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Conventional wisdom in marketing holds that (1) retailer forward buying is a consequence of manufacturer trade promotions and (2) stockpiling units helps the retailer but hurts the manufacturer. This article provides a deeper understanding of forward buying by analyzing it within the context of manufacturer trade promotions, competition, and demand uncertainty. The authors find that regardless of whether the manufacturer offers a trade promotion, allowing the retailer to forward buy and hold inventory for the future can, under certain conditions, be beneficial for both parties. Disallowing forward buying by the retailer may lead the manufacturer to lower merchandising requirements and change the depth of the promotion. In competitive environments, there are situations in which retailers engage in forward buying because of competitive pressures in a prisoner's-dilemma situation. Finally, when the authors consider the case of uncertain demand, they find further evidence of strategic forward buying. In particular, the authors find cases in which the retailer orders a quantity that is higher than what it expects to sell in even the most optimistic demand scenario.

Keywords: marketing channels, game theory, trade promotions, pricing, inventory

Forward Buying by Retailers

Forward buying occurs when retailers purchase units during a particular period, hold some of them in inventory, and then sell them in subsequent periods. Because retailer forward buying tends to be correlated with trade promotions (temporary wholesale price reductions) offered by manufacturers, conventional wisdom in marketing suggests that were it not for these trade promotions, manufacturers would not need to deal with the problem of retailer forward buying (e.g., Coughlan et al. 2006; Kotler and Keller 2006). As a result, researchers have focused their efforts on explaining why trade promotions are observed and *not* on why forward buying is not. An exception is Anand, Anupindi, and Basook (2008), who examine the role of forward buying in a monopoly setting in which the manufacturer does not offer a trade promotion. In contrast, we address the effects of forward buying on the retailers and manufacturers in a variety of settings, including competitive environments and under conditions of demand uncertainty. We also examine the consequences of preventing retailers from forward buying during trade promotions.

Forward buying is an important phenomenon in both marketing and operations literature. In marketing, the general view is that because trade promotions are temporary price discounts, retailers simply stock up on good deals when they are offered (e.g., Blattberg and Neslin 1990). The question here is why the price reduction must be temporary and not permanent. Several explanations for this have been put forth, all of them relying on the competition among firms. From a theoretical standpoint, the consensus views are that trade promotions persist because of the intense competition for the switching segment of the consumer market (e.g., Narasimhan 1988; Raju, Srinivasan, and Lal 1990; Rao 1990) or because of implicit collusion among manufacturers (e.g., Lal 1990). Note that the aforementioned models do not include a strategic retailer in the analysis, so they cannot speak directly to the issue of forward buying. However, they show that the competition leads to trade promotions, which tends to be correlated with forward buying. In contrast, Lal, Little, and Villas Boas (1996) explicitly model two competing manufacturers that sell through a common retailer that has an option to forward buy. From a manufacturer's perspective, being in the

retailer's inventory is important because it makes the manufacturer's product more competitive for switchers in the subsequent period. Indeed, it is the presence of the switching segment that leads to trade promotions and forward buying. In the absence of switchers, there would be a single price and no forward buying. More recently, Cui, Raju, and Zhang (2008) have shown that manufacturer trade promotions can also be a mechanism to price discriminate among retailers that differ in their holding costs.

Forward buying is also a rich area of study in operations management, in which researchers have studied firms' inventory decisions in a variety of models. In these studies, inventory emerges as a mechanism to deal with demand or supply uncertainty or as a trade-off between ordering and holding costs. However, the role of inventory as a strategic choice has not been a prominent issue in this literature. A notable exception is the work of Anand, Anupindi, and Bassok (2008), who show that inventory plays an important strategic role such that a retailer would hold inventory even when there is no uncertainty about demand. The focus of their work is on coordinating the supply chain by using contracts that allow the manufacturer to commit to wholesale prices over time. In contrast, we consider the situation in which manufacturers cannot make credible commitments not to lower prices in the future. This is the case in most packaged goods markets; it is possible for manufacturers to commit not to raise prices, but it is much more difficult to commit not to lower prices. Furthermore, we examine more complex competitive channel structures and focus on the marketing variables of merchandising support and trade promotions and also on the role of demand uncertainty.

We first develop a simple model that specifically excludes the standard operations reasons advanced by researchers for why retailers would forward buy and hold inventory. Thus, we assume a market in which there is no uncertainty about demand or supply, no production lead time, and no ordering or setup costs. Within this framework, we consider both the case when the manufacturer offers a trade promotion and the case when it does not offer a trade promotion.[1] From the terms offered by the manufacturer, the retailer chooses the quantity to order, the retail price, and the inventory level. We analyze forward buying with three channel structures: (1) A single manufacturer sells to a single retailer; (2) two competing manufacturers sell through a single, common retailer; and (3) a single manufacturer sells to two competing retailers.

In the single manufacturer–single retailer case, we find conditions under which both the retailer and the manufacturer are better-off with forward buying and conditions under which forward buying is profitable for the retailer but not for the manufacturer. In the competitive case, we allow two manufacturers to sell through a common retailer and find that, compared with the previous bilateral monopoly case, forward buying becomes even more likely. Importantly, each manufacturer reduces wholesale price in response to the retailer's forward buying not only of its own product but also of the competing manufacturer's product. As a result, forward buying becomes even

more attractive for the retailer. When we introduce competition at the retailer level and allow a single manufacturer to sell through two competing retailers, we still find the presence of forward buying. We also find that the competition between retailers can lead to a prisoner's-dilemma situation such that both retailers are worse-off with forward buying. This occurs partly because competition forces each retailer to pass through a greater part of any reduction in wholesale price. Furthermore, as the retailer competition becomes more intense, we find that the incidence of forward buying goes down.

Although the bulk of this research rules out other reasons for forward buying, we note that two of the most common reasons cited for forward buying are the presence of retailer trade promotions and uncertainty about demand. Therefore, we extend our basic framework to specifically allow for trade promotions and the presence of demand uncertainty. Importantly, we verify that the effects of forward buying identified previously continue to hold even when the manufacturer offers a trade promotion. Furthermore, we show that if the terms of the trade promotion prohibit the retailer from forward buying, the manufacturer will be forced to require a lower merchandising effort and may also need to adjust its trade promotion discount. When it comes to demand uncertainty, forward buying continues to play an important strategic role. When demand can be either high or low with specific probabilities, under certain cases, the retailer orders enough units such that it carries inventory regardless of the demand state that may arise. This is noteworthy because conventional wisdom argues that retailers will end up carrying inventory only when demand turns out to be low. These two extensions further enhance our understanding of forward buying.

Finally, most of the channels research in marketing examines a manufacturer–retailer framework in a static setting and one in which the retailer's ordering quantity is also its selling quantity. However, this static setting becomes inappropriate when retailers can stockpile for the future—that is, when a retailer's purchases in one period have an effect on its purchases in subsequent periods. Given the prevalence of this phenomenon, it is important to develop models that account for this behavior.

We organize the remainder of this article as follows: In the next section, we lay out the basic model and detail our assumptions. In subsequent sections, we analyze forward buying within the three different channel structures. Then, we allow for trade promotions and explore the impact of forward buying on trade promotion.

MODEL

We begin with the simplest possible model that can capture the interactions between manufacturers and retailers and allow the retailer to forward buy. Recall that the typical reasons put forward to explain the presence of forward buying or carrying inventory are temporary price reductions offered by the manufacturer, demand or supply uncertainty, demand or supply lead times, and retailer ordering costs. Our initial model specifically rules out these reasons; thus, there is no temporary price cut, no uncertainty, no lead times, and no ordering costs. By ruling out these reasons, we can determine whether there is an alternative

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[1]As we discuss in greater detail subsequently, a trade promotion in our model is defined as a temporary price reduction that is contingent on a specific level of merchandising support provided by the retailer.

explanation for forward buying and isolate the effect of forward buying on manufacturers and retailers. Subsequently, we incorporate trade promotion and retailer merchandising effort into our analysis.

We assume a two-period model in which the retailer has the option to purchase additional units in Period 1 and carry them as inventory into Period 2. Because there is no uncertainty about demand, a decision to forward buy is based solely on the wholesale prices offered by the manufacturer. We analyze these wholesale prices both with and without trade promotions. We first analyze cases in which the retailer has the option to forward buy when the manufacturer does not offer any trade promotions. Then, we consider the case in which the retailer has the option to forward buy during a trade promotion. Therefore, the retailer in our model may forward buy even when trade promotions are not offered and may forgo forward buying even in the presence of trade promotions.

We begin our analysis with a base model in which one manufacturer sells its products through a single retailer. Subsequently, we examine two duopoly cases, one with two competing manufacturers selling through a single retailer and the other with a single manufacturer selling through two competing retailers. Finally, we consider a case in which the manufacturer offers a trade promotion to its retailer. In the remainder of this section, we describe the base model with a single manufacturer selling through a single retailer. In the subsequent sections, we describe the embellishment to the basic structure that we consider.

Consumer demand for the product in period t $(t = 1, 2)$, d_t, is given by

$$(1) \qquad\qquad d_t = \tau - p_t,$$

where τ is the base level of demand for the product and p_t is the retailer's price in period t.

In each period, the manufacturer offers the retailer the opportunity to purchase goods at an announced wholesale price, w_t. We relax a major assumption of prior models and distinguish between the retailer's order quantity and selling quantity. Thus, given the wholesale price, the retailer must make two simultaneous decisions in each period: the quantity of units to order from the manufacturer and the retail price to charge consumers.[2] The forward-buying quantity or the inventory in period t $(t = 1, 2)$, I_t, is the difference between the quantity q_t that the retailer orders from the manufacturer and the quantity d_t that consumers demand at the price chosen by the retailer: $I_t = q_t - d_t \geq 0$. If the retailer carries inventory, it incurs a holding cost of $h > 0$ per unit. Units carried in inventory do not deteriorate or perish and can be sold in the subsequent period as new goods. The manufacturer faces a constant marginal cost of production that we set to zero. Both players face the same discount factor, $\rho \in (0, 1]$.

In each period, there are two stages. In the first stage, the manufacturer makes its wholesale price decision, and in the second stage, the retailer makes its order quantity, retail price, and merchandising decisions. Thus, the four stages of the game are as follows:

Stage 1: The manufacturer sets the first period wholesale price, w_t.
Stage 2: The retailer chooses the first period order quantity, q_1, and the first period retail price, p_1.
Stage 3: The manufacturer sets the second period wholesale price, w_2.
Stage 4: The retailer chooses the second period order quantity, q_2, and the second period retail price, p_2.

We adopt the notion of subgame perfect Nash equilibrium and solve the game backward, starting from Stage 4. In the subsequent sections, we solve this game in several channel settings that differ on the number of players that are in competition. In the simplest case, we study forward buying in a situation in which a single manufacturer sells to a single retailer. Subsequently, we introduce competition, first at the manufacturer level and then at the retailer level.

ONE MANUFACTURER–ONE RETAILER CHANNEL

The simplest possible case to analyze is one in which a single manufacturer sells through a single retailer. Anand, Anupindi, and Bassok (2008) also analyze this case under the assumption that there is no discounting. In this section, we consider the more general case in which the retailer and the manufacturer face a discount factor, $\rho \in (0, 1]$.[3] This serves as a useful benchmark for the subsequent sections when we consider competition and the impact of trade promotions and demand uncertainty.

We begin with the analysis of the retailer's second period (Stage 4) decisions. In Period 2, the retailer has $I_1 \geq 0$ units in its inventory, and thus the maximum number of units it can sell is $q_2 + I_1$. At this stage, there is no reason to have any unsold units at the end of the period. Therefore, the actual sales at price p_2 is going to be the smaller of two quantities: $\tau - p_2$ and $q_2 + I_1$. Thus, the retailer's optimization problem is given by

$$\underset{q_2, p_2}{\text{Max}} \, \pi_2^R = p_2(\min\{\tau - p_2, q_2 + I_1\}) - w_2 q_2,$$

where π_2^R is retailer R's profits in Period 2. At a given price p_2, the retailer's optimal ordering quantity is $q_2^* = \tau - p_2 - I_1$. Substituting q_2^* in π_2^R and solving the optimization problem, we get the following:

$$p_2^* = \frac{\tau + w_2}{2}, \qquad q_2^* = \frac{\tau - w_2}{2} - I_1.$$

This shows that as the retailer forward buys more units in Period 1, it orders fewer units in Period 2.

The manufacturer's profit function at this stage is given by

$$\pi_2^M = w_2 q_2^* = w_2 \left(\frac{\tau - w_2 - 2I_1}{2} \right).$$

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[2]We can generate qualitatively identical results when the retailers' decisions are made sequentially. However, the algebra is more tedious and the intuition is less clear in that case.

[3]The results in Anand, Anupindi, and Bassok (2008) can be easily replicated by setting $\rho = 1$ in this section. Note that the full "cost" of forward buying is captured not only through the holding cost but also through the discount factor. As we show subsequently, both parameters play a crucial role in determining the effects on the manufacturer and retailer.

Anticipating the retailer's decision, the manufacturer maximizes its Period 2 profit by choosing its optimal Period 2 wholesale price:

$$w_2^* = \frac{\tau}{2} - I_1.$$

This shows that as the retailer forward buys more units in Period 1, it decreases its optimal ordering quantity in Period 2, forcing the manufacturer to decrease its Period 2 wholesale price.

Next, we analyze the Period 1 decisions, beginning with the retailer's decisions in Stage 2. The retailer's profit in Period 1 is $\pi_1^R = p_1(\tau - p_1) - w_1 q_1 - hI_1$. The retailer chooses q_1 and p_1 to maximize the discounted sum of its profits over the two-period horizon,

$$\Pi^R = \pi_1^R + \rho\pi_2^R = p_1(\tau - p_1) - w_1 q_1 - hI_1 + \rho\pi_2^R.$$

The optimal values of q_1 and p_1 are given by

$$p_1^* = \frac{\tau + w_1}{2}, \quad q_1^* = \text{Max}\left\{\frac{\rho(6\tau - 3w_1) - 4(h + w_1)}{6\rho}, \frac{\tau - w_1}{2}\right\}.$$

Given the retailer's optimal choices, the manufacturer chooses the Period 1 wholesale price to maximize the discounted sum of its profit, $\Pi^M = w_1 q_1^* + \rho\pi_2^{M*}$. This yields

$$w_1^* = \frac{9\rho\tau - 2h}{8 + 9\rho} \text{ when } 0 \leq h < h_{r1} = \frac{\tau\rho(9\rho - 4)}{8 + 12\rho}$$

$$\text{and } w_1^* = \frac{\tau}{2} \text{ otherwise.}$$

This leads to the following proposition:[4]

> P_1: The retailer forward buys if and only if $0 \leq h < h_{r1}$. However, the manufacturer is better-off with the retailer's forward buying only when
>
> $$0 < h < h_{m1} = \frac{\tau[2\rho - (1 - \rho)\sqrt{\rho(8 + 9\rho)}]}{4(1 + \rho)} < h_{r1}.$$

P_1 highlights an important result: When the holding cost is not too high, the retailer orders more units than it plans to sell in Period 1, holds the additional units in its inventory, and sells them in Period 2. This happens in our model in the absence of all the typical reasons for a retailer to carry inventory—namely, demand or supply uncertainty, supply lead times, or high ordering costs. Forward buying occurs because a positive inventory in Period 2 gives the retailer a strategic advantage that leads the manufacturer to charge a lower wholesale price in Period 2. Although forward buying in Period 1 clearly has a benefit in Period 2, it also has additional holding costs in Period 1 and the possibility that the manufacturer can raise wholesale price in Period 1. These additional costs in Period 1 can offset Period 2 benefits of forward buying to the retailer. Therefore, forward buying is not always optimal for the retailer but is optimal when the holding costs are sufficiently low, $0 \leq h < h_{r1}$.

Conventional wisdom in marketing argues that manufacturers are hurt by forward buying by retailers. We acknowledge that retailer's forward buying can have other negative effects that are not captured in our model (e.g., variable production cycles that increase manufacturing costs), but P_1 shows that forward buying by a retailer can have a positive impact on the manufacturer's profits. Therefore, even when the manufacturer is able to prevent forward buying by the retailer, it may choose not to do so. However, when $0 < h_{m1} < h < h_{r1}$, the manufacturer's profit decreases with forward buying, whereas the retailer's profit increases with forward buying. We summarize these findings in Figure 1. Note that when there is no discounting, $h_{r1} = h_{m1}$ and both the retailer and the manufacturer are always better-off with forward buying.

Consider how the retailer's optimal ordering quantity (q_1) as a function of wholesale price (w_1) changes with forward buying. In particular, the retailer's optimal q_1 with and without forward buying is given by

$$q_1^* = \frac{(6\tau\rho - 4h) - (3\rho + 4)w_1}{6\rho} \text{ if } I_1^* > 0, \text{ and}$$

$$q_1^* = \frac{\tau - w_1}{2} \text{ if } I_1^* = 0.$$

Thus, when the retailer forward buys, any change in the Period 1 wholesale price has a greater impact on the retailer's purchase quantity. Because of this, the retailer not only shifts part of its Period 2 purchase to Period 1 but also increases the total quantity it purchases across the two periods. In some cases, this increase in total quantities also increases the manufacturer's profits.

Although forward buying in this framework is driven by wholesale prices charged by the manufacturer, the relationship between the two wholesale prices is not completely straightforward. In particular, from Table 1,

$$w_1^* - w_2^* = \frac{3\tau\rho(3\rho - 2) - 4h(1 + 2\rho)}{\rho(8 + 9\rho)}.$$

Therefore,

$$w_1^* \geq w_2^* \Leftrightarrow h \leq h_w = \frac{3t\rho(3\rho - 2)}{4 + 8\rho}.$$

Because $h_w \leq 0$ for any value of $\rho \leq 2/3$, $w_1^* < w_2^*$ for any positive value of holding costs so long as $\rho \leq 2/3$. When $\rho > 2/3$, w_1^* can exceed w_2^* only when the holding costs are sufficiently low. If we assume that there is no discounting (as in Anand, Anupindi, and Bassok 2008), then $w_1^* \geq w_2^*$. Our results show that though the presence of a positive discount rate is not necessary for the retailer to forward buy, the discount rate determines the wholesale price path, which depending on the rate can be either decreasing or increasing over time.

COMPETITION AND FORWARD BUYING

In this section, we study two cases that explore the effect of competition on forward buying. In the first, we consider a single manufacturer selling to two competing retailers, and in the second, we consider two competing manufacturers selling through a single retailer.

Two Retailers–One Manufacturer

We modify our base model to allow for two retailers, A and B, which sell a product from a single manufacturer.

Figure 1
CUTOFF VALUES OF HOLDING COST
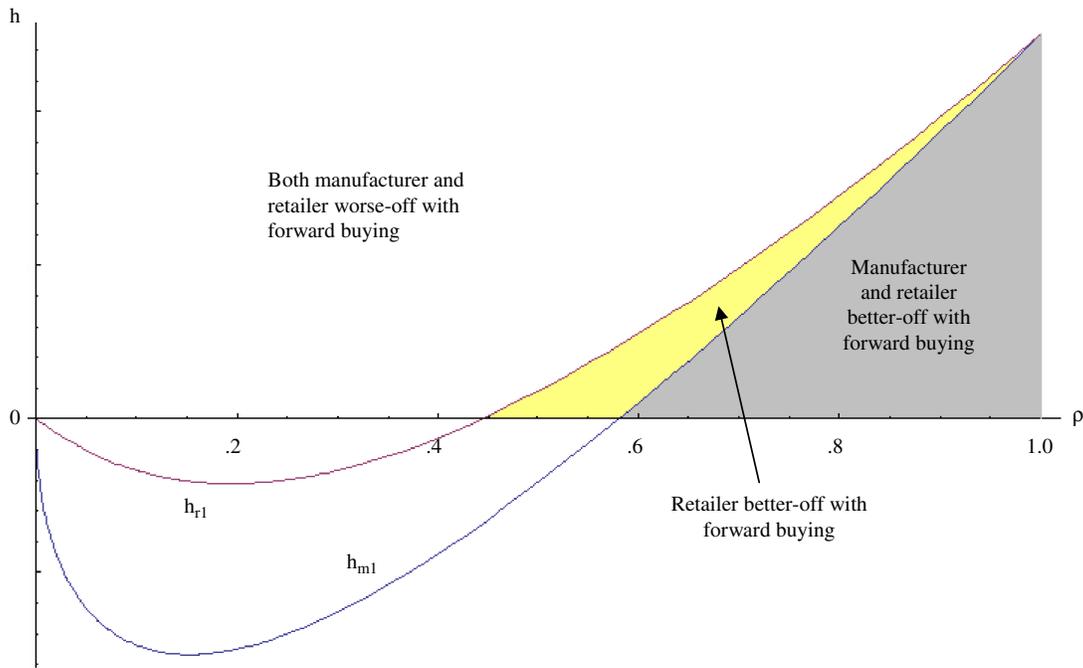
Retailers A and B are symmetric and differentiated from each other, and their demand functions are given by

$$(2) \quad \left. \begin{array}{l} d_{At} = \dfrac{1}{2}[\tau - p_{At} + \theta(p_{Bt} - p_{At})] \\[2mm] d_{Bt} = \dfrac{1}{2}[\tau - p_{Bt} + \theta(p_{At} - p_{Bt})] \end{array} \right\},$$

where the parameter θ represents the intensity of competition between the two retailers. These demand functions are based on the quadratic utility function developed by Shubik and Levitan (1980) and are analogous to the demand function we used in the previous section (see Equation 1). Note that the parameter θ applies only when both demands are positive. An appealing property of this formulation is that the intercept for the total demand does not change as a consequence of bringing an additional manufacturer into the market. This ensures that if we observe forward buying in this framework, it is not because of an expansion of demand that may arise from a second retailer entering the market. Because both retailers are symmetrical, the manufacturer cannot discriminate between them and charges them the same wholesale price.

The sequence of events is the same as before except that the two retailers make their price and ordering quantity decisions simultaneously. Therefore, we report only the important parts of the analysis and delegate the details to the Web Appendix (http://www.marketingpower.com/jmrfeb10). The Period 2 optimal price and ordering quantity for Retailer A are as follows (Retailer B's decisions are symmetrically defined):

$$(3) \quad p_{A2}^{*} = \dfrac{\tau + w_2(1+\theta)}{2+\theta}, \quad q_{A2}^{*} = \dfrac{(\tau - w_2)(1+\theta) - 2(2+\theta)I_{A1}}{2(2+\theta)}.$$

As in the previous case, if a retailer carries inventory from the previous period, it buys less in Period 2. An important effect of competition is that as the competitive intensity increases, each retailer's price responds more to

Table 1
ANALYSIS OF A SINGLE MANUFACTURER AND A SINGLE RETAILER CHANNEL

Condition	$0 \le h < h_{rl} = \dfrac{\tau\rho(-4+9\rho)}{8+12\rho}$	$h \ge h_{rl} \ge 0$
w_1	$\dfrac{9\tau\rho - 2h}{8+9\rho}$	$\dfrac{\tau}{2}$
w_2	$2\dfrac{3\rho(h+\tau)+h}{\rho(8+9\rho)}$	$\dfrac{\tau}{2}$
q_1	$\dfrac{\tau\rho(4+9\rho) - 2h(4+5\rho)}{2\rho(8+9\rho)}$	$\dfrac{\tau}{4}$
q_2	$\dfrac{3\rho(h+\tau)+2h}{\rho(8+9\rho)}$	$\dfrac{\tau}{4}$
d_1	$\dfrac{4\tau+h}{8+9\rho}$	$\dfrac{\tau}{4}$
d_2	$\dfrac{\tau\rho(2+9\rho) - 2h(2+3\rho)}{2\rho(8+9\rho)}$	$\dfrac{\tau}{4}$
p_1	$\dfrac{\tau(4+9\rho) - h}{8+9\rho}$	$\dfrac{3\tau}{4}$
p_2	$\dfrac{\tau\rho(14+9\rho) + h(4+6\rho)}{2\rho(8+9\rho)}$	$\dfrac{3\tau}{4}$
I_1	$\dfrac{\tau\rho(-4+9\rho) - 4h(2+3\rho)}{2\rho(8+9\rho)}$	0

the wholesale price charged by the manufacturer. More formally,

$$\frac{\partial p_{A2}^*}{\partial w_2} = \frac{1+\theta}{2+\theta} > 0, \text{ and}$$

$$\frac{\partial^2 p_{A2}^*}{\partial w_2 \partial \theta} = \frac{1}{(2+\theta)^2} > 0.$$

We know from the previous discussion that the main benefit of forward buying for the retailer is that it enjoys a reduction in Period 2 wholesale price. However,

$$\frac{\partial^2 p_{A2}^*}{\partial w_2 \partial \theta} > 0.$$

indicates that with competition, a greater part of any reduction in Period 2 wholesale price will get passed on to the customers, and therefore the retailer may have less to gain from such reductions in wholesale price.[5]

To better understand why retailers may have less to gain from wholesale price reductions, consider how the retailer's Period 2 profit is affected by changes in the Period 2 wholesale price. In particular,

$$\frac{\partial \pi_{A2}^*}{\partial w_2} = -\frac{(\tau - w_2)(1+\theta) + 2I_{A2}(2+\theta)^2}{(2+\theta)^2} < 0, \text{ and}$$

$$\frac{\partial^2 \pi_{A2}^*}{\partial w_2 \partial \theta} = \frac{(\tau - w_2)\theta}{(2+\theta)^3} > 0.$$

In other words, the retailer's Period 2 profits increase with a decline in the Period 2 wholesale price, but this change becomes smaller as the competition between the retailers increases.

The manufacturer's optimal wholesale price in Period 2 is given by

$$(4) \qquad w_2^* = \frac{\tau(1+\theta) - (I_{A2} + I_{B2})(2+\theta)}{2(1+\theta)}.$$

Equation 4 shows two new strategic effects that are due to the retail competition. First, when either retailer carries inventory from the previous period, the Period 2 wholesale price decreases. Therefore, even if a single retailer carried inventory from Period 1, the manufacturer reduces the Period 2 wholesale price for both retailers. This results in a free-riding problem between the two retailers: Each retailer wants the benefits of a lower w_2 but may have an incentive to let the other retailer carry the inventory and incur the holding costs. Second, compared with the monopoly case, for a given level of inventory a retailer carries, the manufacturer's wholesale price is less sensitive to changes in retailer inventory. This arises because the competition between the retailers dilutes each one's market power.

Given the optimal prices and quantities in Period 2, each retailer maximizes its overall profits by making its Period 1 price and ordering quantity decisions. Here, we provide the optimal choices for Retailer A and note that Retailer B's choices are symmetric:

$$(5) \qquad p_{A1}^* = \frac{\tau(10 + 6\theta + \rho\theta^2) + 2(1+\theta)[w_1(5+2\theta) - \theta h]}{20 + 22\theta + 6\theta^2},$$

$$(6)$$

$$q_{A1}^* = \frac{2(1+\theta)\rho[5\tau(2+\theta) + \theta h - w_1(5+2\theta)] - \tau\theta^2\rho^2 - 8(h+w_1)(1+\theta)(2+\theta)}{4\rho(2+\theta)(5+3\theta)}.$$

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[5]Desai (2000) observes a similar effect in a single period model.

Similar to Period 2, as the competition between the retailers becomes more intense, the retail price is more sensitive to changes in the wholesale price.

Table 2 shows the equilibrium choices of all the players and demonstrates that even in the case of retail competition, the retailers may engage in forward buying. The next proposition describes how the extent of forward buying is influenced by the intensity of competition.

P$_2$: As the competition between the retailers increases, each retailer decreases its equilibrium forward-buying quantity.

This result arises because of the effects described previously: Compared with the monopoly case, an increase in inventory leads to a smaller reduction in wholesale prices. Furthermore, a wholesale price reduction is less valuable for the retailer because a larger fraction of it needs to be passed on to final consumers. Finally, each retailer has incentives to free ride on the forward buying done by the other retailer.

An implication of this result is that there are conditions under which a retailer would forward buy in a less competitive situation but would not do so in a more competitive situation. This suggests that price competition among retailers can be exacerbated by forward buying: If retailers carry inventory in a highly competitive market, they also have an incentive to lower retail prices in both periods and, as a consequence, earn lower profits. This raises the potential for retailers to engage in forward buying because they might find themselves in a prisoner's-dilemma situation. This leads to the following proposition:

P$_3$: When $0 < h < h_{r3}$, both retailers find it optimal to forward buy. However, when $h_{r4} < h < h_{r3}$, both retailers are worse-off with forward buying than when neither one forward buys.

P$_3$ confirms our conjecture of a prisoner's dilemma, and we find that even though the two retailers may be worse-off with forward buying, they still forward buy for competitive reasons. Finally, we conclude this section by noting that as in the previous case, for some values of the parameters, the manufacturer can also be better-off with the retailers' forward buying.

Two Manufacturers–One Retailer Channel

Now we consider our second case of competition, specifically the effect of manufacturer competition on the incidence and profitability of forward buying by a retailer. We consider two manufacturers selling to a single retailer and modify our demand function as follows:

$$(7) \qquad \left. \begin{array}{l} d_{it} = \frac{1}{2}[\tau - p_{it} + \phi(p_{jt} - p_{it})] \\[2mm] d_{jt} = \frac{1}{2}[\tau - p_{jt} + \phi(p_{it} - p_{jt})] \end{array} \right\},$$

where i and j denote the two manufacturers, ϕ is a parameter representing the intensity of competition between the two manufacturers (or the substitutability between the products), and t (t = 1, 2) denotes time. These demand functions are analogous to the demand function used in the previous section (i.e., the intercept for the total demand for the goods is fixed). That is, compared with the previous sec-

Table 2

ANALYSIS OF A SINGLE MANUFACTURER AND TWO-RETAILER CHANNEL

	$0 \leq h < h_{r3} = \rho\tau \dfrac{\{25+\theta[45+\theta(26+5\theta)]\}-2(1+\theta)(2+\theta)(4+3\theta)}{2(1+\theta)(2+\theta)^2(4+5\rho)}$	$h \geq h_{r3} \geq 0$
w_{A1}	$\dfrac{2(1+\theta)[h\theta(5+3\theta)+\tau(2+\theta)(25+17\theta)]\rho-\tau(\theta\rho)^2(5+3\theta)-8h(1+\theta)^2(2+\theta)}{4(1+\theta)\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	$\dfrac{\tau}{2+\theta}$
w_{A2}	$\dfrac{2h(1+\theta)(2+\theta)^2(4+5\rho)+\tau\rho\{2(1+\theta)(2+\theta)(10+7\theta)+\theta[5+\theta(5+\theta)]\rho\}}{2\rho(1+\theta)\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	$\dfrac{\tau}{2+\theta}$
q_{A1}	$\dfrac{\tau\rho[8(1+\theta)(2+\theta)^2+2(1+\theta)(2+\theta)(25+8\theta)\rho-(\theta\rho)^2(5+2\theta)]+2h(1+\theta)[\theta\rho^2(5+2\theta)-12\rho(2+\theta)(3+\theta)-16(2+\theta)^2]}{8\rho(2+\theta)\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	$\dfrac{\tau(1+\theta)}{4(2+\theta)}$
q_{A2}	$\dfrac{2h(1+\theta)(2+\theta)^2(4+5\rho)+\tau\rho\{2(1+\theta)(2+\theta)(10+7\theta)+\theta[5+\theta(5+\theta)]\rho\}}{4\rho(2+\theta)\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	$\dfrac{\tau(1+\theta)}{4(2+\theta)}$
d_{A1}	$\dfrac{\tau[96+\theta(2(104+\rho)+\theta\{(24-5\rho)(6+\rho)+2\theta[16-\rho(2+\rho)]\})]+2h(1+\theta)[8+\theta(5+2\theta)(4+\rho)]}{8(2+\theta)\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	$\dfrac{\tau(1+\theta)}{4(2+\theta)}$
d_{A2}	$\dfrac{\tau\rho\{4+25\rho+\theta[6+35\rho+\theta(2+11\rho)]\}-2h(1+\theta)(2+\theta)(4+5\rho)}{4\rho\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	$\dfrac{\tau(1+\theta)}{4(2+\theta)}$
p_{A1}	$\dfrac{\tau[96+200\rho+\theta(112+298\rho+\theta\{32+\rho[154+5\rho+2\theta(14+\rho)]\})]-2h(1+\theta)(2+\theta)[8+\theta(5+2\theta)(4+\rho)]}{4(2+\theta)\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	$\dfrac{\tau(3+\theta)}{2(2+\theta)}$
p_{A2}	$\dfrac{2h(1+\theta)(2+\theta)(4+5\rho)+\tau\rho\{44+25\rho+\theta[50+15\rho+\theta(14+\rho)]\}}{4\rho(2+\theta)\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	$\dfrac{\tau(3+\theta)}{2(2+\theta)}$
I_{A1}	$\dfrac{\tau\rho[25\rho+\theta^3(5\rho-6)+9\theta(5\rho-4)-16-26\theta^2(1-\rho)]-2h(1+\theta)(2+\theta)^2(4+5\rho)}{2\rho(2+\theta)\{24+25\rho+\theta[28+25\rho+\theta(8+6\rho)]\}}$	0

Notes: Retailer B's decisions are defined symmetrically.

tion, in which the retailer sells a single product, by adding another manufacturer's product to its line, the retailer does not expand the size of the market. Furthermore, if retailer sells zero units of a product, the demand system reverts to the single product case (Equation 1), and the idea of substitutability (ϕ) between the two products is moot.[6] Finally, it is always optimal for the retailer to sell both manufacturers products.

The manufacturers are symmetrical in all respects and move simultaneously to choose their wholesale prices. The other aspects of the model are the same. Because we solve the model in a manner that is similar to the procedure used in the previous section, we do not present all the details. In Period 2, the retailer maximizes profits by choosing the optimal quantity to order and retail price to charge. This yields the following:

$$(8) \qquad p_{i2}^* = \frac{\tau+w_{i2}}{2}, \qquad q_{i2}^* = \frac{\tau-(1+\phi)w_{2i}+\phi w_{2j}-4I_{2i}}{4}.$$

The retailer's decisions for Manufacturer j are symmetrically defined. The two manufacturers maximize their Period 2 profits by simultaneously choosing their optimal wholesale prices. This yields the following:

$$(9) \qquad w_{i2}^* = \frac{\tau(2+3\phi)-8I_{i1}(1+\phi)-4I_{j1}\phi}{4+8\phi+3\phi^2},$$

$$w_{j2}^* = \frac{\tau(2+3\phi)-8I_{j1}(1+\phi)-4I_{i1}\phi}{4+8\phi+3\phi^2}.$$

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[6]If ϕ continued to play a role with zero units of one of the products, we would have a perverse case of a money pump, in which the manufacturer sets an exorbitantly high price for one product to drive up demand for the other.

These equations show the following two effects of the retailer's forward buying on the manufacturers.

1. Direct effect: When the retailer has inventory of manufacturer i's product, the retailer buys less from manufacturer i, which leads the manufacturer to lower its optimal wholesale price.
2. Strategic effect: When the retailer has manufacturer j's product in its inventory, it leads manufacturer i to lower its wholesale price.

Note that the direct effect is similar to the effect in the bilateral monopoly case. The strategic effect arises because of the competition between the two manufacturers and results in each manufacturer's wholesale price declining with the competing manufacturer's price.

The retailer's optimal Period 1 decision for manufacturer i's products are as follows (its decisions for manufacturer j's products are symmetrically given):

$$(10) \quad p_{i1}^* = \frac{\tau+w_{i1}}{2}, \qquad q_{i1}^* = \frac{\tau}{2}+\frac{\chi_j w_{j1}-\chi_i w_{i1}-h(2+\phi)^2(3+4\phi)}{4(3+2\phi)(3+4\phi)\rho},$$

where $\chi_i = (1+\phi)[12+9\rho+\phi(24+11\phi+18\rho+8\phi\rho)]$ and $\chi_j = \phi[8+9\rho+\phi(16+7\phi+18\rho+8\phi\rho)]$.

As in the monopoly manufacturer case, a manufacturer's choice of Period 1 wholesale price affects not only the retailer's Period 1 decisions but also its Period 2 decisions. Furthermore, with forward buying, the retailer orders a higher total quantity than it would order if there were no forward buying. In addition, because of the substitutability between the two products, any increase in one manufacturer's wholesale price leads the retailer to shift demand toward the competing manufacturer. As a result, even when the retailer engages in forward buying, the competition

between the two manufacturers limits each manufacturer's ability to increase its first period wholesale price.

We provide the full solution to this game in Table 3. Note that the manufacturers' optimal wholesale prices in Period 1 are given by

$$(11) \qquad w_{i1}^* = w_{j1}^*$$

$$= \frac{2\tau(3+2\phi)^2(3+4\phi)\rho - h(2+\phi)(6+9\phi-2\phi^3)}{48+156\phi+186\phi^2+99\phi^3+20\phi^4+(2+\phi)(3+2\phi)^2(3+4\phi)\rho}.$$

This leads to the following proposition:

P_4: The retailer finds it optimal to forward buy from two competing manufacturers when

$$0 \leq h < \frac{\tau\rho[(2+\phi)(3+2\phi)^2(3+4\phi)\rho - 24 - 60\phi - 40\phi^2 - \phi^3 + 4\phi^4]}{(2+\phi)^2[(2+\phi)(3+2\phi)(3+4\phi)\rho + 12 + 36\phi + 35\phi^2 + 11\phi^3]}.$$

As in the manufacturer–monopoly case, the retailer finds it optimal to buy more than what it needs in Period 1 so it can get lower wholesale prices in Period 2. The main difference here is that forward buying of either manufacturer's product lowers the wholesale price of both manufacturers' products in Period 2. Therefore, when there is competition between the manufacturers, forward buying in Period 1 provides greater Period 2 benefits to the retailer. Essentially, forward buying of either product allows the retailer to play the manufacturers off each other.

This discussion also indicates that the manufacturers may have less to gain from the retailer's forward buying when there is competition between the manufacturers. We can also derive the conditions in which the manufacturers are better-off with the retailer's forward buying. However, intractable algebra prevents us from fully characterizing the interaction between the degree of manufacturer competition and forward buying. In general, it is still possible for the competing manufacturers to be better-off with the retailer's forward buying. However, as the competition between manufacturers becomes more intense (i.e., ϕ increases), the parameter space for which this is true shrinks.

MODEL EXTENSIONS

In the previous two sections, we showed how forward buying by the retailer affects manufacturer and retailer prices and profitability. Importantly, forward buying occurred in the absence of any trade promotions offered by the manufacturer and in the absence of any uncertainty about demand. The question this raises is the following: How do trade promotions and demand uncertainty affect retailer forward buying? In this section, we focus on each of these issues.

Incorporating Merchandising Effort and Trade Promotion

The essential idea behind trade promotions is that the manufacturer can lower price temporarily and induce the retailer to purchase additional units, some of which can be carried in inventory and sold in future periods (Lal and Villas-Boas 1998). In our basic bilateral monopoly model, because we consider prices across two periods, the cases in which Period 1 wholesale price is lower than Period 2 wholesale price can be thought of as a trade promotion. Strictly speaking, a lower wholesale price in Period 1 does not qualify as a typical trade promotion because there is no viable alternative of a "regular" wholesale price. In other words, the retailer does not have the option of rejecting the

Table 3
ANALYSIS OF TWO MANUFACTURERS AND A SINGLE RETAILER CHANNEL

	$0 \leq h < h_{r2} = \rho\tau \dfrac{[\rho(2+\phi)(3+2\phi)^2(3+4\phi) + 4\phi^4 - \phi^3 - 40\phi^2 - 60\phi - 24]}{(2+\phi)^2[12 + 36\phi + 35\phi^2 + 11\phi^3 + \rho(2+\phi)(3+2\phi)(3+4\phi)]}$	$h \geq h_{r2} \geq 0$
w_{i1}	$\dfrac{2\tau\rho(3+2\phi)^2(3+4\phi) - h(2+\phi)(6+9\phi-2\phi^3)}{48+156\phi+186\phi^2+99\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)}$	$\dfrac{\tau}{2(2+\theta)}$
w_{i2}	$\dfrac{(2+\phi)\{\rho(3+2\phi)(3+4\phi)[2\tau+h(2+\phi)]+h(1+\phi)[12+\phi(24+11\phi)]\}}{\rho[48+156\phi+186\phi^2+99\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)]}$	$\dfrac{\tau}{2(2+\theta)}$
q_{i1}	$\dfrac{(1+\phi)[2\tau\rho[12+36\phi+37\phi^2+12\phi^3+\rho(3+2\phi)^2(3+4\phi)]-h(2+\phi)(6(4+5\rho)+\phi\{60+69\rho+\phi[46+44\rho+\phi(11+8\rho)]\})]}{4\rho[48+156\rho+186\phi^2+99\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)]}$	$\dfrac{\tau(1+\phi)}{4(2+\phi)}$
q_{i2}	$\dfrac{(1+\phi)(2+\phi)\{\rho(3+2\phi)(3+4\phi)[2\tau+h(2+\phi)]+h(1+\phi)[12+\phi(24+11\phi)]\}}{4\rho[48+156\theta+186\theta^2+99\theta^3+20\theta^4+\rho(2+\theta)(3+2\theta)^2(3+4\theta)]}$	$\dfrac{\tau(1+\phi)}{4(2+\phi)}$
d_{i1}	$\dfrac{\tau\{48+\phi[156+186\phi+99\phi^2+20\phi^3+\rho(3+2\phi^2)(3+4\phi)]\}+h(2+\phi)(6+9\phi-2\phi^3)}{4[48+156\phi+186\phi^2+99\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)]}$	$\dfrac{\tau(1+\phi)}{4(2+\phi)}$
d_{i2}	$\dfrac{\tau\rho[12+66\phi+118\phi^2+83\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)]-h(2+\phi)[11+36\phi+35\phi^2+11\phi^3\rho(2+\phi)(3+2\phi)(3+4\phi)]}{4\rho[48+156\phi+186\phi^2+99\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)]}$	$\dfrac{\tau(1+\phi)}{4(2+\phi)}$
p_{i1}	$\dfrac{\tau}{2} + \dfrac{2\tau\rho(3+2\phi)^2(3+4\phi)-h(2+\phi)(6+9\phi-2\phi^3)}{2[48+156\phi+186\phi^2+99\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)]}$	$\dfrac{\tau(3+\phi)}{2(2+\phi)}$
p_{i2}	$\dfrac{h(2+\phi)^2(3+2\phi)(3+4\phi)+\tau(84+\phi\{246+\phi[254+5\phi(23+4\phi)]\})+\tau\rho^2(2+\phi)(3+2\phi)^2(3+4\phi)+h(1+\phi)(2+\phi)[12+\phi(24+11\phi)]}{2\rho[48+156\phi+186\phi^2+99\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)]}$	$\dfrac{\tau(3+\phi)}{2(2+\phi)}$
I_{i1}	$\dfrac{\tau\rho[\rho(2+\phi)(3+2\phi)^2(3+4\phi)+4\phi^4-24-60\phi-40\phi^2-\phi^3]-h(2+\phi)^2[12+36\phi+35\phi^2+11\phi^3+\rho(2+\phi)(3+2\phi)(3+4\phi)]}{2\rho[48+156\phi+186\phi^2+99\phi^3+20\phi^4+\rho(2+\phi)(3+2\phi)^2(3+4\phi)]}$	0

Notes: Decisions related to manufacturer j are defined symmetrically.

manufacturer's offer in favor of a regular offer. Therefore, in this section, we formally model a trade promotion by giving the retailer a choice between a trade promotion that consists of a special wholesale price tied specifically to a level of merchandising effort and a regular wholesale price with no merchandising requirement. This embellishment enables us to examine forward buying when the manufacturer offers a trade promotion. Importantly, it also enables us to examine the implications of a manufacturer's policy of disallowing forward buying (e.g., through the use of scan backs).

We modify the bilateral monopoly model developed previously to include merchandising effort put in by the retailer and trade promotion offered by the manufacturer. In particular, the demand function is given by

$$(12) \qquad d_t = \tau - p_t + \kappa e_t,$$

where e_t is the retailer's merchandising effort and κ is the effectiveness of the merchandising effort in increasing sales. Note that the level of merchandising support offered by the retailer increases the demand for the product. For example, demand increases if a retailer offers more service or provides valuable end-of-aisle displays. Finally, merchandising has an in-store effect only in that period (i.e., merchandising effort in one period does not affect demand in the subsequent period).

With a trade promotion, the manufacturer specifies the retailer's effort level, but the retailer bears the cost of merchandising effort, which is given by $c = e^2/2$. Thus, the trade promotion offered by the manufacturer is a reduced Period 1 wholesale price that is tied to a specific level of merchandising effort. The retailer has the option of not accepting the trade promotion offer, in which case it chooses its own optimal level of merchandising effort and pays the regular wholesale price. More formally, when the manufacturer offers the retailer a trade promotion, it offers the following choice of Period 1 wholesale prices:

$$(13) \qquad w_1 = \begin{cases} w_1^p & \text{if } e_m \geq e_m^p \\ w_1^r \geq w_1^p & \text{if otherwise,} \end{cases}$$

where w_1^p is the Period 1 trade promotion price, w_1^r is the regular (without trade promotion) wholesale price in Period 1, and e_m^p is the promotional merchandising effort. It is straightforward that the retailer would choose the promotional price, w_1^p, only if it is lower than the regular price, w_1^r, which also comes without any requirement on merchandising effort. This formulation is consistent with industry practice in which manufacturers offer promotional prices that are contingent on specific performance levels. That is, if retailers want to benefit from the trade promotion, they must also invest in additional marketing activities. Such a performance-contingent contract has also been used by Lal, Little, and Villas-Boas (1996), who point out that a realistic model should allow the retailer the option of rejecting a trade deal and purchasing at the regular price.[7] Finally,

in keeping with the spirit of trade promotions as temporary price discounts, we assume that the retailer does not offer a trade promotion in Period 2. Therefore, in Period 2, the manufacturer's wholesale price should be higher than the promotional price in Period 1. In our model, this condition is always satisfied when

$$h \leq \frac{3\tau\rho(3\rho - 2)}{4(1 + 2\rho)}.$$

The manufacturer may not always find it optimal to offer a trade promotion, in which case the effect of forward buying is similar to our previous discussion in the bilateral monopoly case.[8] Therefore, in this section, we focus only on cases in which it is profitable for the manufacturer to offer a trade promotion and when it is profitable for the retailer to accept the equilibrium trade promotion offer. As in the previous section, we let the retailer have the option of forward buying in Period 1.

In Period 2, the retailer's maximization problem is as follows:

$$\underset{q_2, p_2, e_2}{\text{Max}} \ \pi_2^R = p_2(\min\{\tau - p_2 + \kappa e_2, q_2 + I_1\}) - w_2 q_2 - \frac{e_2^2}{2}.$$

The retailer's second period choices are given by

$$e_2^* = \frac{\kappa(\tau - w_2)}{2 - \kappa^2}, \qquad q_2^* = \frac{\tau - w_2}{2 - \kappa^2} - (q_1 - d_1),$$

$$\text{and } p_2^* = \frac{\tau + (1 - \kappa^2)w_2}{2 - \kappa^2}.$$

As we would expect, the optimal effort level is influenced by the wholesale price the manufacturer chooses: A higher wholesale price leads to a lower effort level. In addition, any increase in inventory carried from Period 1 decreases the quantity ordered in Period 2.

The manufacturer's second period problem is to choose w_2 to maximize $\pi_2^M = w_2 q_2$, which gives the following:

$$w_2^* = \frac{\tau - (2 - \kappa^2)(q_1 - d_1)}{2}.$$

In Period 1, if the manufacturer offers a trade promotion, the retailer has the option of choosing either the promotional wholesale price with the manufacturer-specified merchandising effort or the higher (regular) wholesale price with no requirement on merchandising effort. Therefore, the trade promotion offer must ensure that it provides the retailer at least as much profit as the regular wholesale price:

$$(14) \qquad \Pi^{Rp}(w_1^p, e_1^p) \geq \Pi^{Rr}(w_1^r).$$

Equation 14 is the retailer's voluntary participation constraint for the promotion.[9]

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[7]Lal, Little, and Villas-Boas (1996) develop a model in which a manufacturer offers a trade promotion to two competing retailers. In their model, trade promotions are driven entirely by the competition for a switching segment of consumers. In our case, the trade promotion has its own demand-enhancing effect that is independent of any switchers in the market.

[8]If we include merchandising effort, e_m, in the one manufacturer–one retailer model, all the essential results go through with only minor modifications.

[9]The model with a regular wholesale price in which the retailer also chooses an effort level is derived similarly to the procedure laid out for the one manufacturer–one retailer model. These details appear in the Web Appendix (http://www.marketingpower.com/jmrfeb10).

If the retailer chooses the trade promotion offer, its profit in the first period is given by

$$\pi_1^{Rp} = p_1(\tau - p_1 + \kappa e_1^p) - w_1 q_1 - hI_1 - \frac{(e_1^p)^2}{2}.$$

The retailer's problem is to choose an optimal q_1 and p_1 and to maximize the discounted sum of its two-period profits. Similarly, the manufacturer's problem is to choose w_1^p and e_1^p to maximize the discounted sum of its two-period profits. This leads to the following:

P_5: Both with and without a trade promotion, the retailer's optimal level of forward buying is given by

$$(15) \qquad Max\left[0, q_1^* - d_1^* = \frac{3\rho\tau - 4(w_1 + h)}{3\rho(2 - \kappa^2)}\right].$$

Thus, forward buying can take place both with and without the presence of trade promotions from the manufacturer. Furthermore, Equation 15 shows that the level of forward buying decreases with an increase in the wholesale price offered by the manufacturer and that it is independent of the specific effort level chosen by either the manufacturer or the retailer. In addition, as the effectiveness of merchandising increases, the retailer carries fewer units in inventory. Because a trade promotion always has a lower wholesale price, it is straightforward that the retailer will do *more* forward buying if it participates in the trade promotion. Thus, the retailer forward buys for two reasons: (1) to benefit from a temporary wholesale price reduction in Period 1 and (2) to create an inventory that can induce the manufacturer to charge a lower wholesale price in Period 2.[10] Thus, even when we allow for trade promotions, we continue to find that retailer forward buying can be used to get a lower wholesale price in the future.

P_5 also suggests that a trade promotion has a tendency to increase retailer forward buying. This means that there are parameters for which the retailer will forward buy only when a trade promotion is offered. This suggests that there can be instances in which it is not optimal for the retailer to forward buy for strategic reasons. However, if the terms of the trade promotion are attractive enough, the retailer will forward buy. This result is consistent with the conventional wisdom that forward buying occurs because of trade promotions being offered by the manufacturer. Because we analyzed forward buying without trade promotion in the previous cases, in this section we restrict our attention to parameters for which the retailer forward buys only with a trade promotion.

Recall that manufacturers often complain about the negative consequences of retailer forward buying associated with trade promotions, and some have even suggested that they would like to eliminate the practice entirely. Eliminating forward buying smoothes out the production process and reduces costs for the manufacturer—both these effects are beyond the scope of this paper. However, there are other

consequences of eliminating forward buying, and these are captured by the following proposition:

P_6: If the manufacturer disallows forward buying by the retailer, it will need to specify a lower merchandising effort for the trade promotion. In addition, the retailer will choose a lower level of merchandising effort in the postpromotion Period 2.

P_6 is applicable to the situations in which the retailer would find it optimal to forward buy with a trade promotion. In these cases, if the manufacturer does not allow the retailer to forward buy during a trade promotion, the trade promotion will be less profitable for the retailer. To make the trade promotion more attractive to the retailer, the manufacturer will need to rethink the terms of the trade promotion such that the retailer's voluntary participation constraint is satisfied. The manufacturer can do this by either requiring a lower level of costly merchandising effort from the retailer or changing the wholesale price. What makes this result particularly intriguing is that though the required merchandising effect will be lower, the depth of the promotional discount can either decrease or increase. To understand this result, note that by disallowing forward buying, the retailers' first-period order quantity, q_1, becomes less sensitive to the first-period wholesale price, w_1^p, and more sensitive to the effort parameter, κ. When κ is low, the manufacturer meets the voluntary participation constraint by reducing e_1^p and decreasing the promotion depth (i.e., increasing w_1^p). Conversely, when κ is high, the merchandising effort has a relatively high impact on sales, and therefore a reduction in the merchandising effort is more costly to the manufacturer. Therefore, the manufacturer does not try to meet the voluntary participation constraint solely by reducing e_1^p but rather through a combination of lower e_1^p and an increase in promotional depth (i.e., lower w_1^p).

Note that disallowing forward buying in Period 1 can carry through and have an impact in Period 2. In particular, the retailer chooses a lower postpromotion merchandising effort in Period 2. The reason is that the Period 2 wholesale price is higher without forward buying, and this decreases the marginal benefits of merchandising effort for the retailer.

Incorporating Demand Uncertainty

Uncertainty about future demand is often cited as a main reason a retailer would hold inventory. In particular, if demand turns out to be high, a retailer does not penalize itself by not having enough stock on hand. In the previous sections, we showed that even when a firm is certain about the level of demand, for strategic reasons, it may still choose to forward buy. The issue then is to observe what happens to forward buying when the players are uncertain about demand. In particular, regardless of the demand state, are there conditions under which a firm would hold inventory?

We follow Desai, Koenigsberg, and Purohit (2007) and model uncertainty by assuming that the base level of demand, τ, can be either high, $\tau = \tau_H$, with probability γ, or low, $\tau = \tau_L$, with probability $(1 - \gamma)$. The demand state is assumed to be the same in Periods 1 and 2. When

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[10]The comparison here is with the Period 2 wholesale price that the retailer would get without forward buying.

firms learn the demand in Period 1, there is no remaining uncertainty about the level of demand in Period 2. There are five stages of the game:

Period 1

Stage 1: The manufacturer sets the Period 1 wholesale price, w_1.

Stage 2: The retailer chooses the Period 1 order quantity, q_1. After it places its order, the players learn the true state of demand, either τ_H or τ_L.

Stage 3: The retailer sets the Period 1 retail price, p_1, and carries unsold units in inventory.

Period 2

Stage 4: The manufacturer sets the Period 2 wholesale price, w_2.

Stage 5: The retailer chooses the Period 2 order quantity, q_2, and the Period 2 retail price, p_2.

As Period 1 begins, the firms observe the true level of demand state after the retailer has ordered and the manufacturer has produced the quantity for Period 1. At this stage, there are three possible cases:

1. $q_1 < d_{1L} < d_{1H}$: The retailer does not have enough units for either the high or the low demand states, and it does not carry any units from Period 1 into Period 2.
2. $d_{1L} \leq q_1 < d_{1H}$: The retailer does not have enough units for the high demand state but has enough units for the low state. Only when demand is low can the retailer carry inventory into Period 2.
3. $d_{1L} < d_{1H} \leq q_1$: In this case, the retailer either will have just enough units to satisfy the high demand or will carry inventory into Period 2 (under both demand states).

This leads to the following proposition:

P_7: When $0 < h < h_{u2}$, the retailer orders a high enough quantity such that it is optimal to carry inventory regardless of whether demand turns out to be high or low, where

$$h_{u2} = \rho \frac{\tau_H[4\gamma(4+9\rho)-(4-3\rho)(8+9\rho)]-4\tau_L(1-\gamma)(4+9\rho)}{4[8+9\rho(2+\rho)]}.$$

When $h_{u2} < h < h_{u1}$, the retailer orders a quantity such that it is optimal to carry inventory only if demand turns out to be low, where

$$h_{u1} = \frac{2\gamma\tau_H(4+3\rho)-\tau_L[4\gamma(4-\rho)+\rho(4-9\rho)]}{4(2+2\gamma+3\rho)}.$$

When $h_{u1} < h$, the retailer orders a quantity such that it never carries inventory. In contrast to the foregoing results, an integrated firm would carry inventory only in the low demand state and never in the high demand state.

The issue here is whether the retailer carries inventory or not. Carrying inventory in the high demand state is evidence of strategic behavior. Most models ignore this strategic effect because they assume that the retailer would never carry inventory in the high demand state. However, we find that under certain conditions, the retailer will carry inventory not only in the low but also in the high demand state.

Finally, a way to understand our results is to compare the decisions made by an integrated firm facing uncertain demand with the retailer's decisions. In this case,

facing uncertain demand, the integrated firm views inventory solely as a safety stock. In contrast, because of the manufacturer's problem with time consistency, a retailer views inventory as a safety stock and a strategic variable. From this perspective, we find that unlike the retailer, an integrated firm would never carry inventory in the high demand state.

DISCUSSION AND CONCLUSION

We began this article by noting that the conventional wisdom in marketing is that trade promotions are the leading culprits behind retailer forward buying (e.g., Kotler and Keller 2006). Moreover, if there is no overall increase in consumer demand associated with the trade promotion, then all the manufacturers have achieved is to sell a larger quantity at a lower price—a practice that helps the retailer at the expense of the manufacturer. Furthermore, manufacturers must deal with the costs of large swings in production volume, which leads to a further decrease in profits (Ailawadi, Farris, and Shames 1999). In contrast, Anand, Anupindi, and Bassok (2008) show that manufacturers are always better-off by allowing retailers to forward buy when the manufacturers cannot commit to future prices. In this article, we examine additional complexities that arise from forward buying in a variety of settings, including product-market competition, demand uncertainty, and trade promotions.

We find that regardless of whether trade promotions are offered by a manufacturer, forward buying can still be an optimal strategy for a retailer. Thus, a trade promotion increases the level of forward buying, but eliminating trade promotions does not mean that forward buying will go away. Importantly, however, forward buying need not always be profitable for retailers. In particular, when two competing retailers purchase from a single manufacturer, competition forces each retailer to pass through more of the wholesale price reductions. In some cases, retailers forward buy because they may be in a prisoner's-dilemma situation. This result provides a contrast to the belief that though manufacturers are hurt by retailer's forward buying, they allow this practice because of competitive pressures from other manufacturers. Our analysis suggests that the level of retailer competition can also drive forward buying.

The main effect of forward buying is that it results in an overall increase in the purchase order from the retailer. In contrast to the commonly held belief that the manufacturer is hurt by forward buying, we show that the manufacturer is better-off when the increase in its total sales offsets the reduction in wholesale prices. Furthermore, when two competing manufacturers are selling to a common retailer, forward buying becomes even more likely than the manufacturer monopoly case. However, competition between manufacturers limits each one's ability to capitalize on the forward buying.

Although conventional wisdom argues that eliminating forward buying would be good for manufacturers, we show that this logic holds only when the holding costs are high enough. For lower levels of holding cost, forward buying by the retailer can benefit the manufacturer and the overall channel. In other words, forward buying potentially can move the channel closer to a coordinated level. The

essential problem in channel coordination is that retailers and manufacturers have conflicting incentives that increase channel inefficiencies and lower the overall profits of the channel.[11] Our analysis suggests that by lessening the problem associated with double marginalization, forward buying can play a previously undiscovered role in moving the channel closer to a coordinated level.[12] The essential problem with double marginalization is that, compared with an integrated channel, the total quantity sold is too low. Conversely, forward buying leads to a decrease in the average wholesale price charged by the manufacturer and an increase in the total quantity sold, thus bringing the solution closer to that of an integrated channel. Furthermore, our analysis suggests that, under certain conditions, total channel profits can increase with holding costs. This surprising result occurs only when the holding cost inefficiency is offset by a decrease in the double marginalization inefficiency.

Disallowing forward buying during a trade promotion can have other consequences as well. In particular, we find that if a retailer is disallowed from forward buying, the manufacturer will need to reduce the merchandising requirement associated with the trade promotion. Furthermore, in the subsequent period when there is no promotion, the retailer will also reduce its own merchandising effort. These decreases in overall effort result in an overall decrease in demand for the product. The effect of disallowing forward buying on the trade promotion wholesale price depends on the effectiveness of the merchandising effort. In particular, when merchandising has a large effect on demand, the manufacturer must increase the depth of the trade promotion; conversely, when merchandising has a small effect on demand, the manufacturer must decrease the depth of the promotion. All these changes can have important effects on the manufacturer's profitability.

Consider the role of forward buying in the context of demand uncertainty. The typical way to model uncertainty is that if a retailer is uncertain about whether demand will be "high" or "low," it keeps inventory on hand. Note that inventory plays the role of safety stock; that is, it provides protection for the case when demand turns out to be high and does not particularly help if demand turns out to be low. Thus, it is typically assumed that the firm will not order more than what it expects to sell in the high demand state. In this article, we relax that assumption and find that in some cases, the retailer ends up holding inventory regardless of whether demand turns out to be high or low. This

is noteworthy and further highlights the role of strategic forward buying by the retailer.

Our research adds to the extensive literature on distribution channels by discovering a new insight from a familiar framework. In particular, Spengler's (1950) bilateral monopoly model has been used extensively in marketing, beginning with McGuire and Staelin (1983). With a few exceptions, most applications of this manufacturer–retailer framework have been in static settings and have assumed that the retailer's ordering quantity is also its selling quantity. The fundamental problem we pose occurs over time: Forward buying by the retailer in one period has an effect in the subsequent period, and we need to separate the ordering and selling decision. When we take a simple channel model and introduce a linkage over time, it gives us a new perspective on the basic model. Allowing forward buying in a one-level marketing channel significantly changes the nature of the solution because it alters the strategic interaction between the manufacturer and the retailer. In particular, in the standard static framework, the manufacturer plays the role of Stackelberg leader and is able to take advantage of its position by moving first. In our dynamic setting, the manufacturer still plays the role of leader in Period 1, but the presence of retailer inventory in Period 2 takes away part of the manufacturer's advantage. Another way of thinking about this is that by having inventory in Period 2, the retailer needs the manufacturer only for the residual demand that its inventoried units cannot satisfy; in this way, the retailer can be thought of as playing the role of leader in Period 2 and earning higher profits than before. As we show, depending on the parameters, the manufacturer's profitability is both helped and hurt by this behavior.

To maintain tractability, we needed to make some simplifying assumptions. In particular, we made the choice of linear demand function for this reason. However, Lee and Staelin (1997) show that in many channel models, the nature of strategic interaction (strategic substitutability versus strategic complementarity) rather than the specific demand function determines the equilibrium outcomes. Despite using a relatively simple demand function, we were not able to analyze a model in which both retailers and manufacturers faced competition. However, our analysis provides insights into the individual effect of competition at each level. In other words, although we are unable to determine much about the interaction between the two types of competition, we can describe their main effects. Finally, we acknowledge that having only two periods may seem to be a limiting assumption. Dynamic models must often make this assumption for tractability reasons (see Hauser, Simester, and Wernerefelt 1994). We also analyzed a more general n-period version of the one manufacturer–one retailer model and found that depending on the level of holding costs, the retailers carry inventory in some periods.

There are several avenues for extending our research. One possibility is to allow the manufacturers to charge quantity discounts or quantity premiums. This can allow the manufacturers to reward or penalize forward buying as necessary and achieve full coordination by using more general contracts. Another factor that could affect our results, and therefore merits further investigation, is the high-end or low-end positioning of the retailers and manufacturers. Another is to consider the situation in which both

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[11]A large portion of channels research is focused on understanding the nature of these inefficiencies and on designing contractual and noncontractual mechanisms that align manufacturers' and retailers' incentives, such that retailers choose the appropriate price, service, promotional spending, or any other marketing decision (see Bruce, Desai, and Staelin 2005; Coughlan and Wernerfelt 1985; Cui, Raju, and Zhang 2007; Desai, Koenigsberg, and Purohit 2004; Lal 1990; Lee and Staelin 1997; McGuire and Staelin 1983; Moorthy 1987). The economics literature on double marginalization (Spengler 1950), downstream moral hazard (Holmstrom 1979), and bilateral moral hazard (Bhattacharya and Lafontaine 1995; Desai 1997; Holmstrom 1982) also deals with vertical relationships in which incentives are misaligned.

[12]It is well established that a linear price contract, such as a wholesale price charged by the manufacturer, leads to inefficiencies because of double marginalization. Conversely, in many situations, including in some of the cases we consider in this article, more general contracts can lead to full channel coordination.

retailers and consumers can forward buy (Anton and Das Varma 2005; Guo and Villas-Boas 2007; Hong, McAfee, and Nayyar 2002). These are fruitful directions in which to take this research.

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