

The Role of Sale Signs

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Abstract

Sale signs increase demand. The apparent effectiveness of this simple strategy is surprising; sale signs are inexpensive to produce and stores generally make no commitment when using them. As a result, they can be placed on any products, and as many products, as stores prefer. If stores can place sale signs on any or all of their products, why are they effective?

We offer an explanation for the effectiveness of sale signs by arguing that they inform customers about which products have relatively low prices, thus helping customers decide whether to purchase now, visit another store, or perhaps return to the same store in the future. This explanation raises two additional issues. First, why do stores prefer to place sale signs on products that are truly low priced (stores could use sale signs to increase demand for any of their products)? Second, how many sale signs should a store use; should they limit sale signs to just their relatively low priced products or should they also place them on some of their higher priced products? The paper addresses each of these questions and in doing so investigates how much information sale signs reveal.

Our arguments are illustrated using a formal game-theoretic model in which competing stores sell imperfect substitutes in two-period overlapping seasons. Stores choose price and sale sign strategies and new customers arrive each period and decide whether to purchase immediately or delay and return in the future (to the same store or a different store). Customers who delay purchasing risk that the product will not be available in the following period and incur an additional transportation cost when they return. Two factors balance these costs. First, customers correctly anticipate that the price will be lower if the product is available in the next period. Second, customers who return to a different store may find a product that better suits their needs. In deciding how to respond, customers use price and sale sign cues to

update their expectations about which products will be available in the next period.

Stores' sale sign and price strategies are entirely endogenous in the model, as is the impact of sale signs on demand. In our discussion we highlight the information revealed by sale signs, including the source of its credibility, its sensitivity to the number of sale signs that are used, and the resulting shift in customer demand.

We point to two key results. First, we show that the underlying signal is self-fulfilling: if customers believe that products with sale signs are more likely to be relatively low priced, then firms prefer to place sale signs on lower priced products. Second, we demonstrate that sale signs are self-regulating. Stores may introduce noise by placing sale signs on some more expensive products. However, if customers' price expectations are sensitive to the number of products that have sale signs, this strategy is not without cost. Using additional sale signs may reduce demand for other products that already have sale signs.

Our model is unique in several respects. First, we describe how stores use multiple signals to communicate with customers and recognize that customers vary in how much they learn from each signal. Price alone resolves uncertainty for some customers, but other customers use both prices and sale signs to resolve their uncertainty. Second, although previous signaling models have recognized that signals may be noisy (not always accurate), noise in these signals is typically exogenous, resulting from uncontrolled environmental distortions. In our model, stores endogenously choose to introduce noise so that sale signs only partially reveal which products are discounted.

Our explanations are supported by several examples. Although we focus on fashion products, our findings have application to any market in which customers are uncertain about relative price levels.

(Sale Signs; Retailing; Pricing; Promotion Signals; Signal Jamming)

1. Introduction

Customers' knowledge of competitive prices and products is generally incomplete. To aid their purchasing decisions, customers must rely upon cues to update their expectations about relative prices and future product availability. In this paper we investigate the information conveyed by prices and sale signs at the point of purchase.

Our findings apply broadly to any market in which customers are unsure about relative price levels, but to simplify exposition we illustrate our arguments with reference to fashion clothing. In this market, frequent changes in prices and products lead to considerable customer price uncertainty. Within a store, historical price comparisons are difficult because of the frequent turnover of products. Between-store price comparisons are difficult as competing stores often sell imperfect substitutes. For example, stores may all introduce knit shirts at the same time, but the brand, colors, fabric weight, stitching, and other design features vary between stores. Finally, stores introduce fashion items throughout the season at staggered and largely unpredictable intervals. Therefore, the current price contains limited information about how long an item has been in a store and whether it will be discounted in the future. We describe how customers use prices and sale signs to resolve their uncertainty about when and where to buy.

For those customers who are well-informed about market prices, price information alone may be sufficient to reveal whether a product is discounted and is finishing its season. However, a series of behavioral studies investigating customers' price knowledge of grocery products suggest that customers are not well informed about prices. Most of these studies reveal that no more than half of customers questioned can recall the prices of recently purchased products (Allen, Harrell, and Hutt 1976; Conover 1986; Dickson and Sawyer 1990). In fashion markets, we expect even less customer price knowledge because of the rapid and unpredictable rate of price and product changes. If customers are unable to identify which products are finishing their seasons from the price alone, they may use other cues. Although we focus on sale signs, we recognize that customers may also rely on other signals, including perhaps the number of products remaining

on a rack and the time of the year (few swimsuits are introduced at the end of summer).

Given customers' lack of price knowledge, we address two questions. First, why are sale signs informative (stores could place them on any of their products)? To convey information that a product is discounted, stores must prefer to place them on their truly discounted products.¹ Second, how many sale signs should stores use? Varying the number of sale signs determines how much information is revealed. If stores limit sale signs to only their discounted items, the resulting signal will accurately reveal which products have low prices. However, if they also place them on high priced products, the signal will be noisy.

We caution that this paper does not seek to explain the source of seasonal price variations (Coasian dynamics). Other authors have explained the decline in prices of fashion products through a season as evidence of temporal *price discrimination* or *demand uncertainty*. The price discrimination argument relies on heterogeneity in customers' reservation prices. Stores charge a high price at the start of the season to sell to customers with higher reservation values, and then discount at the end of the season in order to sell to customers with lower reservation values. The demand uncertainty explanation was proposed by Lazear (1986) and then elaborated on by Pashigian (1988). They argue that if stores are uncertain about which trends will be favored in any season, they may choose to begin the season by charging a high price for all of the trends. The trends that are favored sell quickly, while the remaining trends are marked down to their market-clearing price. Pashigian and Bowen (1991) evaluate how well each hypothesis explains the discounting of fashion products at the end of their seasons and conclude that both appear to be consistent with the data. We use a price discrimination mechanism to induce Coasian price dynamics in our formal model; however, the reason that prices fall over time is distinct from the issues we address. It is sufficient that prices tend to fall so that some customers prefer to purchase

¹We will label as "high" prices at the start of the season and "low" or "discounted" prices that are lower than the prices at the start of the season.

products at the end of their seasons. Given this preference, we investigate how much information stores reveal to customers through price and sale sign cues.

The remainder of the paper is in two parts, beginning with a qualitative discussion of sale sign strategies, followed by an illustration of these qualitative arguments in a formal game-theoretic model. The qualitative discussion can be found in §2, followed by the formal model in §2. The generality and limitations of our findings are discussed in §4 with suggestions for future research. The limitations emphasize that our findings apply to sale signs at the point of sale and not advertising observed by customers prior to reaching the store.

2. Where Do Stores Place Sale Signs?

We begin this section by describing the actual sale sign strategies of two stores and then offer explanations for these strategies (that are formalized in §3). In particular, we explain why stores prefer to place sale signs on discounted products and identify a tradeoff that regulates how many sale signs stores use.

Evidence

We interviewed executives from the corporate office of a large chain of department stores who are responsible for pricing and merchandising strategies for moderately priced women's sportswear.² In addition, we interviewed the owners of a single location specialty women's clothing store that sells premium brand products. In each instance we asked for a description of the store's sale sign strategies. Both the department store executives and the specialty store owners responded that they place sale signs on any product that has a price discounted below its initial price. The owners of the specialty store indicated that these are the only products that have sale signs, which we confirmed by inspecting the store's inventory and sales records.³ However, the department store executives

²Sale signs proliferate in this department where products might include woollen sweaters priced at \$29. Evidence from other sources suggests this category is one of the largest and most profitable departments in these stores (see Ortmeyer 1993).

³These records also confirmed that products have overlapping seasons and arrive at a consistent rate throughout the year.

admitted that they also place sale signs on some products when they are first introduced (before they are discounted), so that not all products with sale signs are truly discounted. This was corroborated by repeated visits to the department store and to one of its competitors. All of the products we observed finishing their seasons at the two department stores had sale signs, while at the start of the season some products had sale signs and others did not.⁴

These policies of placing sale signs on every discounted product without also placing them on all of the nondiscounted products suggest that the presence of a sale sign signals that a product is already discounted.⁵ Similarly, absence of a sale sign reveals that a product is yet to be discounted and may be available in the future. As an illustration we compared price changes for a sample of products at the two department stores. From each store we randomly selected 10 products with sale signs and 10 without.⁶ We returned three weeks later and observed lower prices on 16 of the 20 (80%) products that did not have sale signs on our earlier visit. In contrast, only 10 of the 20 (50%) products *with* sale signs on the first visit had lower prices when we returned (the difference in these proportions is significant, $p \leq .05$).⁷ The sale signs observed on the first visit did contain information about which products would be available at a lower price in the future.

The discussions with the store owners and executives suggest that stores place sale signs on all products

⁴We focused on the moderate women's sportswear departments. To resolve our uncertainty about when products were introduced, we first made a series of weekly visits to each store. This allowed us to become familiar with the products and to identify when new products were introduced.

⁵If a store has N products and α of them are discounted then, with no other information, the probability that a product is discounted is α/N . However, if all of the discounted products and β of the nondiscounted products have sale signs, the probability that a product *with a sale sign* is discounted is $\alpha/(\alpha + \beta)$. This is larger than α/N whenever some of the nondiscounted products do not have sale signs ($\alpha + \beta < N$).

⁶Because there were over 100 different styles in each department (at each store), identifying and tracking the prices of every product was not practical.

⁷The prices of the other products were unchanged, except for one product that had a sale sign on the first trip and was no longer available on the second trip.

finishing their seasons and also choose how many products start their seasons with sale signs. In the remainder of this section we offer a rationale for these strategies.

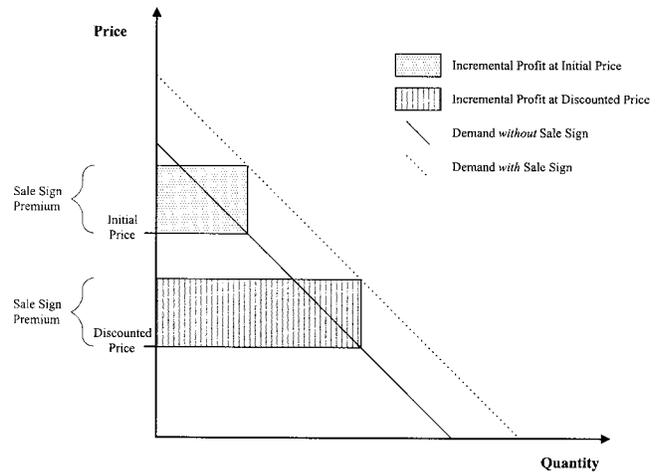
Sale Signs on Products Finishing Their Seasons

Our explanation for why stores place sale signs on all products finishing their seasons focuses on the role of *unit volumes*. If sale signs increase demand, they will lead to either higher prices and/or higher sales volumes.⁸ Charging higher prices (premiums) for products with sale signs argues for placing them on products for which a store sells many units, so that the premium is collected from more customers. Because unit volumes are higher when prices are lower (if demand functions are downward sloping),⁹ this in turn suggests that stores will find it profitable to place sale signs on products that truly are discounted. We illustrate this argument in Figure 1, where the higher demand for products with sale signs is reflected by a shift outwards in the demand function. The additional profit earned from charging a higher price (while holding quantity fixed) is depicted by the shaded areas. We see that the additional profit is higher when a sale sign is placed on a product that is already discounted.

This result illustrates the self-fulfilling nature of the underlying signal. Because sale signs increase customer demand, firms prefer to place them on discounted products. Given this preference, sale signs do reveal which products are truly discounted, which in turn explains why they increase customer demand.

While this finding addresses whether stores prefer

Figure 1 Comparison of Incremental Profit from Sale Sign Premium at Initial and Discounted Prices



to place sale signs on discounted products, it does not explain why stores discount. However, the demand uncertainty and price discrimination explanations for discounting are consistent with our argument. Both assert that stores discount to sell more units, either because the season is finishing and high initial prices have left excess inventory (demand uncertainty) or because the store initially sold to only high reservation customers without penetrating the rest of the market (price discrimination). By revealing which prices are truly discounted, sale signs allow stores to sell their excess inventory and satisfy their remaining demand with smaller discounts.

An alternative explanation might consider the loss of credibility if customers recognize that products with sale signs are not discounted. When stores place sale signs on products that have not been discounted, they risk revealing this deception to customers, diminishing the credence of future sale claims. As we formally demonstrate in §3, stores often find it profitable to reveal which products are discounted, so that this loss of credibility is costly. The more information that stores wish to reveal, the greater the incentive to restrict sale signs to products that are truly discounted.

How Many Products Have Sale Signs Throughout Their Seasons?

Revealing which products have low prices also reveals which products have high prices, leading to higher demand for products that have sale signs but reduced

⁸Evidence that sale signs increase demand is offered in two recent studies, one conducted in a laboratory (Inman, McAlister, and Hoyer 1990) and the other conducted in an actual retail setting (Inman and McAlister 1993). Further evidence can be found in discrete choice models where, despite controlling for the regular price and the extent of any price discount, there is strong evidence that customers are more likely to purchase products that are accompanied by sale signs. Evidence might also be inferred from use: the prevalence of sale signs is a strong indication of their efficacy.

⁹This will generally be true even if customers are not able to recognize that the price is discounted. The increase in units sold when products are discounted was confirmed by the department store executives. They reported that a large majority of total volume occurs after a product has been discounted. Of course, this may in part be due to their policy of placing sale signs on discounted products.

demand for products that lack them. Given the low cost of producing sale signs, stores could place them on all of their products throughout their seasons.¹⁰ We identify a tradeoff that regulates the number of sale signs stores will use. The presence of this tradeoff may be interpreted as evidence that use of sale signs is at least partially self-regulating.

We argue that customers recognize that the accuracy of the signal varies with the number of sale signs displayed. If they suspect that few products are discounted but observe many sale signs, customers doubt that all of the products with sale signs are truly discounted. This presents stores with a tradeoff: placing a sale sign on an additional product increases demand for that product, but may reduce demand for other products that already have sale signs.

Customers' beliefs should be sensitive to the number of products that have sale signs. If stores place sale signs on more than just their truly discounted products, they reduce the accuracy of the resulting signal.¹¹ In the extreme, if stores place sale signs on all of their products, customers get no information about which products have been discounted. Our argument does not require that customers know how many products are truly discounted at each store. It is sufficient that customers have prior beliefs about how many products are discounted and that they use these beliefs in their decisions. Moreover, customers' prior beliefs may vary between stores, product categories, and times of the year. For example, customers may recognize that Wal-Mart has more discounts than Brooks Brothers, and that more swimsuits are discounted at the end of summer than at the start of spring.

Anecdotal evidence that customers are sensitive to the number of sale signs in a store was offered by the department store executives we spoke to. The store has a policy limiting the number of sale signs displayed in

any department. One would normally expect that individual department managers would be best positioned to choose a sale sign strategy. Therefore, existence of a corporate policy limiting the discretion of department managers suggests there may be externalities that individual department managers would overlook. While department managers might optimize use of signs for their own departments, they may fail to internalize the impact of additional sale signs on demand for products in other departments. This interpretation is consistent with observations by the executives that department managers would generally like to use more sale signs than corporate policy allows.

Summary

Stores do appear to place sale signs on products that have been discounted. This might be explained by the increment in unit volume following a price reduction. The evidence also suggests that stores sometimes place sale signs on products throughout their seasons and we have argued that this strategy is regulated by customer sensitivity to how many sale signs are used. In the next section, we present a formal model that illustrates these arguments.

Other Factors

For completeness we offer a brief summary of other factors that may affect which products receive sale signs. We caution that these factors are not featured in the formal model presented in the next section, and in some cases are inconsistent with the description of actual practice revealed in our discussions with store owners and executives.

1. Price knowledge: Stores are more likely to place sale signs on items for which customers have less price knowledge. Credibility concerns may prompt stores to place sale signs on their private label products. Private label products are not available in competing stores, so that customers cannot directly compare prices between stores. This prediction is consistent with statements by the department store executives that they have a policy of first placing early season sale signs on their private label products. Availability of other cues beyond price and sale signs may also help resolve customer uncertainty and reveal inaccurate sale signs. For example, the time of the year (swimsuits in May) and

¹⁰Although retailers who make false claims may face liability under the Uniform Deceptive Trade Practices Act (1966, §2), the primary remedy is simply an order to desist and enforcement is both difficult and rare.

¹¹Recall our earlier example (Footnote 5). The probability that a product *with a sale sign* is discounted decreases when more nondiscounted products have sale signs (β is larger).

full display racks may indicate that a product is starting its season. Even without credibility concerns, sale signs will be less effective at shifting demand if customers are already well-informed.

2. Quality signals: Stores are more likely to place sale signs on items for which quality is known. By signaling that demand is low, sale signs may raise concerns about quality. In a fashion setting, the presence of a sale sign could signal that demand is disappointing and that the product is not fashionable. This is consistent with the response of the specialty store owners when asked why they never place sale signs on newly introduced products. They claimed that some of their customers are more concerned with purchasing fashionable products than saving money, and so would be reluctant to purchase products that are discounted.

3. Unit volumes: Stores are more likely to place sale signs on items with higher unit volumes. Unit volumes vary across products. As a result, the opportunity to charge a premium for products with sale signs argues for placing them on more popular products throughout the season whether or not they are discounted. For example, other types of promotional support may increase unit sales, so we might expect to see sale signs on products that also receive other support.

4. Profit margins: Stores are more likely to place sale signs on items with higher profit margins. The shift in demand upon use of a sale sign can lead to higher prices and also higher unit volumes. The potential for higher unit volumes implies that stores should place their signs on products with large profit margins. This provides a further explanation for why private label products are more likely to have early season sale signs. Profit margins are also higher earlier in the season (before the price is discounted), suggesting some stores may place sale signs only on products starting their seasons. This observation prompted us to initially question which products receive sale signs in practice. However, we found no evidence that stores place sale signs on products at the start of their seasons and later remove them, indicating that this factor is dominated by other concerns.

3. A Formal Model

The phenomenon under investigation is of its nature rather complex, incorporating asymmetric informa-

tion, dynamic pricing, signaling, multiple products, competing stores, and optimal customer search strategies. For this reason, we summarize the key assumptions and results in Table 1. Stores' sale sign and price strategies are entirely endogenous in the model, as is the impact of sale signs on demand. Demand increases for products with sale signs because customers believe these products are less likely to be available in the future. These beliefs are self-fulfilling: the opportunity to charge a premium prompts stores to place sale signs on products finishing their seasons for which they sell more units. In our discussion we highlight the presence of this premium, the change in its size and the credibility of the underlying signal when more products have sale signs.

The model has several unique features. Firms use multiple cues to communicate with customers, and customers vary in the information they learn from each cue. The model also demonstrates that customers need not be able to fully predict actions taken by different types of firms to learn from the actions of those firms.¹² Finally, we show that firms may intentionally introduce noise to their signals, so that inaccurate signals need not arise solely due to exogenous environmental factors.

The Stores

We contemplate an infinite period model of a market in which a large number of competing stores sell fashion products in overlapping two-period seasons. The stores each introduce n new products each period, so that in any one period they have n new products beginning a season and another n old products finishing their seasons. We will refer to the period in which a product is first introduced as "the start of its season" and the second period in which it is available as the "end of its season." After the second period the product is no longer available. The $2n$ products represent different product categories, so that the products vary in style and design and have independent demand. Moreover, while the product categories and the timing

¹²Customers need not be able to invert the firms' profit functions.

Table 1 Model Summary

Assumptions

1. A large number of stores sell imperfect substitutes. The products have two-period overlapping seasons, so that each period some products are starting their seasons and others are finishing their seasons.
2. Stores choose price and sale sign strategies. There is no cost to using sale signs and stores can use as many sale signs as they prefer.
3. New customers arrive each period and must decide whether to purchase immediately or delay and return in the future (to the same store or to a different store). They anticipate that:
 - if a product is finishing its season, it will not be available in the future;
 - if they delay and the product is still available, it will be less expensive in the future;
 - by visiting a different store, they may find a product that better suits their needs; and
 - they incur an additional transportation cost if they delay and return.
4. Customers are unsure which products will be available (at a lower price) in the future. Prices only partially resolve this uncertainty because customers are also uncertain of relative price levels.
5. Customers expect that:
 - products with sale signs are less likely to be available in the future than products without sale signs;
 - the more sale signs they see, the more likely that any product with a sale sign will be available in the future.

Results

1. Stores prefer to price discriminate by charging a high price at the start of the season and selling at a lower price to remaining customers at the end of the season.
 2. By placing a sale sign on a product, stores can raise the price and still sell to the same customers (customers are willing to pay a higher price to purchase products with sale signs).
 3. Stores prefer to place sale signs on products that are truly discounted as they sell more units of these products. As a result, products with sale signs are less likely to be available in the future than products without sale signs.
 4. When more products have sale signs, products with sale signs are less likely to be discounted, and customers will pay less to purchase them. This results in a tradeoff that determines how many sale signs stores use: placing a sale sign on an additional product increases the price that can be charged for that product but reduces the price that can be charged for other products that already have sale signs.
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of product introductions coincide across stores, the products sold by different stores are imperfect substitutes.

At the start of each period stores simultaneously set price and sale sign strategies for each of their $2n$ products. Stores must charge the same price to all customers during the same period, but can vary prices across products and between periods. Stores can also place sale signs on as many or as few products as they prefer, and there are no restrictions on which products can have sale signs. Production and use of sale signs does not result in any transaction cost. Finally, we make the simplifying assumption that stores can predict demand with certainty and assume they discount future revenue using the discount factor δ . We note that allowing demand uncertainty introduces inventory complexities but could lead to a further explanation for discounting at the end of the season.

Customers

Customers have demand for just one product category and purchase at most a single unit from that category.¹³ They decide when and where to purchase but can visit only one store each period. If they delay purchasing, they can visit the same store or a different store the next period but incur an additional transportation cost k . Customers vary in their demand, which we formalize by assuming that a customer's reservation value (V) is either high or low; $V \in \{L, H\}$ where $H - L = M > 0$. We assume that customers know their own reservation values but do not observe the reservation values of other customers. We will later discuss

¹³While our results survive allowing the customers to purchase multiple products at each store, relaxing this assumption adds complexity to the customers' store choice decisions without contributing additional insight.

how uncertainty regarding other customers' valuations affects the information revealed by price cues. Because of the heterogeneity in the stores' products, we assume that if customers choose to delay purchasing and visit a different store in the next period they may find a product that better suits their needs. Formally, we assume that customers who have a low willingness to pay ($V = L$) will, with probability η , have a higher willingness to pay ($V = H$) at a competing store. The symmetric possibility, that customers for whom $V = H$ may have a lower willingness to pay at a competing store, is not relevant to the analysis.

New customers arrive in the market in both periods of a product's season (at both the start and end of each product's season). Because new customers have no information about differences in stores' price or sale sign strategies, they randomly select which store to visit first. A mass of Y high reservation value (for whom $V = H$) and a mass of X low reservation value new customers arrive at each store each period.¹⁴ New customers who do not buy either exit the market, return to the same store, or visit a different store in the next period (the end of the season). After two periods any remaining product is removed from the stores so that customers who do not buy in the second period of a product's season exit the market without making a purchase (few swimsuits are available in winter, while gloves and woollen sweaters are difficult to purchase in summer).

In Figure 2, we summarize customers' options each period together with the actions that they choose in equilibrium. At the start of a product's season (Period 1 for that product), the mass of $X + Y$ new customers are the only customers who have demand for the product.¹⁵ End of season demand (Period 2) includes a second mass of $X + Y$ new customers together with (possibly) some of the customers who arrived in the market at the start of the season but did not purchase.

¹⁴Note that for *each product* stores have a mass of $X + Y$ new customers arriving in each period. Customers who purchase at the end of the season may get less use out of the product, so that valuations might be lower at that time. This suggests an additional reason for why prices are discounted at the end of the season; however, this is another feature that would add complexity and yield few additional insights.

¹⁵Note that demand for a product only occurs during its season, so

There is no communication between customers and customers discount future consumption using the same discount factor as the stores (δ).

Customer Uncertainty

Upon arrival in the market, deciding whether to purchase immediately is complicated by customers' initial uncertainty about which products will be available in the future. New customers realize that products are available for two periods but are unsure whether their arrival in the market coincides with the start or end of each product's season.¹⁶ Customers have two cues available to resolve this uncertainty: the current price and the presence of a sale sign. We will conservatively assume that customers first use the current price and only rely upon sale signs if price information is not fully revealing.

Price Cues. Customers' price expectations are consistent with actual store strategies. Customers expect stores to start the season with high prices and sell only to customers with high reservation values. At the end of the season, customers expect stores to discount and sell to all remaining customers at the market-clearing price (the price at which both high and low reservation customers purchase). If customers can recognize which products are discounted, they can infer which products are finishing their seasons. We consider three ways that customers might use the current price to determine whether an item is discounted.

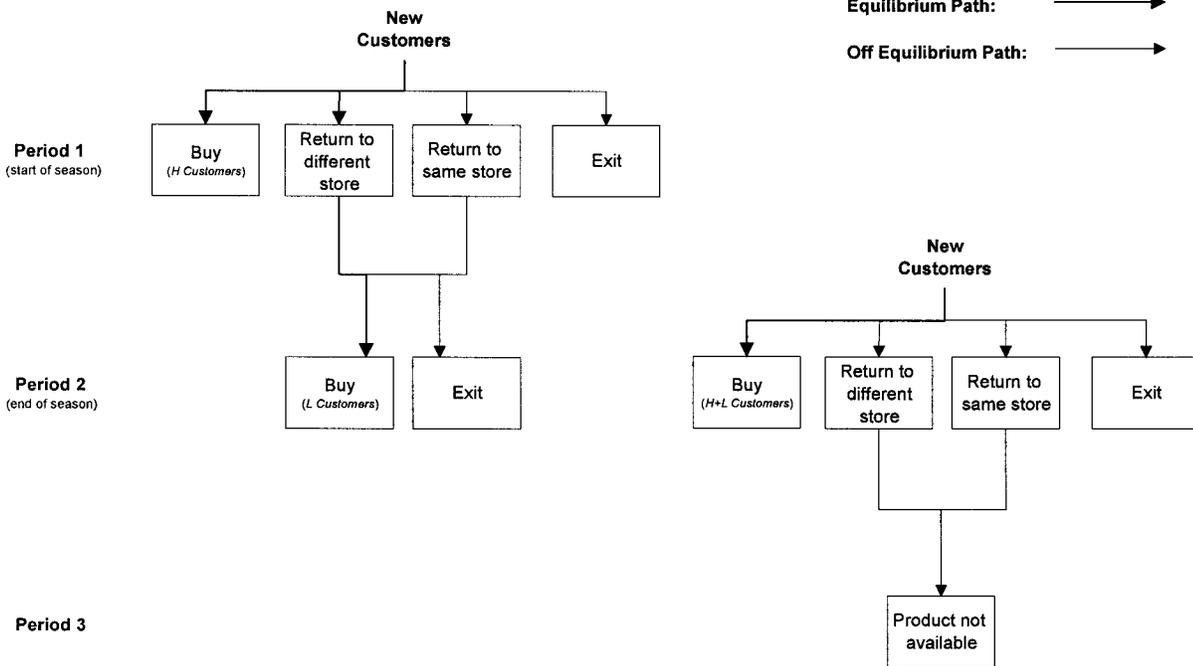
First, if customers can recall historical price levels, a simple comparison of current and historical prices might indicate whether an item is discounted. However, behavioral research on price knowledge has shown that consumers generally have poor recollection of historical prices (Allen, Harrell, and Hutt 1976; Conover 1986; Dickson and Sawyer 1990).¹⁷ In addition, variation in styles and materials between seasons

that when the season begins there are no customers who shopped for the product in the previous period.

¹⁶Our arguments do not require that *all* customers are uninformed and the proportion of customers who are uninformed may vary across product categories and times of the year.

¹⁷Although these studies all consider grocery products, recall that we earlier claimed that the unpredictable rate of price and product changes in fashion markets argues for even lower levels of price knowledge.

Figure 2 Customers' Options and Actions in Each Period



make historical price comparisons difficult. For these reasons, we assume that customers cannot recognize initial and discounted price levels and hence cannot directly identify which products have discounted prices.

Second, knowledge of the store's profit function may allow customers to predict initial and discounted prices. For example, if customers knew that low reservation customers would pay up to \$15, any price higher than \$15 could only be an initial price (because it would not clear the market). These predictions require that customers know the distribution of aggregate demand. However, customers cannot observe the valuations of other customers and (unlike stores) do not have access to data describing historical purchasing behavior. For these reasons, we assume that customers know their own reservation value (V) but do not know how it compares with that of other customers (they do not know the values of L or H).¹⁸ Their

¹⁸For example, customers may observe that their own reservation value is equal to \$15 ($V = 15$). However, because they cannot ob-

prior are that $V = L$ with probability 0.5 and $V = H$ with probability 0.5.

Third, customers might form inferences about aggregate demand from their own reservation values (V). If the current price exceeds a customer's reservation value ($p > V$), then it cannot be discounted as it will not clear the market. Hence, observing $p > V$ implies that the product will be available at a lower price next period. In contrast, a very low price ($p < V - M$) will clear the market whatever the customer's reservation value, so that observing $p < V - M$ leads to a conclusion that the price is already discounted and the product will not be available next period.¹⁹ Intermediate prices ($V - M < p \leq V$) are less informative because

serve the valuations of other customers, they remain uncertain whether $L = 15$ (in which case $H > 15$) or $H = 15$ (so that $L < 15$).

¹⁹Recall that $M = H - L$ so $p < L$ when $p < V - M$.

these prices only clear the market if the customer's reservation value is low ($V = L$). If the customer's reservation value is high ($V = H$), only high valuation customers purchase the product. Because customers do not know whether V equals H or L , prices in the range $(V - M, V]$ do not provide any additional information.²⁰ As a result, customers must rely upon sale signs to infer which products are finishing their seasons and have discounted prices.

Note, we assume customers are unsure how their preferences compare with other customers (they do not know whether V equals H or L), but they do know the variance in other customers' preferences (they know M , the difference between H and L). A more intuitive interpretation is that customers are unsure about initial prices: they recognize that customers differ and so are unsure which initial price will be most profitable for a store. However, they know prices are discounted during the season and can predict the size of those discounts (determined by M , which characterizes the range of customer demand). It is sufficient that customers can anticipate the percentage discount rather than a specific dollar amount. Moreover, we could introduce some uncertainty about the size of future discounts (through the value of M), although this would yield few additional insights. When questioned about these assumptions, department store executives raised few objections. They noted that while initial prices vary greatly, discount strategies tend to be very stable across products, product categories, and stores. In particular, products are first discounted by 25%–30%, typically followed by a further reduction to 40%–50% off the original price. These percentages are consistent with the data we collected during our visits to the two department stores.

Relaxing the assumption that customers have sufficient knowledge to predict optimal prices from store profit functions represents a departure from standard

signaling models. In previous models, equilibrium and out-of-equilibrium beliefs implicitly require that customers can perfectly invert firm profit functions.²¹ This is a step towards acknowledging the growing behavioral literature suggesting that customers may lack this knowledge. Despite their relative lack of information, customers in our model behave strategically and use multiple cues. While prices are sufficient to resolve uncertainty for some customers, others need to rely upon sale signs.

Sale Sign Cues. Customers correctly expect that stores will place sale signs on all of their discounted products. Because they also anticipate that stores discount only products that are finishing their seasons, they expect to see sale signs on at least n products.²² If they see sale signs on more than n products, they infer that not all of them are truly discounted. In accordance with this inference, and in the absence of any additional information, they rely upon Bayes rule to update their expectations. In particular, if there are sale signs on q products, the probability that any one of these products will be available (at a lower price) in the future is equal to $\Phi(q)$, where:

$$\Phi(q) = \begin{cases} 0 & \text{if } q \leq n, \\ \frac{q - n}{q} & \text{if } q > n. \end{cases} \quad (1)$$

It is this Bayesian updating that ensures that customers are not simply misled when stores place sale signs on new products. The accuracy of these beliefs and the expectation that stores will first put sale signs on all of the products that are finishing their seasons underpins the credibility of the signal and will form the basis of an important equilibrium condition. Consistent with Bayes rule and equilibrium firm strategies, products without sale signs are all considered to be new and not yet discounted.²³

²⁰The result that customers get no information from observed prices in this situation depends upon customers having prior beliefs that V is equally likely to equal L or H . Our findings are not sensitive to this result. It might be reasonable to adjust these priors according to the relative masses of each customer type (i.e., X and Y). Alternatively, we could include a parameter describing customers' beliefs after observing prices (and could even allow these beliefs to differ from the true probabilities).

²¹See, for example, Wernerfelt (1988), Chu (1992), Chu and Chu (1994), and Simester (1995).

²²As we discussed earlier, customers' prior beliefs about the number of products that are truly discounted need not be accurate. They may also vary due to store reputation or across product categories and times of the year.

²³The probability that a product without a sale sign will be available

We summarize customers' inferences from price and sale sign cues in Table 2. Note that when inferring which products are finishing their seasons, customers also implicitly update their beliefs about whether their valuations are high or low (whether V corresponds to H or L). Table 2 describes customers who are new to the market. We assume that customers who return after not purchasing on their first visit recognize which products were available in the previous period (and are now finishing their seasons).²⁴

Customer Behavior

Recall that customers have four alternatives after inspecting the product: They may purchase immediately, return to the same store in the next period, return to a different store, or leave the market. If customers delay purchasing, they risk that the product will not be available in the following period and incur an additional transportation cost k if they return next period. Balancing these considerations, if the product is still available in the next period, customers anticipate that the price will be lower. In particular, customers correctly expect prices to be discounted by M between

in the future is equal to one, even if fewer than n products have sale signs. This (out-of-equilibrium) belief is consistent with customers interpreting fewer than n sale signs as an indication that the firm did not introduce n products in the previous season. Alternatively, if customers interpret fewer than n sale signs as an indication that some of the products lacking sale signs have also been discounted, there may exist an equilibrium in which stores use few sale signs to increase demand for the products that lack them.

²⁴Relaxing this assumption would not affect the results. Indeed, assuming that returning customers could not recall which products were available in the previous period would simplify the analysis because new and returning customers would exhibit the same behavior.

seasons.²⁵ Visiting a different store also raises the possibility that they will find a product that better suits their needs (if price and sale sign cues suggest their valuation at the current store is low). In deciding how to respond, customers use the price and sale sign cues to update their expectations about which products will be available in the next period. In this subsection we summarize their responses under each of the four combinations of sale sign and price levels described in Table 2.

First, if the *price is high* ($p > V$) new customers believe that the product will be available next period. Because this also implies that their reservation value at the current store is low, if they return they will visit a different store where their needs may be better served. This strategy yields an expected surplus of at least $\delta(\eta M - k)$, which we assume is positive.²⁶ Therefore, if new customers see a price higher than their reservation value, they visit a different store in the next period. Second, when the *price is low* ($p \leq V - M$), new customers do not expect the product to be available in the future. Hence, if $p \leq V - M$, new customers purchase immediately from the current store.

Third, when a product has an *intermediate price and no sale sign*, new customers believe that the product will be available in the next period. If they do not purchase, they will return to the same store where they believe they have a high reservation value. They expect

²⁵For completeness, if the first period price is very high so that $p > V + M$, we assume that customers expect that the store will charge V in the next period. Charging $p > V + M$ in the first period is an out-of-equilibrium strategy that will result in no demand in that period.

²⁶Customers incur the transportation cost k whether or not they purchase on their second visit and they do not expect the second period price to exceed V .

Table 2 Customers' Posterior Beliefs

p relative to V	Sale Sign	Belief
High prices $p > V$	Not relevant	The product will be available in the future, $V = L$.
Low prices $p \leq V - M$	Not relevant	The product will <i>not</i> be available in the future, $V = H$.
Intermediate prices $p \in (V - M, V]$	No	The product will be available in the future, $V = H$.
Intermediate prices $p \in (V - M, V]$	Yes	Prob $\Phi(q)$: the product will be available in the future, $V = H$. Prob $1 - \Phi(q)$: the product will <i>not</i> be available in the future, $V = L$.

to earn utility $\delta(V - p + M - k)$ from returning to the same store, compared to $V - p$ from purchasing immediately. Rearranging terms we find that customers will purchase immediately iff

$$V - p \geq \frac{\delta(M - k)}{1 - \delta} = \lambda. \quad (2)$$

If this condition is not satisfied, they will return to the same store in the next period. We can interpret λ as the surplus that a store must offer a new customer to induce an immediate purchase when a product does not have a sale sign.²⁷

Finally, for *intermediate priced products that have sale signs*, the expected utility from delaying and returning to the same store in the following period is $\delta\Phi(V - p + M) - \delta k$, where $\Phi = \Phi(q)$ reflects the probability that the product will be available in the following period. Note that if the product is available in the next period, the customer has a high reservation value at the current store, so there is nothing to be gained from returning to a different store. Recall also that customers incur the transportation cost whether or not they purchase on their second visit, and if the product is not available they exit without affecting the demand of other customers or products. We conclude that customers will purchase immediately iff

$$V - p \geq \frac{\delta(\Phi M - k)}{1 - \delta\Phi} = \Lambda, \quad (3)$$

and if not they will return to the same store in the next period. Thus, Λ represents the surplus that a store must offer a new customer to induce purchase of a product that has a sale sign. The optimal behavior of new customers is summarized in Table 3.

²⁷For those customers for which the price is in the range $(V - M, V]$.

Given these interpretations, $\lambda - \Lambda$ represents the sale sign premium, or the additional price that a store is able to charge for products that have sale signs (recall that $\Phi \leq 0.5$, so $\lambda > \Lambda$). This describes the shift in the demand curve when a product has a sale sign. We emphasize that this is an endogenous result. Customers expect that stores will first place sale signs on their discounted products, so that no matter how many products have sale signs, these products are always less likely to be available next period than products without sale signs.

It is helpful to define q^* as the number of products with sale signs at which the sale sign premium is at its maximum (Λ is equal to zero):

$$q^* = \frac{Mn}{M - k}. \quad (4)$$

When Λ equals zero, a product with a sale sign is so unlikely to be available next period that (new) customers will pay their full reservation value to purchase it now. Because customers will never pay more than V ($\Lambda \geq 0$), a firm should use at least q^* sale signs.²⁸ If a store uses more than q^* sale signs, products with sale signs are more likely to be available next period ($\Phi > 0$), and so customers will pay less to purchase them right now (Λ increases with q). This illustrates the tradeoff facing the stores: placing a sale sign on an additional product increases demand for that product ($\lambda > \Lambda$) but reduces demand for other products that already have sale signs ($\lambda - \Lambda$ decreases with q). Again, this result is an endogenous feature of the model.

Recall that when customers return to the same store or a different store after not purchasing in the previous period, they know that the product (if still available)

²⁸To avoid degenerate solutions, we focus on parameters for which $q^* < 2n$.

Table 3 Behavior of New Customers

p relative to V	Sale Sign	Behavior
High prices $p > V$	Not relevant	Delay and visit a different store in the next period.
Low prices $p \leq V - M$	Not relevant	Purchase from the current store immediately.
Intermediate prices $p \in (V - M, V]$	No	Purchase from the current store if $V - p \geq \lambda$, otherwise delay and return to the same store in the next period.
Intermediate prices $p \in (V - M, V]$	Yes	Purchase from the current store if $V - p \geq \Lambda$, otherwise delay and return to the same store in the next period.

is finishing its season. Hence these returning customers will pay up to V . Moreover, because these customers cannot observe a store's price or sale sign strategies prior to visiting, we assume that if they visit a different store they randomly distribute themselves among the other stores.

Store Strategies

The strategy space for the stores is large. Rather than checking all possible deviations from the proposed equilibrium, we provide a series of sufficient conditions that enable us to rule out broad classes of strategies. The first two conditions greatly simplify the analysis by allowing us to treat each period independently (so that an equilibrium in any stage game is also an equilibrium in the infinite period game). In particular, we ensure that each store prefers to sell to its high valuation customers at the start of the season, and that low valuation customers return to a different store if they do not buy at the start of the season. The remaining conditions focus on the prices that stores will charge at the start and end of the season, which products they prefer to place sale signs on, and how many sale signs they will use. We present the formal conditions in the appendix.

High Valuation Customers at the Start of the Season. To ensure that stores prefer to sell to customers with high reservation values at the start of the season, we assume that the price these customers will pay at the start of the season exceeds the maximum discounted price they will pay at the end. This yields our first equilibrium condition (Condition 1) and ensures that at the start of a product's season stores charge no more than $H - \Lambda$ if the product has a sale sign and $H - \lambda$ if it does not.

Low Valuation Customers at the Start of the Season. If the store charges a price higher than L at the start of the season, (new) low valuation customers do not purchase at the current store and return to a different store in the next period (see Table 3). In Condition 2 we ensure that stores prefer to charge more than L when *not* selling to low valuation customers at the start of the season. The next condition addresses whether stores prefer to sell to low valuation customers at the start of the season.

Prices of Products Starting Their Seasons. In Condition 3 we assume that stores can earn more profit from selling to just the high valuation customers at the start of the season; charging $H - \Lambda$ for their new products that have sale signs and $H - \lambda$ for their new products without sale signs.

Prices of Products Ending Their Seasons. At the end of the season, the stores face a mass of X and Y new customers, together with some returning customers who visited another store at the start of the season. We introduce three equilibrium conditions (Conditions 4, 5, and 6) to ensure that at the end of the season the stores prefer to sell to all of these customers, charging $L - \Lambda$ for products with sale signs and $L - \lambda$ for products without sale signs. These conditions are more likely to be satisfied when η is low, so that most of the returning customers have low reservation values. It is these additional customers with low reservation values that prompt stores to discount their prices at the end of the season.

Where to Place Sale Signs. We compare the profit earned from placing sale signs on products starting and finishing their seasons and show that it is always more profitable to take a sale sign off a product starting its season and place it on a product that is finishing its season. As a result, stores first put sale signs on their older products. This ensures that sale signs yield a credible signal. It also implies that all n products finishing their seasons each period have sale signs (recall that firms use at least $q^* > n$ sale signs). Note that the distribution of uninformed (new) customers remains constant, so sale signs do not affect expectations of more customers at the end of the season. Rather, the store simply sells to more customers at that time and thus derives greater benefit from charging a premium.

How Many Sale Signs to Use. Because stores prefer to put sale signs on all of the products finishing their seasons, we need only consider how many products also get sale signs at the start of their seasons (τ). Recall that stores face a tradeoff when placing sale signs on products starting their seasons: the demand for these products will increase; however, stores must charge a lower price for other products that already have sale signs. Stores resolve this tradeoff by selecting

τ to maximize their profits. We present the store profit function in the appendix and derive the following first-order condition:

$$\frac{\partial \pi}{\partial \tau} = Y(\lambda - \Lambda) - (2X + Y + \tau Y) \frac{\partial \Lambda}{\partial \tau} = 0. \quad (5)$$

The first term captures the increased profit earned from the product that receives the additional sale sign, while the second term reflects the lost profits from other products that already have sale signs.

In selecting τ , stores determine how much information they will reveal through their sale signs. Increasing τ increases the number of newly introduced products that have sale signs, reducing the accuracy of the signal. In the limit, if every product had a sale sign, sale signs would not provide any information about which products will be available in the future. For ease of exposition, we focus on the equilibrium that yields the most accurate signal ($q = q^*$ so that $\Lambda = 0$). To support this equilibrium, we introduce a final equilibrium condition (7) ensuring that the first-order condition is negative throughout its relevant range. This equilibrium's existence confirms that stores may prefer not to put a sale sign on every product, so that the discriminating use of sale signs is capable of increasing stores' profits. We formally state sufficient conditions for this equilibrium in Result 1 (the proof should be obvious by construction).

RESULT 1. If Conditions 1 through 7 are satisfied and customers adopt the beliefs in Table 2 and the behavior in Table 3, it is an equilibrium for stores in each period to:

- charge L and place sale signs on all n of the products finishing their seasons,
- charge H and place sale signs on $q^* - n$ of the products starting their seasons,
- charge $H - \lambda$ and do not place sale signs on the remaining products starting their seasons, where λ is defined by q^* .

It is trivial to show that there exists a region of parameter space in which each of the parameter restrictions and equilibrium conditions are satisfied.²⁹

²⁹For example, $n = 100$, $L = 26$, $H = 40$, $k = 1$, $X = 6$, $Y = 11.2$, $\eta = 0.1$, and $\delta = 0.5$.

4. Conclusions

We have shown that sale signs may increase demand by providing customers with credible information about which products are discounted. As a result, stores can charge a premium for products with sale signs. In turn, this premium supports the credibility of the signal by prompting stores to place sale signs on discounted products (for which they sell more units). Stores may introduce noise by also placing sale signs on nondiscounted products. However, if customers' price expectations are sensitive to the number of products that have sale signs, doing so reduces demand for other products that already have sale signs.

The model demonstrates how firms may use multiple cues to communicate with customers and that customers vary in how much they learn from each signal. Price alone resolves uncertainty for some customers, but other customers need both price and sale sign information. The model also illustrates that firms may prefer to reveal only partial information. Previous work has recognized that signals are not always accurate; however, noise typically enters exogenously rather than due to firm preferences.³⁰ In our model, stores endogenously choose to introduce noise so that sale signs only partially reveal which products are discounted.

While the discussion in this paper focuses on fashion products, our results apply quite generally to markets in which prices vary between stores: Stores can use sale signs to reveal whether their prices are lower than prices at competing stores. The credibility of this signal requires that stores prefer to place sale signs on products that truly have lower prices than their competitors. In support of this application, we compared price and sale sign strategies for a sample of 85 home appliance products sold at two competing stores. The sale signs did contain information about which products had low prices; however, similar to the department store example, the sale signs were not always accurate. At both stores we found sale signs on products that were more expensive than at the competing store

³⁰Examples of models incorporating exogenously noisy signals (more commonly described as models of *signal-jamming*) can be found in Gibbons (1985), Fudenberg and Tirole (1986), and Bebchuck and Stole (1993).

(where the products did not have sale signs). We also conducted a simple laboratory experiment that supported our claim that customers anticipate these inaccuracies and are sensitive to the number of products with sale signs. We hope to report these findings in a later paper.

We have considered sale signs placed at the point of sale, yet stores also use sale signs to advertise store-wide sales events, such as grand opening, anniversary, and one-day sales. Although these claims are store-specific rather than product-specific, our results may help to explain why stores restrict reliance on these events. If customers' price expectations are sensitive to the frequency of these events, effectiveness may decrease with repetition. We caution that our results do not address the relative effectiveness of different promotional wordings such as "on sale," "special price," or "hot buy."

Future research might investigate how the explanations advanced in this paper interact with other roles played by sale signs. For example, because sale signs highlight which products have low prices, they may draw customers' attention. Sale signs may also contribute to a store's price image. In particular, stores may increase the proportion of products that have sale signs to signal a low price image (Simester 1995).

Our findings may also relate to Thaler's (1985) model of consumer choice. Thaler introduces the notion of *transaction utility*, reflecting the utility derived from participating in a favorable transaction. More formally, he defines transaction utility as a function of the difference between the price paid and some reference price. The lower the price paid relative to the reference price, the larger the transaction utility. The findings in the current paper may explain why sale signs credibly raise customers' reference prices (in turn, raising their transaction utility).

Finally, future research may also address the need to regulate stores' use of sale signs. Our findings suggest both that stores have an incentive to place sale signs on products with high (non-discounted) prices and that this occurs in practice. However, we also argue that customers may not be deceived. If customers anticipate these strategies and adjust their expectations accordingly, sale signs will continue to result in more

informed purchasing decisions. Enforcing a prohibition on inaccurate sale signs may actually harm customers if it results in stores no longer using any sale signs.³¹

Appendix

Variable definitions

- H = reservation value of high valuation customers,
- Y = mass of new high valuation customers each period,
- L = reservation value of low valuation customers,
- X = mass of new low valuation customers each period,
- $M = H - L$ (the difference in reservation values for high and low valuation customers),
- η = probability that a low valuation customer will have a higher valuation at another store,
- n = number of products introduced each period,
- k = transportation cost incurred when returning to the same store or a different store next period,
- π = store profit function,
- δ = discount factor used by customers and stores,
- τ = proportion of new products that have sale signs,
- Φ = probability that an intermediate priced product with a sale sign is new (not discounted),
- Λ = incentive that new customers require to purchase products with sale signs (Equation (3)),
- λ = incentive that new customers require to purchase products without sale signs (Equation (2)).

The equilibrium conditions

High valuation customers at the start of the season. At the start of the season, all customers are new so that H customers will pay $H - \Lambda$ for products with sale signs and $H - \lambda$ for products without sale signs. At the end of the season, these customers will pay H (irrespective of whether they have a sale sign). To ensure that the stores prefer to sell to the high valuation customers in the first period we assume that:

$$H - \lambda > \delta H. \quad (A1)$$

Low valuation customers at the start of the season. We assume that the store would prefer to start the season by selling to its high valuation customers at $H - \lambda$ rather than charging $p = L$:

³¹This paper has benefited from comments by Jim Brickley, Jeff Inman, Leslie Marx, Ram Rao, Ron Schmidt, Rick Staelin, Mary Sullivan, Birger Wernerfelt, Florian Zettelmeyer, and the area editor and Reviewers of this journal. We also thank seminar participants at Chicago, Florida, Harvard, LBS (London), MIT, Rochester, Texas (Dallas), Washington (St. Louis), and the 1997 Marketing Science Conference at Berkeley. Debbie Desrochers and Vivian Jim provided valuable research assistance. Eric Anderson thanks the University of Rochester Simon School of Business and Duncan Simester thanks the University of Chicago for financial support of this project.

$$(H - \lambda)Y > LY + \delta LX. \tag{A2}$$

Prices of products starting their seasons. To sell to low valuation customers at the start of the season, stores can charge no more than $L - \Lambda$ when using a sale sign and $L - \lambda$ when not using a sale sign. Holding constant the number of sale signs used in any one period, we ensure that the stores prefer to sell only to their high valuation customers at the start of the season:

$$(L - \lambda)(X + Y) < (H - \lambda)Y, \tag{without sale signs: A3'}$$

$$(L - \Lambda)(X + Y) < (H - \Lambda)Y \quad \forall \Lambda \in [0, \Lambda^*]. \tag{with sale signs: A3}$$

where Λ^* equals Λ evaluated at $\Phi = \frac{1}{2}$ (recall that $\Phi \leq \frac{1}{2}$). While for ease of exposition the relevant range in (A3) is defined over Λ , this is actually a restriction on τ . Note that (A3') is satisfied whenever (A3) is satisfied, so we need only consider (A3).

Prices of products ending their seasons. Given Conditions (A1) through (A3), the distribution of customers for products finishing their seasons is summarized in Table 4.

The equilibrium conditions to ensure that for products without sale signs stores prefer to charge $L - \lambda$ rather than $H, H - \lambda$, or L (respectively) are:

$$H\eta X < (L - \lambda)(Y + 2X), \tag{deviating to H: A4}$$

$$(H - \lambda)(\eta X + Y) < (L - \lambda)(Y + 2X), \tag{deviating to H - \lambda: A5}$$

$$L(X + Y) < (L - \lambda)(Y + 2X). \tag{deviating to L: A6}$$

The corresponding conditions for products with sale signs are dominated by these conditions.

Where to place sale signs. If a store puts a sale sign on a product at the start of its season, the additional profit it will earn from that product will equal:

$$Y(H - \Lambda) - Y(H - \lambda) = Y(\lambda - \Lambda).$$

Putting a sale sign on a product that is finishing its season will yield additional profit equal to:

$$(Y + 2X)(L - \Lambda) - (Y + 2X)(L - \lambda) = (Y + 2X)(\lambda - \Lambda).$$

We conclude that $(Y + 2X)(\lambda - \Lambda) > Y(\lambda - \Lambda)$, so it is always more profitable to take a sale sign off a product starting its season and place it on a product that is finishing its season.

How many sale signs to use. In determining how many sale signs to put on newly introduced products each period, the stores maximize the following profit function (with respect to τ):

$$\pi = n\tau Y(H - \Lambda) + n(1 - \tau)Y(H - \lambda) + n(Y + 2X)(L - \Lambda).$$

Differentiating this function with respect to τ yields a first-order condition (recall that Λ is a function of Φ , which in turn depends upon τ):

$$\frac{\partial \pi}{\partial \tau} = Y(\lambda - \Lambda) - (2X + Y + \tau Y) \frac{\partial \Lambda}{\partial \tau}.$$

Our equilibrium implies a boundary solution for which $\Lambda = 0$. Supporting this equilibrium simply requires that this first-order condition is negative throughout the relevant range:

$$\frac{\partial \pi}{\partial \tau} < 0 \quad \forall \Lambda \in [0, \Lambda^*]. \tag{A7}$$

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Table 4 Distribution of Customers at the End of the Season

Reservation value	Mass	Willingness to pay	
		Without a sale sign	With a sale sign
New customers			
H	Y	H - λ	H - Λ
L	X	L - λ	L - Λ
Returning customers			
H	ηX	H	H
L	(1 - η)X	L	L

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