A Theory of Forward Buying, Merchandising, and Trade Deals

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Abstract

Manufacturer-supported trade deals remain one of the major competitive tools in today's marketplace. This is true despite the fact that such trade deals are often claimed to be unprofitable for manufacturers. The unprofitability is attributed to the fact that retailers forward buy and do not pass the price discounts on to the consumers. The audience for this paper includes practitioners and academics who have been concerned with the ubiquitous practice of trade dealing in spite of its purported unprofitability.

The paper attempts to understand the motivations for trade dealing by comparing the profitability of trade dealing in the presence of forward buying to a situation in which retailers carry no inventory. Moreover, we shed light on why manufacturers sometimes offer trade deals even though the retailers do not pass through these deals to the consumers.

We study the problem of trade dealing through an economic model that includes the manufacturers, the retailer, and the consumers. In this way we include all three levels of the distribution system, and model the dynamic effects of forward buying by the retailer.

The main features of the model can be summarized as follows. At the manufacturer level, each of two manufacturers is allowed to offer a regular price and a deal price, which, if accepted by the retailer, requires the retailer to display and merchandise the product. Moreover, the manufacturer is assumed to incur a selling cost with respect to offering a trade deal. The retailer, on the other hand, decides whether to accept the deal, determines how much to order, and sets the retail prices of the two brands. The retailer needs to set a price below the regular price to achieve maximum effectiveness from its display and merchandising activities. If the retailer accepts a trade deal, it incurs a fixed cost of display and merchandising the product reflecting the opportunity cost of display. If the retailer does not accept the trade deal, it can order at the non-deal price. Furthermore, the retailer can order more than what can be sold to the consumers in that period, i.e, forward buy. The retailer can carry inventory from either manufacturer at a cost but has an upper limit to the total amount of inventory carried in any period.

The consumer population is assumed to consist of brand loyals and switchers. The brand loyals buy as long as the price is below the reservation price, while the switchers choose the brand on display if the retail price is lower than the regular price and the price of the competing brand. With these as the basic elements of the model, we characterize the equilibrium manufacturer and retailer pricing strategies with and without inventories in an infinite-horizon model with discounting.

The central result of the paper is derived by comparing the profits to the manufacturers for the case when retailers are allowed to forward buy to the case when they are not allowed to forward buy. This comparison shows that although forward buying is profitable to the retailer through the availability of goods at lower prices, an important consequence of forward buying is the decreased intensity of competition between manufacturers. The decrease in the intensity of competition yields higher profits to the manufacturers as compared to the case where the retailer is not allowed to carry any inventory. The intuition behind our result is seen by taking a closer look at intensity of trade dealing in the presence and absence of forward buying. Consider the worst and the best trade deals offered by manufacturers, in equilibrium, when the retailer is not allowed to carry any inventory and explore their viability when the retailer is allowed to inventory. If the retailer is allowed to carry inventory and holds some inventory, the worst trade deals become unacceptable to the retailer. This is because the inventory allows the retailer to not buy all the units demanded in the subsequent period, and the retailer can therefore reject such trade deals. Similarly, the best trade deals offered by manufacturers when the retailer is not allowed to inventory do not remain as profitable because the retailer forward buys and the manufacturers lose future sales and profits. Thus trade deals at both extremes (the best and the worst) that were profitable to the manufacturers when the retailer is not allowed to forward buy are no longer viable when the retailer is allowed to forward buy. This increases the overall probability of not offering trade deals and leads to decreased intensity of competition.

(Competition; Trade Promotions; Merchandising; Forward Buying)

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1. Introduction

Manufacturers' trade promotions or "trade deals" are temporary price reductions offered by manufacturers to retailers for the purpose of stimulating sales. Trade promotional spending has grown to exceed advertising expenditure in much of the consumer packaged goods industry and, partly as a result of this, has attracted the attention of academic researchers. Some of them have questioned the usefulness of trade promotions because these often shift sales to the promoted brand only for the duration of the promotion. Researchers ask: "Would it not be more profitable for the manufacturers to set wholesale prices at an intermediate value between the temporary price and the usual higher price?" In other words, if price elasticities are such that a lower price means greater profit, why not adjust the price permanently?

Many attempts have been made to explain this phenomenon. Some of these explanations are based on related ideas of prisoner's dilemma and competition for the switching segment (Varian 1980, Narasimhan 1988, Raju et al. 1990, and Rao 1990). Others view it as indicative of collusion among manufacturers (Lal 1990a, b), and some see a justification for trade deals based on category expansion (Peckham 1973, Strang 1976). However, most of these attempts offer a rationale for price promotions in a market, where manufacturers compete directly for the demand of their products, but do not take into account the role of the retailer (which typically sells competing brands to the end consumer). Any reasonably complete explanation of the phenomenon of trade deals must provide a rationale not only for the manufacturers but also for the observed effects at the retail level since the retailers are the manufacturer's customers and make the decision whether to accept or reject the trade deals. Thus the goal of this paper is to explain the ensuing phenomenon at the retail level, and offer some additional insights into the motivation for manufacturer supported trade deals.

More specifically, we focus on the following elements of the phenomenon as observed at the retail level. First, manufacturers are able to offer trade deals with performance clauses. In fact many packaged goods product managers believe that the manufacturer's goal in trade promotion is not just to reduce retail price but also to obtain displays and features. (Features are ads run by retailers in local newspapers and store flyers.) In a trade promotion, a manufacturer offers to reduce wholesale price for a certain period—say, six weeks—in return for the retailer's running a prespecified kind of merchandising during, say, at least one week of the period. Ample evidence demonstrates that such merchandising activities have a large influence on sales beyond the effect of any price reductions (Guadagni and Little 1983). Thus, price is not the whole story.

Second, the retailer may or may not accept the offer. Although this aspect of the relationship between the retailer and the manufacturers may seem innocuous, it has a significant impact on modeling the decisions of the manufacturer and the retailer. In particular, one needs to allow for the existence of a nondeal/regular price whenever a deal is offered such that, if the trade deal is not accepted by the retailer, it can always buy at the nondeal price. Thus a complete explanation for the phenomenon should be able to demonstrate the simultaneous existence of a nondeal and on-deal price at the manufacturer level as an equilibrium outcome.

Finally, and most importantly, retailers regularly take advantage of the temporary price discount to stock up with extra goods, putting them into inventory for later sale. This is known as "forward buying." These additional discounted sales are large and, in fact, manufacturers report that many trade promotions are unprofitable (Schlossberg 1991). The short-term burst of sales due to merchandising often does not compensate for the decreased margin on the larger amount of goods sold at discount. Therefore, to the extent that previous models do not take into account the loss from forward buying by retailers, an explanation of the ubiquity of trade promotions by manufacturers where the terms of the trade deal do not prevent manufacturers from forward buying, remains incomplete.

In this paper we shall search further for an understanding of the competitive nature of trade promotions. In doing so, we build on the works of Narasimhan (1988), Raju et al. (1990), and Rao (1990). However, we deviate from their work in several important ways. First we study the competition between two symmetric manufacturers selling their brands through a retailer. In this way, we involve all three levels of the distribution system in the analysis: manufacturers, retailers, and consumers. Second, we allow the manufacturers to write contracts which require the retailer to carry out merchandising activity, as part of the terms of accepting a trade deal.[1] In other words, trade promotions induce retail merchandising which affects consumers' brand choice independent of the effect of differences in retail prices. Third, manufacturers offer both a nondeal price and a deal price such that when the retailer does not accept a trade deal, it can always buy at the nondeal price. Fourth, not only is the retailer allowed to accept or reject a trade deal when offered but furthermore, it is allowed to forward buy a brand when desirable. Finally, both the retailer and manufacturers incur a transaction cost with respect to offering and implementing a trade deal. Using a mixed strategy framework and restricting our attention to Markov strategies, we are able to offer the following insights.

First, with respect to manufacturer trade deals, we show that there is occasional random discounting motivated in part by the desire of the manufacturer for its trade deal to be accepted and the potential advantage of being in the retailer's inventory. Second, while allowing manufacturers to charge a separate regular and deal price, the transaction costs associated with offering trade deals result in manufacturers not offering a trade deal all the time. This is in contrast to the result in the extant literature where prices below the reservation price are always offered by symmetric manufacturers as in Varian (1980) or not offered all the time as in the case of competition between asymmetric firms (for example, see Narasimhan 1988). Our results stem from the transaction costs of offering trade deals and from allowing the manufacturer to set separate regular and deal prices. Moreover, we show that the cost of offering a trade deal softens the intensity of competition between manufacturers, thereby leading to higher profits.

At the retail level, we are able to show that depending on the size of the trade deals offered by competing manufacturers, the retailer may accept none, or one trade deal. Furthermore, manufacturers offer deals that lead to forward buying.

Finally, our most important result relates to the effect of forward buying on manufacturers' profits. Although forward buying is profitable to the retailer through the availability of goods at lower prices, an important consequence of forward buying is the decreased intensity of competition between manufacturers. Finally, our most important result relates to the effect of forward buying on manufacturers' profits. Although forward buying is profitable to the retailer through the availability of goods at lower prices, an important consequence is the decreased intensity of competition between manufacturers. The decrease leads to higher profits for the manufacturers relative to a case in which retail inventory is not permitted. To see the intuition behind our result, consider the smallest and largest discounts offered by manufacturers in their trade deals at equilibrium, when no inventory is possible, and explore their viability when inventory is permitted. If the retailer has inventory, the smallest discounts become unacceptable to the retailer, because demand in the next period can be satisfied at low cost from inventory. Correspondingly, the largest discounts become unacceptable to the manufacturers, because retailer forward buying decreases future sales and profits. Thus the range of acceptable trade deals is decreased. This results in a decrease in the probability that the manufacturers offer a trade deal and so decreases the intensity of competition. We show that this is all true only when offering a trade deal imposes a transaction cost on the manufacturer.

The rest of the paper is organized as follows. Section 2 presents a brief review of the literature. Section 3 presents the details of the model followed by an analysis of the various cases. Case 1 assumes no possibility of inventory. Case 2 allows the retailer to forward buy. We provide a discussion of our results in §4 and we close with a summary of our findings.

2. Literature Review

The most commonly proposed explanation for the large amount of trade promotion is that, it is the result of a prisoners' dilemma. Thus, if only one manufacturer were to promote, it would be extremely successful at taking sales away from competitors, but, when all manufacturers do, each makes less profit than if none did. The prisoners' dilemma hypothesis is supported to some extent by the comments of practitioners who sometimes declare that trade promotions are "part of

[1] Details of such contracts are available in Blattberg and Neslin (1989, p. 319–320).

the cost of doing business." Furthermore, they note that the frequent merchandising activities of retailers (encouraged and paid for by the trade promotions), have created a sizable group of customers who consistently make many of their purchases during store specials. These customers are often referred to as the "deal-prone segment." To maintain an appreciable share in this segment, a manufacturer must run regular promotions. This phenomenon, it may be argued, exacerbates the prisoners' dilemma.

Competition for the switching segment has also motivated the works of Varian (1980), Narasimhan (1988), Raju et al. (1990), and Rao (1990). In these models, small differences in the price of competing brands lead to a significant change in market share. These authors use a mixed strategy equilibrium framework to model competition among manufacturers and show that price promotions are a result of the need to avoid vulnerability in prices so as to effectively compete for the switching segment.

Using the approach offered by Kinberg et al. (1974), Lal (1990a, b) proposes another explanation which suggests that, in markets with high concentration (e.g., cola drinks), manufacturer trade promotions offered by national brands may be a way of limiting the competitive threat from lesser known and store brands. However, as also noted by Lal, the equilibrium is supported by punishment strategies that are difficult to maintain when the number of competitors is large, as is true in many product categories.

Still another reason for so many trade deals might be that, although manufacturers' promotions may cancel each other out with respect to share changes, the activity as a whole decreases average price and increases merchandising for the category. Perhaps this increases sales enough to justify the expense. While such an argument may apply to some products, there are important categories—for example, detergents—that would not really be expected to expand and yet have trade promotion as a way of life. (See also Peckham 1973 and Strang 1976.)

A limitation of all these analyses is that none consider such real-world behavior as merchandising, forward buying, and rejection of some trade deals by the retailer.

A second stream of literature, based more on an empirical tradition measures the effect of trade promotion on retail activity and brand sales. Using a survey methodology, Chevalier and Curhan (1976) show how characteristics of the manufacturers' promotions affect the retailer's merchandising and store promotion. Abraham and Lodish (1987) develop a baseline method for analyzing a manufacturer's shipments to determine the net effects of trade promotion on brand sales and suggest that retailers buy most of the volume on trade deals, i.e., indulge in "deal-to-deal buying." Blattberg and Levin (1987) present an integrated model and, using Nielsen bimonthly data on retail sales, manufacturer shipments, and information on trade deals and advertising, estimate the effectiveness and profitability of trade promotions. In support of our introductory discussion, these authors conclude: "(i) trade deals increase shipments to retailers, (ii) retailers forward buy, which decreases shipments after promotions has ended, and (iii) consumer sales increase but not as much as the retailer forward buys, as demonstrated by troughs in shipments after deal." For a more comprehensive review of trade promotions, see Blattberg and Neslin (1989).

3. The Model

To capture the proposed phenomena in as simple a way as possible, we model two competing manufacturers each selling its own brand of a frequently purchased product through a single retailer. We conduct the analysis over an infinite number of periods to allow the manufacturers to change their strategies over time and to permit the retailer to forward buy for later sale.

The game between the manufacturers and retailers is modeled as follows. First, the manufacturers set the regular wholesale price for sale of each product for all periods.[2] This is not inconsistent with the observed practice of using a base price which can be used as a reference for other discounts (see Rao 1990). More technically, the justification for this assumption is outside the model and could result from the existence of

[2] As discussed below, since there is no competition at the retail level in our model and category volume is assumed to be fixed, this regular price will be the maximum each consumer is willing to pay for one unit of either brand.

high menu costs in the change of regular prices by manufacturers.

Next, in each period manufacturers can, however, decide to offer a deal price, P_i, $i = 1, 2$, which if accepted by the retailer requires the retailer to display and feature the product of the corresponding manufacturer. Furthermore, it is assumed that display and merchandising is accompanied by a price reduction of d_1 at the retail level when compared to the regular retail price.[3] Although the enforceability of such contracts may be questioned, details of such contracts suggest that the retailer receives the payment only upon "the receipt of the Certificate of Performance," (Blattberg and Neslin 1989, p. 320).[4] Similar proof of performance is also required by other manufacturers as seen from the details of the Cooperative Merchandising Agreement (CMA) obtained by the authors from a major consumer packaged goods company.[5] Further conversations with brand managers at this company confirm that a retail salesforce is employed to conduct spot checks and verify the performance of participating retailers.

When offering a deal, a manufacturer incurs a cost K independent of whether the deal is accepted or not. K represents the cost to the manufacturer of sending its salesforce to promote and explain the terms of the trade deal to the retailers. In addition, there are other costs of implementing a trade deal as noted by Blattberg and Neslin (1989, p. 397). These include the costs of preparing salesforce material which goes beyond outlining the details of such promotions. This material is supposed to carefully present the arguments for why a retailer should buy more and suggest the best merchandising strategies to increase the effectiveness of such deals. The ultimate success of a trade deal depends on the effectiveness of such material in their ability to convince the retailers about the benefits of the proposed trade deal. We will consider the cases of K equal and different from zero.

The retailer decides whether or not to accept the deal, determines how much to order, and sets the retail prices for the two brands. If the retailer does not accept the trade deal, it can order at the nondeal price. Furthermore, the retailer can order more than what can be sold to consumers in that period, i.e., can forward buy, and inventory for the next period. The retailer can carry inventories from either manufacturer, and the maximum inventory is restricted to satisfy the demand from the loyal segment of either manufacturer. The associated inventory holding costs are assumed to be h per unit.[6]

The retailer incurs a fixed cost d_2, independent of the size of the total market, if it displays and features the product of a manufacturer. Moreover, the retailer can accept at most one trade deal in any given period. We consider the case when d_2 is small. In fact, in some cases, d_2 can be significant because it includes the opportunity cost to the retailer of using the display site for another product category. d_2 is fixed through time and is perfectly known by the retailer and manufacturers. For simplicity, the marginal costs of production for the manufacturers and of selling for the retailer are set equal to zero.

For purposes of expositional simplicity, it is assumed that there are only three consumers in the market; and, as discussed earlier, changes in retail price do not affect category volume but only market shares.[7] Total demand is three units per period, one unit per customer. One customer is loyal to manufacturer 1, another is loyal to

[3] This price cut may be due to, for example, the fact that merchandising and display are most effective when accompanied by a price cut.

[4] In their description of a trade deal contract offered by Colgate Palmolive, the certificate of performance requires "documentary proof satisfactory to Colgate that the Special Event performance was rendered as required as Terms and Conditions of this agreement." It is also noted that script/story board, tear sheet of rotogravure or any other proof of performance may be required. Moreover, off-shelf display is acceptable provided the items are floor displayed for a period of at least three consecutive weeks.

[5] This contract reveals that "notification of Merchandiser's performance under this Agreement to the Company's General Office is required as a condition for payment under this Agreement . . . Documentation of performance includes the following as applicable or as requested by the Company representative: newspaper tear sheets, handbills, each broadcast script bearing the ANA/RAB documentation for radio, the ANA/TVB documentation for television, store display bulletins and window posters. . . ."

[6] We are implicitly assuming a step function for inventory holding costs.

[7] As discussed in §4, the results presented herein generalize to cases where there are more switchers or more loyal consumers in the market and hence are robust to more general demand specifications.

manufacturer 2, and the third is a "switcher" who is indifferent between the two brands given the same marketing conditions.

The "loyal" customers purchase only the respective brands and they do so only if the brand is available for sale at a price lower than or equal to the reservation price, r, in that particular period.

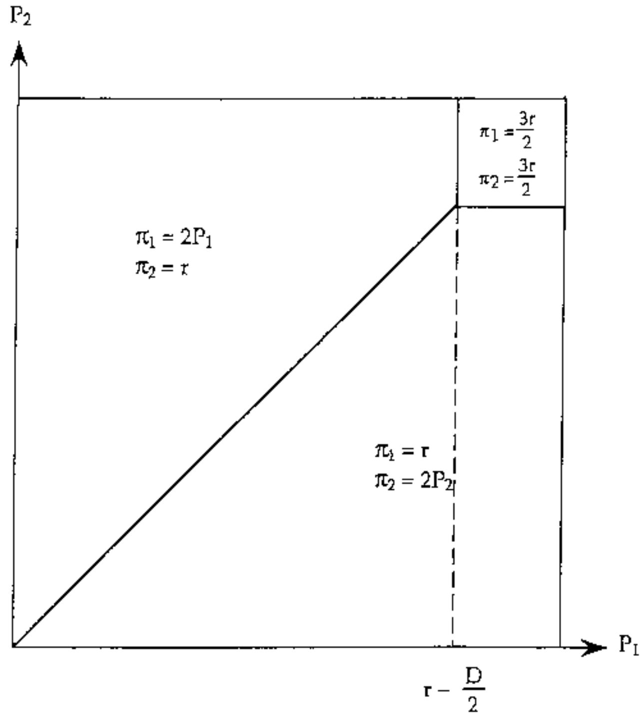
The decision process of the "switcher" is as follows. The "switcher" chooses the brand on display if the retail price for that brand is lower than the regular price and is also lower than the price of the competing brand. If no brand is on display at the retail outlet, the "switcher" chooses the brand with the lowest retail price (or, if the retail prices are equal, purchases each brand with equal probability). In any case, the "switcher" only purchases if there is at least one brand being sold with retail price lower than or equal to the reservation price, r.

The assumptions described above are restrictive in several ways. We allow for only limited heterogeneity within the customer base and no uncertainty in demand. Inventory costs are simplistic, and there is no competition at the retail level. Retailers can accept only one trade deal in any period. However, these assumptions facilitate the analysis of the more essential phenomena and can potentially be relaxed. Since the objective of the analysis is to offer insights rather than precise optimal pricing strategies, we have abstracted from reality while trying to capture the essence of factors that influence the phenomena we are addressing. In later discussion we shall return to these assumptions and argue why the insights gained from the model are likely to continue to hold even when these assumptions are relaxed.

3.1 The No Inventories Case

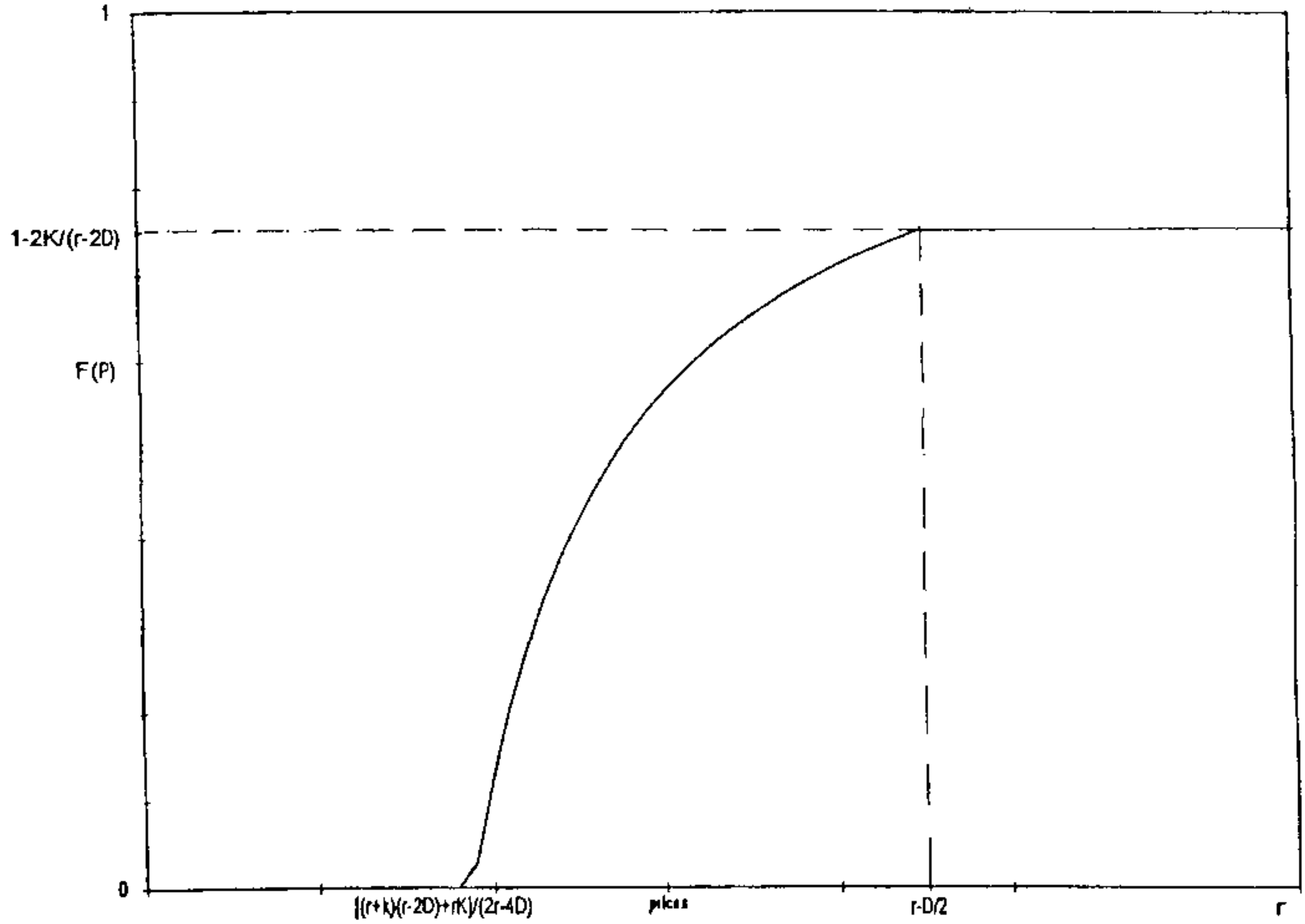
Let us consider first the case in which the retailer cannot carry any inventory. For any given deal prices being offered, one can derive the retailer's best response. The best response of the retailer is to sell the brand supported by a trade deal at $r - d_1$, and r otherwise. Thus the cost of accepting a trade deal to the retailer is $2d_1$ (since two units are sold on deal) plus d_2. Given the retailer best response to the manufacturers' actions, we can derive the manufacturers' payoffs corresponding to any deal prices, and the equilibrium strategies for the manufacturers. These derivations can be found in the appendix and the payoffs to manufacturers 1 and 2, π_1 and π_2, as functions of the deal prices offered by each manufacturer, P_1 and P_2, are described in Figure 1 for the case $K = 0$. These payoff functions enable us to construct the market equilibrium in the form of mixed strategies (in the spirit of Varian 1980: there are advantages to the manufacturer from undercutting for all levels of trade deals in a certain deal range). As in Narasimhan (1988), Raju et al. (1990), and Rao (1990), mixed strategies can be interpreted as trade deals. This interpretation corresponds to manufacturers choosing a price probabilistically from a distribution characterizing the mixed strategies equilibrium. The equilibrium is stated in the following proposition (the appendix presents a sketch of the proof).

Figure 1 Payoffs to Manufacturers in the Case of No-Inventory and Costless Trade Deal Offers



PROPOSITION 1. *The equilibrium payoff for each manufacturer in the case of no inventories is $\pi_1 = \pi_2 = \Delta = r + (rK/[r - 2D])$ where $D = 2d_1 + d_2$. Note that while D is the total cost to the retailer of implementing a trade deal, K is the corresponding cost to the manufacturer of offering a trade deal.*

Figure 2 **Cumulative Probability Distribution of Trade Deals in the No-Inventories Case**



The equilibrium strategies for the manufacturers are mixed and symmetric with deals being offered with probability $1 - \gamma = 1 - [2K/(r - 2D)]$ *and deal prices between* $(\Delta + K)/2$ *and* $r - (D/2)$, *with cumulative probability distribution shown in Figure 2 and described by*

$$F(P) = \frac{2P - \Delta - K}{2P - r} \quad \text{if } \frac{\Delta + K}{2} \le P \le r - \frac{D}{2}.$$

The equilibrium strategy for the retailer is to set the retail price equal to the reservation price if the brand is not bought on deal and lower the price by d_1 *if bought on deal; and always accept the best deal if that deal price is below* $r - (D/2)$.

This proposition shows that, if it is costless to offer price deals ($K = 0$), manufacturers always offer a price deal, and the retailer always accepts the better deal. Moreover, if $K \neq 0$, manufacturers do not always offer trade deals and the probability of not offering a trade deal (γ) increases with increase in the cost of offering a trade deal (K). Furthermore, increasing the costs of offering price deals softens the degree of competition between manufacturers sufficiently enough so that the profits to each manufacturer are greater than r. This result is surprising to the extent that manufacturers' profits increase as the cost of offering a trade deal increases. However, this surprising result can be better understood when one recognizes that the profits of the manufacturers increase with K, only up to a point. In other words, if the costs are too high, say greater than or equal to K^*, manufacturers would not offer a trade deal, and their profits will be $3r/2$. As the cost of offering a trade deal decreases below K^*, manufacturers find it in their best interest to compete for the switcher by offering trade deals. In fact, the frequency of offering trade deals increases with decreases in K; however, this increase in competition overshadows the decrease in the cost of offering trade deals leading to lower profits for the manufacturers. In the limit, when $K = 0$, manufacturers offer deals all the time and all potential profits from the switching segment are dissipated, resulting in total profits of only r to the manufacturers. Finally, it should be noted that the profits to manufacturers also increase with an increase in the cost to the retailer of implementing a trade deal. Once again, this is due to the fact that an increase in this cost reduces the probability of a trade deal being accepted by the retailer and hence increases the likelihood of manufacturers not offering a trade deal (γ increases with D). This in turn reduces the competition between manufacturers sufficiently enough such that the increase in profits completely offsets the increase in cost of implementing a trade deal.

Note that the result of no deals being offered is also obtained in Narasimhan (1988), Raju et al. (1990), and Rao (1990). However, while their result is motivated by asymmetries between the manufacturers, our result is due to the cost of offering trade deals, which is identical for both manufacturers. Therefore, our result is mainly due to the fact that we allow the manufacturers to write contracts which require the retailer to carry out merchandising activity, as part of the terms of accepting a trade deal, and the fact that the retailer can reject a trade deal when offered and buy at the regular price instead.

If $K = D = 0$, manufacturers offer deals all the time, retailers accept all deals, and the equilibrium is exactly as in Varian (1980). If $D = 0$ but $K \neq 0$, manufacturers offer trade deals with a probability $1 - (2K/r)$ and retailers accept all deals. Finally, if both these transaction costs are nonzero, manufacturers offer and retailers accept trade deals only part of the time. The payoffs to the manufacturers increase with increases in the cost of offering a trade deal or the cost to the retailer of implementing a trade deal. This result is directly related to our description of the contractual arrangement between the manufacturers and the retailer, which results in reduced intensity of competition under these circumstances.

3.2 The Possibility of Inventories Case

We consider now the case in which the retailer is allowed to carry at most one unit of inventory and the associated inventory holding costs are assumed to be h.[8] Note that now the model becomes truly dynamic in the sense that variables from the previous periods affect the payoffs in the current period.

We restrict ourselves to equilibria in Markov strategies, i.e., strategies that depend only on the payoff relevant state variables. Restricting attention to Markov strategies allows us to get rid of equilibria in which the players' strategies can be a function of certain variables just because the competitors are making their strategies depend on those same variables, even though they may not directly affect the players' payoffs.

We have three players, the two manufacturers and the retailer, and three possible states: the retailer has one unit of inventory of manufacturer 1, one unit of inventory of manufacturer 2, or no inventory at all. We denote the value function (i.e., the equilibrium net present value of the payoffs) of manufacturer i as $W^i(I_i, I_j)$ for $i = 1, 2$ and $j = 3 - i$, and the value function of the retailer as $V(I_1, I_2)$, where I_1 and I_2 take only the values of one or zero. Future payoffs are discounted by the discount factor δ with $0 < \delta < 1$. We look for symmetric equilibria where $W^1(x, y) = W^2(x, y)\ \forall x, y$ and $V(1, 0) = V(0, 1)$.

3.3a *State* $(I_1 = 1, I_2 = 0)$.

Let us now look for the equilibrium actions in the state $(I_1 = 1, I_2 = 0)$.[9]

The first step in the derivation of the equilibrium is to characterize the optimal reaction of the retailer to the actions of the manufacturers. The retailer compares the following options: (i) not accept any price deals—it sells the three units at a price r and buys only two units at a price r, thereby exhausting its inventory and resulting

[8] We restrict the maximum inventory to one unit for the sake of analytical tractability. As argued in §4, this assumption does not compromise the insights gained from the analysis presented next.

[9] Given that we are looking for symmetric equilibria, this also characterizes the equilibrium actions for the state $(I_1 = 0, I_2 = 1)$.

in a payoff equal to $r + \delta V(0, 0)$; (ii) accept the deal from manufacturer 1—it sells 2 units of brand 1 at a price $r - d_1$ per unit, sells one unit of brand 2 at a price r, and buys two units of brand 1 at a price P_1 and one unit of brand 2 at a price r resulting in a payoff equal to $2r - 2d_1 - 2P_1 - d_2 - h + \delta V(1, 0)$; (iii) similarly, accepting the deal from manufacturer 2 yields a payoff equal to $3r - 2d_1 - 3P_2 - d_2 - h + \delta V(0, 1)$.[10] As in the previous section, let $D = 2d_1 + d_2$ be the total transaction costs to the retailer of accepting a deal. The result of the comparison between these three alternatives is presented in the following proposition.

PROPOSITION 2. *In the case where the retailer can forward buy, the optimal reaction by the retailer in the state ($I_1 = 1, I_2 = 0$) is characterized as follows:*

(i) Do not accept any deal if manufacturer 1 offers a price

$$P_1 > \frac{r - D - h + \delta(V(1,0) - V(0,0))}{2}$$

and manufacturer 2 offers a price

$$P_2 > \frac{2r - D - h + \delta(V(0,1) - V(0,0))}{3};$$

(ii) Accept the deal from manufacturer 1 if $P_2 > \frac{2}{3}P_1 + \frac{r}{3}$, and

$$P_1 \le \frac{r - D - h + \delta(V(1,0) - V(0,0))}{2};$$

(iii) Accept the deal from manufacturer 2 if $P_2 < \frac{2}{3}P_1 + \frac{r}{3}$, and

$$P_2 \le \frac{2r - D - h + \delta(V(0,1) - V(0,0))}{3}.$$

Given these results on the optimal reaction of the retailer, one can then compute the equilibrium strategies of the manufacturer. It is easy to see that for small values of D relative to r, there is no equilibrium in pure strategies. In order to characterize the equilibrium in mixed strategies, let $F_1(\cdot)$ and $F_2(\cdot)$ be the cumulative distribution of the price deals being offered respectively by manufacturers 1 and 2. Also, let the probabilities of not offering trade deals by the two manufacturers be γ_1 and γ_2, respectively.

To determine the equilibrium values of the probabilities of not offering a deal (γ_1, γ_2), note that (as in any mixed strategy equilibrium) the probabilities should be such that a manufacturer is indifferent between offering and not offering a deal. Consider the payoffs to manufacturer 2 when it does not offer a deal. If manufacturer 1 does not offer a deal, manufacturer 2's expected payoff is $\frac{3r}{2} + \delta W(0, 0)$. If manufacturer 1 offers a deal, manufacturer 2's expected payoff is $r + \delta W(0, 1)$. Given that manufacturer 2's equilibrium payoff in state $\{0, 1\}$ is $W(0, 1)$, it must be that

$$(1 - \gamma_1)[r + \delta W(0, 1)] + \gamma_1[\tfrac{3r}{2} + \delta W(0, 0)] = W(0, 1).$$

This yields

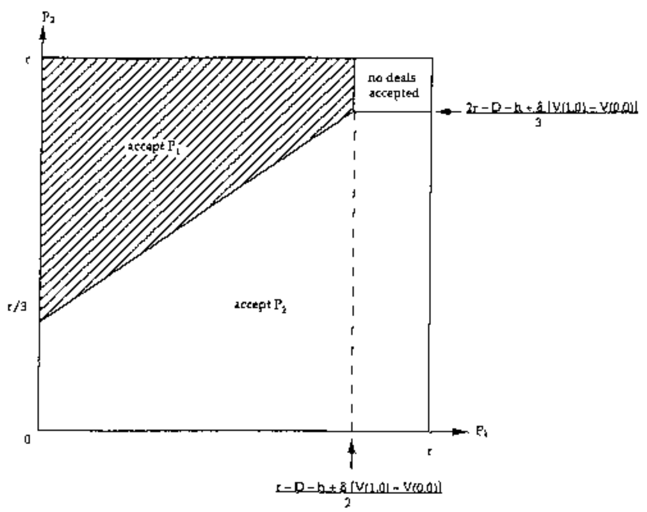
$$\gamma_1 = \frac{W(0, 1)(1 - \delta) - r}{r/2 + \delta[W(0, 0) - W(0, 1)]}. \qquad (1)$$

Similarly, one can get

$$\gamma_2 = \frac{W(1, 0) - \delta W(0, 1)}{r/2 + \delta[W(0, 0) - W(0, 1)]}. \qquad (2)$$

Next, we can determine the equilibrium cumulative probability distributions $F_2(P_2)$ and $F_1(P_1)$. Figure 3 describes the best response of the retailer to the deals offered by the manufacturers. From Figure 3, it can be

Figure 3 **Optimal Reaction of Retailer in State** ($I_1 = 1$, $I_2 = 0$)



[10] Note that these payoffs to the retailer assume that the retailer forwards buys the product if and only if it accepts a trade deal; i.e., $r \ge \delta(V(1, 0) - V(0, 0)) - h \ge \max\{P_i, P_j\}$. As we will show later, this condition is always satisfied in equilibrium.

seen that the retailer accepts manufacturer 2's deal if $P_2 < \frac{2}{3}P_1 + \frac{1}{3}r$, and the payoff to manufacturer 1 is $-K + \delta W(0, 1)$. Similarly, the retailer accepts manufacturer 1's deal if $P_2 > \frac{2}{3}P_1 + \frac{1}{3}r$, and the payoff to manufacturer 1 is $2P_1 - K + \delta W(1, 0)$. Hence it must be that

$$[2P_1 - K + \delta W(1, 0)][1 - F_2(\tfrac{2}{3}P_1 + \tfrac{r}{3})] + [-K + \delta W(0, 1)]F_2(\tfrac{2}{3}P_1 + \tfrac{r}{3}) = W(1, 0), \quad (3)$$

which yields

$$F_2(P_2) = \frac{3P_2 - r - K - W(1, 0)(1 - \delta)}{3P_2 - r + \delta[W(1, 0) - W(0, 1)]}. \quad (4)$$

To determine the equilibrium strategy for manufacturer 1, consider the payoffs to manufacturer 2. The payoff to manufacturer 2 is $r - K + \delta W(0, 1)$ if $P_2 > \frac{2}{3}P_1 + \frac{1}{3}r$ and is $3P_2 - K + \delta W(1, 0)$ if $P_2 < \frac{2}{3}P_1 + \frac{1}{3}r$. Therefore,

$$[r - K + \delta W(0, 1)][F_1(\tfrac{3}{2}P_2 - \tfrac{r}{2})] + [3P_2 - K + \delta W(1, 0)][1 - F_1(\tfrac{3}{2}P_2 - \tfrac{r}{2})] = W(0, 1). \quad (5)$$

This yields

$$F_1(P_1) = \frac{2P_1 + r - K + \delta W(1, 0) - W(0, 1)}{2P_1 + \delta[W(1, 0) - W(0, 1)]}. \quad (6)$$

Furthermore, we know that if the highest deal prices offered by manufacturers 1 and 2 are $\bar{P}_1$ and $\bar{P}_2$, respectively, they must be such that $1 - F_1(\bar{P}_1) = \gamma_1$ and $1 - F_2(\bar{P}_2) = \gamma_2$. Moreover, $\underline{P}_1$ and $\underline{P}_2$ are the lowest deal prices defined by $F_1(\underline{P}_1) = F_2(\underline{P}_2) = 0$.

It can also be easily shown that the highest price deal offered by manufacturer 1 that is accepted by the retailer has to satisfy

$$\bar{P}_1 = \frac{r - D - h + \delta[V(1, 0) - V(0, 0)]}{2}.[11]$$

Similarly, it can be shown that

$$\bar{P}_2 = \frac{2r - D - h + \delta[V(0, 1) - V(0, 0)]}{3}.$$

[11] Suppose that manufacturer 2 does not offer a price deal. Then, if the retailer does not accept the price deal offered by manufacturer 1, its payoff is $3r - 2r + \delta V(0, 0)$. However, the payoff from accepting the highest price deal is $3r - r - 2\bar{P}_1 - D - h + \delta V(1, 0)$. Hence $\bar{P}_1$ must be such that $3r - r - 2\bar{P}_1 - D - h + \delta V(1, 0) = 3r - 2r + \delta V(0, 0)$.

Hence, $\bar{P}_2 = \frac{2}{3}\bar{P}_1 + \frac{r}{3}$. Moreover, using Equations (1), (2), (4), and (6), it can be shown that $W(0, 1) - W(1, 0) = r$ and $\gamma_1 = \gamma_2$.

All these results can be summarized in the following proposition.

PROPOSITION 3. *If the retailer holds inventories, and $r \geq \delta[V(1, 0) - V(0, 0)] - h \geq \max\{\bar{P}_1, \bar{P}_2\}$, the equilibrium strategy of the manufacturer whose brand is inventoried by the retailer is characterized as follows: it does not offer a price deal with probability γ_1 given by (1) and offers a price deal with cumulative distribution $F_1(P_1)$ given by (6), as shown in Figure 4. The equilibrium strategy of the manufacturer whose brand is not inventoried by the retailer is characterized as follows: it does not offer a price deal with probability γ_2 given by (2) and offers a price deal with cumulative distribution $F_2(P_2)$ given by (4), as shown in Figure 5.*

3.3b *State ($I_1 = 0, I_2 = 0$).*

Let us now investigate the state ($I_1 = 0, I_2 = 0$).

Using arguments similar to those presented earlier, it can be shown that the cumulative distribution of price deals offered by each manufacturer, $F(P)$, satisfies

$$F(P) = \frac{3P - K + \delta W(1, 0) - W(0, 0)}{3P - r + \delta[W(1, 0) - W(0, 1)]}, \quad (7)$$

and that the probability of each manufacturer not offering a price deal, γ, is

$$\gamma = \frac{W(0, 0) - \delta W(0, 1) - r}{r/2 + \delta[W(0, 0) - W(0, 1)]}. \quad (8)$$

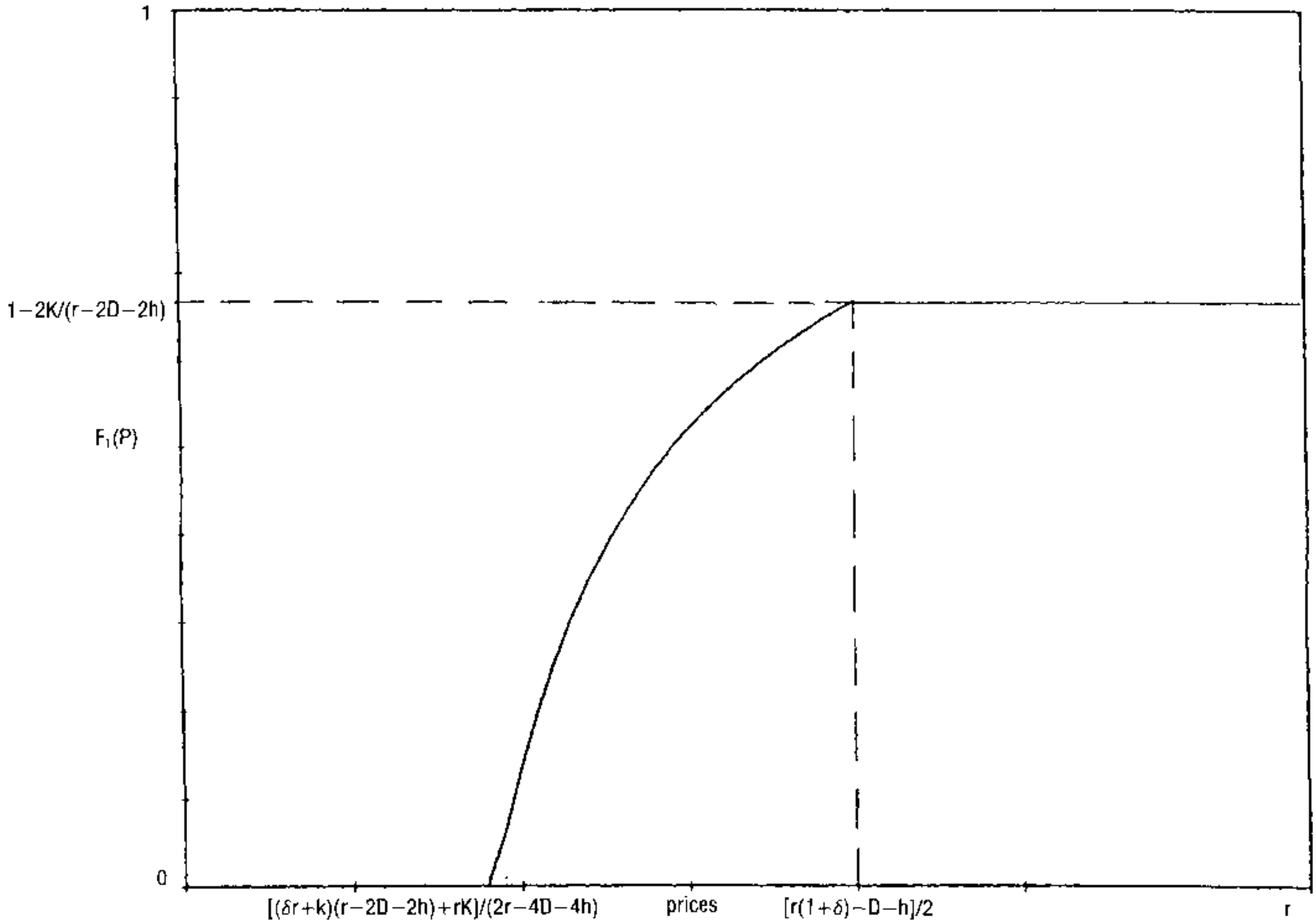
As in the previous subsection, we know that the lowest price deal being offered, $\underline{P}$, is defined by $F(\underline{P}) = 0$, and that the highest price deal being offered, $\bar{P}$, satisfies $1 - F(\bar{P}) = \gamma$. We also know that the highest price deal offered by a manufacturer that is accepted by the retailer is

$$\bar{P} = \frac{2r - D - h + \delta[V(1, 0) - V(0, 0)]}{3}.$$

This completes the characterization of the equilibrium in state $I_1 = 0, I_2 = 0$, and can be summarized in the next proposition.

PROPOSITION 4. *If $\delta[V(1, 0) - V(0, 0)] - h \geq \bar{P}$, and if the retailer is in the state where it does not carry any inventories, the equilibrium payoff for the manufacturers is*

Figure 4 **Cumulative Probability Distribution of Trade Deals in the Inventories Case for Manufacturer 1 in State $I_1 = 1$, $I_2 = 0$**



$W(0, 0)$. The equilibrium strategy for the manufacturers is characterized as follows: they do not offer a price deal with probability γ given by (8) and offer a price deal with cumulative distribution $F(P)$ given by (7), as shown in Figure 5.

3.3c *Integration of the Results in 3.3a and 3.3b*

Proposition 5. *For the discount factor δ sufficiently close to one, transaction costs to the manufacturers and retailer, K and D respectively, not too large, and the inventory holding costs sufficiently small, the strategies described in Propositions 3 and 4 constitute an equilibrium.*

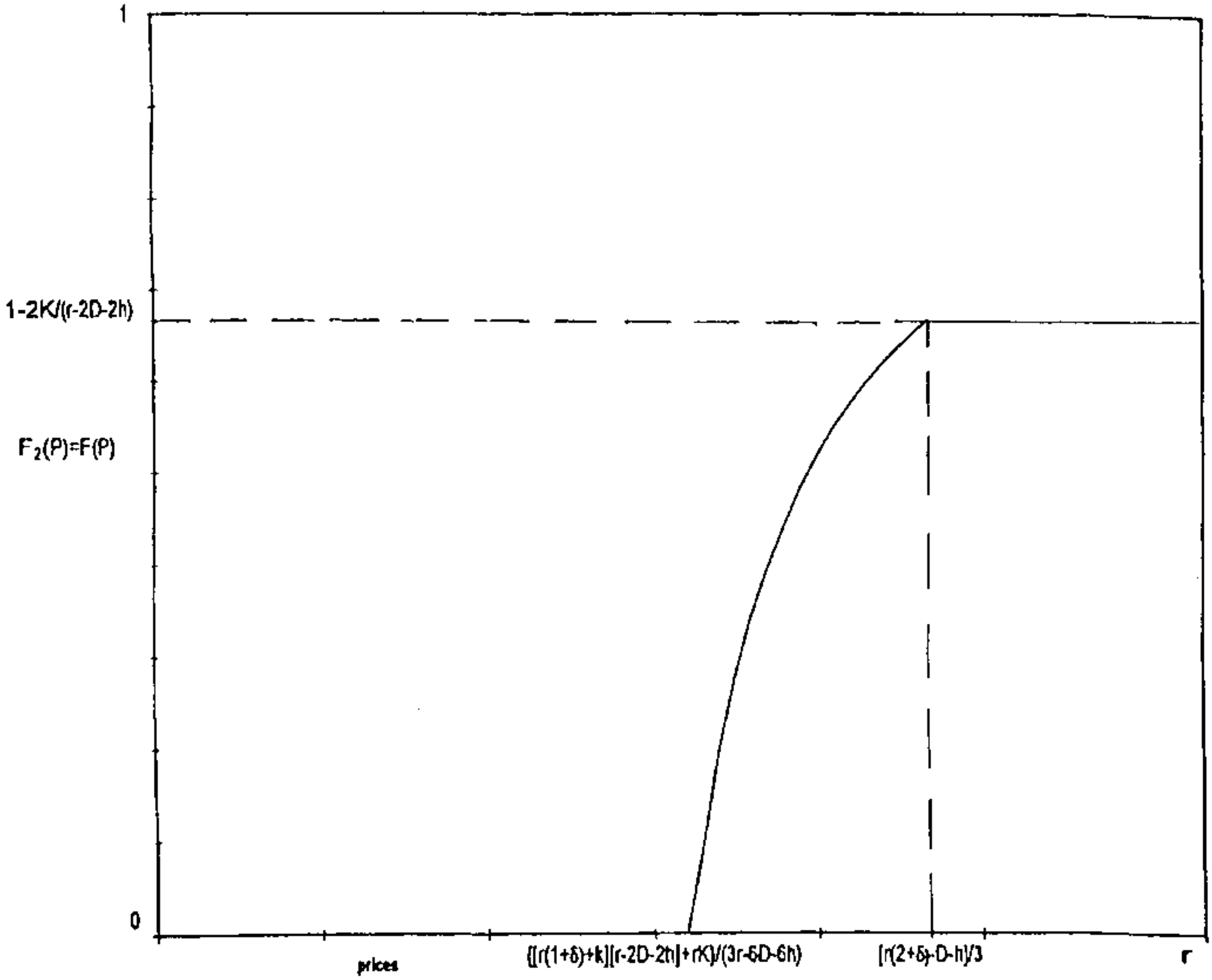
See the appendix for a sketch of the proof. There are several results to be noted. First, $W(0, 0) = W(0, 1)$, i.e., the payoff to the manufacturer depends only on the state of inventory for its brand and is independent of the inventory of the competing brand. Second, $\gamma = \gamma_1 = \gamma_2$; i.e., the probability of not offering a trade deal is independent of the state of inventory. Finally, it can be shown that

$$W(0, 0) = \frac{1}{1-\delta}\left[r + \frac{rK}{r - 2D - 2h}\right]$$

and hence, one of the most interesting results in our paper is that manufacturers are better off than in the case when retailers are not allowed to carry inventories (see Proposition 1).

Now, consider the case when $D = 0$. In this case one has to explicitly consider the possibility that manufacturers might offer trade deals that are accepted by the retailer and do not lead to forward buying at the retail

Figure 5 Cumulative Probability Distribution of Trade Deals in the Inventories Case for Manufacturer 2 in State $I_1 = 1$, $I_2 = 0$ and in State $I_1 = 0$, $I_2 = 0$



level. A formal analysis of this case shows that the equilibrium payoff for each manufacturer is $r + K$ and is identical to that when manufacturers are not allowed to carry any inventory (see Proposition 1). Moreover, the probability of offering a trade deal in this case is $1 - (2K/r)$, and is again exactly the same as in the case when manufacturers are not allowed to carry any inventory.[12] In summary, the manufacturers are better off when retailers are allowed to forward buy only if both transaction costs, D and K are nonzero.

[12] Proofs of this result and of the generalizations presented under *Limitations of the Model* are available upon request from the authors.

4. Discussion

Our results show that the manufacturers offer trade deals randomly so as to realize the benefits of being in the retailer's inventory. Note that once in the inventory, the manufacturer can more effectively compete for the switching consumer in the subsequent period since its profits are no longer affected by demand realized for its loyal consumer.

Propositions 3, 4, and 5 have three important messages which are the main contributions of the paper. First, note that the equilibrium is characterized by periods where no trade deal is being offered and by periods where the retailer accepts one deal. In this way our model offers an explanation for why it may not be in the best interest of the manufacturers to always offer trade deals.

The model results have some face validity. The equilibrium behavior, although stylized, is consistent with the common observation of "deal-to-deal buying" and with the findings of Blattberg and Levin (1987). Their empirical analysis shows that trade promotions increase shipments to retailers, but the shipments decrease to below normal levels after the promotional period. This also occurs in our model. Furthermore, if we look at the increase in retail sales due to promotion, i.e., sales in the promoted period minus normal sales, we find that it is less than the amount bought on promotion by the retailer. This is again consistent with the findings of Blattberg and Levin.

Our equilibrium critically depends on the presence of "switchers" whose behavior is significantly affected by merchandising activities of the retailer. In particular, if there were no such customers in the market, the equilibrium will result in both manufacturers setting the same regular price r but not finding it profitable to offer trade deals. On the other hand if the switchers were present but manufacturers were not allowed to write performance contingent trade deals, our results would be identical to those in the rest of the literature (Varian 1980, Narasimhan 1988).

Our results also show that the equilibrium profits to manufacturers increase with increase in the expenses associated with offering and implementing a trade deal. As argued earlier, this is because, an increase in these costs leads to a reduction in the intensity of competition which increases the profits to manufacturers. This increase in profits more than offsets the increase in transaction costs associated with deals.

Finally and most importantly, we have shown that there exists an equilibrium where manufacturers offer trade deals such that retailers forward buy and the payoff to the manufacturers when the retailer carries no inventory, $W(0, 0)$, is higher when the retailer is allowed to forward buy (as compared to the case when the retailer is not allowed to carry inventories). In other words, manufacturers are better off in allowing the retailer to forward buy rather than imposing restrictions on the terms of the trade deal which prevents them from forward buying. In this way, we have provided an explanation for why manufacturers offer trade deals which are lucrative enough for the retailer to engage in forward buying, and in spite of the loss in revenue, manufacturers may not wish to force retailers to not forward buy the brand on deal.

The fact that there is forward buying in equilibrium is particularly interesting given that forward buying can be inefficient from a total channel perspective. The intuition behind this result is as follows. First, since there are fixed costs associated with trade dealing, a retailer would prefer to spread those over a larger number of units, i.e., buy three units rather than two units, when available on deal. Second, the costs to the retailer could be lower due to forward buying. To see this, note that when there is no forward buying, some units are always bought by the retailer at the regular price. However, when we allow for forward buying, it offers the retailer the possibility of paying only the deal price for some of the above mentioned units.

The payoffs to the manufacturers being greater under forward buying is particularly interesting since it is often argued that the manufacturers are strictly worse off when retailers forward buy on deals. Our result is due to the fact that allowing the retailer to forward buy results in softening the competition between manufacturers. This decrease in the intensity of competition takes place due to two reasons. First consider the state where $I_i = 1$ and $I_j = 0$ and consider the profitability to manufacturer i from the highest deal price in the no-inventory case, $r - (D/2)$. Manufacturer i is in the same conditions as a manufacturer in the no-inventory case in the sense that it can sell at most two units. In the case where the retailer is not allowed to inventory the product, the retailer always buys three units. However, if the retailer is allowed to carry inventory, the retailer does not find such a deal attractive and hence may buy only two units. In other words, manufacturer i has no incentive to offer such a trade deal and will then not offer a deal with a greater probability. It is indeed true that the highest deal price in the case when the retailer can not carry any inventory, $r - (D/2)$, is greater than $\bar{P}_1$, and the probability of not offering a trade deal in the no-inventory case, $2K/(r - 2D)$, is smaller than the probability of not offering a trade deal when retailers are allowed to carry inventory, $2K/(r - 2D - 2h)$. Second, consider the state where $I_i = 0$ and $I_j = 0$ and consider the profitability to the manufacturers from the lowest deal price in the no-inventory case, $(\Delta + k)/2$. In the case where the retailer is not allowed to inventory the product, the retailer always buys three units; however, if the retailer is allowed to carry inventory when desirable, the retailer ends up buying four units. From the manufacturer's perspective, although it sells an extra unit at the lowest deal price, it forgoes the future profits valued at δr. Hence, it is seen that the largest deal offered when the retailer is not allowed to carry inventories is not as profitable for the manufacturers. Once again if we compare the lowest deal price in the two cases, it is easily seen that the lowest deal price is higher when the retailer is allowed to carry inventories; i.e., $\underline{P}_2 > (\Delta + K)/2$. Note also that the magnitude of these effects increases with increases in the holding costs up to a certain extent. This is because the greater the holding costs, the bigger a trade deal a manufacturer has to offer in order to be accepted, which results in the manufacturers offering less deals.

Our result is particularly interesting in light of the fact that forward buying offers additional flexibility to the retailer in its buying decision. Thus our analysis sheds light on the commonly held belief that forward buying hurts the manufacturers (Schlossberg 1991). Said differently, we show that forward buying hurts the manufacturers in the sense that the retailer always buys the inventories at a low wholesale price; however, these prices are better for the manufacturers than those that they would end up offering, if the retailer was not allowed to carry any inventory, and the manufacturers end up better off.

Forward buying, however, has its problems, as both manufacturers and retailers know. The industry-wide system of trade promotions, has historically created serious logistical dysfunctions. To cope with the bursts of shipments created by trade promotions, manufacturers run their production lines at extremely variable rates, first running at a high rate to produce large inventories prior to the start of the promotion, then cutting back. The pile up of inventory adds cost. When the promotion starts, the product is rapidly shipped to the retailers, who forward buy the goods and store them for future use, often renting or building extra warehouse space for the purpose. After a short pulse of high sales due to merchandising, most of the product is mostly sold off at a constant rate. Therefore, the cycle of trade promotion and forward buying adds considerable logistical cost to the distribution system.

The analysis presented here helps explain why this high-cost logistical cycle is stable. The cycle has also helped create a new channel of distribution: the warehouse store that only buys promoted goods. As is the case with the deal-prone consumer, a manufacturer who wants to sell to this segment is pushed to run trade promotions. Although the warehouse store channel is not in our model, it might help stabilize the practice of trade promotions.

If it were not for the trade promotion and the induced forward buying, computer controlled just-in-time inventory policies could drastically reduce inventories at both the manufacturer and the retailer level. This is currently motivating a cautious search for alternative contractual arrangements between manufacturer and the retailer. One possibility is an "electronic forward buy," in other words, a contract for a quantity of goods but with delivery spread out over a predetermined time period.

A supporting force for such arrangements comes from the growing presence of "every day low pricing" (EDLP) stores. These stores avoid big weekly specials with their deep discounts and heavy merchandising for a few products in favor of slightly lower prices across the board. With respect to trade promotions, the EDLP retailers would prefer to substitute long term price wholesale reductions and an even flow of goods to the store for the temporary discount and forward buy. To be comparable to current trade promotion practice, however, the retailer would need to offer some form of in-store support in return for the price reduction.

Limitations of the Model

The game theoretic methodology used in our analysis has the potential to offer insights but has certain limitations. A principal problem is that only relatively simple models are analytically tractable. In our case, none of the main assumptions: two manufacturers, discrete time periods, a single retailer, and a simplified demand function are good representations of real world conditions. Therefore, derived prices and promotional levels do not have numerical meaning, and the results of the analysis are qualitative and not quantitative.

In addition, we can feel more confident about the generality of our results if we can argue that relaxing some of the restrictive assumptions would not change the behaviors found. In this connection, one of the limitations of the model lies in the demand function. Its choice was largely dictated by expositional simplicity. We have extended the analysis to the cases where there are either more switchers or more loyal consumers in the market. While as expected, the exact equilibrium strategies depend on the number of switchers and loyals, the qualitative results of the model with respect to the impact of cost to the manufacturers and retailers of trade deals, forward buying, and payoffs to the manufacturers continue to hold.

Another limitation of the model stems from the assumptions about inventory costs. We assume that holding costs are very high after a certain point, i.e., they are in the form of a step function. A smoother inventory holding cost function would be more realistic. However, once again this modeling choice is made because of the complexity of the overall model. Since our inventory cost assumption leads to corner solutions, we believe that changing its specification would simply bring about an interior solution instead of a corner one without changing the desirability of forward buying. Finally, incorporating retail competition would also move the model to yield more realistic outcomes for retail prices.

Finally, we assumed that retailers accept at most one trade deal in any given period. While this may not be too restrictive an assumption, one may consider allowing retailers to accept both deals, if sufficiently lucrative. Allowing for such possibilities complicates the model significantly. Our analysis of such a model shows that as compared to the previous case retailers do not accept all trade deals all the time but always accept the best trade deal. In this way we can explain why retailers may not accept all deals and this is mainly due to the transaction costs associated with trade deals. A second and more interesting implication of relaxing this assumption is related to the pattern of accepting deals. While in the previous analysis, the probability of accepting a trade deal was independent of which brand was held in inventory, in this case our analysis shows that the probability of the retailer accepting a trade deal is higher for the manufacturer for whom the retailer does not carry inventory; i.e.,

$$\text{Prob(accepting deal from manufacturer } i \mid I_i = 1, I_j = 0)$$
$$< \text{Prob(accepting deal from manufacturer } j \mid I_i = 1, I_j = 0).$$

The intuition for this result of the retailer alternating (in a probabilistic sense) the manufacturer of the inventory being carried has to do with the relative advantages the retailer can obtain from buying on deal from either manufacturer. If the retailer buys on deal from the manufacturer from which it already has inventory, it can only buy on deal the demand per period (in this analysis, two units). If on the other hand, the retailer buys on deal from the manufacturer from which it does not have any inventory, it can buy on deal, not only the demand per period but also the inventory for next period as well (in this particular example, three units). Then, the retailer has some advantages in alternating the manufacturer of the inventory being carried because the quantity bought on deals increases, in comparison to not alternating. This intuition also allows us to conjecture that if the retailer could inventory additional units, it would only reinforce the effect discussed above.

5. Summary

We have introduced several phenomena, not previously considered in the literature, into a competitive model for studying trade promotions. These include merchandising and forward buying, which are major factors affecting the decisions of the manufacturers and retailers in offering and accepting trade promotions in the real world. Since trade promotion is a contractual arrangement between manufacturers and the retailer, we have explicitly modeled the decision making of all these parties. The case we have studied is that of two manufacturers, each having one brand, selling through a single retailer. The retailer sells to a market of consumers who respond to prices and merchandising activities of the two brands. The analysis covers a sequence of periods, thereby allowing consumers to switch brands over time and including the dynamic implications of forward buying in the manufacturers' and retailer's strategies.

The essential ingredients of the model are: (1) manufacturers can write contracts that require retailers to merchandise as part of the terms of accepting a trade deal, (2) merchandising is valuable to the manufacturer, (3) merchandising has a cost to the retailer (part of which may be opportunity cost), (4) forward buying for inventory permits the retailer to transfer profit across time, and (5) inventory has a cost to the retailer.

Our analysis shows that, under rather unrestrictive conditions, it is in the manufacturers' interests to run trade promotions sometimes rather than just reduce wholesale price. The retailer finds it desirable to accept promotions, merchandise the brands, and forward buy.

An insight not anticipated in advance is that costs associated with offering trade deals soften the intensity of competition. This competition is further moderated by forward buying. We have shown that allowing retailers to forward buy is beneficial to the manufacturers despite the fact that it allows the retailers to buy from deal to deal. However, buying from deal to deal is not always feasible since the manufacturers do not offer trade deals all the time.

This may help explain why forward buying, which "seems" to reduce manufacturer margins and certainly adds logistic cost, has been a stable practice. Furthermore, it suggests that, in seeking alternative arrangements between manufacturers and retailers to reduce logistics costs (say, by just-in-time inventory management), the retailer needs to consider the resulting tradeoffs between bigger trade deals and lower inventory holding costs.[13]

[13] The authors thank the reviewers, Area Editor, and the Editor for their helpful comments and suggestions. This work is partially supported by the Graduate School of Business, Stanford University through a research grant awarded to the first author.

Appendix

Sketch of the Proof of Proposition 1. First consider the retailer's problem. The retailer has to decide which deals to accept and the retail price for each brand. The retail prices are always equal to $r - d_1$ for the brand supported by retail merchandising and display and r, otherwise. Without loss of generality, consider the case of $P_1 \geq P_2$. Then the retailer's profits are:

$$\pi_R(P_1, P_2) = 2(r - P_2) - D \quad \text{if the retailer accepts a deal,} \tag{i}$$

$$\pi_R(P_1, P_2) = 0 \quad \text{if the retailer accepts no deals.} \tag{ii}$$

We can now observe that the retailer accepts the best deal $P_2 < r - (D/2)$.

Now, given $K > 0$ the manufacturers may not offer price deals in some periods. The expected payoff for each manufacturer can be defined as $\Delta \geq r$. Then the lowest deal price a manufacturer would be willing to charge is $(\Delta + K)/2$. Therefore the probability of not offering a deal, γ has to be such that the expected payoff from not offering any price deal, $(1 - \gamma)r + \gamma\frac{3}{2}r$ is equal to Δ. This yields $\gamma = 2(\Delta - r)/r$.

Let us now consider the payoffs to a manufacturer from offering a deal. Let $P_i > P_j$. Then the retailer accepts the deal on brand j and the payoff to manufacturer j is $2P_j - K$ if $P_j < r - (D/2)$. Moreover, the payoff to manufacturer i is $r - K$.

If $P_i = P_j$, and $P_j > r - (D/2)$, the retailer rejects both deals and therefore the expected payoff for each manufacturer is $\frac{3}{2}r - K$. If $P_1 = P_2 \leq r - (D/2)$, the retailer accepts only one deal, and hence using the arguments presented above, it is seen that the expected payoff for manufacturer i is $P_i + (r/2) - K$. The summary of payoffs, in the case manufacturer i offers a deal, can be stated as follows. If $P_i > P_j$,

$$\pi_i(P_i, P_j) = r - K \quad \text{if } P_j < r - \frac{D}{2}. \tag{iii}$$

If $P_i < P_j$,

$$\pi_i(P_i, P_j) = 2P_i - K \quad \text{if } P_i < r - \frac{D}{2} \tag{iv}$$

and, if $P_i = P_j = P$

$$\pi_i(P_i, P_j) = \frac{3r}{2} - K \quad \text{if } P > r - \frac{D}{2}, \tag{v}$$

$$\pi_i(P_i, P_j) = P_i + \frac{r}{2} - K \quad \text{if } P \leq r - \frac{D}{2}. \tag{vi}$$

Given these payoff functions, the market equilibrium can be easily characterized.

As in Varian (1980), it can be shown that the mixed strategy equilibrium is such that for any deal price between the two extreme values ($(\Delta + K)/2$ and $r - (D/2)$), the mixed strategy has a positive density. Indifference for all the prices being charged yields an expected payoff Δ. The mixed strategy described by the probability distribution $F(P)$ in the range $(\Delta + K)/2$ and $r - (D/2)$ can be determined by recognizing that the profits from prices below $r - (D/2)$, are $(r - K)F(P) + (2P - K)(1 - F(P))$ and equal to Δ. Thus, the cumulative probability distribution $F(P)$ is described by

$$F(P) = \frac{2P - \Delta - K}{2P - r} \quad \text{if } \frac{\Delta + K}{2} \leq P \leq r - \frac{D}{2}.$$

Sketch of the Proof of Proposition 5. Recall that the analysis presented above assumes that the retailer when offered a deal prefers to carry inventories. This is indeed true if (see footnote 10)

$$\delta[V(1, 0) - V(0, 0] - h \geq r - \frac{D}{2}. \tag{vii}$$

We next determine the conditions under which (vii) is satisfied.

First, using the fact that

$$\bar{P}_1 = \frac{r - D - h + \delta(V(1, 0) - V(0, 0)}{2}$$

and recognizing that $1 - F_1(\bar{P}_1) = \gamma_1$, one obtains

$$\delta[V(1, 0) - V(0, 0)] + \frac{r}{2} - D = \delta[W(0, 0) - W(1,0)]$$

$$+ K\frac{(r/2) + \delta[W(0, 0) - W(0, 1)]}{W(0, 1)(1 - \delta) - r}. \quad \text{(viii)}$$

Similarly, using the fact that

$$\bar{P} = \frac{2r - D - h + \delta(V(1, 0) - V(0,0)}{3}$$

and recognizing that $1 - F(\bar{P}) = \gamma$, one obtains

$$\delta[V(1, 0) - V(0, 0)] + \frac{r}{2} - D = \delta[W(0, 0) - W(1, 0)]$$

$$+ K\frac{(r/2) + \delta[W(0, 0) - W(0, 1)]}{W(0, 0) - \delta W(0, 1) - r}. \quad \text{(ix)}$$

These last two equations imply that

$$W(0, 0) = W(0, 1). \quad \text{(x)}$$

Next, it is easily seen from (1), (2), and (x) that the probability of not offering a price deal does not depend on the state of inventory: $\gamma = \gamma_1 = \gamma_2$.

Finally, to determine the values of $V(1, 0)$, $V(0, 0)$, $W(1, 0)$, $W(0, 1)$, and $W(0, 0)$, one can use the definition of the total surplus in the channel in each of the states, i.e.,

$$V(0, 0) + 2W(0, 0) = 3r + \delta\gamma^2[V(0, 0) + 2W(0, 0)]$$
$$+ \delta(1 - \gamma^2)[V(1, 0) + W(0, 1) + W(1, 0)] - 2\gamma(1 - \gamma)K$$
$$- 2(1 - \gamma)^2K - (1 - \gamma^2)(D + h), \quad \text{and} \quad \text{(xi)}$$

$$V(1, 0) + W(1, 0) + W(0, 1) = 3r + \delta\gamma^2[V(0, 0)$$
$$+ 2W(0, 0)] + \delta(1 - \gamma^2)[V(1, 0) + W(0, 1) + W(1, 0)]$$
$$- 2\gamma(1 - \gamma)K - 2(1 - \gamma)^2K - (1 - \gamma^2)(D + h). \quad \text{(xii)}$$

Then Equations (ix), (x), (xi), (xii), and $W(0, 1) - W(1, 0) = r$, allow us to determine $V(1, 0)$, $V(0, 0)$, $W(1, 0)$, $W(0, 1)$, and $W(0, 0)$. To see that (vii) is satisfied for K and D small, and δ close to one, subtract (xi) from (xii) to obtain

$$V(1, 0) - V(0, 0) = r. \quad \text{(xiii)}$$

Using (xiii) and (ix) one then obtains $W(0, 0)$.

Thus, for δ sufficiently close to one, associated transaction costs not too large, and holding cost sufficiently small, the strategies described above constitute an equilibrium.

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