Wardrobing: Is It Really All That Bad?

by

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This Draft: January 2013

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The authors thank Yossi Aviv, Eyal Biyalogorsky, Gerard Cachon, Skander Esseghaier, Jim Hess, Oded Koenigsberg, Chak Narasimhan, Elie Ofek, and participants in the Marketing seminar at the University of Houston for helpful comments. Any errors remain the responsibility of the authors.

Introduction

In a 2008 survey, about 64% of U.S. merchants reported experiencing "Wardrobing" behavior by consumers buying their items (Barnard 2009). An item is said to have been "Wardrobed" when it is bought by a consumer; used for a short time; and then returned to the store as if it were unused, for a full or partial refund (Enkoji, 2009, Segal 2010).[1] Products such as a Halloween costume, a set of tools for a one-time home improvement job, a wedding dress, a video projector for use in a business meeting, or a TV to watch the Super Bowl can be Wardrobed, for example. Since these returned products cannot later be sold as new, many retailers resort to identifying them as "open-box" items when they are put back on the retail shelf, with a concomitant requirement to lower the price of these products.

Wardrobing behavior has been widely excoriated in the business press literature. Consider the following quotes:

> "The National Retail Federation estimates that in 2009, ***fraudulent returns*** [italics added] amounted to $9.5 billion. Some of these result from a practice known as wardrobing… You get the sense that a lot of people out there regard stores as overnight rental operations that don't charge any fees. Naughty, naughty."[2]

> "Buy a necklace for that holiday gathering, a piece of bling you really can't afford. Wear it and sparkle. Then, put the tags back on, take it back to the store and get your money back. That's a crime…. The most common type of return fraud… is people returning stolen merchandise…. Merchandise bought with stolen gift cards… is the second-most common return fraud. Third is 'wardrobing,' in which a purchase intentionally buys something to wear or use and then return."[3]

> "Retail crime is on the rise. And it's not just an increase in shoplifting…. There's [also] wardrobing or renting: This is when a customer buys merchandise for an occasion – a dress for a dance, a video camera for a wedding, a big-screen TV for a Super Bowl game – with the intent to return it when the event is over."[4]

[1] An alternate term for this behavior is "closeting" (Segal 2010). Enkoji goes as far as to categorize Wardrobing behavior as criminal, and Barnard (2009) calls it consumer fraud.
[2] Segal (2010).
[3] Enkoji (2009).
[4] Barnard (2009).

These quotes implicate Wardrobing in the same class as thievery of merchandise or credit card fraud. Consumers who engage in Wardrobing are depicted as "naughty" at the least and criminal at worst.[5] It is important to note that in fact, Wardrobing is *not illegal* and therefore it is not correct to classify it with merchandise theft. But behind that reality is the clear message that Wardrobing is somehow *harmful or profit-reducing to the retailer* and therefore is an undesirable consumer behavior. Indeed, Joseph LaRocca of the National Retail Federation said, "When someone 'borrows' [i.e. Wardrobes] an item, the merchandise is not in the store, available for a legitimate buyer. And if the item comes back in less-than-mint condition, the store loses again on the opportunity to sell it."[6]

Oddly, however, Wardrobing continues and is not completely stamped out by retailers. It would be quite easy to totally prevent Wardrobing, simply by refusing to accept any returns on purchased products. If Wardrobing is really as nefarious as the above references depict it to be, we would expect retailers to prevent it from occurring by refusing to take back used products for any refund, or through some other similar mechanism. Yet, retailers do not do this. Could it therefore be that Wardrobing is not quite as nefarious as it is depicted to be?

This paper considers this conundrum by analyzing the benefits and costs of Wardrobing in an analytical model of a retailer selling one product over two periods in a heterogeneous market. Specifically, a "Regular" consumer belongs to a segment assumed to derive positive (but within-segment heterogeneous) value from the product in both periods when she[7] buys the product in the first period and holds it over both periods (she could of course also choose to wait to buy until the second period, then deriving positive usage value only in the second period).

[5] Indeed, one academic article classifies Wardobing as one of many "dysfunctional consumer behaviors," along with fake insurance claims, intellectual property theft like music piracy, and tax deception! See Fisk et al. (2010).

[6] Enkoji (2009).

[7] For expositional clarity, we will refer henceforward to the retailer as "he" and a consumer as "she."

Meanwhile, the "Opportunistic" consumer belongs to a segment assumed to derive positive (but again, within-segment heterogeneous) usage value from the product only in the first period (for example, during a wedding weekend; during Super Bowl weekend; etc.). If a member of the Opportunist segment buys at all, she buys a new product in the first period and, if allowed to do so, returns it at the end of the first period for a refund.[8]

With this segmentation structure, our research shows that the retailer always prefers to allow Wardrobing (i.e., allowing Opportunist consumers to buy and then return the product) rather than to prevent it (e.g., by failing to accept returns). This finding stands in direct contrast to the business press attitude that Wardrobing is universally unethical, fraudulent, or otherwise criminal, as well as harmful to retail profit. We show that Wardrobing is in fact not entirely bad because it offers the retailer the ability to practice price discrimination among "Regular" segment consumers who vary in their product usage valuations. In contrast to the previous literature, this paper thus shows that retailers should not always try to squelch Wardrobing behavior, but should instead encourage the Opportunist segment to purchase and return the product by offering low restocking fees when commitment to future pricing levels is not feasible.

We also find that Wardrobing enhances retail profitability under varying abilities to pre-commit to future prices. Wardrobing is a strategy to recoup profits lost when pre-commitment is not possible because of its ability to substitute price discrimination for pre-commitment benefits. Indeed, absent pre-commitment, accommodating Wardrobers leads the retailer to fail to sell new product units in the second period, similar to the pre-commitment result in the standard durable-

[8] If returns are not possible, such an Opportunistic consumer would either not buy at all, or would buy but simply discard the product at the end of the first period. We do not consider peer-to-peer resale of used products here and in any case, such resale is likely to be viewed by potential period-2 buyers as offering inferior quality merchandise as compared with merchandise inspected by and offered for sale by a retailer.

goods literature. But even when the retailer can pre-commit, our analysis shows it is incrementally profitable to accommodate Wardrobers as well.

We also consider the possibility that the retailer could simply dispense with opportunistic Wardrober consumers entirely, instead "insourcing" the "production" of open-box products by slashing boxes itself (an example of a "make versus buy" decision in a durable goods scenario). This analysis shows that the retailer optimally "outsources" the open-box creation function to the Opportunist segment of Wardrobers, rather than internally producing open-box units by slashing its own units for sale. Finally, our research also provides insight into how a retailer's restocking fee charged for Wardrobing behavior varies with market conditions, and may be low even when Wardrobing behavior is predictable (e.g., directly before Super Bowl weekend).

In the sections following, we first set up our model structure, identifying retailer decisions and consumer utility function properties. We then analyze four retailing options, based on two dimensions of retailing policy. One dimension is defined by the retailer's ability to *allow returns (i.e. to offer Wardrobing to Opportunist segment consumers)*, or *not to allow returns*. The other dimension is defined by the retailer's *ability to pre-commit to future prices*, or his *lack of price pre-commitment ability*. The four situations analyzed are therefore {No Wardrobing, pre-commit}; {No wardrobing, no pre-commitment}; {Wardrobing, pre-commit}; and {Wardrobing, no pre-commitment}.

We then show the retailer's optimal strategy regarding Wardrobing, depending on whether pre-commitment is or is not possible, and then analyze whether an inability to pre-commit is ever preferable to pre-commitment (if pre-commitment is feasible). Next, we examine the retailer's optimal choice to insource or outsource the generation of Wardrobed products. Finally, we summarize and suggest avenues for future research.

Literature review

In this paper, we examine Wardrobing behavior in the case of a monopolist selling durable goods. Coase (1973) was the first to shed light on what is now commonly known as the "durable goods problem"; his work was followed by that of Bulow (1982) and Stokey (1981), among others. Coase's work analyzed the implications of the monopolist's ability (or lack thereof) to commit to future production quantities. If the monopolist cannot credibly promise what volume it will offer in the market in the future, consumers rationally expect that it will offer product for sale in the future, at a lower price than that charged today – because a unit bought in the future has a shorter usage life, for any fixed time horizon; and because a non-pre-committed retailer has an instantaneous incentive to sell more units of product in the second period, even if he has "promised" not to do so in the first period. Knowing this, at least some consumers will wait until the future to purchase, and the monopolist's profit from such consumers is lower than that from consumers who buy today. Further, the monopolist's equilibrium first-period price is lower in this scenario than when it can pre-commit. Meanwhile, if the monopolist *were* able to pre-commit, this literature shows that its optimal decision would be to credibly promise not to sell any product in the future.

Later work showed that the durable goods problem can be avoided under various product or market conditions, such as when there is constant number of new customers entering the market (Conlisk et. al 1984), when the value of products depreciates over time (Bond and Samuelson 1984), when demand is discrete (Bagnoli et. al 1989), or when marginal production costs are increasing (Kahn 1986). Bulow (1982) showed that monopolists can avoid the durable goods problem, mimicking the credible commitment solution, via a full rental system instead of a selling system. Renting products instead of selling them is shown to enable the monopolist to avoid the durable goods problem because it is the firm that owns the product (not the consumer) and hence, has no incentive to reduce the price in the future. The rental-market solution is thus shown to produce the same first-best outcome as credible pre-commitment to future prices. The Wardrobing analysis in this paper has some similarities to a Bulow-type rental model, but is distinguished by our consideration of a mixture of consumer types (regular versus opportunist consumers) rather than one segment of consumers and by our relaxation of Bulow's assumption of no depreciation of Wardrobed units. Despite our allowance for product depreciation through Wardrobing, we show that accommodating these opportunistic consumers can nevertheless enhance rather than reduce profitability, and that Wardrobing is not made redundant even when pre-commitment is possible.

The depreciated value of product units returned through Wardrobing relative to new products leads retailers to differentiate them from new goods sold in period 2 by designating them as "open-box" products (literally, products whose boxes have been opened and re-sealed, and hence may be of inferior quality). Despite their depreciated value, open-box products do compete (albeit imperfectly) with new product units offered for sale in the second period and even with new-product sales in the first period, albeit more distantly, so that selling these open-box products will decrease sales of new products and thus threaten the firm's profit. Previous research has shown that eliminating a used-goods market makes the firm better off when new and used goods are close substitutes (i.e., when used goods exhibit little depreciation in value) (Liebowitz 1982; Miller 1974; Nocke and Peitz 2003; Rust 1986). However, Shulman et. al (2007) showed that allowing a secondary market for used goods can nevertheless make firms better off when such a market is imbedded in a channels context, allows for manufacturer pre-commitment, and exhibits a renewable consumer population each period. Our model adds to the insights in this previous paper by showing that even with a non-renewable consumer population and no ability to pre-commit in pricing, allowing a secondary market to arise through Wardrobing can be a profitable marketing behavior.

When the retailer allows for Wardrobing, he is accommodating returns arising from opportunistic consumer behavior. The previous literature examined product returns resulting from different reasons, such as *ex post* consumer dissatisfaction caused by a mismatch between a consumer's preference and actual product attributes. This mismatch can happen as a result of the consumer's uncertainty about either her preferences or product attributes before purchase (Shulman et. al 2009; Shulman et. al 2010; Shulman et. al 2011; Matthews and Persico 2007). In contrast, we look at a different kind of product return driven not by *a priori* uncertainty, but rather by purposeful and informed consumer behavior that takes advantage of returns opportunities for purchased products.

The previous literature suggests that this opportunistic[9] behavior is a threat to retailer profitability and should be fought by awarding only a partial refund for returned products; as the level of opportunism increases, so should the restocking fee (Chu et. al 1998).[10] Wardrobing is also interpreted as evidence of moral hazard that results in increased retailer costs, which can be avoided by an efficient money-back contract that takes the moral hazard into consideration (Mann et al. 1988). These approaches seek to fight opportunistic returns; in contrast, our work shows that the retailer has a reason to welcome this behavior rather than fight it.

[9] We use the term "opportunist" to describe Wardrobing consumers in deference to the belief in the literature that such behavior is (in the Williamsonian sense) "self-interest seeking with guile," that is, purchasing behavior involving a lack of transparency about the motives for buying and later returning the product. However, our results do not rest on any presumption about the nefariousness of such buyers' motives – but only on their observed behavior, which is to buy a new product in the first period and then return it for a refund at the end of that first period, in a planned way.

[10] Indeed, our analysis also shows that the optimal restocking fee the retailer charges increase with opportunistic buyers' valuations (which would imply an increase in opportunistic buying), consistent with Chu's result.

In summary, the current paper adds to the existing literature on durable goods selling and returns by considering purposeful opportunistic behavior that can actually increase, rather than decrease, retailer profits – even in a durable goods market where retailer pre-commitment to future prices is not feasible. In the next section, we thus turn to the development of our model.

The Model: Retailer and Consumers

We model a market served by one retailer over a two-period horizon. In the first period, only new products are sold. Some consumers might return their first-period purchases at the end of the first period; if this occurs, the retailer is assumed to put some or all of these returned units back on the shelf as open-box products. Thus, in the second period the retailer may sell both new and open-box products. We assume common knowledge by all players about the usage value of new and open-box products and of consumer utility functions, and we assume no discounting.

The Retailer

We consider a monopolistic retailer selling a durable good that lasts for two periods without depreciation when bought in the first period and kept by the buyer over its two-period life. The retailer can sell new units of this product in each of the two periods, and faces a constant marginal cost of production of new units, equal to c. The retailer's choice variables are the first-period price of a new product (p_1), the second-period price of a new product (p_2), and (if returns are accommodated) a restocking fee (f) charged to a consumer who returns a new product at the end of period 1. With returns accommodation, a consumer who buys a new product and returns it at the end of period 1 thus has paid p_1 to buy it initially, but then is refunded the amount (p_1-f), paying just f as a net price for acquiring and using the product for one period and then returning it to the retailer. The retailer that accepts returns can then sell the returned product as an open-box unit in period 2, selling at a price p_R set by the retailer.

We examine retailer behavior under two conditions: when pre-commitment to future prices is possible, and when pre-commitment is not possible. When the retailer can and does pre-commit, he sets the prices $\{p_1, p_2, p_R\}$ and the restocking fee $\{f\}$ at the beginning of the first period (if he accommodates returns) and does not change them in the second period. When the retailer is unable to pre-commit, he sets $\{p_1, f\}$ at the beginning of period 1 and $\{p_2, p_R\}$ at the beginning of period 2 if he accommodates returns. A no-returns policy implies the setting of p_1 in period 1 and p_2 in period 2.

Pre-commitment could be the result of a legally binding promise by the retailer in the marketplace; for example, it is considered fraudulent to promise a price and then not to offer it to consumers. Nevertheless, pre-commitment in pricing is not always believed to be credible, and indeed, in our model we do not assume that credible commitment is always possible. Rather, the pre-commitment option offers an important benchmark against which Wardrobing behavior can be evaluated.

Consumers

We model two consumer segments: *Regular consumers* and *Opportunistic consumers* (also known as *Wardrobers*). Regular consumers enjoy consumption utility from the retailer's product in either or both periods in which they own the product. Regular consumers may choose to buy the product in the first period or in the second period. Meanwhile, Opportunistic consumers enjoy consumption utility from the product only in period 1; the product has no value for them in period 2 (just as in our examples in the Introduction section, where a consumer may value a video camera only on her daughter's wedding weekend but not thereafter, or a consumer may value a big-screen TV only for Super Bowl weekend but not thereafter).

We assume that each segment is comprised of consumers with heterogeneous consumption utilities for the product. Regular consumers have a per-period valuation of u for the product, which is uniformly distributed from 0 to u_{max}. Meanwhile, Wardrobers are assumed to enjoy consumption utility of v in period 1 for the product, uniformly distributed from 0 to v_{max}; but they have zero value for the product in period 2.

In period 1, Regular consumers and Wardrobers can buy new units of the retailer's product. In period 2, Wardrobers will never buy because they do not value the product; but a Regular consumer may choose to buy a new unit or (if available) an open-box unit of the product in period 2, to maximize her utility. A Regular consumer's utility depends on her purchase behavior and can be described as follows[11]:

- $U_{1N}(u) = 2 \cdot u - p_1$, if she buys a new product in period 1 and keeps it for two periods;
- $U_{2N}(u) = u - p_2$, if she waits to buy a new product in period 2; and
- $U_R(u) = z \cdot u - p_R$, if she buys nothing in period 1 but buys an open-box product in period 2,

where $0 < z < 1$ is a parameter capturing the depreciation in value of an open-box product relative to a new product. Thus, when z is close to 1 in value, the open-box product is perceived as "almost as good as new," while when z is close to zero, the open-box product is perceived to be almost useless.

[11] One could also imagine a Regular consumer buying a new product in period 1, returning it, and then buying another new product in period 2. However, we assume such behavior does not occur because the consumer prefers not to visit the store again to return and then re-buy an identical product.

Similarly, one could imagine a Regular consumer buying a new product in period 1, returning it, and then buying an open-box product in period 2. However, if such behavior did occur, it would not require a Wardrober segment to facilitate it, because the volume of open-box units that could satisfy this behavior is already supplied by the consumers themselves who return the products. Given our focus on understanding conditions under which Wardrobing behavior can be optimal, we therefore do not examine this type of Regular segment consumption behavior in this paper either.

Meanwhile, a member of the Wardrober segment is assumed to attach a value *v* to the product only in period 1, with $v \sim U\left[0, v_{\max}\right]$ representing the heterogeneity in valuations within this segment. A Wardrober thus enjoys utility of:

$$U_O\left(v\right) = v - f \ .$$

In what follows, w exposit model results when $v_{\max} = u_{\max}$. This avoids apparent undue favoring of the Wardrobing solution, which could otherwise arise if Wardrobers had much higher one-period valuations for the product than Regular consumers. Interestingly, however, we have analyzed the general case where v_{max} is not assumed equal to u_{max}, and our qualitative results do not vary from those presented here.

With this retail and consumer structure, we now turn to an analysis of optimal retail behavior when the retailer does not accommodate Wardrobing through acceptance of product returns.

Retailer Does Not Allow Wardrobing

In this situation, the retailer sells only new products in periods 1 and 2 but does not accept returns at the end of period 1. Thus, any Opportunistic buyer pays the full price for the product purchased in period 1, even if she does not extract any value out of it in the second period; therefore, in this situation, the different consumer segments' behaviors and utilities are:

- $U_{1N}\left(u\right) = 2 \cdot u - p_1$, if a Regular consumer buys a new product in period 1 and keeps it for two periods;
- $U_{2N}\left(u\right) = u - p_2$, if a Regular consumer waits to buy a new product in period 2; and
- $U_O\left(v\right) = v - p_1$, if an Opportunist consumer buys a new product in period 1.

Let Φ_1 be the number of Regular consumers who buy the new product in period 1 (and keep it for two periods), and Φ_2 be the number of Regular consumers who buy the new product in period 2 (and thus consume it for only a single period). We determine Φ_1 by defining the marginal Regular consumer who is indifferent between buying the new product in period 1 versus in period 2. The indifferent Regular consumer's location (i.e., her value of u) is given definitionally by $\left(u_{\max} - \Phi_1\right)$, and satisfies the condition that $U_{1N}\left(u_{\max} - \Phi_1\right) = U_{2N}\left(u_{\max} - \Phi_1\right)$. Solving, we find that the number of Regular consumers who buy the new product in period 1 is:

$$\Phi_1 = u_{\max} - p_1 + p_2 \ .$$

Meanwhile, the marginal Regular consumer who is indifferent between buying a new product in period 2 and not buying at all is located at a u-value of $\left(u_{\max} - \Phi_1 - \Phi_2\right)$, and her location satisfies the condition that $U_{2N}\left(u_{\max} - \Phi_1 - \Phi_2\right) = 0$. Solving, we find that the number of Regular consumers who buy the new product in period 2 is:

$$\Phi_2 = u_{\max} - \Phi_1 - p_2 \ = p_1 - 2p_2 \, .$$

Finally, Opportunistic consumers buy the product in the first period as long as they extract positive utility. Hence, the number of Opportunistic consumers who buy the product is: $v_{\max} - p_1$. We use these demand quantities to analyze first the case where the retailer pre-commits to prices across both periods; and then the case where the retailer is unable to pre-commit.

Retailer Pre-Commits, No Wardrobing

Pre-commitment means that the retailer makes all decisions for the two-period horizon at the beginning of the first period, and cannot change his decisions afterward. Here, the retailer chooses prices p_1 and p_2 to maximize the sum of profits over the two-period horizon, given by:

$$\Pi_R = (p_1 - c)\Phi_1 + (p_2 - c)\Phi_2 + (p_1 - c)(v_{\max} - p_1)$$

$$s.t.\quad \Phi_1 \geq 0,\quad \Phi_2 \geq 0\ ,$$

where Φ_1 and Φ_2 are the quantities of new products sold in the first and second periods, respectively, and (v_{max}-p_1) is the quantity of new products bought by Opportunist consumers in period 1 (and discarded in period 2), as derived above. This maximization problem results in the following prices, quantities, and profits:

$$p_1 = \frac{2u_{\max}}{3} + \frac{c}{2};\quad p_2 = \frac{u_{\max}}{3} + \frac{c}{4};\ \Phi_1 = \frac{2u_{\max}}{3} - \frac{c}{4};\ \Phi_2 = 0;$$

$$\text{Opportunist purchase quantity} = \left(\frac{u_{\max}}{3} - \frac{c}{2}\right);\ \Pi_{R|\text{NoRet,PreCommit}} = \frac{(4u_{\max} - 3c)^2}{24}\ .$$

Retailer Does Not Pre-Commit, No Wardrobing

In this case, the retailer does not accommodate Wardrobing and therefore sells only new products to consumers in period 1 and period 2, as in the above case. However, now we assume that the retailer is unable to pre-commit to his period-2 pricing behavior at the beginning of period 1. Instead, in the first period, the retailer chooses p_1 and in the second period he chooses p_2. We solve for optimal price levels using backward induction. Thus, we first maximize the retailer's period-2 profit with respect to p_2:

$$\max_{p_2} \Pi_{R2} = (p_2 - c)\Phi_2 \quad s.t.\ \Phi_2 \geq 0\ ,$$

which yields a price function $p_2^*(p_1)$. We then find the optimal price p_1^* that maximizes the retailer's two-period profit given his best-response function, $p_2^*(p_1)$:

$$\max_{p_1} \Pi_R = (p_1 - c)\Phi_1(p_1, p_2^*(p_1)) + (p_2^*(p_1) - c)\Phi_2(p_1, p_2^*(p_1)) + (p_1 - c)(v_{\max} - p_1) \quad s.t.\ \Phi_1 \geq 0.$$

This results in the following equilibrium values of prices, quantities, and profits:

$$p_1 = \frac{1}{14}\left(7c + 9u_{\max}\right); \quad p_2 = \frac{1}{14}\left(7c + 3u_{\max}\right); \; \Phi_1 = \frac{4u_{\max}}{7}; \quad \Phi_2 = \frac{1}{2}\left(\frac{3u_{\max}}{7} - c\right);$$

$$\text{Opportunist purchase quantity} = \frac{1}{2}\cdot\left(\frac{5u_{\max}}{7} - \frac{c}{2}\right); \quad \Pi_{R|\text{NoRet,NoCommit}} = \frac{7c^2 - 14c.u_{\max} + 9u_{\max}^2}{14}.$$

Retailer Allows Wardrobing

In this section, we analyze optimal behavior by a retailer who sets prices and the restocking fee so that Wardrobing behavior by the opportunistic Wardrober segment can provide returned product units that can then be sold to Regular consumers in the second period as open-box units. As in the no-returns cases analyzed above, here we also examine the two sub-cases of pre-commitment and no pre-commitment by the retailer. The first task is to derive the demand for new and open-box products by our Regular and Wardrober consumer segments. A Regular consumer can buy either a new product in period 1; a new product in period 2; or an open-box product in period 2. A Wardrober can buy a new product in period 1 only (as she has zero value for a product in period 2). After deriving demand expressions, we then analyze the sub-case of retailer pre-commitment, followed by an analysis of the case where the retailer cannot pre-commit.

Demand by Regular Consumers

Three possible purchase/consumption behaviors for Regular consumers are identified in the section on "The Model" above and are associated with utilities of U_{1N}, U_{2N}, and U_R. Let the unit demands for each purchase behavior be denoted α, β, and δ, respectively. The Technical Appendix at the end of this paper derives these unit demands in detail; here we summarize the demand structure resulting from that analysis.

Our utility analysis shows that demand for each consumption type (in units) by Regular consumers is as follows:

- $\alpha = u_{\max} - (p_1 - p_2)$ is the number of new units sold in the first period that are kept for two periods.
- $\beta = \left[(p_1 - p_2) - \frac{p_2 - p_R}{1 - z} \right]$ is the number of new units sold in the second period.
- $\delta = \left[\frac{p_2 - p_R}{1 - z} - \frac{p_R}{z} \right]$ is the number of open-box units sold in the second period.
- Regular segment consumers with a u-value less than $\frac{p_R}{z}$ do not purchase.

Note that "α"-type purchase behavior is preferred by the highest-utility consumers; "β"-type purchase behavior by lower-utility consumers; and "δ"-type purchase behavior by yet lower-utility consumers. For this demand structure to exist requires that $p_R < p_2 < p_1 < (f + p_R) < (f + p_2)$, which is sensible: an open-box product enjoyed for only one period generates less utility than a new product bought only in period 2, which generates less utility than a new product bought in period 1 and kept for two periods by a Regular consumer, and prices will naturally reflect these differential values. Meanwhile, the inequalities $p_1 < (f + p_R) < (f + p_2)$ guarantee that a Regular consumer does not engage in behavior involving buying a new product in period 1, then returning it only to buy either her own product as open-box, or another identical new product, in period 2.

Demand by Wardrober Consumers

A Wardrober derives value from the product only in the first period (as in the example of the consumer who is interested in buying a video camera the week before a daughter's wedding, but uninterested in owning it thereafter). This type of consumer initially pays p_1 for the product, but upon returning the product, gets a refund minus the restocking fee of f. Thus, the Wardrober pays f in the end for the use of the product during period 1, and therefore is sensitive only to the restocking fee f , but not to the initial price p_1.

The marginal Wardrober is indifferent between buying and not buying the product in the first period (given that she will return the bought product for a refund at the end of period 1). This marginal Wardrober is definitionally located at $(v_{\max} - \mu)$, where μ is the number of units sold to Wardrobers. Thus, this marginal Wardrober is characterized by: $U_O(v_{\max} - \mu) = v_{\max} - \mu - f = 0$. Therefore, when $v_{max}=u_{max}$, the quantity sold to the Wardrober segment is given by:

$$\mu = v_{\max} - f = u_{\max} - f \ .$$

With this demand structure for both Regular and Wardrober consumers, we proceed in the following sub-sections to analyses of optimal retailer pricing with pre-commitment ability, and then without pre-commitment ability, in a model that allows Wardrobing behavior.

Retailer Pre-Commits and Allows Wardrobing

With pre-commitment ability, the retailer sets p_1, p_2, p_R, and f at the beginning of period 1 and does not change them thereafter. With "α", "β", "δ," and "μ" type purchase behaviors as described above, the retailer's profit function is given by:

$$\Pi_{\text{Pre-Commit,Wardrobing}} = \alpha \cdot (p_1 - c) + \beta \cdot (p_2 - c) + \delta \cdot (p_R) + \mu \cdot (f - c).$$

Here, the retailer sells α new units to Regular consumers who buy a new unit of the product in the first period and keep their purchase for two periods, generating a margin of $(p_1 - c)$ per unit; sells β new units to Regular consumers who buy a new unit of the product in the second period, generating a margin of $(p_2 - c)$ per unit; sells μ new units to Wardrobers who buy a new unit of the product in the first period and return it without buying any product in the second period, generating a margin of $(f-c)$ per unit; and sells δ units out of the μ returned units (δ≤μ) to Regular consumers as open-box units in the second period, generating an incremental margin of (p_R) per unit. In total, $(\alpha+\beta+\mu)$ new units are thus sold.

The retailer then maximizes profit subject to the quantities α, β, μ, and δ being non-negative and (δ≤μ) :

$$\max_{\{p_1,p_2,p_R,f\}} L_{\text{Pre-Commit,Wardrobing}} = \Pi_{\text{Pre-Commit,Wardrobing}} + \lambda_1\beta + \lambda_2\delta + \lambda_3\alpha + \lambda_4(\mu-\delta),$$

where L denotes the Lagrangean formulation; λ_1, λ_2, λ_3, and λ_4 are the Lagrange multipliers; and α, β, μ, and δ are given by:

$$\alpha = u_{\max} - (p_1 - p_2)$$

$$\beta = \left[(p_1 - p_2) - \frac{p_2 - p_R}{1-z}\right]$$

$$\mu = v_{\max} - f = u_{\max} - f \quad \text{(under the assumption that } v_{\max} = u_{\max}\text{)}$$

$$\delta = \left[\frac{p_2 - p_R}{1-z} - \frac{p_R}{z}\right].$$

The retailer's optimal pricing strategy depends on whether u_{max} is "small" or "large," generating two equilibria defined as follows:

- Case 1: If $u_{\max} \geq \frac{3-z}{2-z}.c$

$$p_1 = \frac{c}{2} + u_{\max}; \quad p_2 = \frac{(1-z)c + (2-z)u_{\max}}{2(2-z)}; \quad p_R = \frac{z.u_{\max}}{2}; \quad f = \frac{u_{\max}+c}{2},$$

leading to quantities and profits of:

$$\alpha = \frac{(2-z)u_{\max} - c}{2(2-z)}; \quad \beta = 0; \quad \delta = \frac{c}{2(2-z)}; \ \mu = \frac{u_{\max} + c}{2};$$

$$\Pi_{\text{Pre-Commit,Wardrobing,Case1}} = \frac{1}{4}\left(\frac{3-z}{2-z}c^2 - 4c.u_{\max} + 3u_{\max}{}^2\right).$$

- Case 2: If $u_{\max} \le \frac{3-z}{2-z}.c$

$$p_1 = \frac{c}{2} + u_{\max}; \quad p_2 = \frac{(1+(2-z)z)c + (2-z)(1+z)u_{\max}}{2(2+(2-z)z)};$$

$$p_R = \frac{(3-z)z(c+z.u_{\max})}{2(2+(2-z)z)}; \quad f = \frac{2u_{\max} + (2-z)(c+2z.u_{\max})}{2(2+(2-z)z)},$$

leading to quantities and profits of:

$$\alpha = \frac{(2+z-z^2)u_{\max} - c}{2(2+2z-z^2)}; \quad \beta = 0; \quad \delta = \frac{2u_{\max} - (2-z)c}{2(2+(2-z)z)}; \ \mu = \delta;$$

$$\Pi_{\text{Pre-Commit,Wardrobing,Case2}} = \frac{(3-z)c^2 - (4+z-z^2)c.u_{\max} + 2(3-z)(1+z)u_{\max}{}^2}{4(2+(2-z)z)}.$$

Thus, the retailer that can pre-commit and price so as to include "α", "δ", and "β" type purchase behaviors optimally chooses prices that cause no new products to be sold in the second period ($\beta=0$), similar to the result in the durable goods literature where pre-commitment makes it optimal for the retailer not to sell new products in the second period. However, our result goes beyond the basic durable-goods result in that our pre-committing retailer optimally decides to accept returns from Wardrobers at the end of the first period and as a result to sell open-box products in the second period that have a lower value than new products. The retailer disposes of the returned units in one of two ways, defined by the problem's two solution cases. The retailer can either sell all the returned products as open-box products (case 2) or resell only some and not all returned units as open-box units (case 1). Only if u_{max} is high enough (defined in case 1) is the retailer willing to take back more returned units from Wardrobers than it will sell in period 2; this is because a high enough value of u_{max} causes the Wardrobers' price (i.e., f, the restocking fee) to be high enough for it to be optimal to sell units to Wardrobers even if these units will not generate incremental revenue as open-box units in the next period.

Finally, note that the optimal restocking fee, f, is increasing in u_{max} and z. This implies conversely that the restocking fee is lower when Wardrobers' valuations for the product are lower, or when Wardrobed products are viewed as poorer substitutes for a new product. There is thus no hard-and-fast rule that suggests that a retailer optimally controls Wardrobing behavior through application of a draconian restocking fee.

Retailer Does Not Pre-Commit and Allows Wardrobing

With no ability to pre-commit, the retailer sets p_1 and f at the beginning of period 1, and sets p_2 and p_R at the beginning of period 2. To ensure sub-game perfection in our solution, we first consider the retailer's period-2 optimization problem, then substitute the period-2 best-response function into the full two-period optimization problem to optimally set period-1 variables. The retailer's profit function for period 2 is given by:

$$\Pi_{\text{Pd2,NoPre-Commit,Wardrobing}} = \beta \cdot \left(p_2 - c\right) + \delta \cdot \left(p_R\right).$$

The retailer then maximizes profit subject to the quantities β and δ being non-negative, as well as enforcing $p_1 \le f + p_2$ and $\delta \le v_{\max} - f$ (which translates to the condition $\delta \le u_{\max} - f$, as $v_{\max} = u_{\max}$):

$$\max_{\{p_2, p_R\}} L_{\text{Pd2,NoPre-Commit,Wardrobing,Case2}} = \begin{bmatrix} \Pi_{\text{Pd2,NoPre-Commit,Wardrobing}} \\ +\lambda_1\beta + \lambda_2\delta + \lambda_3\left(f + p_2 - p_1\right) + \lambda_4(u_{\max} - f - \delta) \end{bmatrix},$$

where L denotes the Lagrangean formulation; λ_1, λ_2, λ_3, and λ_4 are the Lagrange multipliers; and β and δ are given by:

$$\beta = \left[u_{\max} - \alpha - \frac{p_2 - p_R}{1 - z}\right]$$

$$\delta = \left[\frac{z \cdot p_2 - p_R}{(1-z) \cdot z} \right].$$

The period-2 optimization produces best-response functions for p_2 and p_R in terms of the Lagrangean multipliers. We consider all possible solutions of the second period decisions. Each of these in turn could be considered as a candidate best-response function to substitute into the period-1 problem faced by the retailer, which is to set *p1* and *f* to maximize the sum of period-1 and period-2 profits:

$$\Pi_{\text{Pd1,NoPre-Commit,Wardrobing}} = \alpha \cdot (p_1 - c) + \beta \cdot (p_2(\alpha, \lambda 1, \lambda 3) - c) + \delta \cdot p_R(\alpha, \lambda 2, \lambda 3) + (u_{\max} - f) \cdot (f - c).$$

Of the different candidate solutions, only three are feasible, in the sense that the solution meets all the criteria of the problem (such as non-negative λ's and non-negative quantities and prices):

- Case 1: If $z \le \frac{1}{3}$ and $\frac{5}{3-2z-3z^2} \le \frac{u_{\max}}{c} \le \frac{2-z}{1-z}$

$$p_1 = \frac{1}{10}(9u_{\max} + 5c);\ \ p_2 = \frac{1}{10}(3u_{\max} + 5c);$$
$$p_R = \frac{z \cdot \left(5(2-z)c - (2-8z+3z^2)u_{\max}\right)}{10\left(1+z-z^2\right)};\ \ f = \frac{(1-z)c + (1+2z-2z^2)u_{\max}}{2(1+z-z^2)},$$

leading to quantities and profits of:

$$\alpha = \frac{2u_{\max}}{5};\ \ \beta = \frac{(3-2z-3z^2)u_{\max} - 5c}{10(1+z-z^2)};\ \ \delta = \mu = \frac{u_{\max} - (1-z)c}{2(1+z-z^2)};$$

$$\Pi_{\text{NoPre-Commit,Wardrobing,case1}} = \frac{5(2-z)c^2 - 10(2-z^2)c.u_{\max} + (14+9z-9z^2)u_{\max}^2}{20(1+z-z^2)}.$$

- Case 2: If ($z \le \frac{1}{3}$ and $\frac{5}{3-2z-3z^2} \ge \frac{u_{\max}}{c}$) or ($z \ge \frac{1}{3}$ and $\frac{u_{\max}}{c} \le \frac{7-z}{3-z}$)

$$p_1 = \frac{(-9-6z+z^2)c - 3(3+4z)u_{\max}}{2(-6-6z+z^2)};\;\; p_2 = \frac{(-2-6z+z^2)c + (-6-2z+3z^2)u_{\max}}{2(-6-6z+z^2)};$$

$$p_R = \frac{z((-8+z)c - 5zu_{\max})}{2(-6-6z+z^2)};\;\; f = \frac{(-6+z)c + (-6-9z+2z^2)u_{\max}}{2(-6-6z+z^2)},$$

leading to quantities and profits of:

$$\alpha = \frac{c + (-3-2z+z^2)u_{\max}}{-6-6z+z^2};\;\; \beta = 0;\;\; \delta = \mu = \frac{(-6+z)c + 3(2+z)u_{\max}}{2(6+6z-z^2)};$$

$$\Pi_{\text{NoPre-Commit,Wardrobing,Case 2}} = \frac{(7-z)c^2 + 2(-9+(-5+z)z)c.u_{\max} + 15(1+z)u_{\max}^2}{4(6+(6-z)z)}.$$

- Case 3: If ($z \le \frac{1}{3}$ and $\frac{u_{\max}}{c} \ge \frac{2-z}{1-z}$) or ($z \ge \frac{1}{3}$ and $\frac{u_{\max}}{c} \ge \frac{5}{3(1-z)}$)

$$p_1 = \frac{1}{10}(9u_{\max} + 5c);\;\; p_2 = \frac{1}{10}(3u_{\max} + 5c);\;\; p_R = \frac{3zu_{\max}}{10};\;\; f = \frac{1}{2}(u_{\max} + c),$$

leading to quantities and profits of:

$$\alpha = \frac{2u_{\max}}{5};\;\; \beta = \frac{3(1-z)u_{\max} - 5c}{10(1-z)};\;\; \delta = \frac{c}{2(1-z)};\; \mu = \frac{1}{2}(u_{\max} - c);$$

$$\Pi_{\text{NoPre-Commit,Wardrobing, Case 3}} = \frac{5(2-z)c^2 - 20(1-z)c.u_{\max} + 14(1-z)u_{\max}^2}{20(1-z)}.$$

The retailer that does not pre-commit in pricing but does consider accommodating Wardrobing behavior therefore indeed does sell to Wardrobers. Under one of the cases (case 2 – characterized by the lowest values of u_{max}), the retailer chooses optimally not to sell any new products in the second period, although he does sell open-box products in period 2. In the other two cases, the retailer optimally sells both open-box and new products in period 2.

The results make intuitive sense. Consider the first case: here, z is small, meaning that an open-box product is viewed as a very inferior alternative to a new product in period 2; and

u_{max} is moderately, but not extremely, small. In this situation, the retailer cannot command a very high price for an open-box product, but the value of u_{max} is high enough to make it worthwhile to sell *something* in period 2, and this leads to sales of both new and open-box products in period 2.

In the second case, the dominant parametric feature is a low value for u_{max}, even if z is relatively high. Here, as in the first case, all Wardrobed units are resold as open-box units in period 2 (generating creditable period-2 revenue for these units particularly when z is high); but the retailer prices so as to sell no new units in period 2, because their one-period value is simply too low.

In the third case, u_{max} is high if z is low – meaning that consumers highly value new units of the product, even if the open-box unit has very low value; or, u_{max} is high and z is also high. Now, there is great value in selling units of new product whether they are sold in period 1 or period 2, and whether they are sold to Regular or Wardrober consumers, because a high u_{max} value implies high new-product prices. Thus, new units are now sold in both periods, and the retailer is now also willing to sell more units to Wardrobers than he wishes to sell as open-box in period 2. The retailer leaves some returned (Wardrobed) units unsold as open-box products in order to optimize its pricing over the two periods.

Finally, as in the pre-commitment case with Wardrobing, the optimal restocking fee is lower, the lower is Wardrobers' product valuation range or the poorer is the substitutability of a Wardrobed product for a new product. Retailers do not optimize through a uniform and strictly discouraging stance against Wardrobers' returned units.

Optimal Wardrobing Strategy

We first discuss pre-commitment strategies; then strategies when pre-commitment is not available; and finally show the best strategies if the retailer can choose whether or not to pre-commit.

Optimal Strategy of a Retailer That Pre-Commits

A retailer that pre-commits compares his profits from pre-commitment when Wardrobing is prevented, versus when Wardrobing is accommodated. In neither situation does the retailer sell *new* product units in the second period in equilibrium, as the analysis above shows; but when he does allow Wardrobing, he sells open-box products in the second period. Wardrobing does steal some Regular-consumer segment demand for new products sold in the first period. However, the retailer gains from Wardrobing via his two sources of revenue earned on each Wardrobed unit: the initial Wardrober's purchase price (equal to the restocking fee), and the price charged for the ensuing open-box unit bought by a Regular consumer in period 2. Being able to offer an open-box unit for sale in the second period allows the retailer to practice price discrimination among its Regular consumers, offering a new product in the first period to those with the highest valuations and an open-box product in period 2 to those with lower valuations. As a result, the period-1 new-product price is higher under Wardrobing and commitment, than under commitment with no Wardrobing. Given the standard "durable goods problem" insights, this may seem odd: after all, the open-box units do compete with sales of new units in period 1. However, the degree of competition is lower than it would be, were the retailer to sell *new* goods in period 2. A larger wedge is thus driven between the consumer's options for buying immediately in period 1, versus waiting and buying in period 2 (as compared with the standard "durable goods problem" logic): not only does she lose one period's worth of utility if she waits, but she also gets a product that is inferior in quality. In effect, accommodating Wardrobing is a way of practicing "intensified" price discrimination that makes it profitable to allow *some* period-2 sales to exist. The following Proposition formalizes this argument:

Proposition 1: *When the retailer pre-commits, he optimally chooses to accommodate Wardrobing behavior.*

We next consider the Wardrobing choice of a retailer who does not pre-commit.

Optimal Strategy of a Retailer That Does Not Pre-Commit

When the retailer is unable to pre-commit in pricing, he suffers from the classic durable goods pricing problem discussed by Coase (1972) and Bulow (1982). If Wardrobing is not available, his optimal strategy involves selling new units of the product in both period 1 and period 2 (i.e., $\alpha>0$ and $\beta>0$), with some Regular consumers waiting to buy a product until period 2. The new products sold in period 2 compete with new products for sale in period 1; this induces the retailer to lower the price of period-1 products (relative to the case where this retailer can pre-commit), in order to encourage consumers to buy in the first period rather than to wait to buy in period 2.

Meanwhile, if Wardrobing is considered, the non-pre-committing retailer optimally sells new units in period 1 both to Regular and to Wardrober consumers, and sells some or all of the Wardrobers' returned units as open-box units to lower-utility Regular consumers in period 2. When u_{max} is low enough, *all* sales of new products in period 2 are prevented. This result makes sense: when the range of willingness-to-pay is small, there is no scope for sales of all three types of products (new in period 1; new in period 2; and open-box in period 2), so the intermediate-valued product (new in period 2) is the version dropped from the market, leaving the highest-valued (new in period 1) and lowest-valued (open-box in period 2, by virtue of the fact that z is less than 1) to effect price discrimination. When u_{max} is higher, all three types of products are sold, and it is possible for the volume of new products in period 2 to actually surpass that in the no-Wardrobing, no-pre-commitment case.

We summarize this logic in our next Proposition:

Proposition 2: *When the retailer is unable to pre-commit, he optimally accommodates Wardrobing behavior; for low enough product valuation, new-product sales in period 2 are eliminated.*

Contrary to the protestations in the business-press literature, our first two Propositions show that Wardrobing actually improves retailer profitability – even in the case of Proposition 2, when pre-commitment to future prices is impossible. The advantage of Wardrobing is the alteration it induces in the nature of competition between period-1 product and period-2 product available for purchase, relative to a no-Wardrobing situation. Without Wardrobing, period-2 products are the same new products that were for sale in period 1; while they only offer one period's worth of utility when sold in period 2, they are nevertheless viewed as being of the same quality as products sold in period 1. But with Wardrobing, the products available for sale in period 2 are viewed as lower-quality than period-1 products and thus offer a greater degree of differentiation from the new products available for sale in period 1. Even without pre-commitment, Wardrobing can result in zero new-product sales in period 2, similarly to the first-best (pre-commitment) solution to the standard durable-goods problem. When Wardrobing completely drives out new-product sales in period 2, it therefore allows the retailer to set period-1 new product prices higher than it can without Wardrobing, effectively promoting profitable price discrimination by selling more differentiated products across the two periods than is possible without Wardrobing.

Optimal Pre-Commitment and Wardrobing Choices by the Retailer

In the above discussion, we established that if Wardrobing is possible, a retailer always accommodates it, whether or not the retailer can also pre-commit to future prices. We now broaden our comparisons to consider whether a retailer would or would not be overall better off if he *could* pre-commit. Intuition suggests that the ability to pre-commit is valuable, and we might thus predict that optimal pre-commitment profits would always be greater than the profits obtainable without the ability to pre-commit. However, as our next Proposition states and Figure 1 below illustrates, this intuition is not always correct when Wardrobing is possible:

Proposition 3: *Given a choice between pre-commitment and no pre-commitment, and the ability to practice Wardrobing, the retailer does not always prefer pre-commitment; under some conditions (among them the non-sale of new products in period 2), Wardrobing without pre-commitment is more profitable than Wardrobing with pre-commitment.*

Corollary 1: *A necessary condition for non-pre-commitment to be optimal is zero new-product sales in period 2.*

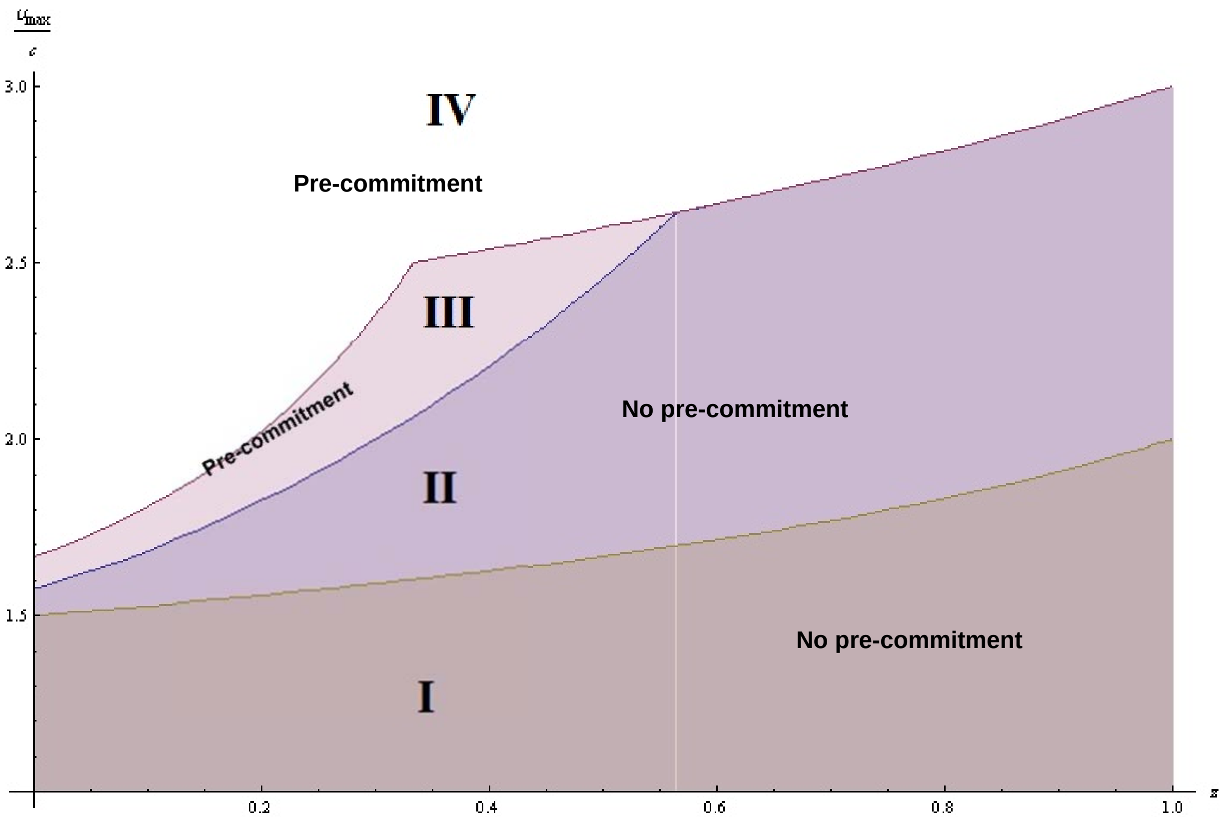

Figure 1: Pre-commitment vs. No pre-commitment when retailer allows wardrobing

Notes:

- In Regions I, II, and III, the non-Pre-Committing retailer resells all Wardrobed units as open-box in period 2 (μ=δ) and sells no new units in period 2 (β=0).
- In Region I, the Pre-Committing retailer also resells all Wardrobed units as open-box in period 2 (μ=δ) and sells no new units in period 2 (β=0).
- In Regions II, III, and IV, the Pre-Committing retailer Wardrobes more units than he resells as open-box in period 2 (μ>δ) and sells no new units in period 2 (β=0).
- Outside Regions I, II, and III, a non-Pre-Committing retail strategy with Wardrobing either does not exist, or involves reselling all Wardrobed units as open-box in period 2 (μ=δ) as well as selling new units in period 2(μ=δ).

Figure 1 shows that the retailer's profit-maximizing strategy depends on how highly-valued the products are relative to their cost to produce (i.e., how large u_{max} is, relative to c), given a value of z (substitutability between new and open-box products). Proposition 3 establishes not only that Wardrobing is a possible viable substitute for being able to credibly pre-commit to future pricing, but also that it can be more profitable overall. This is a surprising result, given the findings in prior literature that a monopolist selling a durable good garners the greatest profit from pre-commitment; but this prior literature does not consider the possibility of Wardrobing behavior.

Figure 1 shows that Wardrobing without pre-commitment is more profitable than Wardrobing with pre-commitment in Regions I and II, characterized by lower values of u_{max} , given a value of z.

In Region I, when u_{max} is very low, both the pre-committing and the non-pre-committing retailer sell no new units of product in period 2. The only sales in period 2 are of open-box products and, furthermore, both the pre-committing and the non-pre-committing retailer price so as to resell every Wardrobed unit as an open-box unit in period 2. The non-pre-committing retailer sells greater volumes, at lower prices, than does the pre-committing retailer when u_{max} is low, which generates more profit because with lower willingness-to-pay, profit is enhanced through higher volume sold (since it cannot be as greatly enhanced through raising prices).

In Region II of Figure 1, again there are no new-product sales in period 2. However, while the non-pre-committing retailer continues to resell every Wardrobed unit as an open-box unit in period 2 ($\mu=\delta$), the pre-committing retailer constrains himself to sell fewer open-box units in period 2 than were returned by Wardrobers at the end of period 1 ($\mu>\delta$). That is, the pre-commiting retailer discards (i.e. fails to gain incremental revenue from) some of the units it takes back from Wardrobing consumers. The logic for this relies on the fact that for high enough willingness-to-pay (i.e., high u_{max} relative to c), it is very profitable to maintain high prices for new product units in period 1. It would work against this profit goal to offer too many open-box units in period 2, because these do compete (albeit imperfectly) with new units in period 1 by causing some Regular consumers to defer their purchase until period 2 when they can buy a lower-priced open-box unit instead of a higher-priced new unit in period 1. But meanwhile, a higher u_{max} value also signifies a higher willingness-to-pay by single-period Wardrobers. The retailer that can pre-commit therefore maximizes profit by selling to more Wardrobers (all of whom return their units at the end of period 1 for a refund minus the restocking fee, f) than the number of period-2 open-box units it intends to offer. Region II's z values are high enough (for the given values of u_{max} that hold there) that the no-pre-commitment solution still dominates the pre-commitment solution, because buyers of open-box products have a high enough willingness to pay for these almost-like-new products that the retailer is able to maintain suitably higher prices in period 1.

In contrast, Region III of Figure 1 is an area in which the pre-committing and non-pre-committing retailer strategies obey the same rules as in Region II, but z is low enough and u_{max} high enough that pre-commitment, accompanied by constrained open-box supply in period 2, now dominates the non-pre-commitment strategy in which the retailer cannot constrain itself from offering every Wardrobed unit as an open-box unit in period 2. When z is this low, the ensuing open-box price must also be low, and this creates enough cannibalization of the increasingly profitable period-1 sales for the pre-commitment strategy to dominate. Finally, pre-commitment dominates in Region IV over both low and high z values. In this Region, u_{max} is very high, implying high willingness-to-pay. The fact that pre-commitment leads the retailer to sell no units of new products in period 2 enhances the spread between period-1 (new-product) prices and period-2 (open-box only) prices in this situation, which is particularly profitable. Meanwhile the non-pre-committing retailer sells all three kinds of products in this area of parameter space, leading to lower period-1 prices.[12] The net effect is higher profitability with pre-commitment.

It is worth emphasizing that as stated in Corollary 1, one notable aspect of the solution is that the most profitable behavior involves suppressing sales of new product units in period 2, even when *some* units (Wardrobed units) *are* sold in period 2. While the general tenor of the standard durable-goods problem discussion (emphasizing the benefit of non-sale of new product units in period 2), our approach expands the basic insight to show that (a) it is optimal to sell *some* units in period 2, even though they somewhat cannibalize sales in period 1; and (b) even a retailer that does *not* practice pre-commitment will still optimally choose not to sell any new units of product in period 2, when Wardrobing offers an alternative.

Thus, a complex interplay of factors contributes to the superiority of non-pre-committed retail pricing behavior over a pre-committing solution. One factor of importance is the overall willingness-to-pay in the market. If it is high enough, pre-committing wins out because a retailer that pre-commits can control its urge to sell more open-box units in period 2, which a non-pre-committed retailer is unable to do (as in the standard "durable goods problem," a non-pre-committed retailer in possession of some amount of Wardrobed product cannot hold itself back from offering *all* of them as open-box units in period 2). Another factor of importance is z, the substitutability between an open-box product and a new product. The higher is z, the greater is the impetus to sell all Wardrobed products as open-box in period 2 – because they are closer in value to new products and can thus command a higher price.

The above discussion is pertinent only when a retailer can choose whether or not to pre-commit in its pricing strategy vis-à-vis Regular and Wardrober consumers. When pre-

[12] In addition, there is a portion of Region IV in which a non-pre-committing retailer has no equilibrium strategy involving Wardrobing, and here, no Wardrobing would occur; *a fortiori*¸ the pre-commitment equilibrium dominates there.

commitment is simply not feasible, the "No Pre-commitment, Wardrobing" solution is the equilibrium retail strategy, as per Proposition 2 above. And conversely, if the retailer is unable to avoid price pre-commitment (e.g. due to some prior public and legally binding statements), then the "Pre-commitment, Wardrobing" solution is the equilibrium retail strategy, as Proposition 1 states. It is certainly interesting that regardless of the retailer's ability to pre-commit to its future pricing strategy, accommodating Wardrobing dominates its prevention. But also of interest is the fact that once Wardrobing is considered, pre-commitment loses its universally dominant role. In effect, Wardrobing can profitably substitute for pre-commitment as a price discrimination and dynamic pricing control mechanism in the market – facilitated by the very segment of consumers who are casually vilified for their "opportunistic" buyer behavior.

The above analysis of Wardrobing also assumes that the only way a retailer can offer open-box products is by taking returns from Wardrobing consumers in period 1. But what if a wily retailer decides to bypass the Wardrober segment (partially or totally) and simply create its own open boxes, by slashing them open and then re-sealing them and calling them "open box"?[13] We consider this possibility in the next section.

Allowing the retailer to "slash boxes"

In this section, we consider a model variant that allows the retailer to open its own boxes of new product and sell them as "open-box" goods in the second period. In the previous sections, the retailer can sell open-box products only by first selling new products to Wardrober consumers and then re-selling these products as open-box products to regular consumers at a discounted price. The results of this model showed the benefit of accepting returns and selling them as open-box products. This fact makes one wonder whether the retailer is then better off

[13] We thank Elie Ofek and Eyal Biyalogorsky for suggesting this possibility to us.

opening the boxes by himself, representing them as if they were returned or used, and selling them at a discounted price in the second period. We examine this retail strategy in two different situations. First, we allow the retailer to open the boxes without selling to any opportunist consumers, thus accepting no returns. In the second situation, the retailer can sell products to Wardrober consumers, accept returns for a restocking fee of *f*, and thus acquire returned products that can be sold as open-box products; and, at the same time, the retailer can also "open the boxes" and sell them as used products as well. We examine these two situations using two different models for the two types of retailers (pre-committed and non-pre-committed).

1.1. Only the retailer opens boxes; no returns accepted

In this model, the retailer sells the products to only the Regular consumer segment (we assume there is only one segment and there are no Wardrober consumers).[14] The retailer sells new products in the first period; in the second period, he can choose to open boxes and sell these units as open-box products at a discounted price, along with offering new products for sale. We examine both the case where the retailer does not pre-commit, and the case when he does pre-commit.

❖ Pre-committed retailer

When the retailer pre-commits, he makes all pricing decisions at the beginning of the first period by maximizing his two-period profit, given by:

$$\Pi_{\text{Pre-Commit}} = \alpha \cdot (p_1 - c) + \beta \cdot (p_2 - c) + \delta \cdot (p_R - c)$$

Subject to: $\alpha \geq 0, \beta \geq 0, \delta \geq 0$

[14] We have also conducted the analysis with Wardrobers and the qualitative results are unchanged.

where "α", "β", and "δ" denote the number of new products sold in the first period, the number of new products sold in the second period, and the number of products opened by the retailer and sold in the second period as used products, respectively.

- ❖ Non pre-committed retailer

When the retailer does not pre-commit, he chooses the price of new products in the first period (p_1) at the beginning of the first period, and the price of new products in the second period (p_2) and the price of open-box products (p_R) at the beginning of the second period.

We solve this model using backward induction. We start by solving the second-period decisions (p_2, p_R) as a function of first period price p_1 by solving the following optimization problem:

$$\Pi_{\text{No Pre-Commit, period 2}} = \beta \cdot (p_2 - c) + \delta \cdot (p_R - c)$$

Subject to: $\beta \geq 0, \delta \geq 0$

Then, we solve for p_1 by maximizing two-period profit:

$$\Pi_{\text{No Pre-Commit, period 1}} = \alpha \cdot (p_1 - c) + \beta \cdot (p_2 - c) + \delta \cdot (p_R - c)$$

Subject to: $\alpha \geq 0$

where "α", "β", and "δ" denote the number of new products sold in the first period, the number of new products sold in the second period, and the number of products opened by the retailer and sold in the second period as used products, respectively.

Direct comparison of equilibrium profits generates the following result:

Proposition 4: *When the retailer has the option to "slash boxes," he chooses to not to do so whether he pre-commits or not.*

This proposition shows that the retailer has no interest in slashing the boxes by himself and selling them as used goods to consumers. In fact, such self-made open-box products steal demand from new products; the price discrimination benefit alone cannot compensate for this cannibalization of first-period sales. In the Wardrobing case, there is an extra benefit that the retailer does not have when he slashes the boxes, which is the double revenue earned from every unit Wardrobed in period one and re-sold in period two. In contrast, the box-slashing retailer does not earn a restocking fee or any extra money out of the slashed product other than the open-box price.

1.2.Retailer opens boxes and allows Wardrobing as well

In this section, we propose a model where the retailer allows Wardrobing by accepting returns from Opportunist consumers, and also has the choice to open the boxes by himself. In this case, the retailer has two ways to amass used products to sell in period 2: either through the returns from Opportunist consumers, or by opening the boxes by himself that can then be sold in the second period as used goods. In this case, the retailer has the following profit:

$$\Pi_R = \alpha \cdot (p_1 - c) + \beta \cdot (p_2 - c) + \delta \cdot p_R + \mu \cdot (f - c) + \max(0, \delta - \mu).c$$

where:

α: number of new products sold in the first period
β: number of new products sold in the second period
δ: number of open-box products sold in the second period
μ: number of products bought by and returned from opportunist consumers

In this case, if the retailer chooses to sell more units of open-box products than the volume returned from Wardrober consumers ($\delta \geq \mu$), he can open the boxes and sell more used products. Hence, we have two cases that should be solved separately:

- If $\delta \geq \mu$ then $\Pi_R = \alpha \cdot (p_1 - c) + \beta \cdot (p_2 - c) + \delta \cdot p_R + \mu \cdot (f - c) + (\delta - \mu).c$
- If $\delta \leq \mu$ then $\Pi_R = \alpha \cdot (p_1 - c) + \beta \cdot (p_2 - c) + \delta \cdot p_R + \mu \cdot (f - c)$

The second case is the same as the one that we examined in our original model where the retailer can only have open-box products through returns from the opportunist consumers. In fact, $\delta \le \mu$ was one of the constraints of the maximization problem that we set. Therefore, the only case left to be investigated is the one when $\delta \ge \mu$.

- Pre-committed retailer

When the retailer pre-commits, he makes all pricing decisions at the beginning of the first period by maximizing his two-period profit, given by:

$$\Pi_{\text{Pr}e-commit} = \alpha \cdot \left(p_1 - c\right) + \beta \cdot \left(p_2 - c\right) + \delta \cdot p_R + \mu \cdot \left(f - c\right) + (\delta - \mu).c$$
$$\text{Subject to:} \qquad \alpha \ge 0, \beta \ge 0, \mu \ge 0, \delta \ge \mu$$

- Non pre-committed retailer

When the retailer does not pre-commit, he chooses the price of new products in the first period p_1 and the restocking fee f at the beginning of the first period; the price of the new product in the second period p_2; and the price of the opened products p_R at the beginning of the second period.

We solve this model using backward induction. We start by solving for second-period decisions (p_2 , p_R) as a function of first year prices p_1 and f by maximizing the following profit:

$$\Pi_{\text{No Pre-Commit, period 2}} = \beta \cdot \left(p_2 - c\right) + \delta \cdot p_R + (\delta - \mu).c$$
$$\text{Subject to:} \qquad \beta \ge 0, \delta \ge \mu$$

Then, we solve for p_1 and f by maximizing two-period profit:

$$\Pi_{\text{No Pre-Commit, period 1}} = \alpha \cdot (p_1 - c) + \beta \cdot (p_2 - c) + \delta \cdot p_R + \mu \cdot (f - c) + (\delta - \mu).c$$
$$\text{Subject to:} \qquad \alpha \geq 0, \mu \geq 0$$

Direct analysis of the results leads to the following Proposition:

Proposition 5: *When the retailer has the option to "open boxes" and allow for Wardrobing, he chooses to not to open boxes whether he pre-commits or not.*

This proposition shows that the retailer only sells the products returned from opportunistic Wardrober consumers as open boxes even when he has the option to open boxes by himself. In fact, since there are enough Wardrober consumers in the market to generate as many open-boxes as the retailer can ever need ($u_{\max} = v_{\max}$), the retailer would never optimally choose to slash the boxes instead of accepting more returns from the opportunistic consumers and earn restocking fees.[15]

In this section, we showed that the retailer decides not to slash the boxes, whether in a situation where there is no opportunistic consumers segment, or when he in fact does receives returns from this segment. The result holds whether the retailer pre-commits or not, because slashing his own boxes generates less revenue than accommodating a Wardrobed sale and then re-selling that unit as an open-box product.

Discussion and Conclusion

Our results overturn the claims in the business-press literature that Wardrobing is a nefarious and possibly even illegal activity that should be suppressed in all cases in the retail marketplace. Instead, our analysis establishes that if Wardrobing is possible, accommodating it is in fact more profitable – not less profitable – than preventing it.

[15] The same qualitative result was found to hold even when v_{max} and u_{max} are not constrained to equal each other.

Meanwhile, prior literature on durable goods has also suggested that optimal pre-commitment strategies are more profitable than the best strategy in the absence of pre-commitment. But, our results overturn this finding from the prior literature as well, because we find that foregoing a pre-commitment strategy can be more profitable – not less profitable – than credible pre-commitment to future prices.

Our new insights vis-à-vis both the managerial literature on Wardrobing and the academic literature on durable-goods pricing both stem from the ability of Wardrobing to promote profitable price discrimination in the retailer's marketplace. Wardrobing is a natural consumer behavior followed by consumers who have a high, but short-term, value for a product and no value for later consumption of the same product. A classic example of such consumer behavior is the value placed on a big-screen TV set the week of the Super Bowl game, versus the value for that same big-screen TV after the Super Bowl is over; but the principle behind Wardrobing can apply in many markets, including apparel, video cameras, or overhead video display systems, for example. When a retailer recognizes this segment's presence in his market, he can sell his product to them and offer a return policy with a restocking fee that leaves the marginal Wardrober just willing to buy the product for use in the first period, and then return it to the retailer. The retailer thus acquires returned units of the product, which can be subsequently re-sold as open-box units. Far from being useless offerings in the market, our analysis shows that open-box products provide a viable alternative consumption option for a lower-utility Regular consumer who prefers the lower price of the open-box product and is willing to endure the loss of one period's utility of product usage, as well as the lower perceived usage utility of an open-box product, in exchange. The lower perceived quality of an open-box product versus a new product in period 2 makes the retailer's Wardrobing strategy profitable because it lessens substitutability between the product available in period 1 (a new product) and that available in period 2 (an open-box product). This lessened substitutability allows the retailer to keep period-1 new-product prices higher than would be possible without Wardrobers, while allowing the retailer to access two sources of revenue for units sold initially to Wardrobers: the net price paid by the Wardrober to acquire, use, and return the product in the first period, and the open-box price paid for that same unit in period 2 by a Regular segment consumer.

We have focused on presenting the case where Wardrobers have similar per-period usage values for the product as those enjoyed by Regular consumers. An extended analysis for general values of v_{max} generates the same qualitative result that Wardrobing is a profitable retailing behavior. Furthermore, it is still reasonable to assume that a Wardrober attaches a high usage value to a product; while the usage period of interest may be short, many of these purchase occasions naturally have an intense value to the Wardrober consumer (e.g., the father of the bride buying a video camera to capture his daughter's wedding day, or the high value a woman might attach to a cocktail dress – but only for one wearing, not for repeated use).

Our research also establishes that it is not just profit-maximizing for the retailer to insource the generation of open-box units by slashing boxes itself, regardless of the accommodation or preclusion of Wardrobers and regardless of the retailer's ability to pre-commit to future prices or not. While we show these results for $u_{max}=v_{max}$, our extended analysis demonstrates their generality.

It will also be of interest to explicitly incorporate hassle costs of returning a product to the retailer in our demand analysis. The current analysis in this paper also abstracts away from explicitly modeling the retailer's costs of handling returns and converting a returned product into an open-box offering; this too can be considered. And finally, our monopolist retailer environment can be expanded through an explicit consideration of retail competition. While these factors could temper our results, we believe that the fundamental value of Wardrobing as a substitute to credible pre-commitment due to its price discrimination power will remain in these expanded modeling spaces.

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Appendix to:
Wardrobing: Is It Really All That Bad?

Demand Structure Derivation in the "Regular" Consumer Segment

There are three potential consumption behaviors for "Regular" consumers (i.e. those consumers who are not in the "Opportunistic" segment):

Description of Type	Utility of This Type of Consumption
α (buy new in pd. 1, keep in pd. 2, consume for 2 pds.)	$U_{1N}(u) = 2u - p_1$
β (no purchase in pd. 1; buy new in pd. 2)	$U_{2N}(u) = u - p_2$
δ (no purchase in pd. 1; buy open-box in pd. 2)	$U_R(u) = z \cdot u - p_R$

First, examine under what conditions Regular-segment consumers prefer "α"-type consumption over the other types:

When does a regular consumer prefer "α" consumption over "β" consumption? →

- When $u > p_1 - p_2$

  Thus, given that we assume that $u \in [0, u_{\max}]$, we then have:

  Prefer "α" consumption over "β" consumption when $u \in [(p_1 - p_2), u_{\max}]$;

  Prefer "β" consumption over "α" consumption when $u \in [0, (p_1 - p_2)]$.

When does a regular consumer prefer "α" consumption over "δ" consumption? →

- When $2u - p_1 > z \cdot u - p_R \quad \Rightarrow \quad u > \dfrac{p_1 - p_R}{(2 - z)}$.

  Note that it is reasonable to impose the condition that $p_1 > p_R$, because the price of an open-box product that will be enjoyed for just one period will be less than the price of a higher-quality, new product that is consumed for two periods. We impose this condition in the profit-maximizing problem.

Thus, comparing these two options ("α"-type versus "δ"-type consumption), we have:

Prefer "α" consumption over "δ" consumption when $u \in \left[\frac{p_1 - p_R}{2-z}, u_{\max} \right]$;

Prefer "δ" consumption over "α" consumption when $u \in \left[\frac{p_R}{z}, \frac{p_1 - p_R}{2-z} \right]$.

Summarizing the insights from these comparisons thus far, the following conditions will be imposed on the retailer's profit-maximization problem:

- $p_1 > p_2$: that is, a new product bought in period 1 (and that can be enjoyed for two periods) will be priced higher than the same new product bought in period 2 (when it can be enjoyed for only 1 period).
- $p_1 > p_R$: that is, a new product bought in period 1 will be priced higher than an open-box product bought in period 2, as argued above.
- $p_2 > p_R$: a new product bought in period 2 will be priced higher than an open-box product bought in period 2.
- $p_1 < f + p_2$ (which guarantees consumers do not buy a new product in period 1, then return it and buy an identical new product in period 2).
- $p_1 < f + p_R$ (which guarantees that consumers do not buy a new product in period 1, then return it and re-buy the same returned unit as an open-box product).

And moreover, "α"-type consumption is preferred only by the highest "*u*" consumers in the regular segment.

Next, we establish the conditions under which "β"-type consumption is preferred to either "σ"-type consumption or "δ"-type consumption.

Second, examine under what conditions Regular-segment consumers prefer "β"-type consumption over"σ"-type consumption or "δ"-type consumption:

When does a regular consumer prefer "β" consumption over "δ" consumption? →

➔ When $u - p_2 > z \cdot u - p_R \;\Rightarrow\Rightarrow\; u > \frac{p_2 - p_R}{1-z}$.

And since $p_2 > p_R$, it is indeed the higher-*u* consumers who will prefer to consume in a "β" fashion and lower-*u* consumers who will prefer to consume in a "δ" fashion.

Thus: When "α", "β", and "δ" consumption types co-exist:

The following constraints must be placed on this problem:

$p_R < p_2 < p_1 < (f + p_R) < (f + p_2)$.

Then, demand for each consumption type (in units) is as follows:

"α"*-type consumption:* Consumers with $u \in [(p_1 - p_2), u_{\max}]$, or equivalently, $\alpha = u_{\max} - (p_1 - p_2)$ is the number of new units sold in the first period that are kept for two periods.

"β"*-type consumption:* Consumers with $u \in \left[\frac{p_2 - p_R}{1-z}, (p_1 - p_2)\right)$, or equivalently, $\beta = \left[(p_1 - p_2) - \frac{p_2 - p_R}{1-z}\right]$ is the number of new units sold in the second period.

"δ"*-type consumption:* Consumers with $u \in \left[\frac{p_R}{z}, \frac{p_2 - p_R}{1-z}\right)$, or equivalently, $\delta = \left[\frac{p_2 - p_R}{1-z} - \frac{p_R}{z}\right]$ is the number of open-box units sold in the second period.