Optimal Restocking Fees and Information Provision in an Integrated Demand-Supply Model of Product Returns

Jeffrey D. Shulman
Foster School of Business, University of Washington, Seattle, Washington 98195,
jshulman@u.washington.edu

Anne T. Coughlan, R. Canan Savaskan
Kellogg School of Management, Northwestern University, Evanston, Illinois 60208
{a-coughlan@kellogg.northwestern.edu, r-savaskan@kellogg.northwestern.edu}

Product returns cost U.S. companies more than $100 billion annually. The cost and scale of returns management issues necessitate a deeper understanding of how to deal with product returns. We develop an analytical model that describes how consumer purchase and return decisions are affected by a seller's pricing and restocking fee policy. Taking into account the consumers' strategic behavior, we derive the seller's optimal policy as a function of consumer preferences, consumer uncertainty about product attributes, consumer hassle cost for returns, and the effectiveness of the seller's forward and reverse channel capability. We allow for two sources of consumer uncertainty and show how the seller may use its price and restocking fee as a means of targeting a segment of consumers who know their product consumption utilities. We find that even if it is possible to eliminate returns costlessly through the provision of information about the fit between consumer preferences and product characteristics, returns can nevertheless be part of an optimal product sales process. That is, we identify conditions under which it is (or is not) optimal to provide product fit information to consumers. We show that the marginal value of information to the seller is decreasing in the operational efficiency of the seller's forward and reverse logistics process as well as the level of product uncertainty. We identify the impact of multiple product options and sources of consumer uncertainty on the model's results. The analysis generates testable hypotheses about how consumer-level and seller-level parameters affect the return policies observed in the marketplace.

Key words: OM-marketing interface; product returns; restocking fees; reverse logistics; demand management
History: Received: December 14, 2006; accepted: August 23, 2008. Published online in *Articles in Advance* June 12, 2009.

1. Introduction

A homeowner buys wallpaper only to find out that it does not look as good as anticipated in the room and decides to incur a 30% restocking fee to return it (http://www.usawallpaper.com/info.html). A photographer pays a 20% restocking fee to return a lens after discovering that a lens with a different focal length would be better suited for his subject (http://www.47stphoto.com). A businessman buys a new smartphone and realizes its trade-off between battery life and functionality does not fit with his lifestyle. These are just a few examples of product returns, a key cost factor that represents a great financial concern for sellers. In this paper, we develop a model of optimal product returns management, not only for cost prevention (i.e., the optimal reduction or even elimination of product returns), but also for demand management (i.e., recognizing the effect that price and restocking fee have on both the consumer's initial propensity to buy and his or her subsequent probability of returning the purchase) and overall profitability.

Product returns are triggered by the combination of the *benefit* to the consumer from returning a product and the consumer's *cost* of doing so. A benefit is likely to exist when consumers are not fully informed a priori about the utility a product will generate for them and the refund is greater than the actual value of keeping the product. This can happen either when a consumer is not fully informed before purchase about key product attributes or when the consumer

is unaware before purchase of the fit between known attributes and the consumer's own utility function (for example, the photographer may know the exact performance of the camera lens only after purchase, not before). The costs of making a return can be personal hassle costs or penalties on returns imposed by the seller. A rational consumer recognizes the possibility of a product misfit when initially considering purchasing the product. Our research recognizes that the consumer's expected net utility (and consequently initial willingness to pay for the product) is affected by the likelihood of a product misfit and the cost of returning the product.

Sellers often attempt to reduce their costs from consumer returns either by implementing restocking fees (thus increasing the consumer's *cost* of returning the product after purchase, which reduces the number of returns) or by better informing consumers before purchase of how well the product will match their preferences (thus reducing the a priori *uncertainty* surrounding the product's characteristics and hence the number of returns). Restocking fees vary across industries and are commonly charged by a wide variety of companies.[1] Similarly, sellers vary in the ease with which they allow product returns (see Davis et al. 1998 for survey results documenting variation in consumer return costs across retailers), so consumers with sufficiently large hassle costs may simply choose to keep a less-than-ideal product rather than go through the pain of returning or exchanging it. By taking account of such hassle costs, the firm's pricing and restocking fee choices in our model balance the avoidance of returns costs against a possible reduction in the consumers' expected net utility from purchase and ultimately their initial willingness to pay.

Technology investments that help the consumer envision the ownership experience before buying are one way to better inform the consumer before purchase and reduce uncertainty about product utility

[1] For example, the Apple Store charges a 10% restocking fee on opened iPods and computer products. Best Buy charges a 15% restocking fee on opened electronics items and 25% on appliances. The website http://www.fibergourmet.com, a high-end online grocery store, charges a 15% restocking fee on unopened and returned pasta items. http://www.popperandsons.com, a retailer of medical supplies, charges 20% on returned merchandise that is in resaleable condition. http://www.plumbingproducts.com, which sells plumbing equipment, charges a 15% restocking fee on all returned products.

and product fit. Lands' End (http://levdr.mvm.com) and Pearle Vision both offer software programs allowing the consumer to envision himself in their products. Alternatively, the information may help the consumer learn his preferences, such as when camera sellers invest in training retail sales staff to help consumers choose the right camera. Our research investigates whether an attempt to provide prepurchase information is or is not optimal, even when information costs the seller nothing.

We focus on the seller's optimal pricing and restocking fee strategies, as well as on information-provision strategies, to manage sales and returns of products for which there is a priori uncertainty among consumers about the product's value to them. We model returns and exchanges as functions of the seller's choices, rather than being parametric. Our research thus *endogenizes* the consumer product return process in an analytical modeling framework and develops a detailed understanding of how a seller can use price, restocking fee, and information provision to strategically affect consumers' purchase and product return behavior for optimal profitability. We examine how product variety and the nature of consumer uncertainty affect sellers' pricing, return policy, and information provision decisions as well. In sum, our research helps answer the following four research questions:

1. How do consumer and seller attributes affect a seller's optimal restocking fee?

2. What is the effect of varying degrees of consumer uncertainty about product characteristics on the seller's optimal targeting, pricing, and returns management strategies?

3. When is it optimal to reduce returns by ensuring that consumers are informed about a product's fit to their preference (taste) before purchasing the product?

4. What are the implications of the seller providing more than one product on its optimal return policy?

The rest of the paper is organized as follows. In the following section, we review the related literature. In §3, we describe the model. In §4, we present results on the optimal price and restocking fee. In §5, we analyze the value of providing product fit information to consumers that obviates returns. In §6, we examine the piecewise impact of selling multiple products and of consumers having multiple types of uncertainty. In §7, we conclude with a discussion of our results.

2. Literature Review

Our work focuses on the use of price, restocking fees, and product fit information to manage consumer returns that arise because of lack of information about product fit. The paper by Matthews and Persico (2007) is most closely related to our focus; they examine a firm's optimal price and refund in a single-product model in which consumers are uncertain only about the product's utility and have the option to return (but not exchange). In contrast, our research assumes that consumers face multiple product options from which to choose and can exchange as well as return products. We also allow for two sources of product uncertainty (individual valuation of utility for the product category and the product's fit with consumer preferences) and heterogeneity in this uncertainty before purchase. Matthews and Persico (2007) find that the optimal refund is equal to the seller's salvage value for a returned unit unless consumers are risk averse or can choose to acquire information on their own, or unless there exists a fully informed segment. We find different conditions under which the optimal refund is above the seller's salvage value. In contrast to Matthews and Persico, we show that the seller's refund may be below the seller's salvage value, and we directly analyze how the optimal refund is affected by an array of consumer- and firm-level parameters. Davis et al. (1995) and Che (1996) consider the two extremes of either full refunds or disallowing returns completely. Our research shows that these extreme options are not always optimal and that the firm may be better off employing a partial refund strategy. Anderson et al. (2009) develop a structural model to empirically estimate consumers' costs (monetary and hassle) of making a return. It has been shown that raising consumers' hassle cost (Davis et al. 1998) or offering partial refunds (Chu et al. 1998) can reduce opportunistic product return behavior (where products are purchased, used, and then returned). By contrast, our research shows that restocking fee penalties on returns can be optimal even without opportunistic behavior, instead arising from a misfit between consumer preferences and product characteristics.

Our model also identifies when the seller should prevent returns entirely, through the provision of information to consumers about product fit. Heiman et al. (2001) examine when a seller should choose to demonstrate the product or offer a money-back guarantee, under the assumptions of exogenous return probability and value of information. We instead endogenously solve for the likelihood of a product return and derive the *seller's* incentive to provide information that eliminates returns, or to leave consumers uninformed. Ofek et al. (2008) show how the optimal level of in-store service in helping customers find a matching product is influenced by the existence of an online channel. Matthews and Persico (2007) also examine information acquisition that can reduce returns but focus on consumer information acquisition. We focus instead on the firm's decision to provide information that eliminates returns (rather than a consumer's decision to acquire information), because for many goods, such as electronics and home furnishing items, consumers cannot learn how well a product matches with preferences unless the firm makes an active investment in demonstrating the product.

In a framework with no returns and no restocking fee, Shugan and Xie (2000), Xie and Shugan (2001), and Bergemann and Pesendorfer (2007) have identified that serving uninformed consumers can increase profit relative to selling to informed consumers because of a demand-side effect of information (forcing the seller to price to the marginal, rather than the average, consumer). Unlike these papers, we examine a product returns setting, which allows us to evaluate the strength of the cost-side (returns of produced units) effect relative to the demand-side effect of information. We show how the demand and cost effects of information expected from prior research may be reversed when the seller is able to penalize returns with a restocking fee. To our knowledge, this paper is the first to simultaneously consider demand-side factors (the consumer's disutility for product mismatch, consumption utility, and the hassle cost of returns) and cost-side factors (the firm's marginal cost of product and the salvage value for returned units) as critical parameters affecting a seller's information provision decision in a product returns setting.

Another literature of interest models firm decisions to minimize costs associated with product returns and maximize value recovered from salvaged products. Guide and Van Wassenhove (2003) and Fleischmann (2001) provide complete literature reviews of reverse logistics management research, including logistic activities to collect, disassemble,

and process used products, product parts, and/or materials in order to ensure a sustainable recovery process. Other research focuses specifically on how sellers minimize cost with regard to network design (Sahyouni et al. 2007, Fleischmann et al. 1997), product returns forecasting (Toktay et al. 2000), or inventory management (Van der Laan et al. 1999). Taking the seller's cost-minimization strategy as given, our work focuses on the interaction between a seller's cost-prevention and demand-management incentives. Other research examines the demand-management problem in product return situations (see, for instance, Majumder and Groenevelt 2001, Ferguson and Toktay 2006, and Guide et al. 2003). Our research extends these demand-side analyses by examining how to serve a segmented market when consumers differ in their valuations of the product category, as well as in their uncertainty about these valuations. Our consideration is apart from instances of returns caused by end-of-life issues (see Savaskan et al. 2004, Savaskan and Van Wassenhove 2006, Majumder and Groenevelt 2001), intrachannel returns (see Cachon 2003), durable good buy-backs (see Desai et al. 2004, Shulman and Coughlan 2007), or product-failure and warranty returns (see Moorthy and Srinivasan 1995, Balachander 2001, and Ferguson et al. 2006); instead, we focus on consumer product returns arising from consumers' prepurchase lack of information about the product's fit with their preferences.

We turn next to the set-up of our model, followed by results and discussion.

3. Model Set-Up and Rules of the Game

We consider a firm that offers two horizontally differentiated products, A and B. In a circular location model (Salop 1979), we denote the location of product j ($j = A$, B) on the unit circle by $x_j \in [0, 1]$ and set $x_A = 0$ and $x_B = 1/2$ (see Table 1 for variable definitions). The marginal cost of producing a product is given by c, and s denotes the net salvage value (i.e., the value extracted from the returned unit minus the costs of remanufacturing, repackaging, restocking etc.) of a returned product to the firm. In practice, the values of c and s are driven by the operational efficiency of the firm in its forward and reverse channels respectively. A more cost-efficient product supply

Table 1   Parameters and Decision Variables

Symbol	Definition
c	Firm's marginal cost of product
s	Firm's net salvage value of a returned unit
h	Consumer hassle cost of return
d	Consumer disutility per unit of deviation from match with preferences
u_θ	Consumer θ's reservation utility for perfect match
α	Fraction of consumers with $u_\theta = u_H$
γ	Fraction of consumers who know value of u_θ
θ	Consumer's ideal taste parameter
x_j	Location of product j
p	Retail price
f	Restocking fee

and delivery process ensures a lower value for c. A positive value of s reflects the firm's ability to resell the returned product through secondary channels at a price higher than the logistics cost of remarketing it. We assume that c is greater than or equal to s.[2] Given values of c and s, the firm chooses the retail price of each product (p) and a restocking fee (f) to charge for each product returned or exchanged by the customer. The seller is assumed to be risk neutral and can rationally forecast the number of returns. We assume that the seller has enough production capacity or inventory to supply demand.

We assume consumers are risk neutral and maximize their expected utility. Consumers are indexed by their taste parameter θ, where $\theta \sim U[0, 1]$. Consumer θ, who owns product j, obtains utility equal to $u_\theta - p - d|x_j - \theta|$, where the reservation utility u_θ is u_H with probability α and 0 with probability $1 - \alpha$ for any $\theta \in U[0, 1]$. Consumer θ has an independent probability γ of knowing the value of u_θ before purchase. Each consumer is uninformed a priori about the fit between his ideal product and the options available in the market ($|x_j - \theta|$) and suffers a disutility of $d > 0$ per unit deviation from consuming a product located away from his ideal taste parameter θ. Consumers thus fall into one of four segments, defined by {a priori knowledge versus uncertainty about their value of u_θ} × {positive versus zero actual value of u_θ}; Table 2 profiles the four segments.

---

[2] This implies that the seller cannot make extra rents from inducing consumers to make exchanges for the sole purpose of profiting from the salvaged unit. This point is demonstrated in the paper's electronic companion.

Table 2   **Description of Consumer Segments**

	α fraction $u_\theta = u_H > 0$	$(1-\alpha)$ fraction $u_\theta = 0$
γ fraction knows value of u_θ	**Segment 1 ($\alpha\gamma$ fraction)** *Ex ante behavior*: Buys initially if expected utility of purchase ≥ 0. *Ex post behavior*: Keeps or exchanges initial purchase.	**Segment 2 ($(1-\alpha)\gamma$ fraction)** *Ex ante behavior*: Does not buy. *Ex post behavior*: N/A
$(1-\gamma)$ fraction does not know value of u_θ	**Segment 3 ($\alpha(1-\gamma)$ fraction)** *Ex ante behavior*: Buys initially if expected utility of purchase ≥ 0. *Ex post behavior*: Keeps or exchanges initial purchase.	**Segment 4 ($(1-\alpha)(1-\gamma)$ fraction)** *Ex ante behavior*: Buys initially if expected utility of purchase ≥ 0. *Ex post behavior*: Returns initial purchase if $p - f \geq h$ and opts out of the market; o/w keeps.

There are many examples of this type of consumer segmentation; we provide the example of a tablet PC purchase here for illustration (please see the electronic companion for others). One Web forum (http://forum.tabletpcreview.com/showthread.php?t=11062) recently posted the following question: "Is a tablet… the best buy for a science student?" This person falls into the $(1-\gamma)$ proportion of the population—who do not know whether they have a positive utility for a tablet PC (and who also do not know how their ideal tablet PC compares to the options available in the market, e.g., screen sizes or slate versus convertible). Meanwhile, a professor who borrows a tablet PC for use in the classroom is in the γ proportion of the population, because he knows the value of a tablet from his accumulated use and familiarity with it. Within these two groups, there is further division between those who in fact have positive utility for a tablet and those who do not (one of the authors tried a tablet PC and discovered he was in Segment 2, part of the $\gamma(1-\alpha)$ proportion of the population who strongly disliked the computer's interface). But other colleagues are devoted tablet PC users. The student posting his question on the Web will need to buy and try the tablet PC to discover his own utility for the technology, no matter how many questions he asks of others, because of the "experience good" nature of the product.

After making a purchase, the consumer may decide to keep his good or return it for a refund. Returning a product imposes a hassle cost h on the consumer.[3] The consumer may also exchange the good for a better-matching product, incurring the restocking penalty and the hassle cost but experiencing the utility of owning his preferred product. Given the descriptions of the firm and consumers, the sequence of events in our model is summarized below. Figure 1 reports the ultimate consumer utility from following each path, as well as the firm's ultimate profit per sale. The model solution will determine whether consumers in Segments 1, 3, and 4 (from Table 2) populate each of the tree paths identified; this discussion sets up the possibilities that must be considered in deriving the equilibrium.

1. The seller sets the price and the restocking fee.

2. The consumer purchases a product if the *expected* utility of purchase is greater than zero; otherwise, the consumer abstains from purchase. The consumer's lack of information means that the a priori expected utility of buying product A is the same as the a priori expected utility of buying product B, and thus the consumer initially randomly chooses which product to buy once he or she decides to own a product.

3. Consumers who purchase a product become informed. They learn whether they value the product and if so, they learn the product's fit with their preferences. Learning the product fit of the initial purchase allows them to rationally discern the value of the product fit for the other product.

4. The consumer decides whether to keep the initial product purchase or return it.

---

[3] Returns can be a "hassle" for consumers in the time spent in line for customer service, traveling to the store, etc. For example,

Swinney (2009) also discusses the hassle cost factor in a model of a quick-response inventory system.

Figure 1   Sequence of Events and Payoffs
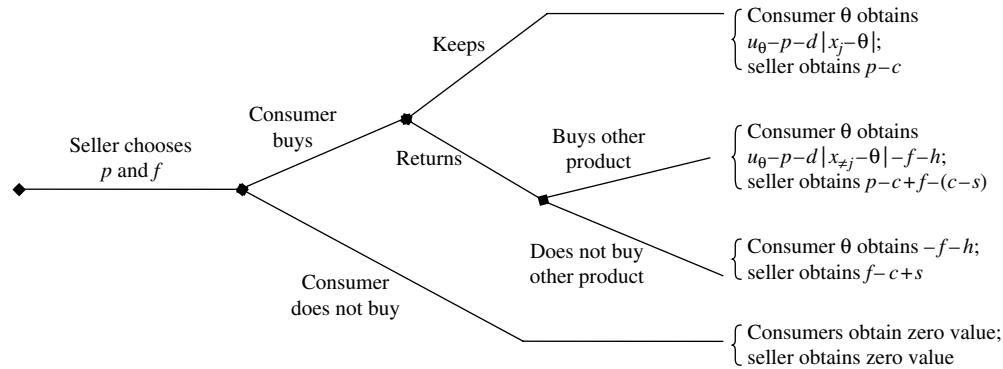
5. Consumers who return their initial purchase buy the other product if the utility of making this repurchase is greater than or equal to the value of the outside option (without loss of generality, assumed to be equal to zero).

4.   Optimal Price and Restocking Fee

Segments 1, 3, and 4 in Table 2 are initially all uninformed about the degree of product fit ($|x_j - \theta|$), and Segment 2 consumers know that they have zero utility for the entire product category, so knowing "product fit" is irrelevant to them; they do not buy. However, consumers in Segment 1 know that their consumption utility in the category is positive ($u_\theta = u_H > 0$), and consumers in Segments 3 and 4 are uninformed about whether they have positive utility ($u_\theta > 0$) from category purchase and consumption. Thus, a priori, each product could be anywhere from a perfect fit to a perfect mismatch for a particular consumer in these segments. The seller knows that consumers have the common and known distribution of product fit before the initial purchase: $|x_j - \theta| \sim U[0, 1/2]$. Consumers' utility-maximizing behavior is derived in the electronic companion. Table 3a reports the expected number of units kept, returned, and exchanged by each segment if making an initial purchase maximizes the segment's expected utility. The index Y denotes the behavior of Segment 1 and the index Z denotes the combined behavior of Segments 3 and 4. The notation {k, e, r} represents actions {keep, exchange, return}, respectively. Each segment's expected utility of making an initial purchase is reported in Table 3b. If the price and restocking fee is such that a segment's

expected utility is negative ex ante, then consumers in this segment do not make a purchase, and the ensuing returns and exchanges are zero.

The expected utilities in Table 3b illustrate an important trade-off. Whereas a restocking fee decreases the number of exchanges, it also lowers consumers' expected utility in the initial purchase for all $f < d/2 - h$, which is the condition for the exchange quantity to be positive. To induce consumers to make an initial purchase, the retail price and restocking fee mix must give the consumer a nonnegative expected utility of purchase. The seller must balance its ability to manage returns costs through the restocking fee and its ability to generate revenue through initial sales. Note that holding constant the price and restocking fee, the ex ante expected utility for consumers in Segments 3 and 4 is strictly less than the expected utility for consumers in Segment 1. This implies that the seller may choose to set a price and restocking fee such that only the proportion $\gamma\alpha$ of consumers (those in Segment 1, who know they value the product) will have positive expected utility and will therefore make an initial purchase. Alternatively, the seller may choose instead to offer a lower price or restocking fee to sell to all three segments. Clearly, the seller's choice of price and restocking fee ultimately affects the initial quantity of sales and its targeting outcomes. We therefore solve for the seller's optimal price and restocking fee in both a separating equilibrium (only Segment 1 buys initially) and a pooling equilibrium (Segments 1, 3, and 4 buy initially). We then identify which conditions dictate the seller's decision to pool the market or target only Segment 1 consumers.

Table 3a   Consumer Response to Price and Restocking Fee

Expected no. of units	Segment 1	Segments 3 and 4
Kept by consumers	$q_{kY}(f; d, \gamma, \alpha) = \gamma\alpha\left(\dfrac{1}{2} + \dfrac{f+h}{d}\right)$	$q_{kZ}(f; d, \gamma, \alpha) = (1-\gamma)\alpha\left(\dfrac{1}{2} + \dfrac{f+h}{d}\right)$
Exchanged by consumers	$q_{eY}(f; d, \gamma, \alpha) = \gamma\alpha\left(\dfrac{1}{2} - \dfrac{f+h}{d}\right)$	$q_{eZ}(f; d, \gamma, \alpha) = (1-\gamma)\alpha\left(\dfrac{1}{2} - \dfrac{f+h}{d}\right)$
Returned by consumers	0	$q_{rZ}(f; d, \gamma, \alpha) = (1-\alpha)(1-\gamma)$

Table 3b   Ex Ante Expected Utility of Purchase for Consumers

Segment 1	$E_Y(U) = u_H - p + \dfrac{(f+h)^2}{2d} - \dfrac{(f+h)}{2} - \dfrac{d}{8}$
Segments 3 and 4	$E_Z(U) = \alpha\left(u_H - p + \dfrac{(f+h)^2}{2d} - \dfrac{(f+h)}{2} - \dfrac{d}{8}\right) - (1-\alpha)(f+h)$

The seller's objective function in the separating equilibrium (only Segment 1 buys) is as follows:

$$\max_{p,f} \quad (p-c)(\alpha\gamma) + (f+s-p+p-c)q_{eY}(f; d, \gamma, \alpha) \tag{1}$$

$$\text{s.t.} \quad q_{eY} \geq 0, \quad E_Y(U) \geq 0.$$

Meanwhile, in the pooling equilibrium, the seller's choice of price and restocking fee encourages consumers in Segments 1, 3, and 4 to buy initially. The seller's objective function is then:[4]

$$\max_{p,f} \quad (p-c)(1-\gamma(1-\alpha)) + (f+s-p)q_{rZ}(f; d, \gamma, \alpha)$$

$$+ (f+s-p+p-c)$$

$$\cdot (q_{eY}(f; d, \gamma, \alpha) + q_{eZ}(f; d, \gamma, \alpha)) \tag{2}$$

$$\text{s.t.} \quad q_{eZ} \geq 0, \quad E_Z(U) \geq 0.$$

We summarize the results of the maximization problems in the separating and pooling cases in Propositions 1A and 1B, respectively (proofs of all propositions are presented in the electronic companion), and present the corresponding comparative-static results on the equilibrium values in the electronic companion:

PROPOSITION 1A. *When the seller chooses to set a price and restocking fee that separates the market and sells only to consumers who know the products will be valued, the equilibrium price, restocking fee, seller profit, and expected number of exchanges are given in Table 4.*

[4] $E_Z(U) \geq 0$ implies that $E_Y(U) \geq 0$, and $q_{eY} \geq 0$ iff $q_{eZ} \geq 0$.

PROPOSITION 1B. *When the seller chooses to set a price and restocking fee that pools the market and sells to all consumers in Segments 1, 3, and 4, the equilibrium price, restocking fee, seller profit, and expected number of exchanges are given in Table 5.*

Propositions 1A and 1B illustrate that, in general, the optimal restocking fee depends on both seller attributes (c and s) and consumer attributes (d and h in the separating equilibrium, and in addition, in the pooling equilibrium α and γ). There are three cases in both the pooling and separating equilibrium, due to constraints on the seller's maximization problem. Case 1 in each equilibrium pertains to the (low) set of d values for which consumers have weak preferences between products and are inclined to keep their initial purchase. The constraint of nonnegative returns volume is binding in this region, so the restocking fee is optimally set to deter as many exchanges as possible (i.e., all of them). For intermediate d values (Case 2, *sep*), the constraint on nonnegative exchange quantities is no longer binding; exchanges are positive, but the optimal restocking fee just covers the cost of the returned products in the separating case. In the pooling equilibrium, consumers face a higher degree of uncertainty about product characteristics (i.e., uncertainty involving a lack of information about both consumption utility and product fit). The seller adjusts the restocking fee to internalize some of the expected costs of potential returns these consumers face at the time of initial purchase. The restocking fee is therefore set below the cost of a return to the seller in Case 2, *pool*. Many online and bricks-and-mortar retailers present return costs as the main reason for charging restocking fees to consumers. Here, we show that recouping return costs would in fact be only *one* of the reasons for having a restocking fee. Meanwhile, Case 3 in each equilibrium pertains to the (high) set

Table 4   Equilibrium Values in the Separating Case

Parameter values	Retail price, p^*, and restocking fee, f^*	Profit, π^*	Exchanges q_{eY}^*
Case 1, *sep*: $d < d_{1,sep}$	$p^* = u_H - \dfrac{d}{4}, \quad f^* \geq \dfrac{d-2h}{2}$	$\pi^* = \alpha\gamma\left(u_H - c - \dfrac{d}{4}\right)$	0
Case 2, *sep*: $d_{1,sep} \leq d \leq d_{2,sep}$	$p^* = u_H - \dfrac{d}{8} - \dfrac{c-s+h}{2} + \dfrac{(c-s+h)^2}{2d}$ $f^* = c - s$	$\pi^* = \alpha\gamma\left(u_H - c - \dfrac{d}{8} - \dfrac{c-s+h}{2} + \dfrac{(c-s+h)^2}{2d}\right)$	$\alpha\gamma\left(\dfrac{1}{2} - \dfrac{c-s+h}{d}\right)$
Case 3, *sep*: $d \geq d_{2,sep}$	$p^* = u_H - \dfrac{d(\sqrt{3}-1)}{4}$ $f^* = d\left(1 - \dfrac{\sqrt{3}}{2}\right) - h$	$\pi^* = \alpha\gamma\left(u_H - c - \dfrac{d(2-\sqrt{3})}{2} - \dfrac{(c+h-s)(\sqrt{3}-1)}{2}\right)$	$\dfrac{\alpha\gamma(\sqrt{3}-1)}{2}$

Note. $d_{1,sep} \equiv 2(c - s + h)$, and $d_{2,sep} \equiv (4 + 2\sqrt{3})(c - s + h)$.

of d values for which the constraint is binding that all targeted consumers who value the product category will keep or exchange their initial purchase; because d is high in this case, the restocking fee is set not just to cover the costs of returns, but to depress the incentive to return goods (although not to reduce exchanges to zero). Specifically, the restocking fee in Case 3 keeps the number of exchanges invariant with respect to d, for either a separating or a pooling equilibrium. The restocking fee thus mitigates the propensity to exchange as the disutility of a mismatch increases.

Propositions 1A and 1B show that the optimal restocking fee may be zero,[5] implying that when the disutility of a mismatch is low enough or the product is perfectly salvageable, the seller optimally offers a full refund. For example, Wal-Mart charges no restocking fees when accepting returns for most products during the return grace period. However, it is clearly not always profit maximizing to allow free returns. The equilibrium generates positive returns, but with a positive restocking fee, when the consumer's disutility of a mismatch, d, is sufficiently high. In fact, the restocking fee may be set above the seller's cost of taking back a return ($f^* > c - s$). This reflects the fact that charging a restocking fee to the consumers who return their initial purchase can be more profitable than charging higher prices to *all* consumers who make a purchase. For example, in a recent survey, the Public Advocate of the City of New York

(Gotbaum 2005) reports that the retailers that sell high-value items (such as antiques, home decoration, furniture, electronics, and jewelry—where the disutility of a mismatch is relatively high) charge the highest restocking fees, which can amount to as much as 30% of the product price. Thornton and Arndt (2003) report the growing trend among retailers and manufacturers of using fees (such as restocking) to extract consumer surplus and improve firm profits. According to the Arizona Attorney General, Terry Goddard: "With some stores it's become a new profit center, with restocking fees of 25 to 30%" (Erikson 2005).

Our analysis thus shows that demand-management factors can moderate the cost-management incentive of the seller in the returns management process. In short, when the restocking fee is positive, it may serve as a means of cost prevention (Case 1), of cost recovery (Case 2), or of both (Case 3). Similarly, the seller's retail price depends on the same seller and consumer attributes. Therefore, the restocking fee and retail price are interrelated and must be set jointly with a consideration of consumer- and seller-level parameters.[6]

---

[5] This occurs in Case 1, *sep* if $d \leq 2h$; in Case 1, *pool* if $d = 2h$; or in Case 2, *sep* if $c = s$.

[6] This model abstracts away from two additional and opposing effects of restocking fees. It is estimated that only nine percent of all returns are fraudulent (Middleton 2007), but intuitively the restocking fee would be higher for products with higher fraud rates. Also, it is possible that restocking fees could negatively impact future purchase behavior for some consumers, which would lower the restocking fee. We abstract away from these opposing forces in order to focus on the relationship between key demand-management factors and cost-management factors not analyzed in the existing literature.

Table 5   **Equilibrium Values in the Pooling Case**

Parameter values	Retail price, p^*, and restocking fee, f^*	Profit, π^*	Exchanges, $(q^*_{eY} + q^*_{eZ})$
Case 1, *pool*: $d \leq d_{1,\,pool}$	$p^* = u_H - \dfrac{d(2-\alpha)}{4\alpha}$ $f^* = \dfrac{d-2h}{2}$	$\alpha u_H - \dfrac{d}{4}(\alpha + 2\gamma(1-\alpha)) + (s-h)(1-\alpha)(1-\gamma)$ $- c(1-\gamma(1-\alpha))$	0
Case 2, *pool*: $d_{1,\,pool} \leq d \leq d_{2,\,pool}$	$p^* = u_H - \dfrac{d}{8} - \dfrac{c-s+h-d\gamma(1-\alpha)/\alpha}{2}$ $+ \dfrac{(c-s+h-d\gamma(1-\alpha)/\alpha)^2}{2d}$ $- \dfrac{(1-\alpha)}{\alpha}\left(c-s+h-\dfrac{d\gamma(1-\alpha)}{\alpha}\right)$ $f^* = c-s-\dfrac{d\gamma(1-\alpha)}{\alpha}$	$\alpha u_H + \dfrac{d}{8\alpha}(4\gamma^2(1-\alpha)^2 - \alpha^2) + \dfrac{\alpha(s-h-c)^2}{2d}$ $+ (s-h)\left(1-\dfrac{\alpha}{2}\right) - c\left(1+\dfrac{\alpha}{2}\right)$	$\dfrac{\alpha}{2} - \dfrac{\alpha(c-s+h)}{d} + \gamma(1-\alpha)$
Case 3, *pool*: $d \geq d_{2,\,pool}$	$p^* = u_H - \dfrac{d(\sqrt{4-\alpha^2}-2+\alpha)}{4\alpha}$ $f^* = \dfrac{d(2-\sqrt{4-\alpha^2})}{2\alpha} - h$	$\alpha u_H - \dfrac{d(1+\gamma(1-\alpha))}{\alpha}\left(1 - \dfrac{\sqrt{4-\alpha^2}}{2}\right)$ $- (c+h-s)\left(\dfrac{\sqrt{4-\alpha^2}}{2} - \gamma(1-\alpha)\right)$ $- \dfrac{\alpha(c-h+s)}{2}$	$\dfrac{(\sqrt{4-\alpha^2}-(2-\alpha))}{2}$

Note. $d_{1,\,pool} \equiv 2\alpha(c-s+h)/(\alpha + 2\gamma(1-\alpha))$, and $d_{2,\,pool} \equiv 2\alpha(c+h-s)/(2(1+\gamma-\alpha\gamma) - \sqrt{4-\alpha^2})$.

Although the optimal restocking fee and price are different for the pooling equilibrium than for the separating equilibrium, the comparative-static effects of exogenous model parameters are directionally very similar across the two equilibria (please consult the electronic companion for a full analysis of all comparative-static effects). The comparative-static results suggest testable hypotheses for the combined setting of prices and restocking fees as follows:

• The optimal price is weakly decreasing in marginal cost and the hassle cost of returns and weakly increasing in the seller's salvage value for returns, with no predicted sensitivity to these effects when the importance of product fit is either very low or very high.

• The optimal price is generally decreasing in the disutility of a product mismatch, except when the proportion of zero-utility consumers in the population is very high and product-mismatch utility is moderate.

• The optimal restocking fee is weakly increasing in marginal cost and weakly decreasing in salvage value, with no predicted sensitivity to these effects when the importance of product fit is either very low or very high.

• The optimal restocking fee is weakly decreasing in hassle costs, with no predicted sensitivity to these effects for intermediate values of product fit.

• The optimal restocking fee is weakly increasing in the disutility of a product mismatch (except for intermediate d levels in the pooling case, where f^* is decreasing in d).

Next, we compare the profits in a pooling equilibrium to those in a separating equilibrium to determine when the seller will prefer each. The relevant comparisons among the three cases depend on model parameters. In the electronic companion we identify a unique function $\bar{u}(c, s, d, h, \alpha, \gamma)$ for each subset of the parameter space such that the seller is indifferent between a separating equilibrium and a pooling equilibrium. For $u_H > \bar{u}(c, s, d, h, \alpha, \gamma)$, the seller earns greater profits from a pooling equilibrium than from a separating equilibrium, as formalized in Proposition 2:

PROPOSITION 2. *There exists a critical reservation value $\bar{u}$ such that for $u_H < \bar{u}$, the seller optimally sets the price and restocking fee to skim the market and only sells to the consumers in Segment 1 (consumers who know that they will have value from owning one of the products,*

i.e., $u_\theta = u_H > 0$). *For* $u_H \geq \bar{u}$*, the seller optimally sets the price and restocking fee such that consumers in Segments* 1, 3, *and* 4 *purchase initially* (*all consumers who potentially value the product*)*, purposefully selling to consumers in Segment* 4 *who will later return the product and opt out of the market* (*because* $u_\theta = 0$).

The seller's optimal targeting strategy (separating versus pooling consumer segments) reflects a key trade-off: on one hand, by targeting only Segment 1 consumers (who know that their consumption value for the product is positive, versus the uncertain Segment 3 and Segment 4 consumers), the seller serves a higher willingness-to-pay segment (because lower product uncertainty leads to higher initial expected utility and thus to higher willingness to pay). On the other hand, by choosing to serve only Segment 1 consumers, the seller foregoes sales from Segment 3 consumers, who would buy and either keep or exchange the product, once aware of their actual positive utility from the product. Targeting only Segment 1 consumers results in higher margins but a lower sales volume. Meanwhile, if the seller chooses to pool all three segments (1, 3, and 4), the sales volume rises, but the price drops to take into consideration a lower average initial willingness to pay that results from the addition of consumers to the target group who are a priori uncertain about overall utility, not just product fit. Proposition 2 shows that this trade-off between selling at a higher margin to a few customers versus at a lower margin to many critically depends on the consumption utility, u_H.

It is interesting to note that for high enough u_H, the seller also chooses to sell to consumers who ex post abandon the market (they return the product, do not exchange, and leave the market). Note that the seller cannot distinguish a priori between Segment 3 and Segment 4 consumers and therefore must target either none of them or all of them. When u_H is high enough, the incremental profit from selling to a broader market base outweighs the loss in margin per unit on the inframarginal (Segment 1) consumers, causing the seller to optimally target consumers who will eventually leave the market with ex post negative utility (Segment 4) along with Segments 1 and 3.

These results hold in a market where consumer information about product fit is incomplete before initial purchase. This raises the question of whether resolving consumers' a priori uncertainty is a profitable activity for the seller.

5. The Value of Product Fit Information

In this section, we examine the value of providing product fit information to consumers by comparing the seller's profits when consumers are informed (about how well the product matches with preferences) to the profit when consumers are uninformed. Intuition suggests that information provision should be good and that lack of information constrains market performance. We therefore make a strict assumption here—that information provision is costless—so that if we nevertheless establish conditions under which the value of information is negative when costless to provide, it is a fortiori also true when information provision is costly.

To capture the value of such information, we model a successful information provision campaign, resulting in the resolution of all consumer uncertainty, so that consumers know whether they will experience $u_\theta = 0$ or $u_\theta = u_H > 0$ (i.e., $\gamma = 1$) as well as their individual value of $|x_j - \theta|$. Consumers are unlikely to become perfectly informed in reality, but this abstraction allows for parsimonious insights about the trade-offs involved in providing product fit information. If an information campaign that works perfectly is ever suboptimal for the seller, it logically follows that a partially successful campaign suffers the same consequences. Informed consumers buy a product if their *actual utility* from making a purchase is positive. Thus, the informed equilibrium involves sales to consumers in Segments 1 and 3, but not to those in Segments 2 and 4. With fully informed consumers, the sequence of events is as follows:

1. The seller sets the product price, p. The restocking fee is irrelevant because consumers make the right purchase initially and do not return.

2. Consumers simultaneously decide whether to purchase the product.

Informed consumers are now heterogeneous before the initial purchase decision. In contrast, prepurchase consumer uncertainty for uninformed consumers renders all consumers in a given segment homogeneous in their initial purchase decisions (based on the

Table 6   The Value of Information

Parameter values	Value = (Profits from informed consumers) − (Profits from uninformed consumers)
Separating equilibrium	
Case 1, *sep*: $d \leq d_{1,sep}$	$\alpha(1-\gamma)\left(u_H - c - \dfrac{d}{4}\right)$
Case 2, *sep*: $d_{1,sep} \leq d \leq d_{2,sep}$	$\alpha(1-\gamma)\left(u_H - c - \dfrac{d}{4}\right) - \alpha\gamma\left(\dfrac{d}{8} - \dfrac{c-s+h}{2} + \dfrac{(c-s+h)^2}{2d}\right)$
Case 3, *sep*: $d \geq d_{2,sep}$	$\alpha(1-\gamma)\left(u_H - c - \dfrac{d}{4}\right) + \alpha\gamma\left(\dfrac{d}{4}(3-2\sqrt{3}) + \dfrac{(c+h-s)(\sqrt{3}-1)}{2}\right)$
Pooling equilibrium	
Case 1, *pool*: $d \leq d_{1,pool}$	$\dfrac{(1-\alpha)(d\gamma + 2(1-\gamma)(c-s+h))}{2}$
Case 2, *pool*: $d_{1,pool} \leq d \leq d_{2,pool}$	$\dfrac{\alpha(8d(c-s+h) - \alpha(2c-2s+d+2h)^2) - 4d^2\gamma^2(1-\alpha)^2}{8d\alpha}$
Case 3, *pool*: $d \geq d_{2,pool}$	$\dfrac{1}{4\alpha}(d(-\alpha^2 - 2\alpha\gamma(2-\sqrt{4-\alpha^2}) + 2(1+\gamma)(2-\sqrt{4-\alpha^2}))$
	$+ 2\alpha(c+h-s)(\sqrt{4-\alpha^2} - 2\gamma - \alpha(1-2\gamma)))$

Note. $d_{1,sep} \equiv 2(c - s + h)$, $d_{2,sep} \equiv (4 + 2\sqrt{3})(c - s + h)$, $d_{1,pool} \equiv 2\alpha(c-s+h)/(\alpha + 2\gamma(1-\alpha))$, and $d_{2,pool} \equiv 2\alpha(c+h-s)/(2(1+\gamma-\alpha\gamma) - \sqrt{4-\alpha^2})$.

expected or *average utility*). The quantity of goods purchased equals $q_p(p; u, d, \alpha) = \min\{4\alpha(u_H - p)/d, \alpha\}$. With informed consumers, the seller solves $\max_p (p - c)q_p(p; u, d, \alpha)$. The optimal price is then given by $p^* = u_H - d/4$.[7] Thus, the profits from informed consumers are $\pi^* = \alpha(u_H - c - d/4)$. We determine the value of information by calculating the difference in the seller's profits when consumers are informed of product fit and when they are not. The value of information is shown in Table 6; in the following subsections, we identify conditions for which the value of information is negative, in either the separating or pooling equilibrium.

5.1.   When to Provide Information in the Separating Equilibrium

When u_H is low enough that the separating equilibrium dominates the pooling equilibrium, then the question remains whether informing consumers would be even better, dominating the uninformed separating equilibrium. Proposition 3A establishes the conditions under which even costless information provision is less profitable than leaving Segment 1 consumers uninformed about product fit (and thus,

a fortiori less profitable if information provision is costly):

Proposition 3A. *When it is costless to inform consumers about their preferences and value for each product (u_θ and $|x_j - \theta|$) and u_H is such that the uninformed separating equilibrium dominates the uninformed pooling equilibrium, then the value of information (VOI) is positive or negative according to the conditions given in Table 7.*

Proposition 3A shows the surprising result that it is not always profitable for a seller to provide product fit information to consumers, even if this information will eliminate returns (which have a cost to the firm and a hassle cost to consumers) and increase initial sales. This result can occur when the negative impact of information provision outweighs the positive impacts. The impacts of providing consumer information can be summarized as follows:

• The need to set price "on the margin" rather than "on the average," because once informed, consumers' initial expected-utility valuations are now heterogeneous, while they were homogeneous in the uninformed situation (favoring the uninformed equilibrium when d is sufficiently high);

• The addition of Segment 3 consumers to the a priori purchase group, because once informed, they

---

[7] We assume that $u_H \geq c + d/2$ to assure that all consumers who have positive value for the good will buy it.

Table 7   When VOI Is Negative in Separating Equilibrium

	Case 1, *sep* $d < d_{1,\,sep}$	Case 2, *sep* $d_{1,\,sep} \le d < d_{2,\,sep}$	Case 3, *sep* $d \ge d_{2,\,sep}$
If $d_{2,\,sep} \ge \hat{d}_{sep}$:	VOI > 0 always	VOI > 0 for $d_{1,\,sep} \le d < \hat{d}_{sep}$ VOI < 0 for $\hat{d}_{sep} \le d < d_{2,\,sep}$	VOI < 0 always
If $d_{2,\,sep} < \hat{d}_{sep}$:	VOI > 0 always	VOI > 0 always	VOI > 0 for $d_{2,\,sep} \le d < \tilde{d}_{sep}$ VOI < 0 for $d \ge \tilde{d}_{sep}$

Note. $d_{1,\,sep} \equiv 2(c - s + h)$, $d_{2,\,sep} \equiv (4 + 2\sqrt{3})(c - s + h)$, $\tilde{d}_{sep} \equiv (4(1 - \gamma)(u_H - c) - \gamma(2 - 2\sqrt{3})(c - s + h))/(1 - 4\gamma + 2\gamma\sqrt{3})$, and $\hat{d}_{sep} \equiv (2/(2 - \gamma))(2(1 - \gamma)(u_H - c) + \gamma(c - s + h) + \sqrt{(2(1 - \gamma)(u_H - c) + \gamma(c - s + h))^2 - \gamma(2 - \gamma)(c - s + h)^2})$.

know their category valuation is positive (favoring the informed equilibrium); and

• The avoidance of all product return costs, because informed consumers do not return products (favoring the informed equilibrium if the net costs of product returns are positive).

The possibility that selling to uninformed consumers can dominate selling to informed consumers is also seen in the advance selling literature (Shugan and Xie 2000, Xie and Shugan 2001). These papers predict that if the marginal cost of production is below the consumers' expected utility of ownership, the seller's profit is lower under spot selling (selling to informed consumers) than under advance selling (selling to uninformed consumers). The predicted demand-side effect of information is negative because of a decrease in quantity or selling price. In contrast, Case 1, *sep* illustrates a positive demand-side effect of information through an increase in quantity sold at the same price (the ability to attract Segment 3 consumers). It is when consumer preferences are strong (high d) that information has a sufficiently negative demand-side effect (a significantly lower selling price dominates the quantity increase) to outweigh the positive cost-side effect (avoidance of costly returns). And for sufficiently high d, even the expected positive cost-side effect of information may be overturned, because the seller uses a high restocking fee that actually earns profit on returned units (Case 3, *sep*).

5.2.   When to Provide Information in the Pooling Equilibrium

When the seller optimally chooses to offer a price and restocking fee to pool the market (serving consumers in Segments 1, 3, and 4) rather than to separate the market (selling only to consumers in Segment 1), many of the drivers of the VOI are qualitatively the same as described in Proposition 3A. In this case, however, ensuring that consumers are informed of product fit before purchase also leads to the loss of sales to consumers in Segment 4 (consumers who do not value the product offering but would otherwise be unaware of this fact a priori). However, information has the additional benefit of resolving whether $u_\theta = u_H$. Proposition 3B defines the minimum d value above which the value of information is negative in the pooling equilibrium:

PROPOSITION 3B. *When it is costless to inform consumers about their preferences and value for each product (u_θ and $|x_j - \theta|$) and u_H is such that the uninformed pooling equilibrium dominates the uninformed separating equilibrium, then the VOI is positive or negative according to the conditions given in Table* 8.

As in the separating equilibrium, providing information for consumers allows the seller to avoid costs associated with product returns but requires pricing to the marginal (not the average) consumer.

Table 8   When VOI Is Negative in Pooling Equilibrium

	Case 1, *pool* $d < d_{1,\,pool}$	Case 2, *pool* $d_{1,\,pool} \le d < d_{2,\,pool}$	Case 3, *pool* $d \ge d_{2,\,pool}$
If $d_{2,\,pool} \ge \hat{d}_{pool}$	VOI > 0 always	VOI > 0 for $d_{1,\,pool} \le d < \hat{d}_{pool}$ VOI < 0 for $\hat{d}_{pool} \le d < d_{2,\,pool}$	VOI < 0 always
If $d_{2,\,pool} < \hat{d}_{pool}$	VOI > 0 always	VOI > 0 always	VOI > 0 for $d_{2,\,pool} \le d < \tilde{d}_{pool}$ VOI < 0 for $d \ge \tilde{d}_{pool}$

Note. $d_{1,\,pool} = 2\alpha(c + h - s)/(\alpha + 2\gamma(1 - \alpha))$, $d_{2,\,pool} = 2\alpha(c + h - s)/(\alpha + 2\gamma(1 - \alpha) - \sqrt{4 - \alpha^2} + (2 - \alpha))$, $\hat{d}_{pool} = 2\alpha(2 - \alpha + 2\sqrt{1 - \alpha - \gamma^2(1 - \alpha)^2})(c + h - s)/(\alpha^2 + 4\gamma^2(1 - \alpha)^2)$, and $\tilde{d}_{pool} = 2\alpha(\sqrt{4 - \alpha^2} - \alpha - 2\gamma(1 - \alpha))(c + h - s)/(\alpha^2 + 2(2 - \sqrt{4 - \alpha^2}) \cdot (\alpha\gamma - 1 - \gamma))$.

Additional effects of informing consumers (versus an uninformed pooling equilibrium) are

• A higher average willingness to pay because of the resolution of the uncertainty about whether u_θ is positive or zero (favoring the informed equilibrium), and

• The loss of Segment 4 consumers from the a priori purchase group, because once informed, they know their category valuation is zero (favoring the uninformed pooling equilibrium when d is sufficiently high).

Proposition 3B shows that it is the value of d, relative to various functions of $(c + h - s)$, α and γ, that determines when it may be profitable to leave consumers uninformed of product fit. Specifically, it is only for *high enough* values of $d/(c - s + h)$ that the VOI is negative relative to the uninformed pooling equilibrium. In the electronic companion, we derive two interesting insights about the effect of segmentation variables on the value of information.

First, higher values of α are associated with a larger range of d values for which the uninformed pooling equilibrium is more profitable than informing consumers. Intuitively, when α is already high, many consumers have a positive utility for the product category, and even if all consumers are uninformed, their expected utility from purchase is already high because of each consumer's assessment of the probability that he is in the positive u_θ group. The increase in willingness to pay due to informing a population of consumers like this is accordingly relatively low. Meanwhile, the firm would still need to price "on the margin" to this population of consumers if it chooses to inform them—a significant cost, given their already high expected utility of a priori purchase.

Second, the range of d values for which the VOI is negative also increases as γ increases, for any given α value. Higher γ values mean that a higher proportion of the consumer population knows whether its u_θ value is positive (although they still do not know their specific value of θ). One of the benefits of informing uninformed consumers is making them aware of whether they have a positive valuation for a perfectly fitting product in the category; this increases a consumer's willingness to pay by increasing the expected utility from purchasing (because among positive-category-utility consumers, there is

now a zero weight placed on the possibility that $u_\theta = 0$). This benefit is lower the higher γ is, because there are fewer consumers who do not already know their category valuation for the product. Hence, the value of information falls as γ rises.

5.3. Uninformed Consumers: Inform, Separate, or Pool?

Propositions 3A and 3B identify conditions under which even a costless technology for perfectly resolving consumer uncertainty about product fit is not profitable: the value of information is negative. This is more likely to occur the *greater* the disutility of a product mismatch (the higher is d), the proportion of consumers who in fact have a positive utility for a perfectly matching product in the product category (α), the proportion of the consumer population that knows whether its u value is positive (γ), or the seller's net salvage value for a returned unit (s) are and the *lower* the production cost (c), the consumer's hassle cost of a return (h), or the consumer's reservation value for owning a product in the category (u_H) are.

Because the value of providing product fit information is more likely to be negative for lower product costs, lower consumer hassle costs, and higher net salvage values, investments in providing information are not complementary with investments in improving efficiency of the forward and/or reverse logistics. Rather, these investments are substitutable. This also suggests that firm strategies to reduce consumer hassle costs (e.g., prepaid envelopes to return unwanted products) are substitutable with investments in information provision.

To illustrate when each of these possibilities gives the seller the greatest profit, Figure 2 depicts a numerical example in which all parameters except u_H and d are fixed, showing how u_H and d affect the seller's decision to inform, separate uninformed consumers, or pool uninformed consumers.

Figure 2 shows that when consumption utility u is high enough that it is profitable to serve the market, a high enough disutility of mismatch favors the uninformed equilibrium over the informed equilibrium. The higher d is, the greater the gap between the lower pricing ("on the margin") to informed consumers and the higher pricing ("on the average") to uninformed consumers is—thus favoring an uninformed strategy for high enough d. At low d values,

Figure 2   Optimal Firm Strategies: When to Pool, Separate, or Inform
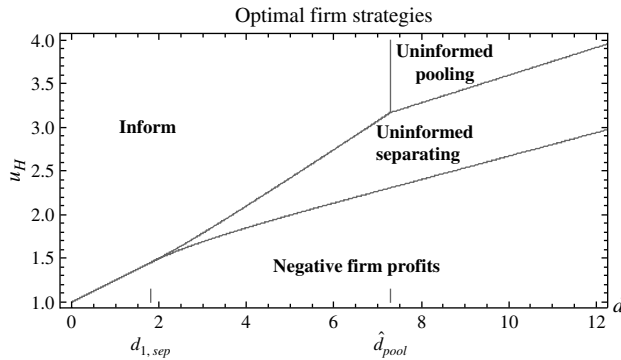
Notes. Parameters generating graph are $c = 1$, $s = 0.2$, $h = 0.1$, $\alpha = 0.6$, $\gamma = 0.4$. These imply that $d_{1,sep} = 1.8$ and $\hat{d}_{pool} = 7.29$.

when the firm uses the return policy as a threat to eliminate returns and exchanges completely, informing consumers is the dominant strategy for all consumption utility levels. This happens because the price decline that accompanies informing consumers is very modest when d is low (equilibrium pricing "on the average" is very close to equilibrium pricing "on the margin") and is more than compensated for by the gain in willingness to pay caused by the resolution of product-fit uncertainty. Meanwhile, as the consumption utility (u_H) increases, ceteris paribus, the firm's optimal strategy moves from the uninformed separating equilibrium to the informed equilibrium for moderate d values and to the uninformed pooling equilibrium for high d values.

This analysis assumes that information is provided at no cost to the consumer. In reality, a seller must make a costly investment to provide information. The effect of costly information provision is to expand the regions in which the seller optimally leaves consumers uninformed. Although incorporating additional costs of information may shift the boundary defining optimal information provision, the trade-offs identified here persist.

6.   Drivers of the Model Results: The Roles of Uncertainty and Product Variety

Our model examines a firm selling two horizontally differentiated products to heterogeneous consumers who vary in their degree of uncertainty about the reservation utility derived from the product category

as well as the fit between their preferences and the attributes of each product. To develop a better understanding about which of our multiple model assumptions are instrumental in establishing our results, we deconstruct the interaction among different model parameters in this section and highlight the piecewise effect of each modeling assumption. This analysis sheds light on the impact of product variety and consumer uncertainty on the optimal return policy. We also identify how the separate provision of information about consumption utility and product fit affects seller profit.

We first examine the drivers behind the optimal restocking fees. To this end, we refer to Matthews and Persico (2007), because the paper offers a parsimonious model of product returns against which to highlight our added insights. A refund equal to the seller's salvage value is described as efficient by Matthews and Persico. They consider refunds greater than the seller's salvage value to be inefficient. They find that the optimal refund will be efficient in a single-product model of an experience product with risk-neutral consumers who are uncertain only about their reservation utility u_θ. Matthews and Persico (2007) find the optimal refund will be excessive if there exists a segment that is fully informed about consumption utility and product fit. In Table 9, we identify which assumptions in our model cause a deviation from the results of Matthews and Persico.

In row 1 of the table, we consider a single-product setting like Matthews and Persico, but in contrast, we consider a more complete feasible region, allowing the restocking fee to eliminate returns from consumers who have positive reservation utility ($u_\theta = u_H$). When the restocking fee eliminates returns from a consumer segment, there are multiple equilibria if all consumers are equally uninformed about either product fit or both product fit and reservation utility (columns 1 and 2). In fact, the refund can be greater than, less than, or equal to the seller's salvage value because the seller adjusts the selling price to hold consumer expected utility and expected profit constant. It is with two types of uncertainty and two consumer segments ex ante (column 3) that the seller will offer a generous refund (even if consumers who have positive reservation value do not return their purchases). The seller charges a higher price but a

Table 9   **Impact of Information Structure and Product Variety on the Optimal Refund**

	One type of uncertainty ($\|x - \theta\|$ unknown to all consumers)	Two types of uncertainty One segment ex ante (u and $\|x - \theta\|$ unknown to all consumers)	Two types of uncertainty Two segments ex ante (u and $\|x - \theta\|$ unknown to a segment, and only $\|x - \theta\|$ unknown to the other segment)
Single-product case Low d values; returns $= 0$ for consumers with $u_\theta = u_H$	**Excess or limited refund possible**[a]	**Excess or limited refund possible**[a]	*Excess refund*[b]
Single-product case High d values; returns > 0 for consumers with $u_\theta = u_H$	Efficient refund[c]	Efficient refund[c]	*Excess refund*[b]
Two-product case Low d values; exchanges $= 0$	**Excess or limited refund possible**[a]	**Excess or limited refund possible**[a]	*Excess refund*[d]
Two-product case Mid d values; exchanges > 0	*Modified efficient refund*[e]	*Modified efficient refund*[e]	*Excess refund*[d]
Two-product case High d values; exchanges > 0	**Modified limited refund**[f]	**Modified limited refund**[f]	**Excess or limited refund possible**[g]

Notes. In all cases, $u_\theta = u_H > 0$ for a fraction α of consumers, and $u_\theta = 0$ for a fraction $(1 - \alpha)$; in italics, the refund is greater than the salvage value; in bold, the refund can be less than the salvage value.

a. $(p^* - f^*)$ may be $<, =$, or $> s$: b. $(p^* - f^*) > s$: c. $(p^* - f^*) = s$: d. $(p^* - f^*) > s + (p^* - c)$: e. $(p^* - f^*) = s + (p^* - c)$: f. $(p^* - f^*) < s + (p^* - c)$; $(p^* - f^*)$ may be $<, =$, or $> s$, depending on u_H: g. $(p^* - f^*) <$ or $> (s + (p^* - c))$.

lower restocking fee than if consumers are homogeneously uninformed, to encourage the less informed consumers (who make a return with probability $1 - \alpha$) to participate in the market.

The second row represents the parameter space for which it is optimal for the seller to choose a refund that will generate returns from consumers who have positive reservation utility ($u_\theta = u_H$). The first and second columns of the second row in Table 9 show that the efficient refund result holds when there are returns from consumers with positive reservation utility whether they are uninformed about product fit ($\|x_j - \theta\|$) only or about both product fit and reservation utility. However, column 3 of row 2 shows that if all consumers are uninformed about product fit, but a fraction of consumers are uninformed about reservation utility as well, then the optimal refund is greater than the seller's salvage value.

In rows 3–5, we examine a two-product setting (a possibility not considered by Matthews and Persico). In row 3, the consumer's strength of preferences, d, is low enough that the seller optimally discourages exchanges through the use of the restocking fee. Because there are no exchanges, the results are very similar to those in row 1. Row 4 represents the seller's unconstrained solutions. When the seller

offers two products and consumers decide in equilibrium to exchange the product initially bought, the refund offered for returns is *greater* than the salvage value. In columns 1 and 2, the retailer gives a refund equal to the salvage value for returns plus the margin the seller earns on an exchange. Matthews and Persico (2007) describe such refunds as excessive. However, the refund $p^* - f^* = s + (p^* - c)$ is actually efficient in the sense that the consumer's incentives for purchase and return are aligned with those of the seller. The costs that the seller experiences from having a return and subsequent exchange are passed directly to consumers. Although the two-product case has a different "efficient refund," the refunds are excessive when there are purchases by both consumers who are uncertain about u_θ and $\|x_j - \theta\|$ and consumers who are uncertain about only $\|x_j - \theta\|$ (row 4, column 3). The seller offers this more generous refund to entice the segments of consumers whose ex ante expected utility of purchase is more adversely affected by the restocking fee.

Row 5 exists because the seller offering two products may optimally use the restocking fee to keep some consumers (whose preferences lie furthest from each product) from making a return without a subsequent purchase. In this case, the seller may penalize returns

to the point where the refund is *less* than efficient: $p^* - f^* < s + (p^* - c)$. In fact, if u_H is low, the refund may even be less than the seller's salvage value: $p^* - f^* < s$. This phenomenon exists across each of the information structures (columns 1, 2, and 3).

In summary, our results are driven by both product variety and the consumer's information structure. Interestingly, the results of column 1 are very similar to column 2 and very different from column 3. This suggests that consumer heterogeneity in the type of information known prior to initial purchase plays a greater role in the seller's strategy than whether homogeneously uninformed consumers have product fit or reservation utility uncertainty alone. Product variety also exerts a substantial impact on the seller's return policy. The possibility of consumers making an exchange can make the optimal refund more generous than in the single-product case (for lower d) or less generous (for higher d and low u_H).

Beyond the differences discussed above in predictive results for the size of the restocking fee, our model also examines the impact of providing information that resolves consumer uncertainty. In the electronic companion, we show the incremental value of each type of information (information about product fit $|x_j - \theta|$ and product category value u_θ). If the seller is able to resolve uncertainty only about u_θ, leaving consumers still uncertain about product fit, profits increase unambiguously for lower values of d. This holds because consumers with $u_\theta = u_H$ now know they are high-valuation consumers, and this increases their willingness to pay. Meanwhile, consumers with $u_\theta = 0$ will not keep their initial purchase, whether or not information on u_θ is provided a priori; thus, information on u_θ has no effect on net quantity sold (total sales minus returns) but does increase equilibrium price.

Meanwhile, resolving uncertainty about u_θ may decrease profit for sufficiently high values of d, because leaving all consumers uninformed about u_θ allows the seller to charge a restocking fee greater than the cost of returns ($f^* > c - s$); the seller therefore earns positive profit from each unit purchased and returned by the consumers with $u_\theta = 0$ (who will not buy at all if their a priori uncertainty about u_θ is resolved). When the profit from these returns outweighs the distortion in all consumers'

expected utility of initial purchase, providing information about u_θ may decrease profit.[8]

When all consumers have information about u_θ, providing further information about product fit $|x_j - \theta|$ has a detrimental effect on seller profit. The information does not affect the net quantity (total sales-returns) but decreases equilibrium price. The reason for this result is that providing information requires the firm to price to the marginal consumer rather than to the average consumer, which is detrimental to profits when the information is only about product fit.

7. Discussion

This paper examines optimal product return policy and information provision strategies and identifies how they are affected by consumer preferences, consumer hassle cost to return products, uncertainty about product consumption value, and the seller's forward and reverse channel cost structures. Our results show that sellers must take a careful look at their cost structure as well as consumer preferences to choose the appropriate restocking fee that will recoup costs associated with returns and diminish return rates without an excessive loss in sales revenue. Sellers should not use the restocking fee solely as a method of passing the costs of returns on to consumers. When consumers have a strong preference for getting the right product that matches their preferences, a higher restocking fee dampens the consumer's desire to exchange and can provide the seller with additional profit on returned units. Thus, the restocking fee plays both a cost-defrayment role and a strategic role in altering consumer behavior.

Our analysis highlights the effect of offering product variety on the firm's optimal return policies. Providing a variety of products to choose from induces some consumers to exchange their initial purchase rather than to return their product and opt out of the market. The possibility of an exchange increases the

---

[8] Although the $f > c - s$ result is derived in constraining the seller to choices that induce all $u_\theta = u_H$ consumers to keep or exchange, this information result can be generalized. The profit from serving uninformed consumers in an unconstrained maximization problem would be greater than or equal to the constrained uninformed profit derived in this model.

consumer's initial willingness to pay for the product and hence the product price. Furthermore, because an exchange results in a final sale for the seller, the multi-product seller has an incentive to provide a refund greater than the salvage value of the product. By modeling multiple consumer segments that vary in their level of product uncertainty, we are able to show that a firm can optimally use the price and restocking fee to target consumers who possess information about the value the product offers. The seller faces a trade-off between serving a more informed, higher-margin, but smaller-sized consumer segment and a less-informed but lower-margin set of multiple consumer segments (including a segment that will certainly return purchases). A higher consumption utility pushes the seller to serve a larger portion of the total market, including more uninformed segments of consumers causing more returns.

Our model also shows that providing consumers with information that will eliminate returns is not always optimal for the seller, even if it can be provided at no cost to the seller. When informing consumers of the relation between their preferences and the product characteristics is a profitable action, our model also shows that the effort in providing this information is a substitute for more cost-efficient and responsive forward and reverse supply chain processes. Because eliminating all returns may not be the optimal strategy for a firm, this paper highlights the continued importance of research on the management of reverse logistics costs and value recovery from returned products.

In sum, the current paper adds to our understanding of optimal product returns management through its simultaneous and endogenous consideration of strategic seller choices and consumer behaviors in a profit-maximizing framework. It highlights the importance of an integrated marketing-operations perspective by showing how a seller's operational capabilities and pricing decisions in the forward and reverse channels jointly drive profitability by affecting both costs and revenues of the firm.

Electronic Companion
An electronic companion to this paper is available on the *Manufacturing & Service Operations Management* website (http://msom.pubs.informs.org/ecompanion.html).

References
Anderson, E. T., K. Hansen, D. Simester. 2009. The option value of returns: Theory and empirical evidence. *Marketing Sci.* **28**(3) 405–423.

Balachander, S. 2001. Warranty signaling and reputation. *Management Sci.* **49**(7) 1282–1289.

Bergemann, D., M. Pesendorfer. 2007. Information structures in optimal auctions. *J. Econom. Theory* **137**(1) 580–609.

Cachon, G. 2003. Supply chain coordination with contracts. S. C. Graves, A. G. de Kok, eds. *Handbooks in Operations Research and Management Science: Supply Chain Management*. North Holland, Amsterdam, 229–339.

Che, Y. 1996. Consumer return policies for experience goods. *J. Indust. Econom.* **44**(1) 17–24.

Chu, W., E. Gerstner, J. D. Hess. 1998. Managing dissatisfaction: How to decrease customer opportunism by partial refunds. *J. Service Res.* **1**(2) 140–155.

Davis, S., E. Gerstner, M. Hagerty. 1995. Money back guarantees in retailing: Matching products to consumer tastes. *J. Retailing* **71**(1) 7–22.

Davis, S., E. Gerstner, M. Hagerty. 1998. Return policies and the optimal level of "hassle." *J. Econom. Bus.* **50**(5) 445–460.

Desai, P., O. Koenigsberg, D. Purohit. 2004. Strategic decentralization and channel coordination. *Quant. Marketing Econom.* **2**(1) 5–22.

Erikson, J. 2005. Many stores assessing hefty fees to return gifts. *Arizona Daily Star* (December 5) A1.

Ferguson, M. E., L. B. Toktay. 2006. The effect of competition on recovery strategies. *Production Oper. Management* **15**(3) 351–368.

Ferguson, M., V. D. R. Guide, G. Souza. 2006. Supply chain coordination for false failure returns. *Manufacturing Services Oper. Management* **8**(4) 376–393.

Fleischmann, M. 2001. *Quantitative Models for Reverse Logistics. Lecture Notes in Economics and Mathematical Systems*, Vol. 501. Springer-Verlag, Berlin, Germany.

Fleischmann, M., J. M. Bloemhof-Ruwaard, R. Dekker, E. A. van der Laan, J. A. E. E. van Nunen, L. N. Van Wassenhove. 1997. Quantitative models for reverse logistics: A review. *Eur. J. Oper. Res.* **103**(1) 1–17.

Gotbaum, B. 2005. Corporate hide and seek: Consumers seek refund, find hidden fees. Report of the Public Advocate for the City of New York, New York. http://www.pubadvocate.nyc.gov.

Guide, Jr., V. D. R., L. N. Van Wassenhove, eds. 2003. Closed-loop supply chains. *Business Aspects of Closed-Loop Supply Chains*. Carnegie Mellon University Press, Pittsburgh.

Guide, Jr., V. D. R., R. H. Teunter, L. N. Van Wassenhove, eds. 2003. Matching demand and supply to maximize profits from remanufacturing. *Manufacturing Service Oper. Management* **5**(4) 303–316.

Heiman, A., B. McWilliams, D. Zilberman. 2001. Demonstrations and money-back guarantees: Market mechanisms to reduce uncertainty. *J. Bus. Res.* **54** 71–84.

Majumder, P., H. Groenevelt. 2001. Competition in remanufacturing. *Production Oper. Management* **10**(2) 125–141.

Matthews, S. A., N. Persico. 2007. Information acquisition and the refunds for returns. Working paper, University of Pennsylvania, Philadelphia.

Middleton, D. 2007. Stores cracking down on returns; target is one of many retailers tightening policies and implementing restocking fees. *Florida Times-Union* (May 19) A-1.

Moorthy, S., K. Srinivasan. 1995. Signaling quality with a money-back guarantee: The role of transaction costs. *Marketing Sci.* **14**(4) 442–466.

Ofek, E., Z. Katona, M. Sarvary. 2008. "Bricks & clicks": The impact of product returns on the strategies of multi-channel retailers. Working paper, Harvard University, Cambridge, MA.

Sahyouni, K., R. C. Savaskan, M. Daskin. 2007. A facility location model for bidirectional flows. *Transportation Sci.* **41**(4) 484–499.

Salop, S. 1979. Monopolistic competition with experience goods. *Bell J. Econom.* **10** 141–156.

Savaskan, R. C., L. N. Van Wassenhove. 2006. Reverse channel design: The case of competing retailers. *Management Sci.* **52**(1) 1–14.

Savaskan, R. C., S. Bhattacharya, L. N. Van Wassenhove. 2004. Closed-loop supply chain models with product remanufacturing. *Management Sci.* **50**(2) 239–252.

Shugan, S. M., J. Xie. 2000. Advance pricing of services and other implications of separating purchase and consumption. *J. Service Res.* **2**(3) 227–239.

Shulman, J., A. Coughlan. 2007. Used goods, not used bads: Profitable secondary market sales for a durable goods channel. *Quant. Marketing Econom.* **5**(2) 191–210.

Swinney, R. 2009. Selling to strategic consumers when product quality is uncertain: The value of matching supply and demand. Working paper, Graduate School of Business, Stanford University, Stanford, CA.

Thornton, E., M. Arndt. 2003. Fees, fees, Fees. *Business Week* (September 29).

Toktay, B., L. Wein, Z. Stefanos. 2000. Inventory management of remanufacturable products. *Management Sci.* **46**(8) 1412–1426.

Van der Laan, E., M. Salomon, R. Dekker, L. N. Van Wassenhove. 1999. Inventory control in hybrid systems with remanufacturing. *Management Sci.* **45**(6) 733–747.

Xie, J., S. M. Shugan. 2001. Electronic tickets, smart cards, and online prepayments: When and how to advance sell. *Marketing Sci.* **20**(3) 219–243.