Managing Consumer Returns in a Competitive Environment

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This paper investigates the pricing and restocking fee decisions of two competing firms selling horizontally differentiated products. We model a duopoly facing consumers who have heterogeneous tastes for the products and who must experience a product before knowing how well it matches with their preferences. The analysis yields several key insights. Restocking fees not only can be sustained in a competitive environment, but also are more severe when consumers are less informed about product fit and when consumers place a greater importance on how well products' attributes fit with their preferences. We compare the competitive equilibrium prices to a scenario in which consumers are certain about their preferences and find conditions defining when consumer uncertainty results in higher equilibrium prices. Comparison to a monopoly setting yields a surprising result: Equilibrium restocking fees in a competitive environment can be higher than those charged by a monopolist.

1. Introduction

Consumers often buy a product only to learn after using it that they would prefer not to keep their purchase. Although the product may be in perfect working condition, some consumers may realize, after purchase, that it does not match with their preferences well enough to justify keeping it. For example, it is estimated that as much as 19% of all electronics purchases are returned to the store even though there is no defect (Lawton 2008). Catalog retailers have return rates as high as 35% (Rogers and Tibben-Lembke 1998). This has a substantive impact on firm profitability because the returned units do not have the same value as when they were sold as new. In fact, it is estimated that the U.S. electronics industry spent $13.8 billion to repackage, restock, and resell returned products (Lawton 2008). Across all industries it is estimated that the annual value of returned goods in the United States is $60 billion with an additional $40 billion spent on managing returns in reverse logistics processes (Enright 2003). Thus, there is an obvious value in developing strategies to manage these consumer returns properly.

For consumers, product returns are triggered when the benefit from returning a product outweighs the benefit from keeping the product. Before making a purchase, consumers may have an expectation about the value of owning the product. However, often this expectation is not precise and a consumer may decide after the initial purchase that a refund or partial refund is more valuable than keeping the product. This can occur when a consumer is not fully informed before purchase about key product attributes or when the consumer is unaware of the fit between known attributes and the consumer's own preferences. For example, a consumer purchasing a shirt through a catalog or online may know his favorite style (color, cut, measurements) but be unable to discern the exact attributes from looking at a picture and reading a description. Or a homeowner may be able to see the exact pattern of wallpaper in a store but be unable to decide whether it matches the décor of the intended room until it is taken home, laid out, and judged carefully. In either of these situations, a poor fit between the actual and the desired product attributes can trigger a product return if the consumer's cost of a return is sufficiently low.

Sellers create costs to the consumer of making a return by imposing financial penalties such as restocking fees or shipping payments. A seller often assesses restocking fees to reduce consumer returns and defray the seller's costs associated with these

returns. Restocking fees vary across industries and are charged by many companies. For example, The Apple Store charges a 10% restocking fee on opened iPods and computer products.[1] Best Buy charges a 15% restocking fee on opened digital cameras.[2] American Blinds charges 30% for returned rolls of wallpaper, even if the rolls are unopened.[3] Ultimately, a rational consumer recognizes the possibility of a product return and its associated costs when considering the initial purchase of the product. Although a restocking fee may seem like an attractive tool for companies to use in an effort to recoup costs and dissuade returns, it can also reduce a consumer's initial willingness to pay for a product.

Previous research shows that the incentive to minimize the costs of processing returns (for example, by charging restocking fees) may outweigh these negative effects on sales revenue for a monopolist (e.g., Matthews and Persico 2005, Shulman et al. 2009). However, it is unclear whether the rigors of competition make it more difficult, or even impossible, to profitably charge restocking fees because consumers purchase the option that offers them the greatest expected utility and ceteris paribus (e.g., price held constant) are more likely to buy from the company with a generous return policy. It is also not immediately clear how the presence of consumer uncertainty leading to product returns affects the prices chosen by competing sellers. On the one hand, product returns increase competing firms' costs, and rather than recouping these costs directly from consumers in the form of restocking fees, competitors may choose to pass on these costs to consumers through higher product prices. On the other hand, product returns also increase costs for consumers, which could potentially drive down prices because of a decreased willingness to pay.

In this paper, we develop an analytical model to examine equilibrium price and restocking fee decisions in a competitive market with product returns where there is a priori uncertainty among consumers about the fit of the products with their preferences as well as uncertainty about their own value derived from the product category. We examine the sales of horizontally differentiated products to study how consumer and seller characteristics affect equilibrium choices. We summarize our research focus in the following three questions:

1. How does competition affect the magnitude of restocking fees?

2. How are equilibrium restocking fees under competition versus monopoly differentially affected by consumer and seller attributes?

3. How does consumer uncertainty about products' fit with preferences and consumer uncertainty about one's own product category value affect the equilibrium prices charged by competing firms?

To answer our first research question, we find that not only may competing firms charge restocking fees above the cost to the firm of a return, but they may actually charge a higher restocking fee than would be optimally chosen by a monopolist. This happens because with competition, sellers use the restocking fee to discourage the marginal consumers (who discover after initial purchase that they would prefer to own the competitor's product) from making returns to switch to the competing seller's product. A monopolist does not share this type of incentive when setting the restocking fee because it does not risk losing the marginal consumer, via an exchange, to a competitor.

To answer the second research question, our model shows the effects on equilibrium restocking fees of consumer disutility for a mismatch,[4] consumer precision in determining the products' match with preferences, and the firm's marginal cost of production. Interestingly, we find that restocking fees in both the competitive and monopoly environments are higher when consumers are *less* informed about how well the products will match with preferences—even though this reduces consumers' initial willingness to pay. The reason for this is that both consumers and sellers recognize the combined effect of the price and restocking fee on initial purchasing likelihood and later return and exchange behavior. Less well-informed consumers are more likely to have a postpurchase surprise that creates a desire to return the initial product purchases. Firms use higher restocking fees to reduce that impulse.

With respect to our third research question, we consider the effect on competitive prices of consumer uncertainty about preferences between products and uncertainty about the consumer's own value for the product category. If consumers are uncertain only about preferences between products, competitors' equilibrium prices are the same as under consumer certainty. If consumers are uncertain only about product category value, competitive prices can be higher than under consumer certainty because each firm's incentive to attract consumers via price is dampened by the possibility that the consumer will ultimately return the purchase. Finally, if consumers face both types of uncertainty, competitive prices can be higher or lower than under consumer certainty, depending on

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[1] Information provided by http://store.apple.com on October 4, 2010.

[2] Information provided by http://www.bestbuy.com on October 4, 2010.

[3] Information provided by http://www1.americanblinds.com/control/info-page?page=return.html&master=resourcecenter on October 4, 2010.

[4] This is also interpretable, as we will show, as a measure of perceived differentiation between products.

the level of product differentiation: under low differentiation, uncertainty pricing can be higher than certainty pricing; under high differentiation, uncertainty pricing is lower than certainty pricing. Product differentiation thus moderates the relationship between uncertainty and the optimal pricing decisions facing competitive firms. These results are driven by the fact that prices and restocking fees are jointly set in recognition of their effects on initial purchase and later exchange and return behavior.

2. Literature Review

Much of the work on product returns has focused on returns of a different nature. Majumder and Groenevelt (2001), Ferguson and Toktay (2006), Savaskan et al. (2004), and Savaskan and Van Wassenhove (2006) focus on end-of-life returns, such as with ink cartridges and leased copy machines, which offer the seller an opportunity to remanufacture the returned products. Cachon (2003) provides an extensive review of the literature examining inventory decisions and return contracts between the retailer and the manufacturer that arise because of lack of information about consumer demand. A series of papers examine sellers offering a buyback price for durable goods to be sold as used (Desai et al. 2004, Shulman and Coughlan 2007, Yin et al. 2010). Another research stream examines warranty returns of damaged or low-quality items that arise because of lack of information about the product's quality (Moorthy and Srinivasan 1995, Balachander 2001, Ferguson et al. 2006). We abstract away from instances of returns due to either end-of-life issues, intrachannel returns, durable goods buybacks, or product-failure and warranty returns; instead, we focus on consumer product returns arising from consumers' prepurchase lack of information about the product's fit with their preferences.

Ofek et al. (2011) examine how consumer returns affect competing sellers' prices, in-store assistance levels, and decisions to offer an online channel in addition to the brick and mortar store. In their model, consumers share a common return probability that can be reduced via an investment in assistance. In contrast, we identify the equilibrium price and return policy as well as accounting for the fact that these decisions influence the number of units that will be returned. Restocking fees as a method of limiting returns differ from in-store service in that they are also a source of revenue for the firm and their effectiveness in preventing a return depends on the consumer's preference between products.[5]

Davis et al. (1995) and Che (1996) examine the implications of a full money-back return policy on seller profit and total welfare, respectively. Davis et al. (1998) develop a model that allows the seller to reduce returns by altering the "hassle" costs to the consumer for returning the product. In these models, the seller offers either no refund or a full refund on a product return. In contrast, our research allows for partial refunds (in the form of a restocking fee), which we find can be more profitable than both full and no refunds. Hess et al. (1996) and Chu et al. (1998) also develop optimal price and restocking fee policies in monopoly models to manage opportunistic consumers who buy and return a product for the strict purpose of free renting. In contrast, we find that returns penalties can be optimal even without opportunistic consumers.

Shulman et al. (2009, 2010) consider restocking fees as a method of managing returns that arise because of a mismatch between consumer preferences and product attributes. However, these models abstract from competitive forces. The current research examines how the restocking fees charged by competing firms differ relative to those charged by a monopolist. Counterintuitively, we find that competing firms charge higher restocking fees than a monopolist would charge. Moreover, we uniquely allow consumers to be heterogeneous in their prior beliefs about preferences, and as such we uniquely identify how the level of information about preferences affects the equilibrium restocking fee.

Our inclusion of heterogeneity in prior consumer beliefs about their preferences leads to different predictions than are found in the previous literature regarding return policies. Matthews and Persico (2005) find that competing firms earn zero profit and offer refunds equal to the seller's salvage value for returned units (the same refund as in their monopolist model) when consumers are homogeneous in the prior beliefs about preference between products. In contrast, we show that when consumers have heterogeneous prior beliefs about their preferences, competing firms earn positive profit and offer a partial refund that can be greater than the seller's salvage value. Guo (2009) builds on Xie and Gerstner (2007) to examine advance and spot selling by competing service providers who can offer a partial refund for advanced purchases and finds that competing service providers offer a refund (partial or otherwise) for advanced sales only if capacity is sufficiently constrained.[6] However, our model shows that when consumers have heterogeneous prior beliefs about their preferences, competing firms offer a partial refund even without a constraint on capacity. Thus, our

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[5] In a related paper, Kuksov and Lin (2010) explore the use of returns as a method of revealing consumers' preference for quality. The return policy does not directly generate revenue as firms in their model either allow returns or do not.

[6] Fay and Xie (2010) also look at advance selling in comparison to selling *probabilistic goods* (see also Fay and Xie 2008, Fay 2008). They examine a monopoly model structure and abstract from the firm's return policy.

research demonstrates that accounting for consumer prepurchase heterogeneity has important implications for a firm's choice of restocking fee.

In sum, the main contribution of this work is the generation of new insights into the effects of competition and consumer uncertainty on price and restocking fee decisions. Moreover, it is the first to incorporate consumer heterogeneity in initial valuations of the product offering. Not only does this heterogeneity allow for an explicit analysis regarding the impact of the precision of the initial beliefs, it also demonstrates that this relaxation in modeling assumptions has a substantive effect on the predicted firm decisions. The rest of the paper is organized as follows. In the following section, the model is described. In the fourth section, we develop the results for a monopolist and for competing firms as well as compare these results. We conclude with a discussion.

3. The Model

3.1. Products

We consider sales of N horizontally differentiated products with locations, denoted by x_j, that are spaced at even intervals along the unit circle (Salop 1979). In the monopoly market scenario $N = 2$, and for the competitive market scenario $N = 4$. Modeling two products in a monopoly market allows consumers not only to return unwanted initial purchases, but to exchange them for a more preferred product, just as is possible in our competitive market scenario. More specifically, let product j be located at $x_j = j/4$. In the first setting, a monopolist sells two products located on opposite sides of the Salop circle (i.e., $N = 2$) with the products located at $x_0 = 0$ and $x_2 = 2/4$.[7] Meanwhile, under competition, the number of products increases to $N = 4$, with the firms' products alternating in location around the circle (i.e., one firm continues to sell x_0 and x_2 as the other firm sells $x_1 = 1/4$ and $x_3 = 3/4$). The results are robust to this assumption and are confirmed when one firm sells x_0 and x_1 as the other firm sells x_2 and x_3.[8] Each product has a common marginal cost of production, c. Without loss of generality, we assume that units that are returned to the firm have zero salvage value to the firm. In the competitive setting, firms simultaneously choose retail prices, p_j, and restocking fees, f_j, ($j \in \{0, 1, 2, 3\}$) to maximize profits. The firms' price offers are assumed to stand for the entire market period.

3.2. Consumers

We model consumer returns of *experience goods* (Nelson 1970). An experience good is one for which the consumer does not know if it is a good match with his or her preferences until after purchase. We assume heterogeneous consumers who are differentiated by an intrinsic taste parameter θ_i. We model two components to the taste parameter: a known component and an uncertain/unknown component prior to purchase. Specifically, $\theta_i = \gamma_i + \varepsilon_i$, where $\gamma_i \sim U[0, 1]$ is observed by the consumer prior to the initial purchase and ε_i is known to have distribution $\varepsilon_i \sim U[-\Delta, \Delta]$ but is observed only after a purchase has been made.[9] The value of Δ is assumed to be less than $1/(2N)$ to simplify the problem and to ensure that the prior belief has enough precision to guarantee that a consumer whose prior lies at $\gamma_i = x_j$, for example, will unambiguously prefer product j to product $j + 1$ and product $j - 1$.[10] In addition to uncertainty about products' fit to preferences, we also assume that the consumer is uncertain a priori about his reservation value, u_i (the value a consumer gets from consuming a product in the category that perfectly matches with preferences). With probability α, the consumer earns zero utility from owning any one of the products in the category offered by the firms, i.e., $u_i = 0$. With probability $(1 - \alpha)$, $u_i = u$ and the consumer has a consumption value for a product located at x_j equal to $u - d|x_j - \theta_i|$, where d is the per unit disutility of mismatch parameter. Both u and d are common to the $(1 - \alpha)$ consumers. Because we have fixed the locations of the products, we may also interpret d as the perceived differentiation between products.[11]

Based on their observation of γ_i, each consumer initially purchases the product that maximizes his expected utility. We examine scenarios in which the two firms are direct competitors and, therefore, all consumers make an initial purchase and keep at most

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[7] We assume that the monopolist sells two products to keep the consumers' ex post action set constant across conditions. That is, consumers can keep, return, or exchange their initial purchase in both the monopolist and competitive setting. Although we assume competition will increase the total number of products in the marketplace, our findings are robust to this change and also hold when each competing firm sells only one product (located at opposite points on the circle).

[8] We have chosen our modeling structure to keep constant the locations of a firm's products in a monopoly setting and a competitive setting. This isolates the impact of competition, but the results are robust to the possibility that the firm can relocate its products when facing competition.

[9] It is mathematically equivalent for consumers to know their preferences and not the locations of the products.

[10] To simplify exposition, we use subscript $j - 1$ to denote the product to the left of product j and $j + 1$ to denote the product to the right of product j. Note that because of the circular representation of the Hotelling model, the exact product references are mod $4(3 + j)$ and mod $4(j + 1)$ for the former and the latter adjacent products.

[11] For a given consumer, the difference in utility between two products is $d|x_j - \theta_i| - d|x_{-j} - \theta_i|$. Although the distance between two products, $|x_j - x_{-j}|$, is commonly viewed as the level of differentiation between products, changing d and holding $|x_j - x_{-j}|$ constant has the same effect on utility as changing $|x_j - x_{-j}|$ and holding d constant. Thus, an increase in d increases the difference in utility between two products, and we interpret d as a measure of the perceived differentiation between products.

one unit of one good. This occurs naturally for a sufficiently high u. A situation in which consumers furthest away from each product do not make an initial purchase is equivalent to a local monopoly setting and outside the scope of this research. With probability α, a consumer will have zero utility from owning any one of the products and will choose to return the initial purchase. Otherwise, consumers may then choose to keep their initial purchase or exchange it for another product after making a purchase and observing ε_i. Without loss of generality, it is assumed that consumers experience no hassle cost of making a return. Mathematically, learning $|x_j - \theta_i|$ allows a consumer to rationally deduce the value of $|x_{-j} - \theta_i|$. Although in practice consumers may not be able to learn the exact product fit from all products after trying just one, it is reasonable to assume that uncertainty about one product is resolved after purchase, and that consumers' beliefs about the fit with the other products are updated.[12] The price and restocking fee influence how many consumers purchase each product, how many consumers return each product, and how many consumers exchange their initial purchase for the competitor's product. Table 1 provides definitions of all parameters and decision variables. Figure 1 depicts the sequence of events.

3.3. Demand and Return Behavior

We derive consumer behavior given the firms' prices and restocking fees. Consumers are forward looking and as such will account for the probability of returning and exchanging a product and will base their initial purchase decision on the average utility value of each possible ex post outcome. Using backward induction, we identify for which consumers each product will maximize expected utility. Under certain regularity conditions, as shown in Appendix A, the initial sales quantities for each product j (denoted by q_{j4} when $N = 4$ and q_{j2} when $N = 2$) can be written as

$$q_{j4} = \frac{1}{4} + \frac{2f_j - (f_{j+1} + f_{j-1}) - 4p_j + 2(p_{j+1} + p_{j-1})}{4d}$$
$$- \frac{2(f_j^2 - f_{j+1}f_{j-1})(1 + \alpha)\Delta}{(f_j + f_{j+1})(f_j + f_{j-1})(1 - \alpha)},$$

$$q_{j2} = \frac{1}{2} + \frac{f_j - f_{-j} - 2(p_j - p_{-j})}{2d} - \frac{2(f_j^2 - f_{-j}^2)(1 + \alpha)\Delta}{(f_j + f_{-j})^2(1 - \alpha)}$$

if there are exchanges, and

[12] Consider a cell phone example with a trade-off between screen-size and portability. A consumer may buy a phone with a large easy-to-view screen and realize that the size makes it uncomfortable to carry around in a pocket. This experience would also allow the consumer to discern that a smaller phone (with a smaller screen) is better suited to match with his preferences.

Table 1   Parameters and Decision Variables

Symbol	Definition
c	Marginal cost of production
d	Consumer disutility per unit of deviation from match with preferences
u	Consumer reservation utility for perfect match with preferences
α	Consumer probability of deriving zero utility from product category
θ_i	Consumer i's ideal taste parameter
γ_i	Consumer i's prior belief about θ_i
x_j	Location of product j, equal to $j/4$
p_j	Price charged for product j
f_j	Restocking fee charged for product j

$$q_{j4} = \frac{1}{4} + \frac{(p_{j+1} + p_{j-1} - 2p_j)}{2d} + \frac{\alpha(f_{j+1} + f_{j-1} - 2f_j)}{2d(1 - \alpha)},$$

$$q_{j2} = \frac{1}{2} + \frac{p_{-j} - p_j}{d} + \frac{\alpha(f_{-j} - f_j)}{d(1 - \alpha)}$$

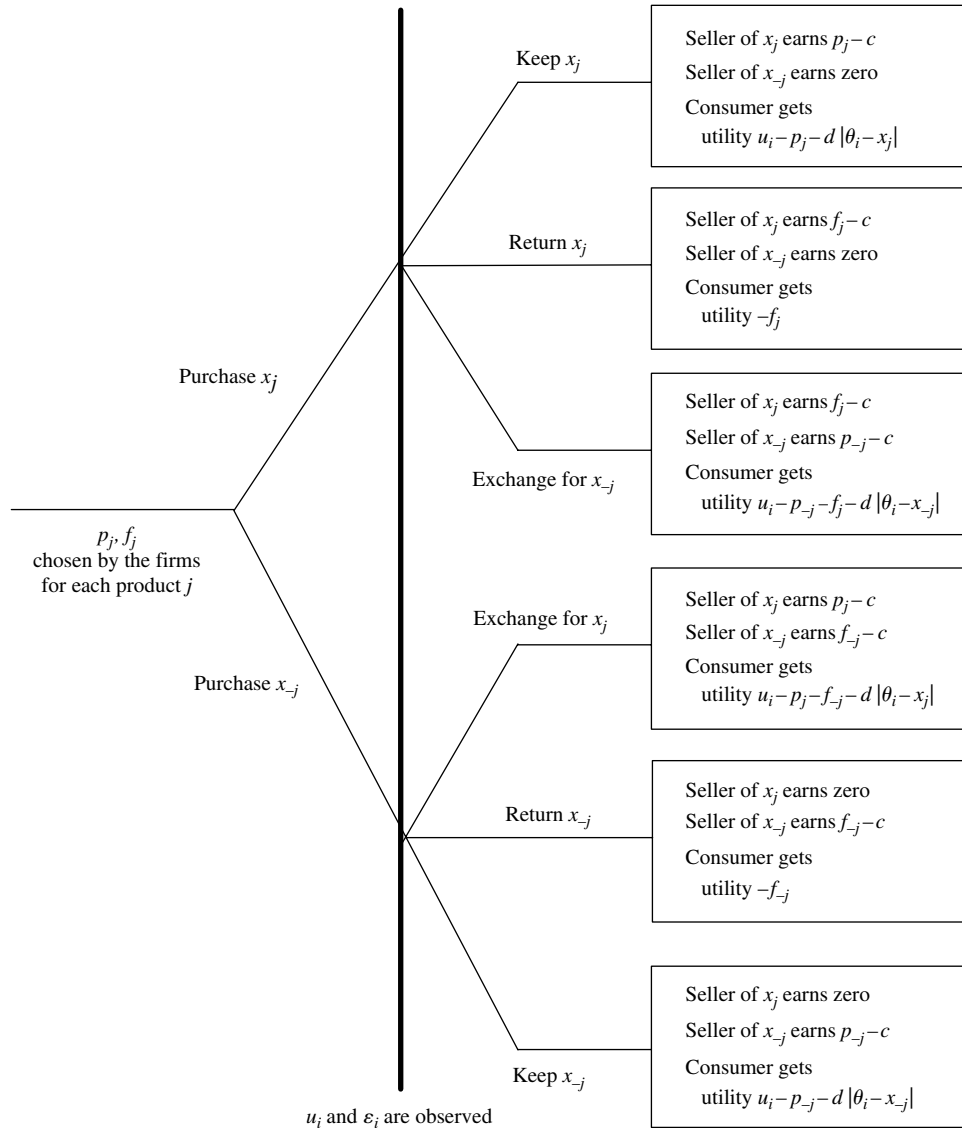if there are no exchanges.[13]   (1)

Equation (1) gives the initial sales quantities for each product j. Consumers make their initial purchase decisions based on expected utility. On purchasing, the consumer experiences the product and makes the postpurchase return decision based on the actual utility derived from owning the product. Let the subscript N denote the number of products in the market. The expected number of units of product j that are returned and exchanged for an adjacent product (either $j - 1$ or $j + 1$) $e_{\text{from } j, N}$, the expected number of units of product j for which an adjacent good was exchanged (either from $j - 1$ or $j + 1$) $e_{\text{to } j, N}$, and the expected number of units of product j that will be returned without an exchange $r_{j, N}$ are derived in Appendix B and presented below:

$$e_{\text{from } j, 4} = \frac{1}{64d^2\Delta(1 - \alpha)}$$
$$\cdot \left(\frac{([8d\Delta(f_{j+1} - \alpha f_j) - (f_j + f_{j+1})^2(1 - \alpha)]^+)^2}{(f_j + f_{j+1})^2} \right.$$
$$\left. + \frac{([8d\Delta(f_{j-1} - \alpha f_j) - (f_j + f_{j-1})^2(1 - \alpha)]^+)^2}{(f_j + f_{j-1})^2} \right)$$

$$e_{\text{to } j, 4} = \frac{1}{64d^2\Delta(1 - \alpha)}$$
$$\cdot \left(\frac{([8d\Delta(f_j - \alpha f_{j+1}) - (f_j + f_{j+1})^2(1 - \alpha)]^+)^2}{(f_j + f_{j+1})^2} \right.$$
$$\left. + \frac{([8d\Delta(f_j - \alpha f_{j-1}) - (f_j + f_{j-1})^2(1 - \alpha)]^+)^2}{(f_j + f_{j-1})^2} \right)$$

[13] The subscript $-j$ marks decision variables for the nearest adjacent product, which is the only substitute when $N = 2$.

Figure 1   Sequence of Events and Payoffs for a Given Consumer *i*

Note. This figure describes the choices and payoffs for any consumer i whose prior location γ_i lies between product x_j and its nearest adjacent product x_{-j}.

$$e_{\text{from } j,2} = \frac{1}{32d^2\Delta(1-\alpha)}$$
$$\cdot \left(\frac{([8d\Delta(f_{-j}-\alpha f_j)-(f_j+f_{-j})^2(1-\alpha)]^+)^2}{(f_j+f_{-j})^2} \right)$$

$$e_{\text{to } j,2} = \frac{1}{32d^2\Delta(1-\alpha)}$$
$$\cdot \left(\frac{([8d\Delta(f_j-\alpha f_{-j})-(f_j+f_{-j})^2(1-\alpha)]^+)^2}{(f_j+f_{-j})^2} \right)$$

$$r_{j,N} = \alpha q_{j,N}. \tag{2}$$

It is useful to remark on the demand and return expressions. As intuition would suggest, initial sales increase as the restocking fee f_j is reduced (i.e., $\partial q_j / \partial f_j < 0$) for any value of f_j that leads to returns in equilibrium. However, the slope of the initial sales

curve with respect to f_j does not tell the whole story. The slope of the total demand curve is significantly flatter. Notably,

$$\left| \frac{\partial Total\, Sales_j}{\partial f_j} \right| = \left| \frac{\partial q_j}{\partial f_j} - \frac{\partial e_{\text{from } j}}{\partial f_j} - \frac{\partial r_j}{\partial f_j} + \frac{\partial e_{\text{to } j}}{\partial f_j} \right| < \left| \frac{\partial q_j}{\partial f_j} \right|.$$

Proof of this claim is in Appendix C. To account for the true effect of the restocking fee on demand, it is necessary to recognize that a lower restocking fee also directly leads more consumers to return product j (i.e., $\partial e_{\text{from } j} / \partial f_j < 0$). This effect holds for three reasons: (1) initial sales are greater, which means that if the return proportion remains unchanged, the total number of returns will increase; (2) consumers have less incentive to keep the product initially purchased because of the lower penalty on returns; and (3) the

increase in sales comes from consumers on the margin whose preferences lie further away from the product attributes, implying a higher propensity to return.

A lower restocking fee for product j also implies fewer purchases from consumers who initially bought from the competing firm (i.e., $\partial e_{\text{to } j}/\partial f_j > 0$). This is true for two reasons: (1) fewer people initially buy from the competing firm, which means the total number of exchanges from the competing firm's product will decrease even if the exchange probability were to remain unchange; and (2) there is a lower exchange probability from the adjacent product because the shift in the marginal consumer implies that those who buy the adjacent product have preferences inherently closer to the attributes of the adjacent product and are more likely to keep their purchase. Therefore, the effect of restocking fee on total sales is dampened relative to the effect on initial sales.

4. Results

In this section, we derive the equilibrium prices and restocking fees charged by two competing firms and compare them with the price and the restocking fee decisions of a monopolist. The comparison helps us highlight the effect of competitive interaction on return policies of a firm. To this end, we first consider a monopolist selling two horizontally differentiated products. Next, we examine the equilibrium when a competitor enters the market also selling two products. To clarify the impact of consumer uncertainty on retail prices, we compare four scenarios: (a) the competitive equilibrium with consumers certain about product value and preferences between products (implying no returns), (b) the competitive equilibrium with returns due to uncertainty regarding one's own value for the product category, (c) the competitive equilibrium with returns due to uncertainty regarding preferences between products, and (d) the competitive equilibrium with returns due to both forms of uncertainty.

4.1. Monopolist

We first examine a monopolist who sells two products (x_0 and x_2). To establish a fair comparison to the competitive case, we assume that u is sufficiently high to ensure that it is optimal for the firm to induce all consumers to initially buy one of the two products. The monopolist has the following optimization problem:

$$\max_{f_0, f_2, p_0, p_2} (p_0 - c)(q_0 + e_{\text{to } 0}) - (p_0 - f_0)(r_0 + e_{\text{from } 0})$$

$$+ (p_2 - c)(q_2 + e_{\text{to } 2}) - (p_2 - f_2)(r_2 + e_{\text{from } 2}).^{14} \quad (3)$$

[14] Note that the quantity and exchange expressions were derived under the assumption that u is sufficiently high for the firm to optimally cover the market. For these expressions to be valid, it must be that the expected utility of buying a product is nonnegative for all consumers.

The monopolist's optimal choices of price and restocking fee are presented in Appendix D. In line with the findings of Shulman et al. (2009), the firm uses the restocking fee as a way of eliminating exchanges if and only if consumers do not have a strong preference for a product that matches with their preferences (i.e., if d is low).

4.2. Competition

We now examine a market where there are two competing firms each selling two products that are maximally differentiated from each other. Each firm earns its unit margin per unit sold of its own product, and offers a refund for returned units equal to the retail price minus the restocking fee. In addition, each firm earns its unit margin on goods sold to consumers who initially bought the competitor's product but decided to exchange it for one of this firm's products. Prices and restocking fees are chosen simultaneously by each firm to maximize profits, which are given by the following.

$$\max_{p_0, f_0, p_2, f_2} \sum_{j=0,2} [(p_j - c)q_j - (p_j - f_j - s) \\ \cdot (e_{\text{from } j} + r_j) + (p_j - c)e_{\text{to } j}]$$

$$\max_{p_1, f_1, p_3, f_3} \sum_{j=1,3} [(p_j - c)q_j - (p_j - f_j - s) \\ \cdot (e_{\text{from } j} + r_j) + (p_j - c)e_{\text{to } j}] \quad (4)$$

In Appendix E, we present the symmetric Nash Equilibrium for competing firms when consumers have uncertainty about both the fit of the products to preferences and their own overall valuation for the product category. As in the case of the monopolist, prices and restocking fees will induce some consumers to exchange in equilibrium if and only if d is sufficiently high.

Our analysis shows that competing firms may in fact charge positive restocking fees. Although restocking fees may be set to recover returns costs, additional factors also affect the level of restocking fees. In fact, restocking fees may be set above the firm's cost of producing a good that is returned. This occurs because the restocking fee not only generates revenue, but also influences consumer returns behavior. Although the restocking fee reduces consumers' expected utility of purchase and ultimately affects the initial purchase decision, it also serves to keep consumers from making a return to buy from the competition. This latter effect gives firms an incentive to charge restocking fees above the costs imposed on the firm from a consumer purchasing and returning a product.

4.3. Monopoly vs. Competition

In this section, we describe how the decisions of an erstwhile monopolist change in the presence of competition. The propositions in this section are developed assuming that a consumer experiences both uncertainty about his or her own preference between products and uncertainty about his or her own product category value. To address our first research question, we highlight several commonalities as well as differences in the impact of market characteristics on equilibrium firm decisions of a monopolist versus those of competing firms.[15] Our first result concerns equilibrium restocking fees.

PROPOSITION 1. *For both competing firms and a monopolist, the equilibrium restocking fees are increasing in consumers' uncertainty about preferences between products, Δ, and are weakly increasing in the marginal cost of production c.*

PROOF. See Appendix F.

Although prior research has focused on consumers who have no prior information about product fit (e.g., Matthews and Persico 2005, Shulman et al. 2009), Proposition 1 uniquely identifies how optimal restocking fees change with the level of information consumers have regarding their preferences. With higher Δ, consumers are less informed about the actual match between preferences and product attributes, resulting in higher restocking fees. This occurs because the firms optimally choose to lower costs by dampening the number of exchanges, which ceteris paribus increase with Δ (evidenced by fact that $\partial(e_{\text{from } j})/\partial\Delta \geq 0$). Proposition 1 also confirms that the relationship between marginal cost and equilibrium restocking fee is maintained in a competitive setting. The following proposition highlights differences in the impact of market characteristics on equilibrium restocking fees in competition versus in monopoly.

PROPOSITION 2. *When the perceived differentiation between products, d, is high enough such that there are exchanges in equilibrium, competing firms increase their restocking fees with d, whereas a monopolist decreases the restocking fee as d increases.*

PROOF. See Appendix G.

Proposition 2 shows that a monopolist *decreases* its restocking fee as d, the perceived differentiation between products, increases, whereas restocking fees *increase* with d under competition. Thus, the advent

of a competitor has a strategic effect on the behavior of the erstwhile monopolist. To understand the logic it is useful to note that d measures the perceived differentiation between products and, therefore, the importance to the consumer of getting a product that matches preferences. A monopolist, who is able to sell another good when an exchange occurs, optimally charges a lower restocking fee when d is high to make sure that consumers end up with the right product, thereby increasing initial willingness to pay. However, under competition, the exchange represents a sale that is lost to the rival firm. Therefore, in the presence of consumers who are more likely to return the product (higher d), competing firms charge a higher restocking fee in an effort to limit postpurchase exchanges. The following proposition highlights the contrasting impact of marginal cost on equilibrium prices in competition versus monopoly.

PROPOSITION 3. *The prices of competing firms are increasing in the marginal cost of production c, whereas the monopolist's prices are weakly decreasing in c.*

PROOF. See Appendix H.

As one would expect, the prices of competing firms are increasing in c. In contrast, the monopolist's prices are weakly decreasing in c. To understand this effect, note that a higher marginal cost of production means a greater profit loss incurred when a product is produced and eventually returned (i.e., c incurred by the firm). The monopolist charges a higher restocking fee as production costs increase to combat these return costs and, without competition, can balance the resulting loss in consumer expected utility of initial purchase by lowering retail prices. With the advent of competition, the firm loses its ability to set the price for the adjacent alternative (a key component in a consumer's decision of whether or not to make an exchange) and cannot offset the restocking fee through commensurate price adjustments without distorting both purchase and exchange quantities from the optimum.

From Propositions 1–3, we see how the impacts of market characteristics on prices and restocking fees depend on market structure (monopoly versus competition). The following proposition addresses our research question concerning the impact of competition on the magnitude of restocking fees.

PROPOSITION 4. *When consumers are uncertain about preferences between products (whether or not they are also uncertain about their own overall category value), restocking fees are weakly greater when competing firms each sell two products than when a monopolist sells two products.*

PROOF. See Appendix I.

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[15] The comparative statics presented herein represent the direct effect of the parameters on the prices and restocking fees. It is possible that there is also an indirect effect of the parameters in influencing the number of products or competitors in the market place (treated as exogenous in this model), which would in turn affect the equilibrium prices and restocking fees. We thank the associate editor for this insight.

Surprisingly, the addition of a competitor will actually increase the penalty charged to consumers for returning a good relative to that in a monopoly market structure. One would intuitively expect that competition would have the same effect on restocking fees as on price, so the result is initially counterintuitive. To understand the result, first consider the fact that higher prices and higher restocking fees both reduce the consumer's expected utility of purchase and ultimately affect the consumer's purchasing decision and demand. The restocking fee, though, also serves to keep consumers from making a return to buy from the competition, in addition to providing revenue for the firm. When a consumer exchanges a product after the initial purchase, there is a stronger negative impact on the profit of a competing firm than on that of a monopolist. The monopolist is often able to make another sale, whereas the competing firm loses the consumer to the rival firm. Therefore, the monopolist internalizes the benefit of the follow-up purchase that accompanies a return and charges a lower restocking fee than do competing firms. This result is robust to both the locations of the competing firm's products (opposing ends of the circle or adjacent to each other) and the number of products sold by competing firms (each firm sells one product, each firm sells two products).

4.4. Impact of Consumer Uncertainty on Competitive Prices

In this section, we examine the impact on competitive prices of consumer uncertainty that leads to product returns. We compare the equilibrium prices in the competitive case under two forms of uncertainty (§4.2) to a standard model of competition without consumer uncertainty (and, therefore, also without returns). In the competitive setting (with $N = 4$) when there is no consumer uncertainty, the standard equilibrium prices are $p = c + d/4$. In our model, in contrast, we have allowed for two possible sources of uncertainty: uncertainty surrounding product category value (unknown u_i) and uncertainty surrounding preferences between products (unknown $|x_j - \theta_i|$). We now dissect the incremental effect of each form of uncertainty on prices and the interaction between the two forms of uncertainty.

If consumers are certain about their value of u_i, but uncertain about their preferences (i.e., about the value of $|x_j - \theta_i|$), the equilibrium is a special case of our competitive model in which $\alpha = 0$. Consider alternatively a model in which consumers know the value of $|x_j - \theta_i|$ but are uncertain about their value for the product category u_i. (They know that with probability α, they will discover that u_i is equal to zero.) As shown in Appendix J, any price/restocking fee combination such that $p_j^* = c + d/4 + \alpha(c - f_j^*)/(1 - \alpha)$

can occur in equilibrium and will result in equivalent profit, sales, and returns. When it is costless to implement a restocking fee (as in our model to this point), competing firms can earn equivalent profit from an array of price/restocking fee combinations because they are indifferent between recovering revenue through price ex ante or through the restocking fee ex post. However, if a fixed administrative cost of implementing a restocking fee, $Y > 0$, is introduced to the model, a unique equilibrium exists in which the restocking fees are zero and the competitive prices are $p_j = c + d/4 + \alpha c/(1 - \alpha)$, which is strictly greater than the equilibrium prices when there is complete certainty and no returns. We describe and derive the resulting Nash Equilibrium in Appendix J.

Proposition 5 describes the effect of each type of uncertainty on competitive prices.

PROPOSITION 5. *The impact of consumer uncertainty on equilibrium competitive prices can be described as follows.*

	Certainty about $|x_j - \theta_i|$	Uncertainty about $|x_j - \theta_i|$
Certainty about u_i	$p^* = p_{\text{certainty}} \equiv c + d/4$	$p^* = p_{\text{certainty}}$
Uncertainty about u_i	$p^* > p_{\text{certainty}}$ unless restocking fee > marginal cost, c	if $d > c/(2\Delta)$, $p^* < p_{\text{certainty}}$; if $d < c/(2\Delta)$, $p^* > p_{\text{certainty}}$ unless restocking fee > marginal cost, c

PROOF. See Appendix J.

Proposition 5 highlights an interaction effect between the two types of consumer uncertainty. Consumer uncertainty about preferences alone does not affect competitive prices. Consumer uncertainty only about the product category value can lead to higher prices if the restocking fee is set below the marginal production cost (i.e., c). However, when there are both forms of uncertainty, product differentiation moderates the relationship between optimal pricing and the presence/absence of consumer uncertainty.

When the products are not highly differentiated (low d), the two competing firms are able to eliminate exchanges with a minimal restocking fee. In this situation, a higher probability α that a consumer will return his initial purchase reduces competition in prices because the value of attracting a customer is diminished by the heightened possibility of a return. However, when the products are more differentiated (high d), the opposite is true. Competing firms then

charge higher restocking fees to recoup revenue from returns and prevent a number of consumers on the margin from making returns with the intent to purchase from the competition. Consumers recognize the α probability that the end result will be a return without exchange, implying a loss in utility equal to $-f^*$, and consumers calculate their expected utility of purchase accordingly. This lower expected utility of purchase drives equilibrium prices down.

5. Discussion
Our results show that marketing managers must take a careful look at the firm's cost structure as well as at consumer preferences in order to choose the appropriate restocking fee that recoups costs associated with returns and diminishes return rates without an excessive loss in sales revenue. Firms should not use the restocking fee solely as a method of passing on the costs of returns to consumers. When consumers perceive strong differences between products, a monopolist offers a lower restocking fee to ensure that a consumer eventually keeps their closest matching product. However, competing firms selling strongly differentiated products (i.e., facing consumers with strong preferences for a particular product) charge a higher restocking fee to counter the consumer's desire to exchange and buy from the competition. Both a monopolist and competing firms charge higher restocking fees when consumers are less informed about the product's match with preferences. In both cases, less-informed consumers are more likely to return the product (at a cost to the firm), and the seller attempts to discourage these returns as well as to pass these costs on to consumers through the use of a higher restocking fee. Thus, the restocking fee plays both a cost-defrayment role and a role in altering consumer behavior.

This paper also supports the findings of the previous literature (e.g., Davis et al. 1998, Shulman et al. 2009) that higher production costs lead to more restrictive return policies. By endogenizing consumer return and purchase behavior, however, our results uniquely identify how consumer-level parameters affect the optimal return policy in a competitive market. More specifically, we identify how the disutility of mismatch (i.e., level of perceived differentiation between products) and the precision of consumers' prior knowledge about product/preferences (mis)match affect optimal restocking fees in a competitive environment.

Although one may expect that competition would force firms to set lower restocking fees than would a monopolist, our results show that competition actually provides an additional incentive to charge higher restocking fees. Competing firms use the higher restocking fee as a means of keeping a portion of consumers from exchanging for the competitor's product

as well as generating an additional source of revenue from the consumers who ultimately do make a return.

If consumers are only uncertain about the product's fit with preferences, but not about overall category value, we show that the fact that consumers make returns to buy their preferred product does not affect the equilibrium prices relative to horizontally differentiated firms selling to consumers who are certain of their preferences. However, when consumers are uncertain about their value for the product category, prices may be higher than when there is no uncertainty. When consumers are uncertain about both preferences between products and their value for the product category, differentiation between products is a key driver in determining the impact of uncertainty on equilibrium prices. For products with little differentiation, the existence of product returns can increase prices because of the associated reduced price competition. With higher differentiation, the existence of product returns drives prices down because of the increased consumer cost of returns (in the form of higher restocking fees).

In looking at the effect of competition on restocking fees, we examine when a competitive entrant also sells the same amount of products as the monopolist. Although this leads to additional products in the marketplace, the results are preserved when analyzing one product sold by each competing firm relative to a monopolist selling both products. The finding of Proposition 4, that restocking fees weakly increase with competition, is relevant to situations in which the consumer choice set is consistent across the monopoly and competitive settings (i.e., after purchase a consumer can keep, return, or exchange their purchase in each case). Future research may examine the combined impact of competition and possibility for exchange by modeling a monopolist selling a single product. In such a model, the equilibrium restocking fee would be higher than presented in this paper because a return would always represent a lost sale rather than a potential opportunity to sell the more appropriate product.

In summary, competition creates several key differences in the way restocking fees are set. Different sources of consumer uncertainty that lead to product returns also have substantive effects on pricing. This paper shows that companies may naturally charge nontrivial restocking fees even in competitive markets and identifies how consumer and firm-level factors affect pricing and restocking fee choices.

Technical Appendix

Additional definitions derived and used in Appendices A and B:

a: Value of θ_i for which consumer who purchased product j is indifferent between keeping it and exchanging it for product $j+1$.

b: Value of θ_i for which consumer who purchased product $j+1$ is indifferent between keeping it and exchanging it for product j.

γ^j: Value of γ_i for which consumer is initially indifferent between purchasing product j and purchasing product $j+1$.

$e_{j,j+1}$: The number of consumers in the interval $\gamma_i \in [x_j, x_{j+1}]$ who buy product j and exchange it for product $j+1$.

$e_{j+1,j}$: The number of consumers in the interval $\gamma_i \in [x_j, x_{j+1}]$ who buy product $j+1$ and exchange it for product j.

Appendix A. Derivation of Demand Functions (See Equation (1))

We first derive demand functions for $N = 4$. The demand functions for $N = 2$ follows from the same steps.

Consider a consumer i whose prior location is $\gamma_i \in [x_j, x_{j+1}]$. Given our assumption that $\Delta < 1/(2N)$ and examining situations where each product has positive demand, this consumer will initially choose to buy either product j or product $j+1$, but not one of the other products. If instead a consumer with $\gamma_i \in [x_j, x_{j+1}]$ prefers product $j-1$ over product j (or equivalently $j+2$ over $j+1$), then no consumers would buy product j (or equivalently $j+1$). Consider this consumer's ex post optimal action based on actual utility. All consumers have probability α of getting zero utility from the product category and choosing to return the initial purchase without subsequent purchase. We first examine the ex post actions if a consumer purchases product j initially. We will then examine the ex post actions if the adjacent product was purchased initially. With probability $(1 - \alpha)$, consumer i who purchased product j initially has greater actual utility from keeping product j than exchanging for product $j+1$ if and only if $u - p_j - d|x_j - (\gamma_i + \varepsilon_i)| > u - p_{j+1} - f_j - d|x_{j+1} - (\gamma_i + \varepsilon_i)|$, which simplifies to

$$\gamma_i + \varepsilon_i < a \equiv \frac{f_j + p_{j+1} - p_j}{2d} + \frac{j}{4} + \frac{1}{8} \quad \text{when}$$

$$x_j \equiv \frac{j}{4} < (\gamma_i + \varepsilon_i) < x_{j+1} \equiv \frac{j+1}{4}.$$

Now consider the ex ante expected utility of a consumer with prior location γ_i who purchases product j initially. The expected utility for consumer i buying product j is $E_{ji} = (1 - \alpha) \sum_{k=j,\,j+1} P_{jki} E_{jki} - \alpha f_j$, where P_{jki} is the probability that, given product j was initially purchased and the product category is positively valued, product k is ultimately kept by consumer i, and E_{jki} is the average utility of ultimately owning product k given product j was initially purchased (for consumer i). A consumer who observes γ_i and buys x_j will maximize utility by keeping x_j if $\varepsilon_i \in [-\Delta, a - \gamma_i]$, whereas exchanging x_j for x_{j+1} will maximize utility if $\varepsilon_i \in [a - \gamma_i, \Delta]$. Because $\varepsilon_i \sim U[-\Delta, \Delta]$, $P_{jji} = \max\{\min\{\frac{1}{2\Delta}(a - \gamma_i + \Delta), 1\}, 0\}$ and $P_{j(j+1)i} = \max\{\min\{\frac{1}{2\Delta}(\Delta - a + \gamma_i), 1\}, 0\}$. The realized utility from keeping product j if it is purchased will be $u - p_j - d|x_j - (\gamma_i + \varepsilon_i)|$, where γ_i

is known ex ante and $\varepsilon_i \in [-\Delta, a - \gamma_i]$. The realized utility from exchanging product j for product $j+1$ will be $u - p_{j+1} - f_j - d|x_{j+1} - (\gamma_i + \varepsilon_i)|$, where γ_i is known ex ante and $\varepsilon_i \in [a - \gamma_i, \Delta]$. Thus, the average utilities are

$$E_{jji} = u - p_j - d\left(\gamma_i + \frac{-\Delta + a - \gamma_i}{2} - x_j\right) \quad \text{and}$$

$$E_{j(j+1)i} = u - p_{j+1} - f_j - d\left(x_{j+1} - \gamma_i - \frac{\Delta + a - \gamma_i}{2}\right),$$

where $x_j = j/4$ and $x_{j+1} = (j+1)/4$. Consumer i's ex ante expected utility of purchasing product j, when $\gamma_i \in [x_j, x_{j+1}]$ for this consumer, is

$$E_{ji} = (1 - \alpha)\left[\frac{1}{2\Delta}(a - \gamma_i + \Delta)\right.$$
$$\cdot \left(u - p_j - d\left(\gamma_i + \frac{-\Delta + a - \gamma_i}{2} - \frac{j}{4}\right)\right)$$
$$+ \frac{1}{2\Delta}(\Delta - a + \gamma_i)\left(u - p_{j+1} - f_j\right.$$
$$\left.\left. - d\left(\frac{j+1}{4} - \gamma_i - \frac{\Delta + a - \gamma_i}{2}\right)\right)\right] - \alpha \cdot f_j$$
$$\text{if } -\Delta < a - \gamma_i < \Delta.$$

Consumer i's ex ante expected utility of purchasing product $j+1$, when $\gamma_i \in [x_j, x_{j+1}]$ for this consumer, is derived in similar fashion. Let

$$b \equiv \frac{j}{4} + \frac{1}{8} - \frac{f_{j+1} - p_{j+1} + p_j}{2d}$$

denote the ex post location (i.e., θ_i) of the consumer who is indifferent between keeping product $j+1$ and exchanging product $j+1$ for product j. Then,

$$E_{(j+1)i} = (1 - \alpha)\left[\frac{1}{2\Delta}(\Delta - (b - \gamma_i))\right.$$
$$\cdot \left(u - p_{j+1} - d\left(\frac{j+1}{4} - \gamma_i - \frac{b - \gamma_i + \Delta}{2}\right)\right)$$
$$+ \frac{1}{2\Delta}(\Delta + b - \gamma_i)\left(u - p_j - f_{j+1} - d\right.$$
$$\left.\left. \cdot \left(\gamma_i + \frac{b - \gamma_i - \Delta}{2} - \frac{j}{4}\right)\right)\right] - \alpha \cdot f_j$$
$$\text{if } -\Delta < b - \gamma_i < \Delta.$$

The consumer indifferent between buying product j and buying product $j+1$ (i.e., γ_i s.t. $E_{ji} = E_{(j+1)i}$) is located at

$$\gamma^j \equiv \frac{1}{8} + \frac{j}{4} + \frac{f_j - f_{j+1} - 2(p_j - p_{j+1})}{4d} + \frac{\Delta(f_{j+1} - f_j)(1 + \alpha)}{(f_j + f_{j+1})(1 - \alpha)}.$$

Consumers with $\gamma_i \in [j/4, \gamma^j]$ buy product j initially. Consumers with $\gamma_i \in [\gamma^j, (j+1)/4]$ buy product $j+1$ initially. This works for any product j. Thus, product j gets initial sales from two intervals, $\gamma_i \in [j/4, \gamma^j]$ and $\gamma_i \in [\gamma^{j-1}, j/4]$, and the total initial sales of product j are equal to $\gamma^j - \gamma^{j-1}$, which is simplified in Equation (1) of the text.

Without exchanges, expected utility of buying product j is equal to $E_{ji} = (1 - \alpha)(u - p_j - d|x_j - \gamma_i|) + \alpha(-f_j)$ because $\varepsilon_i \sim U[-\Delta, \Delta]$ implies that the expected value of ε_i is zero. Quantity is derived by analysis of the marginal consumer. Q.E.D.

Appendix B. Derivation of Expected Exchange and Return Quantities (See Equation (2))

We derive the functions for $N = 4$. The same steps can be followed for $N = 2$.

A consumer will return product j without a subsequent purchase if they discover $u_i = 0$ (occurring with probability α) and they purchased product j initially. Thus, returns of product j equal $\alpha q_{j,N}$.

A consumer for whom $\gamma_i \in [x_j, x_{j+1}]$ exchanges product j for product $j+1$ provided that (1) product j offered greater expected utility ex ante (i.e., $\gamma_i < \gamma^j$), (2) product $j+1$ offers greater utility ex post (i.e., $\gamma_i + \varepsilon_i > a$), and (3) the product category offers positive utility occurring with probability $(1 - \alpha)$. Thus, we need to identify the number of consumers for whom $a - \varepsilon_i < \gamma_i < \gamma^j$. For a given draw of ε_i, this is $[\gamma^j - (a - \varepsilon_i)]^+$. If $8d\Delta(f_{j+1} - \alpha f_j) - (f_j + f_{j+1})^2 \cdot (1 - \alpha) < 0$, then $\gamma^j - (a - \varepsilon_i) < 0$ for all $\varepsilon_i \in [-\Delta, \Delta]$ and there are zero exchanges. Let $e_{j,j+1}$ denote the number of consumers in the interval $\gamma_i \in [x_j, x_{j+1}]$ who buy product j and exchange it for product $j+1$. If $-\Delta < a - \gamma^j$ (which holds trivially for symmetric choices and nonnegative restocking fees), integrating $[\gamma^j - (a - \varepsilon_i)]^+$ over $\varepsilon_i \in [-\Delta, \Delta]$ and multiplying by the $(1 - \alpha)$ probability that $u_i = u$ yields

$$e_{j,j+1} = \frac{([8d\Delta(f_{j+1} - \alpha f_j) - (f_j + f_{j+1})^2(1-\alpha)]^+)^2}{64d^2\Delta(1-\alpha)(f_j + f_{j+1})^2}.$$

Similarly, a consumer for whom $\gamma_i \in [x_j, x_{j+1}]$ exchanges product $j+1$ for product j provided that $\gamma^j < \gamma_i < b - \varepsilon_i$ and $u_i = u$. It follows that

$$e_{j+1,j} = \frac{([8d\Delta(f_j - \alpha f_{j+1}) - (f_j + f_{j+1})^2(1-\alpha)]^+)^2}{64d^2\Delta(1-\alpha)(f_j + f_{j+1})^2},$$

where $e_{j+1,j}$ denotes the number of consumers in the interval $\gamma_i \in [x_j, x_{j+1}]$ who buy product $j+1$ and exchange it for product j. Note that these expressions are derived for any product j. We can now derive the total number of exchanges to and from product j.

In the interval $\gamma_i \in [x_{j-1}, x_j]$, the number of exchanges from product $j-1$ to product j is simply $e_{j-1,j}$, where 1 is subtracted from each of the subscripts in the expression for $e_{j,j+1}$. The number of exchanges from product j to product $j-1$ is simply $e_{j,j-1}$, where 1 is subtracted from each of the subscripts in the expression for $e_{j+1,j}$. The total exchanges from product j is equal to $e_{j,j+1} + e_{j,j-1}$. The total exchanges to product j is equal to $e_{j-1,j} + e_{j+1,j}$. The expressions are presented in their simplified form in Equation (2). Q.E.D.

Appendix C. Proof of Slope of Total Sales Curve w.r.t. Restocking Fee (See §3.3)

In this appendix, we examine the slopes of sales, exchanges to product j, and exchanges from product j, each with respect to the restocking fee of product j:

$$\frac{\partial q_j}{\partial f_j} = \frac{1}{2d} - \frac{2\Delta f_{j+1}(1+\alpha)}{(1-\alpha)(f_j + f_{j+1})^2} - \frac{2\Delta f_{j-1}(1+\alpha)}{(1-\alpha)(f_j + f_{j-1})^2},$$

which is decreasing Δ and is negative for any Δ such that exchanges from product j for product $j+1$ occur (i.e., $8d\Delta(f_{j+1} - \alpha f_j) - (f_j + f_{j+1})^2(1-\alpha) > 0$).

$$\frac{\partial e_{\text{from } j}}{\partial f_j} = \left(\frac{\alpha}{4d} + \frac{(f_{j+1}+f_j)(1-\alpha)}{32d^2\Delta} - \frac{2\Delta f_{j+1}(1+\alpha)(f_{j+1}-\alpha f_j)}{(f_{j+1}+f_j)^3(1-\alpha)} \right)$$
$$+ \left(\frac{\alpha}{4d} + \frac{(f_{j-1}+f_j)(1-\alpha)}{32d^2\Delta} - \frac{2\Delta f_{j-1}(1+\alpha)(f_{j-1}-\alpha f_j)}{(f_{j-1}+f_j)^3(1-\alpha)} \right)$$

The first part of the expression equals zero at the minimum bound on Δ for which exchanges from j to $j+1$ occur and is decreasing in Δ given this condition. The remainder of the expression is equal to zero at the minimum bound on Δ for which exchanges from j to $j-1$ occur and is decreasing in Δ. Thus, $\partial e_{\text{from } j}/\partial f_j < 0$.

$$\frac{\partial r_j}{\partial f_j} = \frac{\partial \alpha q_j}{\partial f_j} < 0,$$

$$\frac{\partial e_{\text{to } j}}{\partial f_j} = -\left(\frac{1}{4d} - \frac{(f_{j+1}+f_j)(1-\alpha)}{32d^2\Delta} - \frac{2\Delta f_{j+1}(1+\alpha)(f_j - \alpha f_{j+1})}{(f_{j+1}+f_j)^3(1-\alpha)} \right)$$
$$- \left(\frac{1}{4d} - \frac{(f_{j-1}+f_j)(1-\alpha)}{32d^2\Delta} - \frac{2\Delta f_{j-1}(1+\alpha)(f_j - \alpha f_{j-1})}{(f_{j-1}+f_j)^3(1-\alpha)} \right)$$

The first part of the expression is equal to zero at the value of Δ for which $e_{j+1,j} > 0$ and is increasing in Δ if both $e_{j+1,j} > 0$ and $e_{j,j+1} > 0$. The second part of the expression is positive at Δ for which $e_{j,j-1} > 0$ and is increasing in Δ if both $e_{j,j-1} > 0$ and $e_{j-1,j} > 0$. Thus, if there are exchanges to product j from the adjacent products and exchanges from product j to the adjacent products, then $\partial e_{\text{to } j}/\partial f_j > 0$. Q.E.D.

Appendix D: Optimal Choices by Monopolist (See §4.1)

When offering two horizontally differentiated products, the monopolist charges a restocking fee and a selling price given by

(i) a combination of price and restocking fee such that

$$p_j = u - d/4 - \alpha f_j/(1 - \alpha), \quad \text{and}$$

$$(1 - \alpha)\left(u - \frac{d}{4}\right) > f_j \geq 2d\Delta \quad \text{if } 0 \leq d \leq \frac{2c}{1 + 4\Delta},$$

causing there to be zero exchanges, but product returns equal to $r_j = \alpha/2$ for each product j; or

(ii) a price and restocking fee equal to

$$p_j = u - \frac{2(c(1+2\alpha) - d\Delta(1-4\alpha))}{9(1-\alpha)}$$

$$- \frac{d(5 - 17\alpha)}{36(1-\alpha)} + \frac{(2c-d)^2}{72d\Delta},$$

$$f_j = \frac{1}{3}(2c - d(1 - 2\Delta)) \quad \text{if } d > \frac{2c}{1 + 4\Delta},$$

causing there to be exchanges,

$$e_{\text{from } j} = \frac{(1-\alpha)(d - 2(c - 2d\Delta))^2}{72d^2\Delta},$$

and product returns equal to $r_j = \alpha/2$ for each product j.

PROOF. If prices and restocking fees are chosen such that there are both returns and exchanges (i.e., the market is fully covered), the monopolist's optimization problem is

$$\max_{f_0, f_2, p_0, p_2} (p_0 - c)(q_0 + e_{to\,0}) - (p_0 - f_0)(r_0 + e_{\text{from } 0})$$

$$+ (p_2 - c)(q_2 + e_{to\,2}) - (p_2 - f_2)(r_2 + e_{\text{from } 2})$$

$$\text{s.t. } E_{ji} > 0 \quad \text{for the consumer located at } \gamma^j.$$

The constraint on the problem simply means that if the monopolist chooses to fully cover the market (i.e., u is sufficiently high to warrant full market coverage), the market is indeed covered (i.e., $E_{ji} > 0$ for the indifferent consumer). By definition of the consumer located at γ^j, $E_{0,i} = E_{2,i}$. Therefore, we have the following maximization problem:

$$\max_{f_0, f_2, p_0, p_2, \lambda} \ (p_0 - c)(q_0 + e_{\text{to } 0}) - (p_0 - f_0)(r_0 + e_{\text{from } 0})$$

$$+ (p_2 - c)(q_2 + e_{\text{to } 2}) - (p_2 - f_2)(r_2 + e_{\text{from } 2})$$

$$\text{s.t.} \quad \lambda \geq 0, \qquad \lambda E_{0i} = 0 \quad \text{for consumer located at } \gamma^j.$$

The Kuhn-Tucker conditions are satisfied at two possible symmetric solutions. In the first solution, (i), we have

$$p_0 = p_2 = u - \frac{d}{4} - \frac{2\alpha d\Delta}{(1-\alpha)}, \quad f_0 = f_2 = 2d\Delta, \quad \lambda = 1.$$

Plugged into Equation (2) from the text, this results in $e_{\text{to } 0} = e_{\text{to } 2} = 0$ and $r_0 = r_2 = \alpha/2$. In the second solution, (ii), we have

$$p_0 = p_2 = u - \frac{2(c(1+2\alpha) - d\Delta(1-4\alpha))}{9(1-\alpha)}$$

$$- \frac{d(5 - 17\alpha)}{36(1-\alpha)} + \frac{(2c-d)^2}{72d\Delta},$$

$$f_0 = f_2 = \frac{1}{3}(2c - d(1-2\Delta)), \quad \lambda = 1.$$

Plugged into Equation (2) from the text, the second solution results in exchanges of

$$e_{\text{to } 0} = e_{\text{to } 2} = \frac{(1-\alpha)(d - 2(c - 2d\Delta))^2}{72d^2\Delta}$$

and product returns of $r_0 = r_2 = \alpha/2$.

Solution (i) will yield the seller profit equal to $\pi_i = (1-\alpha)(u - d/4) - c$.

Solution (ii) will yield the seller profit equal to

$$\pi_{ii} = (1-\alpha)\left(u - \frac{d}{4}\right) - c + \frac{(1-\alpha)(d(1+4\Delta) - 2c)^3}{216d^2\Delta}.$$

Clearly the profits from solution (i) are greater than the profits from solution (ii) if and only if $d < 2c/(1+4\Delta)$. The following can be shown to be true. Solution (i) satisfies the second-order conditions for a local maximum if and only if $d < 2c/(1+4\Delta)$. Any solution such that

$$p_0 = p_2 = u - \frac{d}{4} - \frac{\alpha f_0}{(1-\alpha)}, \quad (1-\alpha)\left(u - \frac{d}{4}\right) > f_0 = f_2 \geq 2d\Delta$$

will yield the same profit as solution (i). Solution (ii) satisfies the second-order conditions for a local maximum only if $d > 2c/(1+4\Delta)$. The local maximum of solution (ii) is a unique global maximum for

$$\frac{2c}{1+4\Delta} < d$$

$$< \frac{2c((1-6\Delta)(1+\alpha^2) - 2\alpha(1+2\Delta) - 2\Delta(1+\alpha)\sqrt{7+2\alpha+7\alpha^2})}{(1-\alpha)^2 - 4\Delta(3+2\alpha+3\alpha^2) + 8\Delta^2(1+\alpha^2)}.$$

Q.E.D.

Appendix E. Equilibrium Choices by Competing Firms (See §4.2)

When two competing firms each offer two maximally differentiated products (i.e., one firm offers $x_0 = 0$, $x_2 = 2/4$ and the other offers $x_1 = 1/4$ and $x_3 = 3/4$) and consumers are uncertain about both their own product value and preferences between products, the symmetric equilibrium is given by

(i) a price and restocking fee combination such that

$$p_j^* = c + \frac{d}{4} + \frac{\alpha(c - f_j)}{(1-\alpha)} \quad \text{and}$$

$$c + \frac{d(1-\alpha)}{4} > f_j^* \geq 2d\Delta$$

if $d \leq c/(2\Delta)$, causing there to be zero exchanges and positive product returns equal to $r_j^* = \alpha/4$; or

(ii) a price and restocking fee equal to

$$p_j^* = \left[\frac{1}{4(1-\alpha)^3}\left(c(1-\alpha)^2(4-\alpha) + d((1-\alpha)^3 + 8\alpha^2\Delta)\right.\right.$$

$$\left.\left. - \alpha\sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}\right)\right]$$

and

$$f_j^* = \frac{c}{4} + \frac{1}{4(1-\alpha)^2}\left(-8d\alpha\Delta\right.$$

$$\left. + \sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}\right)$$

if $d > c/(2\Delta)$, causing exchanges equal to

$$e_{\text{to } j}^* = e_{\text{from } j}^*$$

$$= \left[c(1-\alpha)^2 - 8d\Delta(1-\alpha+\alpha^2)\right.$$

$$\left. + \sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}\right]^2$$

$$\cdot (128d^2\Delta(1-\alpha)^3)^{-1}$$

for each product j and product returns without a subsequent purchase equal to $r_j^* = \alpha/4$.

PROOF. Given the maximization problems from Equation (4) in the text, there are three possible symmetric solutions to the first-order conditions.

Solution (I):

$$f_j^{*I} = 2d\Delta, \quad p_j^{*I} = c + \frac{d}{4} + \frac{\alpha(c - f_j)}{(1-\alpha)} = c + \frac{d}{4} + \frac{\alpha(c - 2d\Delta)}{(1-\alpha)},$$

which implies zero exchanges and product returns for each product j equal to $\alpha/4$.

Solution (II):

$$p_j^{*II} = \frac{1}{4(1-\alpha)^3}\left[c(1-\alpha)^2(4-\alpha) + d((1-\alpha)^3 + 8\alpha^2\Delta)\right.$$

$$\left. - \alpha\sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}\right]$$

and

$$f_j^{*\text{II}} = \frac{c}{4} + \frac{1}{4(1-\alpha)^2}\Bigg[-8d\alpha\Delta$$
$$+ \sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}\,\Bigg].$$

When substituted into Equation (2) of the text, this generates exchanges for each product j equal to

$$e_{\text{to }j}^* = e_{\text{from }j}^*$$
$$= \Bigg\{\Big[c(1-\alpha)^2 - 8d\Delta(1-\alpha+\alpha^2)$$
$$+ \sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}\,\Big]^2\Bigg\}$$
$$\cdot(128d^2\Delta(1-\alpha)^3)^{-1}$$

and product returns without a subsequent purchase equal to $r_j^* = \alpha/4$.

Solution (III):

$$p_j^{*\text{III}} = \Bigg\{\frac{1}{4(1-\alpha)^3}\Bigg[c(1-\alpha)^2(4-\alpha) + d((1-\alpha)^3 + 8\alpha^2\Delta)$$
$$+ \alpha\sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}\,\Bigg]\Bigg\}$$

and

$$f_j^{*\text{III}} = \frac{c}{4} + \frac{1}{4(1-\alpha)^2}\Bigg[-8d\alpha\Delta$$
$$- \sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}\,\Bigg],$$

which is ruled out because $f_j^{*\text{III}} < 0$ for any $c > 0$ using the positive root of

$$\sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}.$$

CLAIM 1. Solution (I) satisfies the second-order conditions for a local maximum if and only if $d < c/(2\Delta)$. Because

$$\frac{\partial^2\pi}{\partial p_j \partial p_{j+2}} = 0, \qquad \frac{\partial^2\pi}{\partial f_j \partial f_{j+2}} = 0,$$

we can examine a firm's profit expression for each product j (i.e., $(p_j - c)q_j - (p_j - f_j - s)(e_{\text{from }j} + r_j) + (p_j - c)e_{\text{to }j}$) separately. The discriminant of a firm's objective function for product j when simplified at solution (I) is positive if and only if $d < c/(2\Delta)$.

The second derivative with respect to price $\partial^2\pi/\partial p_j^2 = -2(1-\alpha)/d < 0$ and the second derivative of profit with respect to f_j when evaluated at solution (I) is negative for all $d < c/(2\Delta)$. □

CLAIM 2. Solution (II) satisfies the second-order conditions for a local maximum if and only if $d > c/(2\Delta)$. The discriminant of a firm's objective function for product j when simplified at solution (II) is positive if and only if $d > c/(2\Delta)$. The second derivative with respect to price $\partial^2\pi/\partial p_j^2 = -2(1-\alpha)/d < 0$ and the second derivative of profit with respect to f_j when evaluated at solution (II) is negative for all $d < c/(2\Delta)$.

Solution (II) is the unique symmetric equilibrium when $d > c/(2\Delta)$ because solution (II) satisfies the conditions for a local maximum iff $d > c/(2\Delta)$, profit is strictly concave in price, $\lim_{f_j \to -\infty} \pi = -\infty$ (the direction of $-(1-\alpha)/(d^2\Delta)$) and increasing f_j to the point that there are no exchanges results in diminished profit if $d > c/(2\Delta)$. Therefore, not only will local deviations from solution (II) reduce profit, all deviations from solution (II) will reduce profit if $d > c/(2\Delta)$. Solution (I) is not unique because any

$$p_j = c + \frac{d}{4} + \frac{\alpha(c - f_j)}{(1-\alpha)} \quad \text{and} \quad c + \frac{d(1-\alpha)}{4} > f_j \geq 2d\Delta$$

will result in the same profit. This is because $f_j \geq d\Delta$ will lead to zero exchanges, which implies the ex post exchange decisions are invariant with respect to restocking fees and there are an array of prices and restocking fees that will result in equivalent profit and consumer expected utility of initial purchase. □ Q.E.D.

Appendix F. Proof of Proposition 1
For $d > c/(2\Delta)$, the restocking fees in a symmetric competitive equilibrium are

$$f_j = \frac{c}{4} + \frac{1}{4(1-\alpha)^2}(-8d\alpha\Delta + Z), \quad \text{where}$$
$$Z \equiv \sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}.$$

Comparative statics are given by

$$\frac{\partial f^*}{\partial c} = \frac{1}{4}\left(1 + \frac{c(1-\alpha)^2 + 8d\Delta(1+\alpha+\alpha^2)}{Z}\right) > 0 \quad \text{and}$$
$$\frac{\partial f^*}{\partial \Delta} = \frac{2d}{(1-\alpha)^2}\left(\frac{c(1-\alpha)^2(1+\alpha+\alpha^2) + 8d\Delta\alpha^2}{Z} - \alpha\right) > 0,$$

the latter being true for the positive root of Z. The remaining comparative statics are immediately obvious from Appendices D and E. Q.E.D.

Appendix G. Proof of Proposition 2
In the monopoly case when there are exchanges, the derivative $\partial f_j^*/\partial d = -(1-2\Delta)/3$ is negative by fact that $\Delta < 1/4$. In the competitive case when there are exchanges, the derivative

$$\frac{\partial f_j^*}{\partial d} = \frac{2\Delta}{(1-\alpha)^2}\left(\frac{c(1-\alpha)^2(1+\alpha+\alpha^2) + 8d\Delta\alpha^2}{Z} - \alpha\right)$$

is positive for the positive root of Z. Q.E.D.

Appendix H. Proof of Proposition 3
In the monopoly case, prices from Appendix D are invariant w.r.t. c if $d < 2c/(1+4\Delta)$. If $d > 2c/(1+4\Delta)$, then

$$\frac{\partial p_j^*}{\partial c} = \frac{2c(1-\alpha) - d(1-\alpha+4\Delta(1+2\alpha))}{18d\Delta(1-\alpha)},$$

which is negative for all $d > 2c/(1+4\Delta)$.

In the competitive case, prices are presented in Appendix E. For $d < c/(2\Delta)$, $\partial p_j^*/\partial c = (1-\alpha)^{-1} > 0$. For $d > c/(2\Delta)$,

$$\frac{\partial p_j^*}{\partial c} = \frac{1}{4(1-\alpha)}\left(4 - \alpha - \frac{\alpha(c(1-\alpha)^2 + 8d\Delta(1+\alpha+\alpha^2))}{Z}\right),$$

where

$$Z \equiv \sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}.$$

For the positive root of Z, this is positive by fact that

$$Z^2 - \left(\frac{\alpha(c(1-\alpha)^2 + 8d\Delta(1+\alpha+\alpha^2))}{4-\alpha}\right)^2 > 0$$

because $\alpha \leq 1$.   Q.E.D.

Appendix I. Proof of Proposition 4

We draw on the restocking fees of Appendices D and E. We have three areas of the parameter space to examine: (1) $d < 2c/(1+4\Delta)$, which implies there are no exchanges for a monopolist nor for competing firms; (2) $2c/(1+4\Delta) < d < c/(2\Delta)$, which implies that there are exchanges in the monopolist case, but not the competing case; and (3) $d > c/(2\Delta)$, which implies that there are exchanges in the case of the monopolist as well as the case of two competing firms.

First we examine the restocking fees. In the first case, restocking fees are the same in both scenarios. In the second case, the monopolist's restocking fee minus the restocking fees chosen by competing firms is equal to $(2c - d(1 + 4\Delta))/3 < 0$ by fact that $d > 2c/(1 + 4\Delta)$. In the third case, the monopoly restocking fee minus the competitive restocking fee is equal to $-c/(6\Delta) < 0$ when evaluated at the minimum bound on d for Case 3 (i.e., $d = c/(2\Delta)$). As shown in Proposition 2, competitive restocking fees are increasing in d and monopoly restocking fees are decreasing in d. Therefore, the monopoly restocking fee is less than the competitive restocking fees for all $d > c/(2\Delta)$. Thus, for all $d > 2c/(1+4\Delta)$, competing firms each selling two products charge higher restocking fees than a monopolist selling two products.   Q.E.D.

Appendix J. Proof of Proposition 5

First we examine when consumers are uncertain only about u_i.

Consumers uncertain about u_i will choose product j if it maximizes expected utility: $(1-\alpha)(u-p_j-d|x_j-\theta_i|) - \alpha f_j$. Thus,

$$q_j = \frac{1}{4} + \frac{(p_{j+1} + p_{j-1} - 2p_j)}{2d} + \frac{\alpha(f_{j+1} + f_{j-1} - 2f_j)}{2d(1-\alpha)}.$$

Consumers will make a return if it is discovered that $u_i = 0$. Therefore, profit for each product j is $\pi_j = q_j((p_j - c) + \alpha(f_j - p_j))$. Firm 1's profit is $\pi_0 + \pi_2$, Firm 2's profit is $\pi_1 + \pi_3$. For each firm the profit function is concave in the price of each product j,

$$\frac{\partial^2 \pi_j}{\partial p_j^2} = -\frac{2(1-\alpha)}{d} < 0$$

or restocking fee of each product j,

$$\frac{\partial^2 \pi_j}{\partial f_j^2} = -\frac{2\alpha^2}{d(1-\alpha)} < 0,$$

but not in both

$$\frac{\partial^2 \pi_j}{\partial f_j^2} \cdot \frac{\partial^2 \pi_j}{\partial p_j^2} - \frac{\partial^2 \pi_j}{\partial p_j \partial f_j} \cdot \frac{\partial^2 \pi_j}{\partial f_j \partial p_j} = 0.$$

Therefore, there is not a unique equilibrium. Rather there is a set of price and restocking fee combinations that satisfy the first-order conditions. By solving the first-order conditions simultaneously, we find that any set of price and restocking fee such that $p_j^* = c + d/4 + \alpha(c-f_j^*)/(1-\alpha)$ gives each firm expected profit of $d(1-\alpha)/8$.

The equilibrium prices when consumers are uncertain only about u_i are greater than $c + d/4$ if and only if the restocking fee is less than the marginal cost of production (i.e., $f_j < c$).   □

Next, we examine when consumers are uncertain only about $|x_j - \theta_i|$.

This is a special case of the model in which $\alpha = 0$. The prices, presented in Appendix E, simplify to $c + d/4$ at $\alpha = 0$.   □

Finally, we examine when consumers are uncertain about both u_i and $|x_j - \theta_i|$.

With both types of uncertainty, there are two cases to consider. For $d < c/(2\Delta)$, as shown in Appendix E, $p_j^* = c + d/4 + \alpha(c-f_j)/(1-\alpha)$ with $f_j^* \geq 2d\Delta$. This price is greater than $c + d/4$ if the restocking fee is less than the firm's cost of production ($f_j < c$). For $d > c/(2\Delta)$, the difference between the uncertainty price presented in Appendix E and the certainty price is equal to

$$\frac{\alpha(3c(1-\alpha)^2 + 8\alpha d\Delta - Z)}{4(1-\alpha)^3}, \quad \text{where}$$

$$Z \equiv \sqrt{c^2(1-\alpha)^4 + 16d\Delta c(1-\alpha)^2(1+\alpha+\alpha^2) + (8d\alpha\Delta)^2}.$$

This is negative if $Z^2 > (3(1-\alpha)^2 + 8\alpha d\Delta)^2$, which is true for $d > c/(2\Delta)$ (by fact that $Z^2 - (3(1-\alpha)^2 + 8\alpha d\Delta)^2 = 8c(1-\alpha)^4(2d\Delta - c)$.   □   Q.E.D.

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