be -6.1. To make the results comparable across product categories, we normalize the prices of each product according to the manufacturer suggested retail price (MSRP) when the product was first introduced to the market.

To estimate the model, we use maximum likelihood estimation. The value function is calculated using a nested fixed-point algorithm. We set 30 grids for each of the two state variables and use interpolation to approximate the expected optimal value for the other points in the state variable spaces.

4. Data Description

4.1. Industry Background
Both Best Buy and Circuit City entered the warranty business seriously in the mid-1990s. To jumpstart its contract sales, which then totaled less than 1% of the revenue, Best Buy started pushing its employees to sell contracts much harder. It also turned to insurance giant American International Group Inc. to underwrite the plans so it would not have to insure the products itself. Circuit City turned to insurer AON Corp. for much of its underwriting as it expanded its warranty sales. Wal-Mart and Target, which were initially resistant to the value of service contracts, also started using this profit generator in 2005 and 2006, respectively (Consumeraffairs.com 2005). Today, across the entire business ecosystem, ESCs accounted for $15 billion in 2005 alone. On average, a company selling the contracts keeps more than half the value of the transaction—$7.5 billion in pure profit. In electronics, ESCs accounted for as much as $6 billion in 2005, with a growth rate of 7%.

Because ESCs are underwritten by independent insurance companies, retailers do not bear the risks of repairing or replacing broken electronic products. Instead, they serve as middlemen that obtain the revenue from selling service contracts to consumers, transferring them to third-party contractors that are actually the insurance underwriters, and sharing a (fixed) percentage of the lump sum revenue with the provider. Retailers’ revenue is defined by a percentage of the price of the ESC, which is typically 50% across the industry. This situation is different from manufacturers who provide ESCs and usually also repair or replace the product. This industry set-up implies two things: First, across the ESC industry, retailers take approximately 50% of the price of ESCs as their profit. Their profit is realized at the point of sales, and their objective is to sell as many ESCs as possible. Second, other than a sales role, retailers serve as liaisons between consumers and insurance underwriters when products actually break down. Thus, the retailers sell ESCs and provide store networks to help settle in case of a
product failure. This second function adds a service component to the relationship between consumers and retailers. According to marketing literature, good services make consumers more likely to patronize retailers again to purchase other electronic products and ESCs in the future.

4.2. Data Description

We use data provided by the electronics department of a retailer, which includes consumer purchase histories for ESC plans of 291 households from November 2003 to October 2004, who made a total of 603 product purchases and 201 ESC purchases. More specifically, the data consist of the complete history of the households’ purchases of electronic durables and service contracts during 12 months, as well as detailed information about both the products and the available service contracts, such as product types, product prices, promotions offered, features (or advertised promotion), prices and lengths of coverage of service contracts, and time and location of purchases. We also have access to demographic information, such as income, gender, and age. Because the number of product models is unmanageable, we follow the retailer’s practice and classify the products into six categories: digital camera, printer, computer, monitor, MP3 player, and DVD player. If a brand is well-known, we code the dummy variable \( \text{BRAND}_j = 1 \) to indicate that the purchased product is of a premium brand.

We define product shelf life as the number of months since the product was introduced to the market. We collect information about the date of introduction and MSRP when the product was introduced for each model, from new product press releases and product reviews. From the introduction date and observed purchase date, we can calculate the number of months that this product was on the market when it was purchased.
Table 2A presents the sample statistics. On average, 43% of brand name products were purchased, and 30% of consumers purchased an ESC during the observed period. We also observe that 56% of the purchases were made by men, whose average age was 40 years. Although we do not have actual income levels, we observe an income index of these consumers. The average MSRP is $459.99; the average price paid for the product is $417.69 (i.e., 90% of the MSRP), and the price of an average ESC is $83.65, or 20% of the price paid for the product.

Table 2B provides information about how the product and ESC prices change across product categories. On average, consumers bought products that were 7.87 months old, or 40% into their product shelf life. On average, ESC purchases constitute 29% of all purchase occasions. The ESC and product price ratio varies from 13% for MP3 players to 32% for DVD player, with an average of roughly 20%. The average length of coverage is 36 months, varying from 24 to 48 months.

5. Empirical Results

5.1 Model Fitting Statistics

We compare the model fit using the likelihood criteria. We compare the proposed forward-looking model with a myopic model by setting $\delta = 0$. We find that our proposed
dynamic model performs better than the myopic model. This is consistent with previous literature on consumers’ dynamic product adoption models. Consumers are strategic in the durable goods purchase.

5.2 Estimation Results

Insert Table 4A about here

We first report the estimation results for the price processes of both the product and the ESC. The coefficients of lagged price for all product categories are positive and significant, indicating that if prices are higher in the previous period, they also are likely to be higher in the current period. The constant terms are all negative, and the coefficients of lagged price for all product categories are less than 1. These findings suggest a downward sloping curve for all product categories. Comparing across product categories, we find that the digital camera category reveals the fastest product price reduction rate, whereas the printer category’s prices drop most slowly.

For most categories, retailers set ESC prices on the basis of the product price. For categories such as digital cameras, notebooks, and MP3 players, the ESC price relates significantly to the product price. For categories such as desktop computers and monitors, the price bracket is wide relative to the product price drop, which implies no significant positive relationship between the price of the ESC and the price of the product. For categories such as
printers and DVD players, retailers use one-tier pricing. All categories have a significant and positive coefficient with the product price.

Insert Table 4B about here

In Table 4B, we report the parameter estimates in the perceived probability function. The results show that the constants for segment 1 are consistently lower than segment two. It means that the first segment consistently perceive lower probability of failure than the first segment. The two segments’ perceptions of product breakdown differ most in Desktop, Monitor and MP3 Player categories. The difference in the printer, notebook, DVD player categories are insignificant. We also didn’t find a significant relationship between the brand name and consumer perceived probability of failure. Also, neither the price nor the coverage length of ESCs is found to affect the consumer perceived probability of breakdown. In other words, consumers do not rely on the observed terms of the service contract to infer the product reliability. This is in contrast with what is observed for manufacturers’ (basic) warranties in the automobile industry (BS). We conjecture that consumers may have realized that the retailer’s pricing of ESCs does not reflect the reliability of the product or the cost of honoring the service contracts.

In the purchase utility equation, the constant terms which capture the consumption benefit coefficients are all positive. This implies positive consumption benefits. The coefficients for price and future replacement cost are also positive, which suggests that consumers are sensitive to price or expected future replacement cost. The coefficients of the squared price term
which capture the risk attitudes are positive. This shows that both consumer segments are risk-
averse.

To compare the coefficients of the first and second segments, we find that the first segment and the second segment differ in the consumption benefit coefficients, price sensitivity and the risk aversion attitudes. The consumption benefit coefficients generally are significantly higher for consumers in the first segment than the second segment. The two segments’ consumption benefit coefficients differ most in categories such as notebook and digital camera category. This shows that the first segment consumers are more likely to derive high consumption utility and thus have incentive to buy earlier. We also find that the first segment is more sensitive to the price and the expected future replacement cost. The higher price sensitivity will make consumers more likely to delay their purchases. Looking at the coefficients alone, it’s difficult to tell which segment will buy early. Later, we will use a graph to show their purchase propensity over time. The third difference between the two segments is their risk attitudes. The first segment is less risk averse than the second segment. In summary, compared with those in the second segment, consumers in the first segment have higher per period consumption benefits, are more sensitive to price and the expected replacement cost, and are less risk averse. Therefore, we term consumers in the first segment “less risk-averse consumers” and those in the second segment as “more risk-averse consumers.”

In the heterogeneity equation, the coefficient of male consumers is positive and significant at the 0.1 level. Therefore, men are more likely to belong to the less risk-averse segment. The coefficients for age and income variables are insignificant. This suggests that age and income doesn’t significantly explain consumers’ behavior in their joint product and ESC purchase decisions.
To determine whether the probability of ESC purchases relates to the time when the consumer adopts the product, we use digital cameras as an example and draw (1) the probabilities of product adoption $\Pr(D_{jt}^3 = 1, \ldots, D_{jt-1}^3 = 1, D_{jt}^3 = 0)$ in Figure 2A, (2) the conditional probabilities of ESC purchases after product adoption over the product’s shelf life $\Pr(D_{jt}^3 = 1, \ldots, D_{jt-1}^3 = 1, D_{jt}^1 = 1)/\Pr(D_{jt}^3 = 1, \ldots, D_{jt-1}^3 = 1, D_{jt}^1 = 0)$ in Figure 2B; and (3) the unconditional probability of purchasing ESCs $\Pr(D_{jt}^3 = 1, \ldots, D_{jt-1}^3 = 1, D_{jt}^1 = 1)$ in Figure 2C.

Figure 2A shows that consumers are more likely to adopt the product at month seven in the product’s shelf life. The first segment is more likely to adopt the product at month 5 while the second segment is more likely to adopt the price at month 10. So we can see the first segment is adopting the product earlier than the second segment.

Figure 2B shows that conditional on the timing of product adoption, consumers’ propensity to purchase ESCs increases over time, which contradicts the intuition that as product prices decrease over time, the expected replacement cost and uncertainty also decrease, so insurance should become less attractive. We posit that this increasing trend results from two forces. The first reason is the decreasing prices of the ESC itself. On the one hand, as the product price decreases over time, expected replacement costs and uncertainty fall, and the ESC becomes much less attractive. On the other hand, the ESC price also declines, which makes the ESC more
attractive. When the impact from the ESC price reduction dominates, consumers are more likely to purchase ESCs, even though the benefit of the insurance is less. We can see the impact is significant on the less risk-averse segment. They may purchase ESCs more in the later part of the product lifecycle because the price of ESC is significantly lower. The second reason is that there is changing consumer mix across the product lifecycle. The first segment, less risk averse segment, are more likely to buy in the earlier periods, while the second segment, more risk averse segment, are more likely to buy in the later periods. So retailers are facing more risk averse consumers at the later part of the product lifecycle. So we can see the overall conditional ECS purchase probability increases faster than any of each individual segment.

Figure 2C shows the unconditional probability of purchasing ESCs. We find that the overall trend of the unconditional ECS purchase probability is similar to the trend in the product purchase probability. It increases first and decreases later. But consumers are most likely to buy ESCs at month 10, 3 month later than the time when consumers are most likely to purchase the product. This delay is due to the fact that consumers are more likely to buy ESCs at the later part of the product lifecycle.

Figure 2D shows the discounted expected option value of waiting to consider at next periods. We can see that the value of waiting decreases over time for both segments.

6. Simulation

_____________________________

Insert Figure 3A and 3B about here
To study how the changing trends of product price affect the intertemporal patterns of product adoption and ESC purchases, in Figure 3A and 3B, we increase the speed of the decrease of the product price and report the simulated product purchase probabilities and unconditional product purchase probabilities for the digital camera category. Specifically, we increase the speed of the product price decrease by reducing the coefficient $\gamma_{1j}$ in the pricing process by 5%. As shown by Figure 3A, a faster decrease of product price makes consumers delay their product adoptions by two to three months on average. In the baseline scenario, consumers are likely to purchase the product during months five and seven; in the new scenario, they purchase during months eight and nine.

If the product price decreases faster, it changes two factors that influence the consumer’s product adoption timing decision. First, it reduces the future price to acquire the product, which gives consumers an incentive to delay their product purchase. Second, it reduces the future expected replacement cost and uncertainty, which encourages consumers to buy today. The overall impact on the product adoption therefore depends on the relative force of the price and replacement cost effects.

To answer the research question regarding whether decreasing product prices affect consumers’ intertemporal pattern of ESC purchases, in Figure 3B we draw the conditional probability of purchasing ESCs. It shows a reduction in the purchase probability, which falls by almost 50% compared with the baseline scenario. Therefore, ESC purchases are not independent of the product price, and the speed of the reduction of the product price negatively affects ESC purchases, because consumers face much lower expected replacement costs and the associated uncertainty. Thus, consumers confront less product failure risk, and the ESC becomes much less valuable. As confirmed by Figure 3C, the unconditional probability of ESC purchases is reduced
by almost half. If there is little change in total demand for the product, retailers will lose more than half of the ESC sales when manufacturers decrease the price of their products more quickly.

---

Insert Figure 4A, 4B, 4C and 4D about here

Retailers have virtually no control over how fast product prices decrease, so they must understand whether they can change the ESC pricing, over which they have direct control, to avoid the negative impact. As shown in Figure 4A, in the next set of simulations, we change the ESC pricing trend and report the probabilities of product adoption and ESC purchase probabilities for various pricing trends. To make the two simulated scenarios comparable with our baseline situation (decreasing trend), when we vary the slope of the pricing trend, we keep the mean the same by setting ESC prices at the mean level of the current pricing arrangement, so as to construct a constant dynamic pricing arrangement case. We then flip the current ESC prices along the product shelf life dimension to construct an increasing dynamic pricing arrangement. That is, we change the coefficient in the ESC price process to 0 and 0.01, which correspond to constant and increasing trends. However, we do not study how to implement the increasing pricing trend; one possibility is when retailers offer ESC promotions during earlier stages of the product shelf life.

Under the current tiered pricing scheme, ESC prices decrease with product prices and should encourage consumers to delay their product adoption to later periods, because the lower replacement cost and uncertainty make ESCs less valuable. As shown in Figure 2B, when the price effect dominates the risk effect, consumer purchase propensity of ESCs increases over time.
To control for the price effect, we first simulate the case in which ESC prices remain constant over time. Figure 4C shows that when the ESC prices are fixed over time (or the price effect is eliminated), consumers decrease their purchase propensity for ESCs over time, because the replacement cost and the associated uncertainty decrease with the reduction of the product price over time. This finding confirms our previous conjecture that the decreasing trend of ESC pricing motivates consumers to purchase ESCs at later stages of the product shelf life when risks are lower.

Figure 4B shows that the ESC pricing affects the timing of product adoption. When ESCs are cheaper at the earlier stages of the product shelf life, forward-looking consumers adopt the product earlier and purchase ESCs to insure their investment. Therefore, even though retailers cannot directly control product pricing and prevent consumers from purchasing the product later, they can interact with strategic consumers by offering cheaper ESCs to encourage early product adoption.

Figure 4C shows the consumer’s conditional ESC purchase probability increases in earlier periods and decreases in the later periods. Under the constant pricing arrangement, consumers are more likely to purchase ESCs during the earlier product shelf life, when they face higher risks. Thus, their purchase propensity of ESCs is more aligned with risk considerations, consistent with the design of an insurance contract.

Figure 4D shows the overall impact on the unconditional ESC purchase over time and reveals two interesting results: First, consumers significantly increase ESC purchases in the early product shelf life, because they increase both product adoption and ESC attachment when they face lower ESC prices. Second, consumers do not reduce ESC purchases later in the product
shelf life much, because most consumers who buy later are more risk averse and less sensitive to the ESC price change.

---

**Insert Table 5 about here**

Although we demonstrate how the price trend of ESCs changes inter-temporal product adoption and ESC purchase patterns over time, we still must compare the overall ESC sales for the alternative pricing trends. With the industry setup, retailers’ profit from ESCs depends primarily on sales volume. In Table 5, we report and compare the average timing of product adoption, overall ESC sales over the observed product shelf life, and some rough estimates of the retailer’s total revenue from selling ESCs. Shifting from a decreasing trend to an increasing trend, consumers adopt the product earlier, and both total sales and revenue from ESCs increase significantly. Because we keep the mean of ESC prices stable over time, the increase of ESC sales stem mainly from the change of price trends, that is, higher perceived risk due to earlier product adoption.

To answer the question that which segment of consumers is more likely to be affected by the new ESC price arrangement, we report the same measurements in Table 5 for the two segments separately. Sales of ESCs contributed by consumers in the first segment improve more, indicating that consumers in this segment, who purchase the product early in its shelf life and face higher risk, do not buy ESCs because they are price sensitive. These consumers are more likely to be encouraged by the lower ESC pricing during the new product introduction stage, and so adopt the product earlier and purchase ESCs to hedge their investment.
7. Discussion

Electronics retailers mainly rely on extended service contracts as profit engines. Thus, it has become increasingly important for retailers to examine how consumers respond to ESC pricing and to evaluate how current ESC pricing affects consumer purchase decisions.

We adopt an optimal stopping framework to study forward-looking, risk-averse consumers’ joint decision on product and ESC purchases. We model how a forward-looking, risk-averse consumer forms his or her future price and replacement cost expectations and optimally decides when to adopt the product and whether to purchase the ESC. Our results show that, independent of when the consumer adopts the product, he or she is more likely to purchase ESCs during the early stages of the product’s shelf life because of the higher risk associated with replacement costs and uncertainty. In addition, quickly declining product prices significantly and negatively affect consumers’ propensity to purchase ESCs. The current decreasing trend of ESCs does not align with the dynamics of consumer product adoption in the digital camera category. It further destroys ESC value by encouraging consumers to delay product adoptions. However, an increasing ESC price trend helps encourage consumers to adopt the product earlier and increases their propensities to purchase ESCs.

The setup of the industry suggests electronics retailers take some interesting positions. They dominate the ESC add-on market and fully control the price of ESCs. On the other hand, they lack control over the decreasing product prices set by the manufacturers. Our research provides some empirical evidence about consumer purchase behavior of ESCs in a retail environment and thus sheds light on how current ESC pricing may be improved. We also demonstrate the detrimental effect on retailers’ ESC sales if the product price decreases very fast.
This is also a warning to the retailers given the fact that manufacturers are speeding up the product obsolescence.

First, retailers should recognize that consumers strategically adjust their product adoption and ESC purchase decisions to coincide with future product and ESC prices. Although the product prices decrease over time, a corresponding decrease in the ESC price may further encourage consumers to delay their product purchase and drive consumers to later periods where the product price is even lower. So, the current declining ESC pricing arrangement does not align with consumer decision dynamics. Retailers could be better off by adopting an increasing inter-temporal price discrimination strategy for ESCs. A price promotion in ESC for the product which is first introduced to the market may achieve better results than slashing the ESC price at the later part.

Second, our results show that if the product price falls faster, consumers will dramatically decrease the ESC purchase. We indeed are observing the fact that manufacturers are putting forward newer models faster and faster and speeding up the product obsolescence. So this is going to be a big threat to retailers whose profit rely so much on ESC sales. Due to the strategic position of retailers in the ESC supply chain, it captures the major profit. As manufacturers do not share this part of the profit, they try to gain more profit from the product sales by reducing the replacement cycle. Retailers have to watch out for this trend and need to think of new mechanism to possibly slow down the process: e.g. profit sharing.

8. Future Research

This paper focuses on the joint decision of the timing of product adoption and ESC purchases. It’s assumed that consumers have already made the decision as to which brand or
model to buy. In reality, there could be consumers who are monitoring several brands or models. Future research may consider consumer brand or product decisions together with the product purchase timing decisions and ESC purchase decisions.

Due to the fact that we only have one year of observations, we didn’t observe the actual replacement choice of each consumer in the same product category. So we have to make assumptions as to when the consumer is going to replace the product. We assume that consumers are replacing the product after possessing the product for the length of the ESC. In reality, consumers may replace the product at different speed. Some consumers who love technology may replace the product much faster than consumers who are in sensitive to the technology advances. By assuming consumers replacing at the same time, consumer’s heterogeneity in replacement cycle is going to be reflected in their risk sensitivity. Future research is needed to separate out the two effects when data permit.

We only consider consumer decisions within one retailer, as we only observe the data from one retailer. We know in the consumer electronics market, retailers compete fiercely against each other. On the other hand, the ESC terms and prices across retailers are very difficult to compare. This makes an interesting product and add-on market conditions: homogeneous and competitive in the product market and local monopoly in the add-on market. It will be intriguing to study consumers’ and firms’ behavior in that type of market.

In this paper, we treat the product and ESC prices as exogenous and focus on how consumers respond to ESC pricing in a partial equilibrium. However, additional research might address the price endogeneity problem by modeling both the demand and the supply sides.
References

ABC News (2006),

Signaling Theory: Do Consumers Perceive Warranties as Signals of Quality?”, Journal of


Paper, Department of Economics, University of Wisconsin-Madison.


Chatterjee, Rabikar and Jehoshua Eliashberg (1990), “The Innovation Diffusion Process in a
Heterogeneous Population: A Micromodeling Approach”, Management Science, 36(9),
1057-79.


29th, 2005.


Coordination”, Review of Marketing Science, 2(1), 2.

Erdem, Tülin, Michael Keane, and Baohong Sun (2007), “The impact of advertising on
consumer price sensitivity in experience goods markets”, Quantitative Marketing and
Economics, forthcoming.

analysis of Information Search and Technology Choice”, Quantitative Marketing and
Economics, 3(3), 207-247


82


UK Insurance Industry Review


## Table 1. Comparison of ESC Pricing across Retailers

<table>
<thead>
<tr>
<th>Retailer</th>
<th>Products</th>
<th>Price of product</th>
<th>Price of EW</th>
<th>Length (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best Buy</td>
<td>Camera</td>
<td>$0-$99.99</td>
<td>$29.99</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$100-$199.99</td>
<td>$39.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$200-$299.99</td>
<td>$49.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$300-$399.99</td>
<td>$59.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$400-$499.99</td>
<td>$69.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$500-$599.99</td>
<td>$79.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$600-$699.99</td>
<td>$89.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$700-$799.99</td>
<td>$99.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$800-$899.99</td>
<td>$109.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$900-$999.99</td>
<td>$119.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1000-$1249.99</td>
<td>$129.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1250-$1499.99</td>
<td>$139.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1500+</td>
<td>$149.99</td>
<td></td>
</tr>
<tr>
<td>Amazon</td>
<td>All Electronics Products</td>
<td>$100-$124.99</td>
<td>$21.99</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$125-$149.99</td>
<td>$24.99</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$200-$599.99</td>
<td>$29.99</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$600-$999.99</td>
<td>$49.99</td>
<td>2</td>
</tr>
<tr>
<td>Walmart</td>
<td>Camera and camcorder</td>
<td>$50-$149.99</td>
<td>$14.33</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$150-$299.99</td>
<td>$23.88</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$300-$449.99</td>
<td>$44.33</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$500-$999.99</td>
<td>$88.33</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1000-$1499.99</td>
<td>$118.33</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1500-$2499.99</td>
<td>$149.33</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$2500-$3999.99</td>
<td>$283.33</td>
<td>3</td>
</tr>
<tr>
<td>Target</td>
<td>All Electronics products</td>
<td>$0-$200</td>
<td>$19.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$201-$500</td>
<td>$29.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$501-$1000</td>
<td>$59.00</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1001+</td>
<td>$79.00</td>
<td>3</td>
</tr>
</tbody>
</table>

### Table 2A. Sample Statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Explanations</th>
<th>Means or Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_{ijt}^3 = 1/D_{ijt}^3 = 0$</td>
<td>Whether to purchase warranty conditional on product purchase</td>
<td></td>
</tr>
<tr>
<td>Digital Camera</td>
<td></td>
<td>0.41</td>
</tr>
<tr>
<td>Printer</td>
<td></td>
<td>0.18</td>
</tr>
<tr>
<td>Computer</td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>DVD Player</td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>Monitor</td>
<td></td>
<td>0.17</td>
</tr>
<tr>
<td>MP3 Player</td>
<td></td>
<td>0.46</td>
</tr>
<tr>
<td>$BRAND_{ij}$</td>
<td>Whether the product has a premium brand</td>
<td>0.43</td>
</tr>
<tr>
<td>$MSRP_{ij}$</td>
<td>Manufacturer Suggested Retail Price</td>
<td>459.04</td>
</tr>
<tr>
<td>$PRICE_{ij}$</td>
<td>Price of purchased product</td>
<td>417.69</td>
</tr>
<tr>
<td>$PRICE_{ESC}^{ij}$</td>
<td>Price of warranty</td>
<td>83.65</td>
</tr>
<tr>
<td>$LENGTH_{w_{ij}}$</td>
<td>Coverage period of warranty (years)</td>
<td>3.01</td>
</tr>
<tr>
<td>$INCOME_{ij}$</td>
<td>Income Index</td>
<td>64.76</td>
</tr>
<tr>
<td>$GENDER_{ij}$</td>
<td>Male</td>
<td>0.56</td>
</tr>
<tr>
<td>$AGE_{ij}$</td>
<td>Age</td>
<td>39.67</td>
</tr>
</tbody>
</table>

### Table 2B. Sample Statistics

<table>
<thead>
<tr>
<th></th>
<th>Number of Product Purchases</th>
<th>Adoption/Shelf Life [months]</th>
<th>Product Price [$]</th>
<th>ESC Price [$]</th>
<th>ESC-Price Ratio</th>
<th>Length of ESC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Camera</td>
<td>144</td>
<td>8.25/16</td>
<td>381.78</td>
<td>74.08</td>
<td>19%</td>
<td>4</td>
</tr>
<tr>
<td>Printer</td>
<td>117</td>
<td>7.94/23</td>
<td>145.36</td>
<td>31.86</td>
<td>22%</td>
<td>3</td>
</tr>
<tr>
<td>Computer</td>
<td>117</td>
<td>3.80/18</td>
<td>1190.71</td>
<td>222.22</td>
<td>19%</td>
<td>3</td>
</tr>
<tr>
<td>DVD</td>
<td>148</td>
<td>8.76/20</td>
<td>117.71</td>
<td>37.49</td>
<td>32%</td>
<td>3</td>
</tr>
<tr>
<td>Monitor</td>
<td>42</td>
<td>13.23/27</td>
<td>370.56</td>
<td>68.32</td>
<td>18%</td>
<td>3</td>
</tr>
<tr>
<td>MP3</td>
<td>35</td>
<td>8.77/23</td>
<td>278.99</td>
<td>36.27</td>
<td>13%</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 3. Comparison of Myopic and Forward-looking Model

<table>
<thead>
<tr>
<th></th>
<th>Myopic model</th>
<th>Forward-looking Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL</td>
<td>2384.01</td>
<td>2210.42</td>
</tr>
<tr>
<td>AIC</td>
<td>2411.01</td>
<td>2238.42</td>
</tr>
<tr>
<td>BIC</td>
<td>2421.55</td>
<td>2249.42</td>
</tr>
</tbody>
</table>
### Table 4A. Estimation Results of the Product Price Process

<table>
<thead>
<tr>
<th>Product Price</th>
<th>Constant</th>
<th>Lagged Price</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Camera</td>
<td>-0.04 (0.005)**</td>
<td>0.88 (0.03)**</td>
<td>0.003(0.0004)**</td>
</tr>
<tr>
<td>Printer</td>
<td>-0.06(0.01)**</td>
<td>0.26 (0.15)*</td>
<td>0.005(0.001)**</td>
</tr>
<tr>
<td>Notebook</td>
<td>-0.02(0.002)**</td>
<td>0.84 (0.05)**</td>
<td>0.0010(0.0001)**</td>
</tr>
<tr>
<td>Desktop</td>
<td>-0.03(0.01)**</td>
<td>0.61 (0.12)**</td>
<td>0.0010(0.0002)**</td>
</tr>
<tr>
<td>DVD</td>
<td>-0.07(0.01)**</td>
<td>0.68 (0.04)**</td>
<td>0.005(0.0005)**</td>
</tr>
<tr>
<td>Monitor</td>
<td>-0.004(0.001)**</td>
<td>0.99 (0.02)**</td>
<td>0.0003(0.0002)</td>
</tr>
<tr>
<td>MP3</td>
<td>-0.001(0.001)**</td>
<td>0.95 (0.01)**</td>
<td>0.05(0.001)**</td>
</tr>
<tr>
<td><strong>ESC Price</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Camera</td>
<td>0.83 (0.02)**</td>
<td>0.0087(0.003)**</td>
<td>0.13(0.01)**</td>
</tr>
<tr>
<td>Printer</td>
<td>1 (fix)</td>
<td>0 (fix)</td>
<td>0 (fix)</td>
</tr>
<tr>
<td>Notebook</td>
<td>0.78(0.01)**</td>
<td>0.04(0.003)**</td>
<td>0.07(0.01)**</td>
</tr>
<tr>
<td>Desktop</td>
<td>1.00(0.01)**</td>
<td>0.01(0.01)</td>
<td>0.05(0.01)**</td>
</tr>
<tr>
<td>DVD</td>
<td>1 (fix)</td>
<td>0 (fix)</td>
<td>0 (fix)</td>
</tr>
<tr>
<td>Monitor</td>
<td>0.94(0.02)**</td>
<td>0.01(0.01)</td>
<td>0.21(0.01)**</td>
</tr>
<tr>
<td>MP3</td>
<td>0.95(0.01)**</td>
<td>0.002(0.001)**</td>
<td>0.05(0.01)**</td>
</tr>
</tbody>
</table>
### Table 4B. Estimation Results of the Perceived Failure Rate

<table>
<thead>
<tr>
<th>Perceived Probability Equation</th>
<th>Segment 1</th>
<th>Segment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-6.10 (Fixed)</td>
<td>-6.10</td>
</tr>
<tr>
<td>Digital Camera</td>
<td>-6.21(0.08)**</td>
<td>-6.11(0.08)**</td>
</tr>
<tr>
<td>Printer</td>
<td>-6.03(0.09)**</td>
<td>-6.01(0.29)**</td>
</tr>
<tr>
<td>Notebook</td>
<td>-6.33(0.06)**</td>
<td>-5.49(0.06)**</td>
</tr>
<tr>
<td>Desktop</td>
<td>-6.23(0.21)**</td>
<td>-6.00(0.11)**</td>
</tr>
<tr>
<td>DVD</td>
<td>-6.45(0.15)**</td>
<td>-5.57(0.15)**</td>
</tr>
<tr>
<td>Monitor</td>
<td>-5.80(0.11)**</td>
<td>-4.78(0.67)**</td>
</tr>
<tr>
<td>Brand Name</td>
<td>-0.28(0.20)</td>
<td>-0.30(0.26)</td>
</tr>
<tr>
<td>Price of ESC</td>
<td>-0.07(0.10)</td>
<td>-0.09(0.17)</td>
</tr>
<tr>
<td>Length of ESC</td>
<td>-0.13(0.10)</td>
<td>-0.11(0.21)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Utility Function</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption Utility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Camera</td>
<td>5.41(1.75)**</td>
<td>1.89(0.51)**</td>
</tr>
<tr>
<td>Printer</td>
<td>5.73(0.36)**</td>
<td>3.06(0.23)**</td>
</tr>
<tr>
<td>Notebook</td>
<td>13.17(0.58)**</td>
<td>5.73(0.85)**</td>
</tr>
<tr>
<td>Desktop</td>
<td>3.00(0.19)**</td>
<td>2.44(0.27)**</td>
</tr>
<tr>
<td>DVD</td>
<td>3.14(0.14)**</td>
<td>0.98(0.05)**</td>
</tr>
<tr>
<td>Monitor</td>
<td>2.13(0.22)**</td>
<td>1.44(0.09)**</td>
</tr>
<tr>
<td>MP3</td>
<td>3.01(0.09)**</td>
<td>1.74(0.14)**</td>
</tr>
<tr>
<td>Sensitivity to price/replacement cost</td>
<td>-3.97(0.93)**</td>
<td>-2.23(0.57)**</td>
</tr>
<tr>
<td>Risk attitude</td>
<td>0.25(0.03)**</td>
<td>0.36(0.08)**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heterogeneity Equation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.36(0.70)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.31(0.66)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.20(0.71)*</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>0.02(0.56)</td>
<td></td>
</tr>
</tbody>
</table>

**significant at 0.05 level  *significant at 0.1 level
Table 5. Counterfactual Price Policy Simulation on Digital Camera Category

<table>
<thead>
<tr>
<th></th>
<th>Product adoption Timing</th>
<th>ESC Sales</th>
<th>ESC Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Pricing</td>
<td>6.89</td>
<td>31.09</td>
<td>51.50</td>
</tr>
<tr>
<td>Flat Pricing</td>
<td>6.75 (-2%)</td>
<td>33.59 (8%)</td>
<td>55.50 (8%)</td>
</tr>
<tr>
<td>Increasing Trend</td>
<td>6.48 (-6%)</td>
<td>34.59 (11%)</td>
<td>56.06 (9%)</td>
</tr>
</tbody>
</table>

Segment 1

<table>
<thead>
<tr>
<th></th>
<th>Current Pricing</th>
<th>ESC Sales</th>
<th>ESC Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Pricing</td>
<td>6.81 (-2%)</td>
<td>29.84 (13%)</td>
<td>49.30 (13%)</td>
</tr>
<tr>
<td>Increasing Trend</td>
<td>6.58 (-5%)</td>
<td>30.80 (17%)</td>
<td>49.78 (14%)</td>
</tr>
</tbody>
</table>

Segment 2

<table>
<thead>
<tr>
<th></th>
<th>Current Pricing</th>
<th>ESC Sales</th>
<th>ESC Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat Pricing</td>
<td>6.74 (-1%)</td>
<td>42.20 (2%)</td>
<td>69.73 (3%)</td>
</tr>
<tr>
<td>Increasing Trend</td>
<td>6.26 (-8%)</td>
<td>43.03 (4%)</td>
<td>70.14 (3%)</td>
</tr>
</tbody>
</table>
Figure 1. Price Trend of Product and ESC for Canon Powershot 75
Figure 2A. Product Purchase Probability (Digital Camera)

Figure 2B. Conditional ESC Purchase Probability

Figure 2C. Unconditional ESC Purchase Probability
Figure 2D. Discounted Expected Option Value

Segment One

Discounted Expected Option Value

Segment Two

Discounted Expected Option Value
Figure 3A. Product Purchase Probability

Figure 3B. Conditional ESC Purchase Probability

Figure 3C. Unconditional ESC Purchase Probability
Figure 4A. Simulated Pricing Trend

Figure 4B. Product Purchase Probability

Figure 4C. Conditional ESC Purchase Probability

Figure 4D. Unconditional ESC Purchase Probability