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# Counteracting Strategic Purchase Deferrals: The Impact of Online Retailers' Return Policy Decisions

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Online shoppers value lenient return policies as they are unable to assess whether products match their expectations. We study how consumers' discount-seeking purchase deferrals affect online retailers' return policy choices. Lenient returns may induce higher full-price sales by limiting consumer regret, while signaling clearance unavailability risk. Contrasting earlier research that concluded a monopolist must set the refund at the clearance price when strategic consumers were overlooked, we find that an optimal refund bounded by the clearance price can mitigate purchase deferrals only when a monopolist salvages at mild discounts. To explore conditions under which a monopolist permits "full-refund returns," we consider three scenarios: we permit clearing inventory without a loss; we assume lenient returns stimulate aggregate demand; we consider consumers' transaction costs. We also derive a unique rational expectations equilibrium for competing retailers, wherein each retailer's equilibrium refund is nondecreasing in its clearance price. Furthermore, retailers with clearance prices below a threshold should not allow returns, and those who do, higher clearance revenues imply higher full prices, higher quantities, and higher profits. We conclude that a credible clearance partner salvaging at higher prices than those at competing clearance mediums helps retailers gain competitive advantage when selling to strategic consumers.

*Keywords*: OM-marketing interface; retailing; pricing and revenue management; returns; strategic purchase deferrals; rational expectations
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## 1. Introduction

As consumers become increasingly aware of the conveniences of online shopping, their purchasing behavior becomes more complex as well. Not only do strategic online shoppers compare prices at competing online retailers in no time, but also they take into account various factors such as the possibility of future discounts, stock levels, and retailers' return policies. Online shoppers also face unique challenges. For example, they may not be able to assess the fit between their expectations and the products at the time of purchase; or, because the retailers' stock levels are mostly not visible, consumers may have to rely on prices to infer future stock availability levels. Consequently, how the Internet retailer's marketing and operations strategies are perceived by consumers significantly impact the retailer's ability to induce higher sales.

Today, many online retailers recognize the changing consumer behavior patterns, and have implemented various strategies to affect primary selling season sales (i.e., sales prior to the clearance period). For example, to compensate for the reduction in revenues because of the discount-seeking behavior of an estimated 20% of customers who strategically defer their purchases until the clearance period (whom the CEO of Best Buy referred to as *devils*; McWilliams 2004), Best Buy focuses marketing efforts on *angels* (consumers who are willing to pay full prices for high-margin products shortly after they are introduced to the market (Arndorfer and Creamer 2005). An increasing number of retailers (including the world's larger online retailer, Amazon.com) utilize operational tactics to complement traditional marketing and pricing strategies, such as selectively disclosing nuanced inventory information to raise future product unavailability concerns for strategically waiting consumers (Liu and van Ryzin 2008, Yin et al. 2009, Aydinliyim et al. 2014).

The retail strategy we focus on in this research is the increasingly popular practice of offering lenient returns and generous refunds. Although varied return policies are increasingly implemented by online retailers, it is not clear how effective a lenient return policy can be in mitigating the adverse impact of consumers' strategic purchase deferral behavior. This issue is of significant managerial importance especially in the Internet retailing context where a customer may not know her exact valuation of a product at the time of purchase, thus making a lenient return policy a "double-edged sword." On one hand, a generous refund policy may induce a positive *valuation effect* by reducing the likelihood that a consumer would be stuck with a product that is potentially unsuitable to his needs. (Consider, for example, a consumer purchasing an apparel item, when he/she is unsure whether the online sizing chart is accurate.) If purchasing consumers end up keeping the products purchased during the primary selling period, fewer leftover units yield less clearance period availability. In this case, an *availability effect* would reduce consumers' surplus from waiting, thereby inducing more full-price sales. On the other hand, a generous refund policy may induce too many low-risk purchases by low-valuation consumers while enabling these consumers to return at low transaction cost. In this latter case, high return volumes may increase clearance period availability and encourage strategic purchase deferrals.

The contrasting effects a generous refund may have on consumer behavior and the ensuing purchase/return dynamics have given rise to a series of managerially relevant questions: Should a monopolist online retailer permit returns, and what should be the magnitude of the refund, when consumers are strategically forward looking and sensitive to clearance period availability? How does the monopolist's decision to permit returns change with respect to product cost and demand characteristics? How does strategic consumer behavior impact the effectiveness of an optimal return/refund policy? What economic effects underlie the increasingly common retail practice of permitting returns without a restocking fee? What changes when retailers face competition? Given the varying clearance sales practices leading retailers implement to salvage similar products, what (if any) competitive advantage can a retailer gain by choosing a specific clearance sales channel? As a case in point, consider Nordstrom and Macy's, two leading department-store-type retailers whose catalogs overlap significantly, which use different clearance strategies. Whereas Nordstrom salvages leftover units via its own discount chain, Nordstrom Rack, at mild discounts, Macy's partners with mainstream clearance sales stores such as Marshall's, T.J. Maxx, and Ross, which are known for clearance sales with steep discounts.

To address the aforementioned research questions, we study both a monopolistic setting and competition among multiple retailers. In each case, we consider a price-setting newsvendor which also chooses an optimal refund if returns are allowed. Should there remain any leftover and/or returned units after the primary selling season, the retailer can salvage them during the clearance period. To reflect consumers' uncertain valuations prior to their purchases, we permit product valuations to be drawn from an arbitrary distribution. Similar to the existing literature on strategic consumer behavior, we adopt a rational expectations framework, wherein consumers use the retail price to infer clearance period availability. In this framework, each consumer self-selects, ex-ante, to (i) buy during the primary selling season, or (ii) wait until clearance, or (iii) leave without a purchase, by taking into account the price and the expected surplus from each option. In the case of waiting, the expected surplus depends on the consumer's expected valuation, the salvage price, and the expected clearance period fill rate. For consumers who buy immediately, valuation uncertainty is resolved after the purchase, and thus these consumers decide, ex-post, to keep or return the product based on their true surplus given the refund the retailer offers.

Our study contributes to the existing literature on product returns, strategic purchase deferrals, and inventory dependent demand in several ways. Although each of these issues has been studied independently in monopolistic settings, this study, to the best of our knowledge, is the first to characterize a monopolist's optimal price, refund, and inventory decisions while considering several factors (i.e., strategic purchase deferrals, clearance period availability and consumers' sensitivity to stock-outs, the retailer's return policy, and product valuation uncertainty) that influence consumers' purchasing behavior in an integrated manner. Similarly, we are not aware of any earlier study that considers this retail setting with an arbitrary number of competing retailers. Furthermore, as opposed to earlier studies which treated offering a full refund as a suboptimal decision by a monopolist retailer (e.g., Su 2009), we investigate the economic factors that yield a full-refund equilibrium strategy.

The significance of this integrated approach is highlighted by our key findings, some of which contrast conclusions from earlier studies. For example, in contrast to Su (2009), who focused on the optimal returns policies for a monopolist selling to myopic consumers and concluded that a refund *equal to* the salvage value of the product is optimal, we find that the optimal refund must be *less than* the salvage value. Whereas a higher refund increases consumers' ex-ante valuation of the product, and permits—in some cases—the retailer to charge a higher price, it also induces returns by consumers with low valuations. That availability effect, combined with purchase deferrals because of a higher equilibrium price drives the optimal refund below the salvage value. What is even more striking is that the monopolist can actually be worse-off by allowing returns to strategic consumers. Specifically, the monopolist should not allow returns unless the salvage value is above a threshold that is a function of the unit procurement cost and the mean consumer valuation. Therefore, lenient returns would only help a monopolist retailer with the ability to salvage without a heavy discount. In such cases, the refund permits the monopolist to stock more and set a higher primary selling season price compared to when no returns are allowed (i.e., the setting studied by Su and Zhang 2008); in other words, it helps mitigate the adverse effects of strategic consumer behavior.

Even though we show the optimal refund to be bounded by the clearance price, which is consistent with the findings of prior studies on a price-setting newsvendor, the fact that an increasing number of retailers have adopted a "no-restocking-fee" return policy warrants further analysis regarding the economic factors that underlie such a strategy. To this end, we offer three explanations: First, we permit a clearance price that may exceed the product cost, and find consumers' valuations being bounded (from below) by the clearance price to be a sufficient condition to support an equilibrium with a full refund. Second, we study the case wherein a lenient return policy might attract additional aggregate demand by incorporating in our demand model a multiplier that is nondecreasing in the refund amount. In this case, we show the optimal refund to be strictly higher than the best refund without the multiplier, and as high as the optimal price even if the retailer takes a loss on clearance sales. Third, we extend our analysis to account for a transaction cost consumers incur when they return a product, and find that when the associated disutility is significant enough, offering a full refund may sustain as an equilibrium decision for the monopolist.

We also find the monopolist's optimal refund as a percentage of the optimal price to be increasing in the salvage price. As a result a higher clearance price implies a larger stocking quantity, and, under certain conditions, a higher price and thus a higher profit. (Surprisingly, the aforementioned demand stimulating effect yields one scenario where a higher clearance price does not necessarily imply a higher retail profit.) This begs the question: Is the ability to salvage without a heavy discount a strategic advantage for a retailer facing competition? To this end, we study a setting with an arbitrary number of competing retailers, and characterize the unique rational expectations equilibrium, where each retailer's optimum price, refund, and quantity decisions leave the consumers indifferent regarding which retailer to patronize in the primary selling season; thus, the first period demand is split equally among retailers. We find competition to be another economic factor driving equilibrium refunds higher; more specifically, a retailer who should not permit returns as a monopolist, may optimally offer a partial refund when facing competition. Furthermore, we find each retailer's equilibrium refund to be nondecreasing in its unit salvage revenue, which we use to highlight that retailers whose unit salvage revenues are below a threshold should not allow returns, and for the retailers who should optimally offer a refund, a higher salvage revenue implies a higher full price, a higher stocking quantity, and thus a higher profit. Consequently, choosing a clearance sales partner who can salvage at prices higher than competing clearance mediums helps a retailer to gain competitive advantage when selling to a strategically forward-looking consumer base.

The rest of the article is organized as follows. We survey the related literature in §2. In §3, we study the case of a monopolist retailer. In, §4 we discuss the economic effects that may induce a full-refund strategy to sustain as an equilibrium. We study competition among an arbitrary number of competing retailers in §5. Section 6 concludes with a summary of managerial findings. We relegate all proofs as well as some technical analysis to the electronic companion (available as supplemental material at http://www.dx.doi.org/10.1287/msom.2015.0570).

## 2. Related Literature

Our work relates and contributes to four different research areas; namely, (i) returns management and its consumer behavior implications, (ii) inventory dependent demand considerations with stock-out implications, (iii) strategic (i.e., forward-looking and discount-seeking) consumer behavior, and (iv) retail competition. In what follows, we discuss how our work is positioned with respect to extant literature in each of these areas, and highlight our specific contributions.

Existing literature on consumer return policies mostly highlights marketing benefits, and particularly focuses on the ensuing positive sales impact a return policy induces by limiting consumers' regret. For example, Heiman et al. (2002) argue that money-back-guarantees (MBGs) are analogous to financial put options, and Davis et al. (1995) show that MBGs can increase retailer profits, a finding Che (1995) supports in a more general setting wherein consumer valuations follow a general distribution. Moorthy and Srinivasan (1995) highlight another benefit that a lenient return policy signals higher perceived quality in contexts where return transaction costs are substantial. Others emphasize the potentially negative profit impacts of lenient return policies; see, for example, Hess et al. (1996), who demonstrate (for a mail order catalog setting with nonrefundable shipping charges) the adverse consequences of return policy abuse when consumers purchase without the intention to keep the product beyond the permissible return period. To counter such opportunistic behavior, Davis et al. (1998) propose offering only partial refunds; in other words, charging a restocking fee. Alternatively, Akcay et al. (2013) show that optimizing the restock and resale of returned products by discounting open-box items complements MBGs and increases retailer's profit. In the same spirit, Shulman et al. (2009) also favor controlled restocking and resale of returns, and consider pricing decisions of a monopolist retailer selling two horizontally differentiated products where the seller has the option to provide more information to prevent misfit, and hence returns. The authors identify the conditions under which this aforementioned strategy is optimal. More recently, Altug (2012) consider both the positive and the negative effects of returns and showed for a finite horizon multiperiod setting how a monopolist retailer can dynamically update his refund decisions to affect demand and return volumes. A recent working paper by Cai and Chen (2014) consider a setting similar to ours, yet their demand model is discrete with a focus on optimal mark-down pricing for only a monopolist. Therefore, an immediate comparison of their findings with those of Su and Zhang (2008) and Su (2009) is not possible.

The second stream of related literature explores the inventory-demand link with particular focus on fill rate effects and stock-out implications. The empirical work of Wolfe (1968) is among the first to highlight the positive effect of inventory on demand. Others including Anderson (2008), Anupindi et al. (1998), Bruno and Vilcassim (1998), Musalem et al. (2010), and Conlon and Mortimer (2010) argue inventory stock-outs may influence consumers' purchasing decisions, and thus induce substitution effects and/or future sales. Exploring this inventory-demand link for classical newsvendor settings requires modeling demand endogenously as a function of the fill rate, which was first done by Dana and Petruzzi (2001). Others that followed the demand models of Dana and Petruzzi (2001) to explore further issues; for example, Su and Zhang (2009) considered the value of service guarantees, Liu and van Ryzin (2008) investigate whether retailers can use stock-out risk as a mechanism to encourage early (and full price) purchases, Aydinliyim et al. (2014, 2015) explore if selective inventory disclosure can induce the same stock-out effect to prevent strategic purchase deferrals.

Our paper also relates to the literature that studies strategic (i.e., forward-looking and discount-seeking) consumer behavior, and investigates the effectiveness of various operational levers to mitigate the adverse effects such consumer behavior induces on retail profits. In a book chapter, Aviv et al. (2009) survey papers that consider dynamic pricing strategies to counteract strategic purchase deferrals. For example, Su (2007) and Aviv and Pazgal (2008) consider optimal markdown pricing, and Lai et al. (2010) highlight how posterior price matching can help mitigate strategic waiting. Among other full-price purchase inducing tactics earlier research focused on include capacity and/or price commitments by Su and Zhang (2008, 2009), quick response by Cachon and Swinney (2009, 2011), price guarantees by Levin et al. (2010), capacity rationing by Liu and van Ryzin (2008), and selective inventory disclosure by Yin et al. (2009) and Aydinliyim et al. (2014, 2015).

The fourth related literature stream focuses on retail competition. Deneckere and Peck (1995) analyze firms that compete on fill rate (and price). Dana (2009) study a model of competition in price and availability where demand is uncertain and consumers make their decision based on observable price and unobservable inventory and show that firms use higher prices to signal higher availability. Balachander and Farquhar (1994) are among the first to focus on stock-out implications for competing retailers, who show that stock-outs can lead to reduced price competition, and hence yield higher profits. Gaur and Park (2009) also analyze a competitive environment with two firms, but add customer learning effects. Shulman et al. (2011) study the pricing and restocking fee decisions of two competing firms selling horizontally differentiated products and find that restocking fees may be higher compared to that charged by a monopolist. Our work can be considered relevant to the papers on competition in service industries as well in which the service firms compete not only on price but another service-related attribute such as waiting time standards. Luski (1976), Luski and Levhari (1978), So (2000), Cachon and Harker (2002), and Allon and Federgruen (2007) are some of the few papers in this area. In our model, uncertain demand is split among multiple retailers as a function of not only price and quantity but also the refund amount of each retailer, which effectively shows the interplay of these three decisions and their impact on retailer's profit in a setting with competing retailers.

We contribute to the aforementioned literature streams by studying the impact of (i) forward-looking (i.e., discount-seeking) consumer behavior, and (ii) consumers' sensitivity to clearance period stock availability on retailers' returns management decisions and the ensuing profit effects in monopolistic and competitive settings. Consistent with the extant literature, we refer to such consumers who take into account both of the aforementioned considerations while making their purchases as *strategic* consumers. Although each of these factors and the ensuing effects in a monopolistic setting had been studied independently, to the best of our knowledge, our study is the first to investigate strategic consumer behavior in a context where a potential mismatch between the product a monopolist sells and consumers' valuation of that product exists, and hence, the issue of returns and the retailers returns management decisions are relevant, and consumers and the retailer possess private information about consumers' reservation prices, and the retailer's stock level, respectively. Consequently, our analysis of the monopolistic setting extends both Su (2009), who characterized a monopolist retailer's optimal price, quantity, and refund decisions when consumers are myopic, and Su and Zhang (2008), who investigated the effects of strategic consumer behavior on a price-setting newsvendor's price and quantity decisions without any refund policy considerations. We also present and discuss economic factors that induce an equilibrium wherein the retailer offers a full refund. Last but not least, our analysis of competing online retailers in this setting is, to the best of our knowledge, the first attempt to research whether retailers can gain competitive advantage by implementing optimal refund policies when selling to strategic consumers.

## 3. Monopoly

In this section, we will first describe the analytic modeling framework we utilize to study a monopolist retailer's price, inventory, and refund decisions when selling to strategic consumers. Then, we will derive the optimal policy, and explain how optimal decisions drive demand and profit.

### 3.1. Equilibrium Strategies for Consumers and a Monopolist

In the monopoly setting, the aggregate market demand, which we denote by random variable $D > 0$, is drawn from distribution $F$. As is applicable to the online retailing context, we assume that the consumers' true valuation of the product they intend to purchase is not known a priori, which we model via random variable $v > 0$ following distribution $G$ with mean $\mu_v$. To explore the impact of strategic consumer behavior (i.e., "buy now or wait") on the monopolist retailer's policy choices, we employ a price-setting-newsvendor-type framework, which provides two purchasing opportunities to the consumers: the primary selling period, and the clearance period depending on stock availability. Given prices, consumers' expectations of the product's value to them, and the anticipated stock levels, consumers self-select if and when they attempt to make a purchase.

The retailer's decisions include the stocking quantity $Q$, procured at $c$ per unit, and the full price $p$ prior to the primary selling season. We also permit the retailer to decide whether to allow returns, and if so, the refund amount $r$. Should there be any returned or unsold units at the end of the primary selling period, the retailer sells them at the exogenously determined price $s$ during the clearance period, but does not allow returns; in other words, all clearance sales are final. To avoid trivial demand realizations, we assume $\mu_v > c > s$. (We will later permit $s \geq c$.)

Reflecting the information asymmetry among the consumers and the retailer in an online retailing context, we assume that the retailer's price and refund choices are observable, whereas the stocking quantity is not. Therefore, online shoppers cannot precisely assess the actual clearance period availability, which we denote by $\eta$; instead, they form beliefs about the probability of completing a purchase during the clearance period. We will henceforth refer to this probability as the *perceived clearance fill rate*, given refund $r$, and denote it by $\xi^s(r)$. (For ease of notation, we will henceforth drop the argument in $\xi^s(r)$, and instead use $\xi^s$.)

Given the retailer's price and refund announcement, and the perceived clearance fill rate, consumers assess their expected surplus from all purchasing opportunities to decide whether they should pay the full price to obtain the product. Assuming consumers are risk neutral, they would self-select to purchase immediately if

$$\mathbb{E}\max\{v, r\} - p > (\mu_v - s)\xi^s. \tag{1}$$

The left-hand side of expression (1) reflects the uncertainty about the true value of the product to the consumers prior to their purchases, as well as the positive *valuation* effect the refund has on consumers' expected utility. More specifically, the refund allows consumers, whose true valuation of the product turn out to be less than the refund, to return the product for a credit of $r$. In other words, the retailer partially assumes the risk associated with a potential mismatch between the product and the customers' expectations by guaranteeing that the (potential) regret from a purchase cannot exceed $p - r$. Evidently, this effect deters more consumers from deferring their purchases to the clearance period, while giving the retailer more flexibility in setting a higher full price. The right-hand side of expression (1) also reflects valuation uncertainty while highlighting how retailer's policy of not allowing returns on purchases made during the clearance period affect expected valuations. (Note that $\mathbb{E}\max\{v, r\} > \mu_v$ for any $r > 0$.)

The right-hand side of expression (1) also highlights an *availability* effect via the perceived clearance fill rate term $\xi^s$. Specifically, consumers' expected surplus from deferring an immediate purchase is discounted due to the possibility of a stock-out in the clearance period. At first sight, forward-looking consumers' sensitivity to a future stock-out provides the retailer with the opportunity to set a higher full price, while achieving higher first-period sales. With refund considerations, whether such first-period sales will be final is not clear. Especially when consumers are more likely to associate a low value with the product, a sizeable refund may induce many returns, thus increasing clearance period availability. In this case, forward-looking consumers' sensitivity to a potential stock-out may adversely impact the retailer's refund strategy and hurt its profit.

Given the consumers' buy-now-or-wait trade-off subject to uncertainty about product valuation and availability, the retailer aims to optimize the price, refund, and stocking decisions to extract as much surplus from full-price purchases as possible. This requires anticipating the consumers' maximum willingness to pay, i.e., *reservation price*, that would not induce a purchase deferral. We denote this reservation price by $p^r$, which must satisfy

$$p^r = v^e - (\mu_v - s)\xi^s, \tag{2}$$

where $v^e$ denotes consumers' expected valuation of the product given the return option (i.e., $v^e = \mathbb{E}\max\{v, r\}$). Evidently, $p^r$ is not observable by the retailer, and hence the retailer forms belief $\xi^r$.

An equilibrium solution for the aforementioned dynamics between the retailer and the consumers will be referred as a *rational expectations* (RE) equilibrium if and only if the retailer and consumers have no incentive to deviate from their ensuing strategies, and their beliefs $\xi^s$ and $\xi^r$ are consistent with the actual outcomes. In other words, an RE equilibrium $(Q, r, p, \eta, p^r, \xi^s, \xi^r)$ is a Nash equilibrium where consumers accurately predict the actual fill rate, i.e., $\eta = \xi^s$, and the retailer accurately predicts the consumers' reservation price, i.e., $p^r = \xi^r$.

### 3.2. The Monopolist Retailer's Optimal Pricing, Stocking, and Refund Decisions

In this subsection, we will formulate and solve the monopolist retailer's profit maximization problem, and then, use that solution, together with the aforementioned consumer decisions, to characterize an RE equilibrium. As the decisions the monopolist and the consumers make are sequential in nature, we will employ a subgame perfect equilibrium framework, for which we begin by establishing a sequence of events. In this modeling framework, the retailer first forms belief $\xi^r$ on consumers' willingness to pay, chooses full price $p$ and refund $r$, and procures $Q$ units while taking into account aggregate demand uncertainty according to distribution $F$. Having observed $p$ and $r$, but not $Q$, consumers assess the product's fit to their needs according to valuation function $G$, and try to predict clearance period availability by forming beliefs $\xi^s$. As consumers self-select to maximize their surplus, random demand $D$ is split to those who buy at the full price, and those who defer their purchases to the clearance period. Upon receipt of the product, consumers' valuation uncertainty is resolved, and those with valuations that exceed $r$ keep the product, whereas others return it, and collect the refund. Finally, consumers who previously deferred their purchases buy during the clearance period, provided the remaining inventory and the returns are enough to satisfy the clearance period demand. In case of a shortage, available inventory is split randomly, i.e., only fraction fill-rate of clearance period demand is satisfied. The monopolist retailer's optimization problem maximizes profit $\Pi(Q, r, p)$ subject to the constraints ensuring the consumers' and the retailer's strategies yield the following RE equilibrium:

Definition 1. Strategy $(Q, r, p, \eta, p^r, \xi^s, \xi^r)$ is an RE equilibrium if and only if the following conditions are satisfied:
(i) $(Q, r) = \arg\max_{Q,r} \Pi(Q, r, p)$, (ii) $p = \xi^r$, (iii) $\xi^r = p^r$, (iv) $\eta = F(Q) + \bar{F}(Q)G(r)$, (v) $\xi^s = \eta$.

Condition (i) in Definition 1 ensures that the retailer's optimal stocking quantity and refund choices are profit maximizing in anticipation of the consumers' buy-(return)-or-wait decisions. Condition (ii) states that the retailer will set the full price at what he expects the consumers' maximum willing-to-pay for an immediate purchase is, and condition (iii) ensures that this expectation is consistent with the consumers' actual reservation price. At the equilibrium, the retailer does not choose a higher price than $p^r$ (see Equation (2)), as doing so would cause all consumers to defer their purchases. If, on the other hand, the retailer's equilibrium price is lower than $p^r$, then the retailer would not extract all the possible surplus from the consumers. In other words, conditions (ii) and (iii) together imply that the retailer makes the consumers indifferent between purchasing immediately and deferring to the clearance period. Assuming all consumers will attempt a purchase anticipating the same surplus from buying and waiting, the clearance period availability $\eta$ would be equal to the probability of inventory exceeding demand (i.e., $F(Q)$), plus the probability that someone will return the product (i.e., $\Pr(v < r) = G(r)$) when demand exceeds inventory (happening with probability $\bar{F}(Q)$); condition (iv) formally states this observation. Lastly, condition (v) ensures the consumers' beliefs regarding with clearance period availability is consistent with the realization. The retailer's optimization problem involves maximizing

$$p\,\mathbb{E}\min(Q, D) - cQ + s\,\mathbb{E}(Q - D)^+ \\ - rG(r)\,\mathbb{E}\min(Q, D) + sG(r)\,\mathbb{E}\min(Q, D),$$

that one can rewrite to obtain

$$(p - (r - s)G(r))\,\mathbb{E}\min(Q, D) - cQ + s\,\mathbb{E}(Q - D)^+. \tag{3}$$

The coefficient of the first term in expression (3) highlights the unit revenue $p$ net of the unit loss/gain $r - s$ the retailer would incur as fraction $G(r)$ of customers return their primary selling season purchases. (Note that the retailer would lose $r - s$ per customer who returns if the refund exceeds the salvage value, whereas $r < s$ would yield an additional revenue of $|r - s|$ per customer once the returned unit is salvaged in the clearance period.) The second term $cQ$ is the retailer's total procurement cost, whereas the last term is the retailer's total salvage revenue, which the retailer enjoys only if the stocking quantity exceeds the primary selling season demand.

Consistent with the RE equilibrium conditions (i)–(v) in Definition 1, the retailer's optimization requires finding *only* the optimal stocking quantity and refund, as the retailer maximizes profit (3) over the $p(Q, r)$ surface satisfying $p = v^e - (\mu_v - s)\xi^s$. We formally establish the ensuing endogenous relationship among price, stocking quantity, and refund in the following lemma, which we will later use to characterize the equilibrium refund amount.

Lemma 1. *An RE equilibrium quantity and price that are consistent with Definition 1 must satisfy*

$$\bar{F}(Q) = \frac{c-s}{(p-s)-(r-s)G(r)}, \quad \textit{and} \tag{4}$$

$$p-s = 0.5\left(\left((r-s)G(r)+\int_0^r G(v)\,dv\right) + \sqrt{\left((r-s)G(r)-\int_0^r G(v)\,dv\right)^2 + 4(\mu_v - s)(c-s)\bar{G}(r)}\right). \tag{5}$$

Lemma 1 simplifies the problem of finding the optimal price $p^*$, stocking quantity $Q^*$, and refund amount $r^*$ to a single dimensional optimization problem, as one can express the monopolist's retailer as a function of only $r$ using Equations (4) and (5). The next proposition formally characterizes the optimal RE equilibrium refund $r^*$.

Proposition 1. *Let $r^m$ be a value of $r$ satisfying $r < s$ and*

$$(r-s)^2 - \left(\int_0^r G(v)\,dv\right)(r-s) - (\mu_v - s)(c-s) = 0. \tag{6}$$

*Then, we have*

$$r^* = \max\{r^m, 0\}. \tag{7}$$

Proposition 1 offers a closed-form representation of the optimal refund amount, which, via Equations (4) and (5), induces closed-form expressions for the optimal stocking quantity and price. Equation (7) also highlights the possibility that the monopolist may not benefit from permitting returns, as indicated by scenarios when $r^* = 0$. Understanding when a lenient return policy does or does not work necessitates grasping how refund amount $r$ induces changes in $p$ and $Q$, and how these policy decisions drive demand and profit. We further elaborate on this issue in the following subsection.

### 3.3. When Do Lenient Refund Policies Work?

We earlier discussed, in §3.1, that the refund amount influences the consumers' expected utility from buying immediately or waiting for a discount in a multitude of ways. A valuation effect increases a consumer's expected utility from buying in the first period, whereas an availability effect may induce an increase or a decrease in consumers' expected utility from a purchase deferral depending on what fraction of first period buyers keep (or return) the product. However, the consumers' self-selection decision cannot be explained by only the expected utilities; it also depends on the expected net surplus from each option. As outlined by expression (1), in addition to the refund's valuation and availability effects, consumers' expected net surplus is influenced by the changes in the monopolist's price and quantity decisions that accompany a change in the refund.

Specifically, a higher refund lowers the maximum regret for a first-period purchasing consumer and thus induces more surplus from an immediate purchase. The monopolist may partially (or even fully) extract this additional surplus by increasing the first-period price. These dynamics would be consistent with what was highlighted by the extant economics literature (see, for example, Che 1995), which suggests the equilibrium price increases with the refund amount. This literature, however, does not take into account the potential increase in clearance period availability if purchasing consumers return the product they see unfit to their expectations.

The net demand impact of the aforementioned price change is also nonintuitive. Although the valuation benefit increases expected utility because of a higher refund, the accompanying price increase may shrink the full price demand as the monopolist may prefer selling fewer units at prices ensuring a higher margin. Furthermore, if a disproportional fraction of first-period purchasing consumers return their products, the monopolist may be stuck with more leftover inventory to salvage at a loss. To avoid such high volume of returns, the monopolist may extract only part of the additional consumer surplus a higher refund permits, while inducing a large proportion of consumers to keep the products they purchase at full price. Consequently, the ensuing first period demand resulting in final sales can be higher, thus permitting the monopolist to optimally stock more.

The aforementioned price-quantity-demand dynamics explain how a monopolist may benefit from permitting returns, yet, they do not fully explain when a return policy improves retailer profits. The next proposition sheds further light onto this matter by formally stating the conditions under which a monopolist retailer would not benefit from permitting returns:

Proposition 2. *When facing strategic consumers, the retailer should not allow returns, i.e., $r^* = 0$, if and only if the following condition is satisfied*:

$$\frac{1}{s} \geq \frac{1}{\mu_v} + \frac{1}{c}. \tag{8}$$

Proposition 2 links the profitability of a refund policy to the cost and the discounted salvage revenue of a product and the consumers' average willingness to pay, and permits alternative interpretations. First, rewriting inequality (8) as $s \le \mu_v c/(\mu_v + c)$ establishes a threshold salvage value below which allowing returns is not profitable for the monopolist. This implies that the monopolist's (in)ability to salvage without taking a significant loss is an important determinant of whether a refund policy would work (or not). Taking into account the natural ordering, $\mu_v > c > s$, a sufficient condition for inequality (8) to hold becomes $s \le c/2$. In other words, if the monopolist takes losses at the order of 50% or more, allowing returns would hurt the monopolist regardless of the consumers' valuation of the product. A second interpretation of condition (8) exploits the monopolist's flexibility in taking a loss while optimally permitting returns. To explore this further, we express (8) as

$$1 - \frac{s}{c} \ge l_{\max} = \frac{c}{\mu_v + c},$$

where the right hand side, which we denoted by $l_{\max}$, is the maximum loss (as a percentage of cost $c$) the monopolist can take before offering a refund becomes nonprofitable. It is easy to verify that $l_{\max}$ is increasing in cost and decreasing in consumers' mean willingness to pay. In other words, permitting returns is less likely to be profitable for products that a monopolist can sell with a high margin (i.e., large $\mu_v - c$) in the primary selling season unless the monopolist can salvage such products at a salvage revenue that is very close to the cost. Indeed, there exist numerous online electronics retailers which do not permit returns unless the purchased goods are returned in original packaging and are in full operating condition, as such products can only be sold as "open-box" items at a significant discount.

It is worth noting that, for scenarios in which the monopolist should not permit returns (i.e., $r^* = 0$), the equilibrium quantity and price expressions, (4) and (5), reduce to $\bar{F}^{-1}(\sqrt{(c-s)/(\mu_v - s)})$ and $\sqrt{(\mu_v - s)(c-s)}$, respectively. These findings are consistent with those of Su and Zhang (2008), who studied strategic consumer behavior without any refund/returns considerations. They noted that forward-looking consumers' stock-out sensitivity causes the monopolist to set the (full) price and the stocking quantity lower when compared to a standard newsvendor setting, thus hurting the profit. In light of Proposition 2 and the subsequent discussion, we show that permitting returns would further damage the monopolist's profit unless it can salvage the leftovers at $(100 - l_{\max})$%, or more, of the cost. Alternatively, for monopolist retailers that can salvage without deep discounts, Proposition 2 highlights an opportunity to mitigate the adverse implications of purchase deferrals.

Whereas our analysis shows that a flexible return policy can mitigate the adverse effects of strategic consumer behavior in certain settings, the issue of how such behavior impacts the effectiveness of a return policy remains open to investigation. In other words, how does the monopolist optimal refund decision change when consumers are forward looking and sensitive to stock-outs? We elaborate on this issue further within the next subsection.

### 3.4. Is the Optimal Refund Policy as Effective When Consumers Are Strategic?

To assess the effects of consumers' strategic purchases deferrals on the monopolist retailer's optimal refund policy, we first consider a special case of our model formulation where consumers act myopically. Mathematically, we set consumers' perceived fill rate for the salvage period $\xi^s$ to 0, in which case, our formulation overlaps with that of Su (2009). As per Equation (2), consumers' reservation price equals their expected utility from an immediate purchase, i.e., $p^r = \mathbb{E}\max\{v, r\}$, thus implying that consumers would buy only if the monopolist's full price satisfies $p \le p^r$. Evidently, the optimal price must bind this aforementioned constraint, because the monopolist cannot induce more demand despite not extracting all consumers' surplus by setting a price less than $p^r$. Then, as in Su (2009), it is easy to verify that the monopolist's optimization problem becomes separable, yielding optimal refund that equals the salvage revenue $s$, optimal price $\mathbb{E}\max\{v, s\}$, and optimal stocking quantity $F^{-1}((\mathbb{E}\max\{v,s\}-c)/(\mathbb{E}\max\{v,s\}-s))$. The next proposition demonstrates the change in the monopolist retailer's optimal refund when consumers are strategic.

Proposition 3. *The monopolist retailer's optimal refund satisfy $r^* < s$. Furthermore, the monopolist retailer's optimal equilibrium refund $r^*$ increases with $s$; and, if distribution $G$ of consumer valuations satisfies $G(s) < \frac{1}{2}$, then the optimal refund as a percentage of the optimal price $r^*/p^*$ increases with $s$.*

Proposition 3 highlights the monopolist retailer's inability to offer as large a refund as it would when facing myopic consumers. This finding is largely due to the potentially negative availability effect of the refund as it may create an additional supply of returned products to be sold during the clearance period, thus inducing strategic waiting. As a result, the monopolist retailer may be better off by offering a lower refund, which (a) discourages some full-price purchases because of a lower valuation effect, and (b) reduces the possibility of a return, and hence clearance period availability.

Note that Proposition 3 implies that the unit salvage revenue $s$ poses a limit on how effectively the monopolist can use refunds to mitigate strategic behavior. This observation is consistent with the findings from earlier studies on price-setting newsvendors; for example, Su (2009) showed the optimal refund equals the clearance price when the consumers with uncertain valuations are myopic. In our setting, consumers' forward-looking behavior drives the refund even lower because of returns' impact on clearance period availability. Evidently, a higher $s$ would provide the retailer with more flexibility to offer a higher refund. Proposition 3 also sheds light on Whether it is optimal for the retailer to utilize this flexibility. In particular, a higher $s$ reduces the expected surplus from waiting, thus making an immediate purchase more favorable to consumers. This presents the retailer with an opportunity to make its refund offering more attractive. A higher $r$ enables the retailer to induce an increase in consumers' valuation of the product, while at the same time, it leaves some room to absorb the adverse impact of potentially higher clearance period availability because of more returns. Proposition 3 also highlights that the retailer would charge a lower restocking fee percentage as the clearance price increases provided more than half of the consumer base is willing to purchase above the clearance price. In other words, even though a more generous refund may induce a higher price, we expect the refund to grow faster than the price does.

## 4. The Economic Factors That Induce Higher Refunds

An alternative way to interpret Proposition 3 is that a full-refund (i.e., $r = p$) strategy never sustains as an equilibrium. Nevertheless, offering full refunds has increasingly become common practice among retailers, thus invoking the question: What economic factors (not included in a price-setting newsvendor setting) would induce an equilibrium wherein the retailer offers a full refund? Whereas the prevalence of this retail practice had long been recognized in the literature, permitting returns without a restocking fee had always been considered a suboptimal decision in earlier studies. Throughout the rest of this section, we offer three explanations regarding this aforementioned discrepancy between the theory and retail practice by extending the standard price-setting newsvendor setting to account for the following: First, we permit a clearance price that exceeds the product cost. Second, we study the case wherein a lenient return policy might attract additional demand by incorporating in our demand model a multiplier that is nondecreasing in the refund amount. Third, we extend our analysis to account for a transaction cost consumers incur when they return a product. For each of these three extensions, we will demonstrate whether and under what conditions the monopolist should offer a full refund.

### 4.1. Profitable Clearance Sales

In this subsection, we consider the scenario wherein the retailer can salvage leftover units without a loss (i.e., $s \geq c$). In this scenario, the retailer's overage and underage costs dictate that the optimal quantity yields a 100% fill rate, thus yielding the equilibrium price-refund pair satisfying

$$p = v^e - (\mu_v - s) \quad \Leftrightarrow \quad p - s = \int_0^r G(v)\, dv.$$

Denoting the retailer's optimal price and refund by $p_{sc}^*$ and $r_{sc}^*$, respectively, we can state the optimal refund percentage as in the next proposition:

Proposition 4. *When $s \geq c$ holds, the optimal refund $r_{sc}^*$ satisfies $r_{sc}^* \geq s$. Furthermore, one of the following two refund-price pairs $(r_{sc}^*, p_{sc}^*)$ sustain optimally at the ensuing RE equilibrium*:

$$\frac{r_{sc}^*}{p_{sc}^*} = \frac{s}{s + \int_0^s G(v) dv} < 1, \quad \textit{or} \tag{9}$$

$$\frac{r_{sc}^*}{p_{sc}^*} = 1, \quad \textit{where } r_{sc}^* > s \textit{ is a solution to} \quad 1 - G(r) - \frac{dG(r)}{dr}(r - s) = 0. \tag{10}$$

Proposition 4 suggests two possible price equilibriums. Specifically, a partial optimal refund implied by Equation (9) sustains when the market comprises enough many consumers with low valuations, i.e., those with valuations within support $[0, s]$. In this scenario, the firm does not offer a full refund even when it can clear inventory without a loss. On the other hand, when there are not too many consumers with low valuations, there is an opportunity for the retailer to increase the refund to 100% of the price to support first period sales at a higher price. The latter scenario (i.e., when (10) sustains) is possible when consumers have a certain affinity for the product such that their willingness to pay has a large enough lower limit, as is the case, for example, for the clearance sales of sports jerseys of professional sports teams. In this scenario, the fans are still willing to pay a substantial clearance price for jersey designs for previous seasons, thus permitting the sporting goods retailers to enjoy a positive, albeit small (i.e., $p_{sc}^* > s > c$), margin on leftover units.

### 4.2. Demand Stimulating Effects of Lenient Return Policies

As noted in Bower and Maxham (2012), the leniency of the return policy may influence consumers' patronage in the long term. Therefore, one might expect that, despite the short term costs of charging low (or no) restocking fees, firms that bundle a lenient return option with a product sale may benefit in the long run by attracting more consumers. In other words, Zappos.com's full-refund policy may attract demand that would have belonged to a different retailer (online and/or brick and mortar) that charges a restocking fee. Indeed, Bower and Maxham's findings overlap with reports from late 2010 suggesting a similar shift regarding how numerous retailers had relaxed their return policy restrictions, see, for example, the *Wall Street Journal* article titled "Retailers Loosen Up on Returns" by Bustillo (2010). In this section, we permit the retailer's demand to vary with the refund decision, by using a multiplier function $\beta(r)$. Specifically, we express the random aggregate demand by $\beta(r)D$, where $\beta(r)>1$ implies a demand boost because of the retailers's refund decision, which we will henceforth refer to as the "demand stimulating effect." We also permit $\beta(r)$ to take values less than 1 to capture scenarios where the refund may be perceived insufficient by consumers, thus causing them to patronize an outside option. Intuitively, a more lenient return policy should not cause a decline in aggregate demand, and thus we will assume that function $\beta(r)$ is nondecreasing, i.e., $d\beta(r)/dr=\beta'(r)\geq 0$.

In this case, the expected first period sales becomes $\mathbb{E}\min(Q,\beta(r)D)$ and the expected clearance inventory can be written as $\mathbb{E}(Q-\beta(r)D)^+$. Assuming the retailer's profit permits a unique maximum $r_a^*\in[0,p]$, we formally characterize the equilibrium decisions of the monopolist in this scenario, which we denote by $p_a^*$, $r_a^*$, and $Q_a^*$, in Lemma E1 within the electronic companion. To appreciate the impact of this demand stimulating effect on the retailer's optimal decisions, one should consider the following alternative representation of first order condition (FOC) in Lemma E1 within the electronic companion, where we denote the retailer's expected profit by $\mathbb{E}\,\pi_a$:

$$\frac{d}{dr}((p-s)-(r-s)G(r))\mathbb{E}\min(Q,\beta(r)D)+\frac{\beta'(r)}{\beta(r)}\mathbb{E}\,\pi_a=0. \tag{11}$$

Note that the expected sales $\mathbb{E}\min(Q,\beta(r)D)$ and the expected profit $\mathbb{E}\,\pi_a$ terms in Equation (11) are nonnegative, and hence the FOC will be heavily influenced by the other two terms. Also note from Proof of Proposition 1 that the $(d/dr)((p-s)-(r_m-s)G(r_m))=0$ is the FOC for the retailer's profit maximization problem without the demand stimulating dynamics for cases when the monopolist offers a positive refund, i.e., $r^*=r_m$. Therefore, how the left-hand side of Equation (11) changes at $r=r^*$ dictates whether the retailer can acquire more demand by employing a more lenient refund policy. Evidently, these dynamics hinge upon the sign of $\beta'(r^*)$, as formalized within the next proposition.

Proposition 5. *The optimal refund $r_a^*$ when the refund stimulates demand is higher than the optimal refund $r^*$ without such demand stimulation effects, i.e., $r_a^*\geq r^*$.*

Proposition 5 highlights that, when the magnitude of the refund influences the aggregate demand, the retailer should offer at least as big a refund as when such demand stimulating effects are absent. The impact of this more lenient refund policy on the other decisions of the retailer is less obvious, as such decisions rely on the magnitude of the multiplier at the revised optimal level $\beta(r_a^*)$. If $r_a^*$ is sufficiently large to stimulate more demand, i.e., $\beta(r_a^*)>1$, the retailer would stock more relative to the case without the demand stimulating effects. The change in the optimal price decision is less straightforward. The retailer may complement an increase in refund by an increase in price to capture some of the additional surplus because of the refund's valuation effect. Alternatively, the retailer may choose to reduce the price to mitigate the adverse effects of the increased clearance period availability because of a higher return rate. Therefore, whether the retailer charges a higher or a lower price depends on the magnitude of the optimal refund and the willingness-to-pay function.

Whereas Proposition 5 implies a more lenient refund policy because of demand stimulating effects, it does not shed light on whether such dynamics yield an equilibrium wherein the optimal refund is 100% of the price. We address this issue in the next proposition:

Proposition 6. *Let $s_f$ be the clearance price satisfying*

$$\begin{aligned}(1-G(r_a^*))\,\mathbb{E}\min(Q_a^*,\beta(r_a^*)D)\left(1+\frac{\beta'(r_a^*)}{\beta(r_a^*)}(r_a^*-s_f)\right)\\=\left.\frac{d\,G(r)}{dr}\right|_{r=r_a^*}(r_a^*-s_f)\,\mathbb{E}\min(Q_a^*,\beta(r_a^*)D)\\+\frac{\beta'(r_a^*)}{\beta(r_a^*)}(c-s_f)Q_a^*.\end{aligned}$$

*If $s_f<c$, then $r_a^*=p_a^*$ for all $s$ satisfying $s\geq s_f$.*

In some sense, Proposition 6 is a corollary to Propositions 3 (i.e., the optimal refund increases with the clearance price) and 5 (i.e., the demand stimulating effects yield a larger optimal refund), as it implies that a retailer that can salvage leftover units with a milder loss should offer a more generous refund. Furthermore, it takes the earlier findings one step further by stating that if the demand stimulating effect is strong enough to stimulate substantial new demand, the retailer can optimally offer a full refund even when the clearance sales yield a loss.

### 4.3. Consumers' Transaction Cost of Returns

Whereas the option to return a product may stimulate demand for a retailer, the actual process of returning the product may be a source of disutility for the consumers. In this subsection, we assume that returning a product is costly to the consumers, either as an explicit cost (e.g., transportation cost for an in-store return, packaging and shipping costs for online returns) or in the form of disutility associated with the return process. More specifically, we will permit a transaction cost $t > 0$ that consumers incur when they return a product, thus implying that full-price purchases would be returned if the true valuation $v$ does not exceed the net utility from a return $r - t$. Mathematically, this transaction cost yields the following self-selection constraint:

$$\mathbb{E}\max\{v, r-t\} - p > (\mu_v - s)\xi^s, \tag{12}$$

and the probability that a consumer will return the product to $G(\max\{r-t, 0\})$. In this case, the monopolist's optimization requires maximizing

$$(p - (r-s)G(\max\{r-t, 0\}))\,\mathbb{E}\min(Q, D) - cQ + s\,\mathbb{E}(Q-D)^+ \tag{13}$$

subject to the RE equilibrium constraints (i)–(v) as in Definition 1 with the following exceptions: Constraint (iii) regarding the consumers' reservation price must reflect the effect of the transaction cost on consumers' surplus, i.e., $p^r = v^e - (\mu_v - s)\xi^s$, where $v^e = \mathbb{E}\max\{v, r-t\} = \mu_v + \int_0^{(r-t)^+} G(v)\,dv$. In addition, constraint (iv) regarding the true availability second-period must be revised as $\eta = F(Q) + \bar{F}(Q)G(\max\{r-t, 0\})$.

We denote the retailer's optimal decisions in this scenario by $p_t^*$, $r_t^*$, and $Q_t^*$, for which we provide closed-form expressions in Lemma E2 within the electronic companion. Even though these expressions are similar in structure to those we obtained in §3, one notable difference is that the retailer's refund would induce a lesser valuation effect and yield fewer product returns relative to when the consumers' transaction cost is zero. As a result, these aforementioned dynamics influence the retailer's refund choice in contrasting ways: the former (lower valuation effect) would discourage the retailer from using refund as a mechanism to induce full-price demand, whereas the latter (fewer returns) permits the retailer to offer a higher refund more liberally as the ensuing adverse impact on clearance period availability would be less substantial. Consequently, how the transaction cost influences $r_t^*$ is nonintuitive, which we clarify within the next proposition.

Proposition 7. *The monopolist retailer's optimal refund $r_t^*$ satisfies*

$$r_t^* = \begin{cases} \max\{r_t^m, 0\} & \text{if } t < s - \sqrt{(\mu_v - s)(c-s)}, \\ t & \text{if } s - \sqrt{(\mu_v - s)(c-s)} \le t \le s + \sqrt{(\mu_v - s)(c-s)}, \\ p_t^* & \text{if } t > s + \sqrt{(\mu_v - s)(c-s)}. \end{cases} \tag{14}$$

*Furthermore, when $r_t^* = r_t^m$, the optimal refund satisfies $t < r_t^* < p_t^*$ and is decreasing in $t$.*

Proposition 7 highlights that, when it is optimal for the retailer to offer a refund (i.e., $r_t^m > 0$), the optimal refund is partial (i.e., less than 100% of the price) unless the transaction cost exceeds a threshold $s + \sqrt{(\mu_v - s)(c-s)}$. This threshold equals the retailer's optimal price when no returns are allowed, indicating that the retailer should optimally charge a restocking fee if there is *any* volume of returned products.

Proposition 7 also highlights that, when the transaction cost of returns is low enough for some consumers to return the product, i.e., $r_t^* = r_t^m$, the retailer should permit returns, yet charge a restocking fee. Furthermore, this restocking fee must be increasing in the transaction cost. To appreciate why the retailer does so, note that a higher transaction cost significantly hinders the refund's valuation effect. With a lower valuation effect in place, the retailer has to either lower the price or increase the refund, both of which hurt the retailer's profit: the former lowers margins, whereas the latter induces too many returns increasing clearance period availability. As neither strategy mitigates the adverse effect of a higher transaction cost, the retailer's optimal response becomes a lower refund to lower returns. Therefore, to sustain a lenient return policy, the retailer should look for ways to reduce consumers' transaction cost. Indeed, many online retailers are offering incentives to lower such transaction costs, for example, by providing return labels in packages, by partnering with logistics companies to accept returned packages in consumers' residences, or by permitting in-store returns for online purchases.

Last but not least, Proposition 7 also shows that a retailer can optimally offer a full refund when the transaction cost of returns is high relative to the product price. In such cases, consumers are expected to keep the products even though they may not be fully satisfied with the purchase; thus eliminating the increased clearance availability effect of a high refund.

## 5. Competition

Our findings in the previous section highlighted that the ability to clear inventory at a higher price provides an opportunity to offer a more lenient return for a monopolist retailer. This observation begs the question whether the ability to salvage at a higher price can yield a similar benefit when the online retailer faces competition from others; we research this issue in this section.

We model competition among multiple retailers by considering $n \ge 2$ price-setting newsvendors, where each retailer $i$ $(1 \le i \le n)$ chooses stocking quantity $Q_i$, full price $p_i$, and refund $r_i$. (Note the difference in notation, compared to the monopoly case, where we use subscript $i$ to denote the parameters and decision variables for retailer $i$.) Although the product can be acquired at unit price $c$ from a common supplier, the retailers are asymmetric with respect to the clearance channel they utilize and the corresponding salvage prices $\{s_i\}$. Without loss of generality, we rank the retailers by salvage prices $s_i$, i.e., we assume $s_i < s_j$ for $1 \le i < j \le n$. We assume that these clearance prices are exogenous in our model, wherein a clearance entity purchases the excess inventory of the retailer $i$ at a set price $s_i$. Similar to the monopoly case, we will denote the aggregate market demand by random variable $D > 0$, which is drawn from distribution $F$. As consumers have $n$ competing retailers to choose from (should they decide to purchase in the full price period), retailers' policy choices will yield first period demand split $\{\phi_i^1\}$ satisfying $\sum_i \phi_i^1 = 1$ and $\phi_i^1 \ge 0$ for each retailer $i$. Also similar to the monopoly analysis, consumers' true valuation of the product $v > 0$ follows distribution $G$ with mean $\mu_v$. To avoid trivial demand realizations, we assume $\mu_v > c > s_n = \max_i\{s_i\}$. We will further assume that the average consumer valuation $\mu_v$ exceeds $s_n$ by at least $(c - s_1)(c + s_n - s_1)/((c - s_n)(1 - G(s_n)))$ to ensure a positive equilibrium margin for all retailers.

### 5.1. Equilibrium Strategies for Consumers and Competing Retailers

In case of competing retailers, consumers are exposed to more information asymmetry, but, at the same time, they have more purchasing options to choose from. Similar to the monopoly case, consumers cannot predict actual clearance period availability $\eta_i$ at each retailer, and thus form beliefs $\{\xi_i^s\}$. If the consumers forego a purchase in the primary selling season, then they may be able to find the product in one of the $n$ clearance channels. In this case, consumers' probability of acquiring the product at a particular retailer's clearance channel during the clearance season also depends on their probability of visiting that particular clearance channel. Therefore, we assume a consumer believes that she will visit clearance channel $i$ with a certain probability, which we denote by $\{\phi_i^2 \mid \sum_i \phi_i^2 \le 1\}$; in other words, $\{\phi_i^2\}$ values denote the clearance period demand split.

Given the retailers' price and refund announcements, consumers assess their expected surplus from all purchasing opportunities. More specifically, consumers compare the expected surplus $\{\mathbb{E}\max\{v, r_i\} - p_i\}$ they would gain by patronizing each retailer during the primary selling season to their expected surplus $\sum_i (\mu_v - s_i)\xi_i^s \phi_i^2$ from deferring a purchase to the clearance period and visiting and finding the product at one of the $n$ clearance channels. In other words, consumers self-select among the $n+1$ options the one that yields

$$\max\Big\{\max_i\{\mathbb{E}\max\{v, r_i\} - p_i\}, \sum_i (\mu_v - s_i)\xi_i^s \phi_i^2\Big\}. \quad (15)$$

Given consumers' decision mechanism highlighted by expression (15), each retailer tries to anticipate the maximum price $p_i^r$ up to which consumers are willing to pay to patronize retailer $i$ during the primary selling season. Denoting by $v_i^e$ consumers' expected valuation of purchasing from retailer $i$ given the return option (i.e., $v_i^e = \mathbb{E}\max\{v, r_i\}$), reservation price $p_i^r$ must satisfy

$$p_i^r = v_i^e - \sum_i (\mu_v - s_i)\xi_i^s \phi_i^2. \quad (16)$$

As $p_i^r$ values are not observable by the retailers, they will form beliefs $\{\xi_i^r\}$.

Similar to the monopoly case, we will invoke the RE concept to characterize the equilibrium behavior of the consumers and the competing retailers. More specifically, we will find the Nash equilibrium $(\{Q_i\}, \{r_i\}, \{p_i\}, \{\eta_i\}, \{p_i^r\}, \{\xi^s\}, \{\xi^r\})$ where consumers accurately predict the actual fill rates at each retailer, i.e., $\eta_i = \xi_i^s$, and the retailers accurately predict the consumers' reservation prices for patronizing each retailer, i.e., $p_i^r = \xi_i^r$. To ensure the uniqueness of this RE equilibrium, we will assume that clearance period demand split $\{\phi_i^2\}$ satisfies $1 - \phi_i^2 > (\mu_v - c)/(\mu_v - s_i)$, which implies a higher lower bound for the competitors' clearance period demand share $1 - \phi_i^2$ of a retailer with higher $s_i$. One would expect this condition to hold in practical outcomes as it reflects standard demand-price dynamics, where a clearance channel with a higher price is expected to lose more clearance period demand to other clearance channels.

### 5.2. Competing Retailers' Optimal Pricing, Stocking, and Refund Decisions

Our analysis of competition among multiple retailers underlies a sequence of events similar to the one we modeled for the monopolistic setting. First, all $n$ retailers will form beliefs $\{\xi_i^r\}$ regarding consumers' willingness to pay at each retailer $i$. Then, each retailer $i$ will choose price $p_i$, refund amount $r_i$, and stocking quantity $Q_i$ simultaneously with the other retailers in anticipation of uncertain aggregate demand $D$, and the other retailers actions $\{p_j \mid j \ne i\}$, $\{r_j \mid j \ne i\}$, and $\{Q_j \mid j \ne i\}$. (We will henceforth utilize the standard game theory nomenclature, and denote the vector of decisions by retailers that are not retailer $i$ using subscript $-i$, e.g., $\{p_j \mid j \ne i\} \equiv p_{-i}$.) Having observed all prices and refund values, but not knowing retailers' true stock levels, consumers form their beliefs $\{\xi_i^s\}$ regarding the probability of completing a purchase at each retailer's clearance channel, and self-select the surplus maximizing action as prescribed by expression (15). Consequently, aggregate demand $D$ is split among $n$ retailers according to vector $\{\phi_i^1\}$. Among consumers who purchase from retailer $i$ by paying full price, those with true valuations that are at least $r_i$ keep the product, whereas others return. Then, the leftover and returned units are sold by each retailer $i$ at a loss ($s_i < c$) to a clearance partner. Finally, consumers who had chosen to defer their purchases are split among these $n$ clearance channels according to vector $\{\phi_i^2\}$. Given the aforementioned sequence of events, each retailer's optimization requires maximizing

$$\begin{aligned}\Pi_i(Q_i, r_i, p_i \mid Q_{-i}, r_{-i}, p_{-i}) &= (p_i - (r_i - s_i)G(r_i))\,\mathbb{E}\min(Q_i, \phi_i^1 D)\\ &\quad - cQ_i + s\,\mathbb{E}(Q_i - \phi_i^1 D)^+ \end{aligned} \tag{17}$$

given the other retailer's actions subject to the conditions ensuring the following RE equilibrium:

Definition 2. Strategies ($\{Q_i\}$, $\{r_i\}$, $\{p_i\}$, $\{\eta_i\}$, $\{p_i^r\}$, $\{\xi_i^s\}$, $\{\xi_i^r\}$) form an RE equilibrium if and only if the following conditions for each retailer $i$ are satisfied: (i) $(Q_i, r_i) = \arg\max_{Q_i, r_i} \Pi_i(Q_i, r_i, p_i \mid Q_{-i}, r_{-i}, p_{-i})$, (ii) $p_i = \xi_i^r$, (iii) $\xi_i^r = p_i^r$, (iv) $\eta_i = F(Q_i/\phi_i^1) + \bar{F}(Q_i/\phi_i^1)G(r_i)$, and (v) $\xi_i^s = \eta_i$.

One can interpret conditions (i)–(v) in Definition 2 similar to their counterparts in Definition 1. Condition (i) ensures that retailer $i$ acts optimally given other retailers' decisions, conditions (ii) and (iii) together ensure the retailers' expectations regarding how much consumers are willing to pay at each retailer is consistent with their actual reservation prices, and conditions (iv) and (v) ensure that the consumers accurately anticipate the likelihood of completing a purchase at one of the retailers in the clearance period given the retailers' price and refund signals. As a result, these RE constraints reduce each retailer's optimization to maximizing $\Pi_i(Q_i, r_i, p_i \mid Q_{-i}, r_{-i}, p_{-i})$ over the surface

$$p_i(Q_i, r_i \mid Q_{-i}, r_{-i}) = v_i^e - \sum_i (\mu_v - s_i)\xi_i^s \phi_i^2. \tag{18}$$

In other words, the retailers equilibrium prices $\{p_i\}$ leaves consumers indifferent between buying from either one of the $n$ retailers or deferring their purchases in the hopes of finding the product in *any* of the $n$ clearance channels. The retailers act this way as doing otherwise would either drive their demand to zero (in case of overcharging), or cause them to not extract all the possible surplus from a customer purchasing in the full-price period. Consequently, the resulting RE equilibrium splits aggregate demand equally among the retailers, i.e., $\phi_i^1 = 1/n$ for $i = \{1, \ldots, n\}$, which permits a characterization of all equilibrium decisions as a function of the refund decisions; we formally state this finding with Lemma E3 within the electronic companion. The structure of the RE equilibrium Lemma E3 dictates as well as the ensuing equal demand split permit an insightful comparison of the retailers' price decisions. Specifically, the equilibrium prices must satisfy

$$\begin{aligned} v_1^e - p_1^* = \cdots = v_i^e - p_i^* = \cdots = v_n^e - p_n^* \\ = \sum_i (\mu_v - s_i)\xi_i^s \phi_i^2 \end{aligned} \tag{19}$$

to make consumers indifferent between patronizing one of the $n$ retailers or waiting for clearance sales. Using $v_i^e = \mathbb{E}\max\{v, r_i\}$, we can thus conclude that a higher equilibrium refund must imply a higher equilibrium price. Expression (19) also highlights how consumers perceive clearance period availability as the aggregate "pool" of unsold and/or returned products across all clearance channels. In this environment, an exceedingly generous refund policy one retailer implements may adversely affect all other retailers, if such a policy induces too many returns and increases clearance period availability for the entire industry. Hence, each retailer's refund choice affects not only the surplus that retailer can directly extract from full price purchases, but also how much surplus the other retailers can extract. In other words, for competing retailers, whereas a retailer's refund induces a valuation effect for only that retailer, its availability effect is relevant to all other retailers.

Recall that Lemma E3 relates each retailer's refund decision to its price and quantity, thereby reducing each retailer's optimal action $r_i^*$ to a response to other retailers' optimal decisions $r_{-i}^*$. The next propositions leverages this observation, and fully characterizes a unique RE equilibrium:

Proposition 8. *Let $r_i^c$ be a value of $r_i$ satisfying $r_i < s_i$ and*

$$\begin{aligned}(r_i - s_i)^2 + \left(U_{-i} - \int_0^{r_i} G(v)\,dv - (1-\phi_i^1)(\mu_v - s_i)\right)\\ \cdot (r_i - s_i) - (\mu_v - s_i)(c - s_i)\phi_i^2 = 0. \end{aligned} \tag{20}$$

*Then, we have*

$$r_i^* = \max\{r_i^c, 0\}. \tag{21}$$

Note that Equation (20) returns 0 when $r_i^c \le 0$ thus highlighting that some retailers, under certain conditions, should not allow returns at the equilibrium. As we will formally state via the next proposition, we find such conditions to depend on the retailer's unit salvage revenues—as in the monopoly case—as well as other retailers' equilibrium decisions, which reflects competition effects.

Proposition 9. *A retailer facing competition while selling to strategic consumers should not allow returns, i.e., $r_i^* = 0$, if and only if the following condition is satisfied:*

$$s_i < \frac{\mu_v c \phi_i^1}{\mu_v + c\phi_i^1 - U_{-i}}. \tag{22}$$

Proposition 9 highlights that allowing returns is a "double-edged sword" for competing retailers as well. Indeed, inequality (22) is similar to its counterpart for the monopoly case, i.e., condition (8), as it imposes a lower bound on a retailer's unit salvage revenue for the practice of allowing returns to be optimal. Furthermore, these two aforementioned conditions are consistent with each other in the sense that (22) reduces to (8) when $n = 1$. The effect of competition is evident as one compares the right-hand side of inequality (22) with the analogous bound in the monopoly case, i.e., $\mu_v c/(\mu_v + c)$, which strictly exceeds $\mu_v c\phi_i^1/(\mu_v + c\phi_i^1 - U_{-i})$. This ordering of the aforementioned bounds implies that a retailer that does not profitably allow returns as a monopolist, should offer a positive refund when facing retailer competition, i.e., when condition $\mu_v c\phi_i^1/(\mu_v + c\phi_i^1 - U_{-i}) < s_i < \mu_v c/(\mu_v + c)$ holds. In other words, as other retailers' salvage channels present alternative clearance purchase opportunities for the consumers, the threshold salvage revenue above which allowing returns becomes optimal for retailer $i$ decreases. This is because failing to allow returns when competition does so would hurt retailer $i$ as consumer demand is likely to shift away from that retailer. The ensuing demand shift may be toward the retailer offering a better refund as such refund generates a positive valuation effect. Alternatively, as higher refunds by other retailers are likely to yield more returns, resulting in more clearance period availability, the retailer will now have to match that increase in second-period utility in the first period and that it can do so by improving customers' valuation through higher refund.

### 5.3. The Impact of Retailers' Asymmetric Clearance Practices

Proposition 9 highlights when a retailer facing competition and a strategic consumer base should optimally allow returns, and links the conditions of doing so to costs and salvage revenues, consumers' willingness to pay, as well as its competitors' equilibrium action. However, it falls short of offering insights regarding the impact of retailers' asymmetric clearance practices, which, as evidenced by the varied clearance channels major retailers utilize, are not uniform. For example, Nordstrom and Macy's, two leading department-store-type retailers, whose national brand catalogs overlap significantly, use different clearance partners. Although Nordstrom salvages leftover units via Nordstrom Rack, its own affiliate clearance store, at mild discounts, Macy's partners with mainstream discount stores such as Marshall's, T.J. Maxx, and Ross, which are known to offer steep discounts on products not sold during the primary selling season. Consequently, it is not uncommon that the same product is sold at significantly different prices at different clearance stores.

The varied clearance practices and the salvage price disparity among major retailers prompts an investigation of the changes in competing retailers' optimal retailers in our model setting. Our analyses of the optimal equilibrium decisions of competing retailers, which can clear the leftover inventory of products at different clearance prices even though such products might have been procured at the same cost, yield the following characterization:

Proposition 10. *The optimal equilibrium decisions and profits for two retailers $i$ and $j$ $(1 \le i < j \le n \Leftrightarrow s_i < s_j)$ satisfy* (i) $r_i^* \le r_j^*$, (ii) $p_i^* \le p_j^*$, (iii) $Q_i^* < Q_j^*$, *and* (iv) $\Pi_i^* < \Pi_j^*$.

Proposition 10 validates our earlier conjecture that the ability to clear inventory at a higher price point is a strategic advantage for a retailer facing competition while selling to strategic consumers. Furthermore, we find that, for a retailer to fully benefit from this aforementioned strategic advantage, offering a lenient return policy is paramount. More specifically, a higher salvage price entails a retailer an opportunity to offer a higher refund, provided that salvage price is above the threshold we highlighted in Proposition 9. (Note in Proposition 10(a) that, it may be optimal for two retailers to not allow returns, i.e., the optimal refund is zero for both, if their unit salvage revenues are both below their corresponding threshold levels as per Proposition 9.) Furthermore, as noted in Proposition 10(b), the retailer with the more lenient return policy can charge a higher full price in the primary selling season. This finding is consistent with the structure of the RE equilibrium we demonstrated earlier via expression (19), where consumers are made indifferent between purchasing from any retailer in the first period, as the higher refund's valuation effect (via term $v_i^e = \mathbb{E}\max\{v, r_i\}$) creates more surplus, thus necessitating a price adjustment by all retailers. These dynamics not only permit a higher equilibrium price for the party offering a higher refund, but also require those that cannot profitably permit returns to reduce their full prices; the net effect of such concurrent price changes creates the price parity as highlighted by Proposition 10(b). The ensuing price dynamics also have implications on the optimal equilibrium quantity decisions. Not only does a retailer that can charge a higher clearance price enjoy a lower overage cost, but also his underage cost is higher due to the higher equilibrium price; consequently, that retailer should stock a higher quantity as highlighted in Proposition 10(c). Finally, as per Proposition 10(d), we can conclude that the net profit impact of the aforementioned price-quantity dynamics yield higher profits for retailers with higher unit salvage revenues, thus confirming that the ability to clear inventory at a higher price by choosing a reputable clearance partner is indeed a strategic advantage for retailers facing competition while selling to strategic consumers.

## 6. Discussion and Conclusion

Shopping on the Internet offers consumers unique conveniences that they may not encounter when they visit brick-and-mortar retail stores. Consequently, consumers are more savvy while making their online purchase decisions; for example, they are strategically forward looking and discount seeking. Retailers, on the other hand, constantly look for ways to please customers and possibly stimulate demand, for example, by bundling numerous after-sales services with the products they sell. One such strategy is to permit returns, thus enabling consumers to not consider a purchase final until they are certain that the purchased products indeed match their prior expectations. Whereas retailers use after-sales services to generate more sales, failure to account for all indirect demand implications may significantly hurt profits, especially if consumers abuse such policies. In this paper, we studied whether retailers can design lenient return policies to mitigate the adverse effects of consumers' strategic purchase deferrals.

We analyzed the optimal decisions of price-and-refund-setting newsvendor(s) in both monopolistic and competitive settings, while taking into account online shoppers' purchasing behavior. Our endogenous demand model captures unobservability of the retailers' clearance period availability, consumers' buy-now-or-wait decisions, as well as consumers' product valuation uncertainty. Consequently, the retailers' return policy choices function as a double-edged sword: Whereas a positive refund can limit potential regret and stimulate more full-price sales, it may also induce returns yielding higher clearance period availability, and thus more purchase deferrals.

Our analytic results not only confirm these aforementioned effects, but also offer a full characterization of when retailers selling to strategically purchase deferring customers should profitably permit returns. We found that, retailers selling high-margin products with low salvage value should not allow consumer returns as they induce further strategic purchase deferrals, and subsequently hurt profit. Even for retailers who should optimally permit returns, the fact that the consumers are strategic influences refund size. More specifically, the optimal refund should not exceed the salvage value, which is the optimal refund when consumers are not strategic. In other words, consumers' consideration of the buy-now-or-wait alternatives hurt retailers' ability to fully exploit returns management benefits.

Despite the aforementioned potentially negative impacts of lenient return policies, a high number of retailers continue to sizable, even full, refunds. Therefore, we extended our analysis to include economic factors that can increase the equilibrium refund, which was bounded by the clearance price in our base model. We found the optimal refund to be increasing in the clearance price, both in absolute value and as a relative to the optimal price. Furthermore, when the retailer can enjoy profitable clearance sales we find 100% refund to emerge at the equilibrium provided there are enough consumers with willingness to pay exceeding the clearance price. We also considered a scenario wherein a more lenient return policy stimulates demand, and found that an equilibrium with a 100% refund is possible even when the leftovers are salvaged at a (mild) loss. Finally, we looked into how the transaction cost consumers incur while returning a product influence retailer's decisions. We found that when the returns volume is significant to cause increased clearance period availability, the equilibrium refund is decreasing in the transaction cost. Therefore, it is advisable for retailers selling high-margin products to facilitate a low-transaction-cost return process, for example, by offering prelabeled return boxes. On the other hand, if the transaction cost is comparable to the product price, then a high refund will not generate much returns volume, thus making a 100% equilibrium refund possible.

We found returns management to be an effective tool in mitigating the adverse impact of strategic purchase deferrals in certain settings, especially for retailers selling low-margin high-salvage-value products and/or those facing competition. More specifically, a monopolist who can salvage leftover and returned units above a threshold price should offer a positive refund for returns. We showed that this threshold decreases as more retailers compete, implying that it is more likely for a retailer to combat purchase deferrals by permitting returns when facing competition than when it is a monopolist.

Furthermore, we showed that the optimal equilibrium prices, refunds, quantity choices, and the ensuing profits for competing retailers are ranked consistently with their clearance prices. We found these price dynamics to be evident for many products sold in major retailers and their clearance partners. As a case in point, we collected pricing data for a pair of designer women's shoes, Sergio Rossi Leather Zip-Trim Platform Pumps, which were on sale at three different clearance stores on July 17, 2014. These shoes were initially sold at high-end department stores such as Saks Fifth Avenue at the retail price of $815, and has recently been offered at the company's affiliate discount branch, Saks Off Fifth, for $489.99. Taking into account the 30% discount code SaksOffFifth.com has offered, the product can be purchased at $342.99. The same pair of shoes are also available for $285.23 at "TheOutnet.com," an independent online discount retailer who specializes in salvaging high-end fashion items that are left unsold at various other retailers and department stores. Even more strikingly, at T.J. Maxx, which mostly salvages unsold inventory of low-to-medium-end department stores such as Macy's, J. C. Penney, and Kohl's, the same pair of shoes has been offered at $249.99. Furthermore, the retail price for the shoes was $500, suggesting that the retailer salvaging via T.J. Maxx had offered these shoes at a lower price than Saks Fifth Avenue even during the main season.

Regarding the return policies, we found Saks Fifth Avenue's full-refund offering to be more lenient than the return policy of the retailers, which are known to salvage through T.J. Maxx. For example, Macy's charges restocking fees of $6.95 and $20 for domestic and international returns, respectively. These price-refund dynamics also coincide with the pricing practices Zappos.com, which became famous by entertaining a full-refund policy, making an online purchase risk-free for consumers, notwithstanding the nonmonetary transaction cost of the consumer repackaging and shipping an unfit product back to the online retailer for free. However, the full prices at Zappos.com are almost always higher than those at competing retailers with less lenient return policies, i.e., those charging a restocking fee, or those not paying for shipping costs for returns. In other words, Zappos bet on consumers who will retain the products they purchased at a relatively higher price, and use such additional revenues to partially finance the costs the company bears on returned products. Although it is difficult to find hard evidence regarding the retailers' stocking decisions, it is known that the clearance period availability at generic discount stores such as T.J. Maxx, Marshall's, and Ross are known to be very limited relative to department store affiliated clearance outlets. For example, one may find only one pair of a particular shoe for a rather unpopular size at T.J. Maxx, whereas Nordstrom Rack oftentimes offers multiple pairs of the same in varying sizes.

Our finding regarding the consistent ordering of equilibrium decisions also suggests that establishing a credible clearance sales partner that can salvage at prices higher than that of competitors is a strategic advantage for a retailer selling to strategic consumers in a competitive market. Indeed, one can find recent examples of such partnerships in practice, wherein leading retailers have increasingly established their own clearance outlets. For example, Macy's has been the last retailer to follow the trend set by Nordstrom Rack and Saks Fifth Avenue, as per the recent announcement that it has moved to the off-the-mall outlet business by opening Bloomingdale's Outlet stores.[1] It remains to be seen whether lower end department stores such as J. C. Penney and Kohl's will follow suit, or continue to clear their inventory via generic discount stores such as T.J. Maxx and Ross. In the latter case, our analyses shows that one would expect these retailers to keep their prices low, while stocking lower quantities and offer limited after-sales services such as limiting returns or charging high restocking fees.

[1] See, for example, http://www.cbsnews.com/news/bloomingdales-outlets-emerge-as-reality-providing-macys-flexibility.

### Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/msom.2015.0570.

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