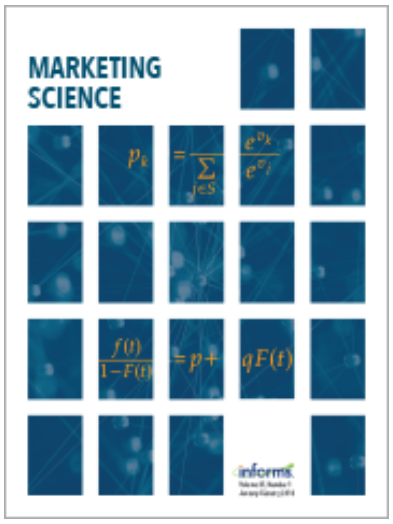

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Effectiveness of Trade Promotions: Analyzing the Determinants of Retail Pass Through

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Abstract

Trade promotions are temporary price cuts that manufacturers offer retailers to encourage them to reduce retail prices. While trade promotion spending as a percentage of marketing budget has increased dramatically, the inefficiency of trade promotion represents the ''number-one concern'' among manufacturers, as indicated by recent trade surveys. At the heart of this dissatisfaction lies manufacturers' concern regarding widespread retailer opportunism with low retail pass through.

Our objective is to develop a simple game-theoretic framework to examine the strategic considerations that underlie a retailer's decision to pass through a trade deal. In particular, we are interested in answering the following questions:

(i) What and how do product-market characteristics impact the extent of retail opportunism?
(ii) How can the manufacturer alleviate the retail pass-through problem by strategically supplementing trade promotions with advertising trade deals directly to consumers?

To address these issues, we consider a stylized channel with a single manufacturer who serves two customer segments through a single (focal) retailer. We implicitly capture the essence of retail competition by allowing customers to have an outside option: other retailers that customers might search if they deem the price at the focal retailers to be ''too high.'' Customers differ in their valuation for the manufacturer's product and in the costs they incur when searching for a better price at other retailers. While customers are unaware of the existence of a trade deal in any particular time period, through prior experience they know the frequency of such deals and, furthermore, they update their beliefs about the occurrence of a deal by observing the posted retail price. The retailer decides whether to pass through a deal or not, recognizing the impact of his pass-through policy on customers' search propensity, and hence, their willingness to pay.

The main message of the paper is that in an environment where manufacturer offers trade promotions, a retailer may not have the incentive to pass a low wholesale price onto consumers because consumers do not have perfect information about ongoing trade promotions. When consumers observe a high price at the focal retailer and yet are not sure if a trade promotion is on, they may not look around for a low price. Therefore, the retailer can price opportunistically to gain a higher margin by not passing a low price to consumers. However, if the retailer never passes savings on, consumers can infer opportunistic pricing based on prior knowledge of trade promotion frequency and have a higher tendency to shop elsewhere, thus reducing sales volume. The retailer resolves the conflicting incentives by occasionally charging a low price when a trade promotion is on, while posting a high price on other occasions. We find that the extent of retail opportunism depends on product-market characteristics, such as the retailer's clientele and the heterogeneity in consumer search costs, as well as on the characteristics of the manufacturer's trade promotion policy, such as the frequency of trade promotion and the depth of discount offered. When the low-valuation consumers have search costs that make them exit the market when the focal retailer posts a high price, the manufacturer will intervene by advertising his trade promotion directly to consumers, thus performing a channel coordination function.

We consider several extensions of the base model—explicit retail competition, differentiated retailers, and heterogeneity in consumers' knowledge about the frequency of trade deals—and show that our results still hold.

(*Trade Promotion; Price Uncertainty; Customer Search; Retail Pass Through; Channel Coordination; Semiseparating Sequential Equilibrium*)

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1. Introduction

Trade promotions are inducements offered by manufacturers to retailers to encourage them to reduce retail prices. In her study of trade promotions, Armstrong (1991) found that manufacturers most frequently required retailers to offer reduced prices to avail of trade deals. She found price reduction to be the main compliance requirement: 94.25% of trade promotions in the ground regular coffee category required retail price reduction; the corresponding figures for disposable diapers, toilet tissues, and canned tuna were 90.41%, 98.94%, and 90.79%, respectively. Although trade promotions can take different forms—off-invoice allowances, bill-back allowances, flat allowances, free goods, display allowances, and inventory financing—more than 90% of trade promotions involve off-invoice allowances (Blattberg and Neslin 1990, Hess et al. 1995).

In 1998, spending on trade promotions for frozen food alone amounted to a record $3 billion, or approximately 13% of gross sales in the frozen food industry (Merli 1999). The total spending for trade promotions in the grocery industry as a whole have risen from $8 billion in 1980 to more than $75 billion in 1998 (Merli 1999). This increasing reliance on trade promotions is not restricted to the grocery business but pervades many other retail segments. For instance, nonpackaged goods manufacturers spent more than $400 billion, or 10% of sales, on trade promotions in 1994, up from $10 billion, or only 4% of sales, in 1978 (Schiller 1996, Cox Direct 1997).

While trade promotion spending as a percentage of marketing budgets has increased dramatically, the inefficiency of trade promotion represents the number-one concern among manufacturers, as indicated by the 1998 Trade Promotion Best Practices survey by Cannondale Associates (Hilarides 1999). More than 75% of the manufacturers rated the value of their trade promotion to be only either fair or poor. A recent A. C. Nielsen study on trade promotion practices further buttresses this concern: The study found that 90% of manufacturers listed trade promotion as an important issue relative to 86% for category management, 78% for new product introduction, and 73% for understanding consumers (Nielsen Market Research 1998). At the heart of this dissatisfaction lies manufacturers' concern regarding widespread retailer opportunism and the consequent low retail pass through. Retail opportunism refers to actions by a retailer that are in conflict with what the manufacturer would like the retailer to do, and it is driven by imperfect monitoring. Besides the case of the retailer not passing through the trade deal, other instances of retail opportunism studied in the literature include underprovision of local service/quality (Lal 1990, Desai and Srinivasan 1995) and of local advertising (Bergen and John 1997). The Cannondale and Nielsen surveys indicate that manufacturers believe that only 51% of their trade promotion dollars are being passed through to consumers, with more than 20% of the trade promotion dollars going directly to the retailer's bottom line. The following quote from the article ''Not-So-Free Trade'' (Wellam 1998) aptly summarizes manufacturers' concerns:

> Manufacturers are pumping $75 billion trade promotion dollars annually into the retail community, about 13% of which retailers freely admitted went straight to their bottom line. Manufacturers believe that upwards of 30% of trade dollars or more were applied straight to the bottom line. Whatever the exact amount, it is the chunk of trade change being pocketed by retailers that annoys manufacturers. What manufacturers want is more of their trade dollars to get through to consumers . . .

It is worth noting that this inefficient use of trade dollars has prompted leading manufacturers such as Procter & Gamble, Kellogg's, and General Mills to initiate the move from hi-lo pricing supported by frequent trade deals to every day low prices (EDLP) pricing in the early 1990s. However, despite such a move, practitioners believe that trade promotions are here to stay. As Lal (1990) notes:

> . . . many practitioners believe that promotions cannot be avoided because of the size of the deal-prone segment in those categories. Any attempt to move away from such behavior may lead to a significant decline in market share if a competitor continues with its promotional policy.

This view of the inevitability of trade promotions seems to be supported by the experience of Procter & Gamble in the diaper category—a category that had been firmly entrenched in EDLP—when it had to abandon pure EDLP in the face of increasing promotional competition from private labels in 1994

(Neff 1995). Similarly, *Supermarket Business*'s 16th Annual Product Preference Study reveals that both retailers and manufacturers acknowledge strong incentives to continue trade promotions (Weir 1999).

Despite the concerns raised by practitioners regarding retail opportunism and the difficulty in managing trade promotions, few extant research works have explicitly addressed these issues. However, some likely causes of retail opportunism can be identified. In particular, a customer who visits a retailer is seldom aware of the retailer's actual cost in that period. Even if the manufacturer offers the product to the retailer at just one of two prices, a regular wholesale price and a discounted (promoted) wholesale price, uncertainty about ongoing trade promotions would result in customers being unsure about retailers' current costs. This will hold even if customers are certain about all other costs that the retailer incurs. This asymmetry in information regarding ongoing promotions may in itself prompt retail opportunism and impact the effectiveness of trade promotions. Indeed, practitioners, who have worked with both manufacturers and retailers on trade promotion issues, recognize this and argue that ''the only way both [manufacturers and retailers] make money is if the consumer needle moves. You have to run [trade] promotions that get consumer response. But that's not the way that retail runs.'' (Wellam 1999). This appears to suggest that the effectiveness of trade promotions critically hinges on how customers respond to trade promotions. Consumers' response depends on their awareness or knowledge of ongoing promotions.

In light of the above concerns of practitioners, we seek answers to the following questions. First, how do customers' anticipation of a trade deal and consequent propensity to engage in price search affect the retail pass-through decision? We thus analyze the interrelationship between customers' response to trade promotions and the efficiency of trade promotions. Second, what market/product characteristics impact the extent of pass through and retail opportunism? Finally, we highlight a proactive role that manufacturers can undertake to alleviate the retail pass-through problem. In particular, by strategically complementing trade promotions with advertisement of trade deals directly to customers, we show that retailer cooperation can be enhanced.

1.1. Overview of the Model, Main Results, and Intuition

To address these issues, we consider a stylized channel with a single manufacturer serving two consumer segments through a single (focal) retailer. We implicitly capture the essence of retail competition by allowing customers to have an outside option: other retailers that customers might search if they deem the price at the focal retailer to be ''too high.'' Customers differ in their valuation of the manufacturer's product and in the costs they incur to search other retailers for a better price. While the customers are unaware of the existence of a trade deal in any particular time period, through prior experience they know the frequency of such deals, and furthermore, they update their beliefs about the occurrence of a deal by observing the posted retail price. The retailer decides whether to pass through a deal or not, recognizing the impact of his pass-through policy on customers' search propensity and hence on their willingness-to-pay.

Our analysis shows that the optimal strategy of the retailer entails passing through trade deals on certain occasions by offering consumer promotion, while on other occasions retaining manufacturer's deal money and posting ''regular'' price. We refer to this behavior as *retailer opportunism,* because while the manufacturer would like to serve all consumers when there is a trade promotion, the retailer chooses not to do so. The intuition behind why the retailer may wish to act opportunistically only some of the time is as follows. If customers know that the focal retailer is truthful and offers low prices whenever the manufacturer offers trade promotions, then they have no incentive to search for a better price for the manufacturer's product (we consider the case of the manufacturer offering trade promotions to all dealers per antidiscrimination laws). On the other hand, if consumers know that the retailer acts opportunistically and does not always offer a low price when the manufacturer offers trade promotions, then they may benefit from searching other retailers for a better price. The customers' incentive to search will be stronger when the retailer acts more opportunistically; the stronger the customers' incentive to search, the lower the price the retailer can command when acting opportunistically. The endogenous relationship between retailer opportunism

and the price that the retailer can command when posting regular price is central to the intuition.

This randomization strategy, wherein the retailer occasionally passes through trade deal while on other occasions chooses not to do so, is consistent with the empirical observations by Curhan and Kopp (1988) and Walters (1989). In addition, these studies document significant variations in the extent of pass through across categories. We do find that pass through depends critically on the mix of the retailer's clientele and the heterogeneity in customers' search costs. Specifically, we show that retail pass through is decreasing both in the size and search cost of the high valuation segment, but increasing in the size and search cost of the low valuation segment. In addition, we find that characteristics of the trade promotion also impact retail pass through. Retail pass through is increasing in the frequency of trade promotions but decreasing in the depth of discount. These results are consistent with Armstrong's (1991) empirical observations that trade promotions that are offered frequently and have smaller depths have a higher pass through.

We consider several extensions of the base model—explicit retail competition, differentiated retailers, and heterogeneity in consumers' knowledge about the frequency of trade deals—and show that our results still hold.

The paper also posits an alternative role for manufacturer advertising targeted at end consumers. Advertisements such as McDonald's informing customers of an ongoing promotion that they can avail of at participating restaurants; Vanguard Airlines informing customers of a special offer; automobile manufacturers informing customers about ongoing factory rebates at participating dealers are commonly seen in the media. We show that manufacturer advertisements of this type aimed directly at the end customer can help regulate retail opportunism. By informing some customers about ongoing promotions, the manufacturer increases customers' price sensitivity by increasing their propensity to search. Thus, the retailer is faced with the option of (1) charging a low enough price to deter customers from searching or (2) losing customers to a more competitive retailer. This analysis in conjunction with our earlier analysis on the determinants of retail opportunism highlights market characteristics in which manufacturer advertisements of this type may be most warranted.

1.2. Literature Review and Research Contributions

This paper builds on three research streams. The first stream entails empirical analysis of retail response to trade promotion. A frequently cited work in this area is that of Chevalier and Curhan (1976). They examine, using SAMI data, 992 manufacturer trade promotions over a period of 24 weeks for a large supermarket chain, and find that 55% of trade deals are pocketed by retailers. Curhan and Kopp (1988), using survey data, examine the factors that determine the strength of retail support for trade deals and find promotional elasticity to be an important determinant. They also note that manufacturer's support for trade promotion in the form of advertising, coupon drop, etc., aimed at customers, was the second most important determinant of the strength of retail support of trade deals. Armstrong (1991) empirically examines 605 manufacturer trade promotions for a period of two years for four product categories—ground regular coffee, disposable diapers, toilet tissues, and canned tuna—and finds that for 37% of trade deals retailers do not offer any price reduction, even when consumer promotion is a compliance requirement. She further finds significant variation in the extent of retail pass through, ranging from a low of 33% for canned tuna to a high of 82% for toilet tissue. Our paper seeks to contribute to this research stream in two ways. First, our analysis provides a rationalization for the empirical observation that retailers often pocket trade deals while on other occasions they pass through. Second, we provide a framework to explain empirically observed variations in pass-through level in terms of product-market characteristics.

The second research stream analytically investigates various strategic issues relating to trade promotions. In a model incorporating both manufacturer- and retail-level competition, Lal and Villas-Boas (1998) argue that trade deals and consumer promotions could arise when customers are heterogeneous in their brand and store loyalty. They find that under

certain conditions (when brand loyalty is weaker than store loyalty), there could be more than 100% pass through. Chun (1994) and Lal et al. (1996) show that even in the presence of stock-up and forward-buying by retailers, offering trade promotions may be the equilibrium strategy for manufacturers to soften brand-level competition. Kim and Staelin (1999) offer a framework that helps explain why manufacturers offer trade promotions despite poor pass throughs. Tyagi (1999) represents the first paper to theoretically investigate the factors affecting the extent of retail pass through that he defines as the change in retail price (depth of consumer promotion) as a fraction of change in wholesale price (depth of trade deal). He shows that for linear and concave demand functions, there is less than 100% pass through, while for some convex demand curves, there could be more than 100% pass through.

Finally, the third research stream advocates mechanisms that manufacturers can use to enhance retail pass through. Gerstner and Hess (1991, 1995) show that manufacturers can use rebates in conjunction with trade promotions to both price discriminate and enhance retailer participation. They show that manufacturer rebates (pull promotion) effectively increase the price the low-valuation customers are willing to pay, thereby increasing the retailer's incentive to serve this segment. In a similar spirit, quantity discounts and two-part tariffs offered by manufacturers proposed by Jeuland and Shugan (1983a,b) and Moorthy (1987) can be interpreted as channel coordination mechanisms intended to enhance market coverage. Our model complements the insights from these studies by highlighting the role of imperfect customer knowledge and price search on the extent of retail pass through. We find a new role for manufacturer advertising of trade allowances directly to consumers as a coordination mechanism.

The rest of the paper is organized as follows. In §2, we present the basic assumptions of our model. We present the equilibrium analysis in §3 and characterize the optimal retail promotional pass-through strategies. We also investigate the impact of product-market characteristics on the retailer's pass-through decision. In §4, we highlight the role of manufacturer's advertising in achieving channel coordination. Section 5 presents three extensions. The first extension incorporates asymmetric retail positioning and explores the impact of relative quality position on pass through. The second extension analyzes the implication of heterogeneity in consumers' knowledge about frequency of trade deal and shows that even in this setting, our qualitative results remain. Finally, the last extension incorporates retail competition and shows that in this case as well, occasional retail pass through continues to be the equilibrium strategy. Section 6 concludes with a summary of main findings and directions for future research.

2. The Model

To analyze the product-market characteristics that influence a retailer's pass-through decision, we initially consider a simplified channel with a single manufacturer and a single retailer (the focal retailer).[1] The manufacturer charges constant wholesale price of w_H when there is no trade promotion and w_L when there is a promotion with frequency α. These elements of the manufacturer's trade promotion policy $\{w_H, w_L, \alpha\}$ are exogenous to the model. We let $w_L = w_H - \delta$ with δ being the depth of discount. We recognize that the choice of the depth and frequency of promotion are influenced by several considerations including, but not limited to, manufacturer-level competition (e.g., Narasimhan 1988, Raju et al. 1990, Lal 1990, Rao 1991). While this is an important question, it is not the focus of this paper. Instead, we seek to investigate the determinants of retail pass through for any given trade promotion policy adopted by the manufacturer.

While deciding his retail pass-through strategy, the retailer takes the manufacturer's trade promotion policy as given and sets retail price p that can either be

[1]Although we initially consider a single retailer setup, we implicitly capture retail competition by allowing customers to have outside options. We relax this assumption in §5.3 by explicitly modeling retail competition. We demonstrate that our results about retail opportunism and partial pass through of trade deals hold even in this case. Unlike §5.3, the outside option formulation allows us to obtain closed-form expressions for prices, pass through, profits, and advertising intervention, thus making our results easily interpretable.

the "regular" price (p_H) or the "sale" price (p_L). These prices are targeted at two customer segments—high valuation (HV) and low valuation (LV) of sizes X and $(1 - X)$ respectively. Customers in the LV and HV segments value the product at ν and $\gamma\nu$, respectively, where $\gamma > 1$, so that relative to customers in the LV segment, customers in the HV segment are willing to pay a higher price for the product. The indirect utility or surplus derived from purchasing the product for customers in the two segments is as follows:

$$LV \text{ customers:} \qquad U^F_{LV}(p, \nu) = \nu - p, \qquad (1)$$

$$HV \text{ customers:} \qquad U^F_{HV}(p, \nu, \gamma) = \gamma\nu - p. \qquad (2)$$

The superscript F on the utility function refers to the focal retailer. This utility specification has been widely used in the literature (e.g., Moorthy 1988, Moorthy and Png 1992, Tirole 1988).

We assume $w_L < \nu < w_H < \gamma\nu$. These assumptions capture the idea that one of the central motivations for the manufacturer to offer trade promotions is to enhance demand. The manufacturer discounts the wholesale price to $w_L < \nu$, so that the retailer can increase demand by serving the LV segment. Of course, in this case, since the margins from serving the HV customers are larger, the retailer has an incentive to act opportunistically and may not always serve the LV segment when the manufacturer offers a trade promotion.[2] Indeed, in the extreme case of retailer opportunism the LV segment will never be served. We capture this opportunistic behavior on part of the retailer with the parameter β, where $\beta = \Pr(p = p_H | w = w_L)$.[3] In other words, β is the probability with which the retailer acts opportunistically (i.e., does not serve the LV segment), when the manufacturer offers a trade promotion. In our model, the parameter $1 - \beta$ represents *pass through,* which has been used widely in the trade press to refer to the degree to which the retailer cooperates in achieving the manufacturer's objectives. In our formulation, 100% pass through ($\beta = 0$) would represent a situation when the retailer always serves the LV segment (as well as the HV segment) when the manufacturer offers a trade promotion, while zero pass through ($\beta = 1$) would represent a situation when the LV segment is never served.[4]

As stated earlier, we implicitly capture retail competition by endowing customers with "outside options." The underlying premise is that if a consumer believes that the price charged by the focal retailer is "too high," she could purchase the product from some other retailer. When the manufacturer offers a trade deal to the focal retailer, he must offer the same terms to other retailers (as enjoined by the Robinson-Patman Act). Consequently, if a consumer believes that there is an ongoing trade promotion, she recognizes that by searching across other retailers she will "almost surely" find a retailer charging the "low" price, w_L. On the other hand, if she believes that the manufacturer is not promoting the product, price search may at best yield the high price, w_H. For intermediate consumer beliefs, $b = \Pr(w = w_L)$, the expected price from searching is $bw_L + (1 - b)w_H = w_H - b(w_H - w_L)$. Note that in this formulation, we assume that by searching across other retailers, customers can get the product at retailer's cost. This abstraction is made only for analytical tractability and is not central to our results about retail opportunism. In fact, this formulation clearly biases the model against the focal retailer finding opportunistic behavior prof-

[2]The reader might wonder why the retailer would randomize between serving only the HV consumer by posting the regular price (i.e., no retail pass through) and serving the entire market by posting the sale price (i.e., retail pass through). This is because the prices and hence the payoff from acting opportunistically are endogenously determined by the extent of retail opportunism. Please refer to the discussion following Proposition 1 in §3.2 for details.

[3]For simplicity, we abstract away from consumer promotions of the type discussed in Narasimhan (1988), Raju et al. (1990), Lal (1990), and Rao (1991) that can arise even in the absence of manufacturer's trade promotions. Note, however, that if we allowed retail promotions motivated by competitive considerations, retailer opportunism, while diminished, may still not vanish. Indeed, in the extension where we allow for consumer promotion even in the absence of a trade deal (see "Discussion of Model Assumptions"), we find that retailers do act opportunistically and manufacturer intervention of some sort is required to alleviate retailer opportunism.

[4]An alternative operationalization of retail pass through used in the literature is $(p_H - p_L)/(w_H - w_L)$, which is simply the fraction of the depth of discount that is passed through to the consumer (e.g., Chun 1994, Tyagi 1999). Our characterization of retail pass through is closer in spirit to Gerstner and Hess (1991, 1995).

itable. Our results require only that the expected price at the outside retailer be decreasing in customers' beliefs (b) about ongoing promotions. We will revisit this issue later as we discuss and develop alternative formulations. We assume that search is costly, so that customers in the LV segment incur a cost s, while customers in the HV segment incur a cost ψs, where $\psi > 1$. Under these assumptions, the indirect utility or surplus associated with the outside option for the two segments is as follows:

LV customers:

$$U^O_{LV}(\nu, b) = b(\nu - w_L) - s, \quad (3)$$

HV customers:

$$U^O_{HV}(\nu, \gamma, \psi, b) = \gamma\nu - \psi s - [bw_L + (1 - b)w_H]. \quad (4)$$

The superscript O on the utility function refers to the outside option/retailer. Note that for the LV consumers, $\nu < w_H$, so that if the prevailing price at the outside option is w_H, they will not buy the product. In this case, her surplus is $-s$ (she has incurred this cost anyway just to discover that the prevailing price is "too high"), thus the one term $b(\nu - w_L)$ in Equation (3), as opposed to the two-term $b(\gamma\nu - w_L) + (1 - b)(\gamma\nu - w_H)$ that leads to Equation (4). A customer in segment $j \in \{HV, LV\}$ will purchase the product at the focal retailer if and only if the surplus from purchasing the product at the focal retailer is no less than her outside option, i.e., $U^F_j \geq U^O_j$, $\forall j$.

Discussion of Key Model Assumptions

Before deriving results, we provide a brief discussion of the key model assumptions.

1. Retail Competition and Modeling of an Outside Option. Note that in the above setup, we implicitly capture the essence of retail competition by allowing customers to have an outside option. In a competitive retail environment, an individual retailer is unable to exploit customers (i.e., charge monopoly price) because customers have outside options: Customers can visit a neighboring retailer if the prices charged by the local retailer are "too high." It is this threat of losing customers to competition that keeps retail prices in check. Endowing customers with outside options allows us to capture this basic essence of a competitive environment without unduly complicating the model. In technical terms, the retailer is not able to extract all consumer surplus so that the individual rationality (IR) constraint is not binding. Rather, the retailer's prices are set by the incentive compatibility (IC) constraints. Thus, in this baseline setup, high outside option will correspond to a very competitive retail environment. This is consistent with a practitioner's rationale for why retailers pass through the trade deals: ". . . the top reason retailers cite for passing funds along is reaction to competition. In other words, I'm discounting because the other guy's doing it" (*Supermarket Business* October 1999).

A few words about our modeling of the outside option are in order. As discussed earlier, in this formulation, the prices at the outside option are exogenously assumed to be w_L (ongoing trade promotion) and w_H (when there is no trade deal). Furthermore, the outside option does not act opportunistically: During trade promotion, it sets the price w_L. Thus, the outside option pricing policy is assumed to be nonstrategic. An alternative formulation would entail the symmetric outside retailer to follow the same strategy as the focal retailer: setting high and low prices at p_H and p_L, respectively, and passing through β fraction of trade deals. As we show in §5.3, this formulation greatly complicates the analysis (with no tractable closed-form expression for β^*) without changing our qualitative results. This formulation also loses the desirable feature of our outside option, namely that it allows (albeit implicitly) for multiple outside retailers to be visited.

2. Impact of Dynamics. To keep the analysis simple and to highlight the main forces impacting retail pass through in a transparent way, we model the interaction between the retailer and the customers as a single-period game. While we do not explicitly model dynamics, following Narasimhan (1988) and Raju et al. (1990) we will interpret the mixed strategy equilibrium (retail opportunism β) in a temporal sense.[5]

[5]The dynamic interpretation of the mixed strategies relies on a result due to Benoit and Krishna (1985): The unique sub-game perfect equilibrium characterized for a static game is also the equilibrium of a dynamic finitely repeated game where the players play their static game strategy over and over again.

Having said that, we do recognize that a full treatment of retail and consumer dynamics would need to consider issues such as retail forward buying, consumer stockpiling and consumer inferences from repeated exposure to retail promotions.[6] Fortunately, retailer forward buying and consumer stockpiling do not qualitatively change our results, and consumers' repeated exposure to retail promotions actually helps sustain the proposed equilibrium. First, let us discuss retailer forward buying. Suppose the retailer forward buys for k periods every time the manufacturer offers a trade promotion. This implies that the retailer has a low cost (w_L) in not just α periods but in αk periods. In a model extension, we show that as long as k satisfies certain parametric conditions, our results do not change qualitatively. Second, we consider the impact of consumer stockpiling, i.e., in addition to purchase incidence (buy/not buy) as in the baseline model, consumers also make quantity decision (how much to buy). If the elasticity of demand is the same for the HV and LV customers, then the relative attractiveness of these segments remains unchanged, and hence our results remain unaffected. On the other hand, if the LV customers are more inclined to stockpile because of lower inventory costs (Jeuland and Narasimhan 1985), then the retailer may be more inclined to pass through initially. However, in the periods following the initial retail promotion, the mix of customers will be skewed more toward HV customers because the LV customers who stockpile initially may not enter the market for several periods. This suggests that in the presence of consumer stockpiling the retailer may have a stronger incentive to pass through in some periods; however, in subsequent periods this incentive is likely to be diminished. In summary, even if consumers stockpile when the retailer offers promotions, the retailer's incentive to act opportunistically, while diminished in some periods, becomes stronger in subsequent periods and therefore does not completely vanish.

Finally, consider customers' repeated exposure to retail promotions. In the equilibrium characterized below, when the manufacturer offers a trade promotion, the retailer acts opportunistically with probability β^* and passes through the trade deal with complementary probability. In the model, for analytical simplicity we assume that defections from the equilibrium strategy are transparent to the customer. It is this assumption about β that prevents the retailer from deviating from the equilibrium strategy and never passing through, i.e., setting $\beta^* = 1$. This assessment of retail opportunism can result from prior visits to different stores, when customer may have observed the relevant prices despite purchasing in a different category. Assessments of retail opportunism may also be made from observing advertisements in the newspaper. While this may seem at first to be a strong assumption, one can show that it is less so in a more dynamic setting when consumers are exposed to repeated trade deals (please refer to the technical supplement for a formal treatment). Essentially, the argument is that should the retailer defect from the equilibrium strategy (and always post the ''regular'' price), the customers by repeatedly observing regular price would quickly conclude that the retailer has defected from the equilibrium strategy (we show that only a few periods of repeated observation are sufficient for such customer inference). Customers will then have a strong incentive to search other retailers for a better price, rendering the retailer's defection from the equilibrium strategy unprofitable. Thus, dynamic interaction between customers and the retailer actually strengthens the rationale behind our assumptions regarding the information structure.

3. Imperfect Consumer Knowledge. In our analysis, we make two simplifying assumptions: (a) All customers have accurate knowledge about the manufacturer's trade promotion frequency, α; and (b) in the absence of manufacturers' trade promotions, retailers do not initiate sales on their own, possibly driven by retail competition. Both these issues affect the inference that customers make about ongoing trade promotions, and hence their incentive to search

[6]We thank the editor and two anonymous reviewers for their comments on these issues. Details of the model extensions addressing these issues are given in a technical supplement available at http://www.informs.org. Other aspects of consumer dynamics such as brand inertia (Jeuland 1979) are likely to significantly complicate the model.

other stores for a better price. Using model extensions, we show that relaxing these assumptions does not qualitatively change our results. Section 5.2 discusses an extension that allows customers to differ in their estimate of α. In the technical supplement, we analyze an extension that allows the retailer to offer promotions even when there are no trade promotions. Aside from making customers' inferences about ongoing trade promotions noisier, there is no impact on our results.

3. Analysis of Retail Pass Through

As noted in the previous section, the game unfolds in two stages. In the first stage, while deciding his pass-through strategy, the retailer takes the manufacturer's trade promotion policy $\{w_H, w_L, \alpha\}$ as given and simultaneously sets p_H, p_L, and β, i.e., the regular price, the discounted price, and the probability with which he will behave opportunistically. Then, in the second stage, customers observe price, revise their expectations about ongoing promotions, and purchase the product if the surplus from the focal retailer exceeds that from their outside options.

The analysis proceeds by backward induction. In §3.1, we take the manufacturer and retailer strategies as given and analyze customer behavior. Section 3.2 investigates the retailer's decision to pass through a trade deal, realizing its impact on customer's beliefs and consequently their willingness to pay. In general, $\beta^* \in [0, 1]$, with $\beta^* = 0$ depicting the situation in which the retailer never acts opportunistically (i.e., 100% pass through), while $\beta^* = 1$, depicts the situation in which the retailer always acts opportunistically. These two strategies represent extremes of retailer opportunism. In the following analysis, we focus on an intermediate scenario in which, $\beta^* \in (0, 1)$.[7] Section 3.3 highlights the impact of product-market characteristics on the extent of retailer opportunism. Before proceeding, it may be useful to allay the concern one might have about a manufacturer's incentive to offer trade promotions if retailers do not totally pass through trade deals. Using an extension of the price promotion model of Bester and Petrakis (1995), we demonstrate in the technical supplement that even in the presence of retail opportunism, manufacturers would offer periodic trade deals provided such opportunism is not too large.

3.1. Customers' Beliefs and Purchasing Behavior

In analyzing customer behavior, we take as given both the manufacturer's trade promotion policy $\{w_H, w_L, \alpha\}$ and the retailer's strategy $\{p_H, p_L, \beta\}$. The customers' problem is to decide whether or not to purchase at the focal retailer, given the price posted by that retailer (p_H or p_L) and their assessment of retail opportunism (β). In deciding whether or not to purchase at the focal retailer, customers must compare the surplus from purchasing at the focal retailer with that from their outside options. However, because the surplus from their outside options is contingent on customers' beliefs about ongoing promotions (or retailer's costs) we begin with a discussion of customers' beliefs.

Because the manufacturer offers w_L with frequency α, customers' priors about ongoing promotions are α, where $\alpha = \Pr(w = w_L)$. Recall that by assumption $w_H > \nu$. As a result, when the manufacturer does not offer a trade promotion, the retailer has no incentive to serve the LV segment because this requires $p_L \leq \nu < w_H$. Thus, if customers observe the retailer charging the low price p_L, they can infer with certainty that there is an ongoing trade promotion:

$$\mu_L = \Pr(w = w_L | p = p_L) = 1. \quad (5)$$

However, when customers observe the retailer charging a high price p_H, what should they infer? Customers recognize that when there is no trade promotion, the retailer always charges p_H; but when there is a

[7] $\beta^* = 0$, represents a separating equilibrium because the retailer's strategy implicitly reveals whether or not there is an ongoing trade promotion—the retailer charges a high price when there is no trade promotion but always offers a sale when there is a promotion. In contrast, $\beta^* = 1$ represents a pooling equilibrium because the retailer's strategy is completely uninformative—the retailer charges a high price whether or not the manufacturer offers a trade promotion. The analysis focuses on a *partial pooling* or a *semi separating* strategy in which $\beta^* \in (0, 1)$. Conditions for existence of these equilibria are in the technical supplement available at http://www.informs.org.

Figure 1 Relationship Between Posterior Beliefs and Retailer Opportunism

Note: Frequency of promotion α was set to 0.3 for this plot.

trade promotion, the retailer charges p_H with probability β. Consequently, when customers observe p_H, they are not fooled into believing that there is no ongoing trade promotion. Instead, they revise their beliefs in a Bayesian manner consistent with the retailer's pass-through strategy. The posterior beliefs of customers upon observing p_H are as follows:

$$\mu_H = \Pr(w = w_L | p = p_H) = \frac{\alpha\beta}{\alpha\beta + (1 - \alpha)}. \quad (6)$$

The following lemma summarizes the impact of retailer opportunism on customers' posterior beliefs.[8]

LEMMA 1. *Customers' posterior beliefs of ongoing promotions (μ_H), when the retailer charges regular price (p_H), are increasing in retailer opportunism (β) and, consequently, decreasing in retailer pass through ($1 - \beta$).*

Figure 1 depicts the relationship between customer beliefs (μ_H) and retail opportunism (β). The intuition behind this relationship is the following. Suppose the retailer never acts opportunistically ($\beta = 0$) so that he offers a low price every time there is a trade promotion. In this scenario, retail prices are completely informative—i.e., when customers observe a high price, they can be certain that there is no trade promotion ($\mu_H = 0$). Contrast this with a scenario in which the retailer always acts opportunistically so that the retailer charges a high price regardless of whether or not the manufacturer offers a trade promotion. In this scenario retail prices are uninformative ($\mu_H = \alpha$).

Given these beliefs, the outside option of the *HV* customers and *LV* customers are given by:

After observing discounted price, p_L

$$U^O_{LV}(\nu, \mu_L | p = p_L) = \nu - s - w_L, \quad (7a)$$

$$U^O_{HV}(\nu, \gamma, \psi, \mu_L | p = p_L) = \gamma\nu - \psi s - w_L. \quad (7b)$$

After observing regular price, p_H

$$U^O_{LV}(\nu, \mu_H | p = p_H) = \mu_H(\nu - w_L) - s, \quad (8a)$$

$$U^O_{HV}(\nu, \gamma, \psi, \mu_H | p = p_H) = \gamma\nu - \psi s - [\mu_H w_L + (1 - \mu_H)w_H]. \quad (8b)$$

Equations (7a)–(8b) are obtained by replacing b with $\mu_L = 1$ and μ_H in Equations (3) and (4), respectively. As noted earlier, because the expected price at the outside retailer is decreasing in μ_H, customers' outside options are increasing in μ_H. Purchasing the product from the focal retailer is optimal if the surplus from purchasing exceeds customers' outside options.

3.2. Retailer's Pass-Through Strategy

The retailer's policy specifies the fraction of trade deals that he should pass through and his regular and sale prices. While deciding his pass-through policy, the retailer must recognize the impact of these decisions on customers' beliefs and purchase behavior. Note that when the manufacturer offers a trade promotion, the retailer's costs are lower. Therefore, when the manufacturer offers a trade promotion, serving only the *HV* customers by charging regular price (p_H) is an attractive strategy because the retailer can extract a higher margin. However, this strategy is not without costs. Recall from the above discussion (and Lemma 1) that customers' posterior beliefs of ongoing promotions are increasing in retailer opportunism. Consequently, increasing opportunistic behavior will increase customers' incentive to search, forcing the retailer to offer a lower price (even when acting opportunistically) to deter customers from searching. For-

[8]Proofs of Propositions 1–3 are given in the appendix. Proofs of Lemmas 1 and 2 and Results 1–5 are in the technical supplement available at http://www.informs.org.

mally the retailer's pass-through policy regarding ongoing trade promotions is modeled as

$$\text{P1:} \quad \max_{\beta, p_H, p_L} \beta(p_H - w_L)X + (1 - \beta)(p_L - w_L),$$

subject to

$$\gamma\nu - p_H \geq U^O_{HV}(\nu, \gamma, \psi, \mu_H | p = p_H), \qquad (\text{IC}_{HV})$$

$$\nu - p_L \geq U^O_{LV}(\nu, \mu_L | p = p_L). \qquad (\text{IC}_{LV})$$

The first term in the objective function denotes the profit from acting opportunistically and serving only the *HV* customers. The second term denotes the profit from serving the entire market. The retailer maximizes its expected profits subject to two conditions. The first condition imposes a constraint on the price that the retailer can charge when it acts opportunistically. In particular, at price p_H, the surplus that the *HV* customers derive from purchasing the product must exceed their outside options. The second condition imposes a similar constraint on p_L. Specifically, at price p_L the surplus that the *LV* customers derive from purchasing the product must exceed their outside options. To see how customers' beliefs about ongoing promotions affect the retailer's pricing strategy, we rearrange the two conditions:

$$\gamma\nu - U^O_{HV}(\nu, \gamma, \psi, \mu_H | p = p_H) \geq p_H, \qquad (\text{IC}_{HV}')$$

$$\nu - U^O_{LV}(\nu, \mu_L | p = p_L) \geq p_L. \qquad (\text{IC}_{LV}')$$

The left-hand side of these two inequalities represents the maximum values of p_H and p_L, respectively. Notice that the left-hand side of both these inequalities is decreasing in customers' outside options. Intuitively, when customers associate a high likelihood of ongoing trade promotions, the benefits from engaging in search are large. This effectively decreases their willingness to pay for the product, forcing the retailer to either charge a low enough price or forgo the customer.

Solution of program P1 yields the equilibrium values of the prices and the probability that the retailer will act opportunistically. It is summarized in Proposition 1.

PROPOSITION 1. *When there is a trade deal, the retailer does not pass through with probability $\beta > 0$, thus charging a high (regular) price p_H (and serving only the HV segment), and charges a low (sale) price p_L (and serving the entire market) with probability $1 - \beta^*$.*

Explicit expressions for the equilibrium prices p_H and p_L and for the probability β^* of opportunistic behavior are given in Table 2, second column.[9]

It is worthwhile to note that in equilibrium when the manufacturer offers trade promotions, the retailer prefers to act opportunistically with positive probability, i.e., the retailer prefers to randomize between high and low prices when the manufacturer offers trade promotions instead of adopting a pure strategy in which he either always acts opportunistically or never acts opportunistically. What is the rationale for randomizing? Lemma 1 sheds light on this issue. If the retailer always acted opportunistically, then observing a high price conveys no information about ongoing trade promotions. Because the *LV* customers are not served at the high price, only the beliefs of the *HV* customers are important. Customers in the *HV* segment will continue to maintain their prior beliefs about ongoing trade promotions—the outside options of the *HV* customers in this case is $U^O_{HV}(\nu, \gamma, \psi, \mu_H | p = p_H) \equiv \gamma\nu - \psi s - [\alpha w_L + (1 - \alpha)w_H]$. Now, consider the case when the retailer does not always act opportunistically. Following Lemma 1, because customers' posterior beliefs are increasing in β, their posteriors when $\beta < 1$ are less than their priors: $\mu_H < \alpha$. Because customers' outside options are increasing in their beliefs about ongoing promotions, their outside options are lower when $\beta < 1$ vis-à-vis the case when $\beta = 1$. Thus, the retailer's opportunistic behavior endogenously affects customers' outside options and the price that they are willing to pay.

In summary, by increasing β, the retailer serves the *HV* segment alone more often. Because the margin

[9]Clearly for the equilibrium to be interpretable, prices have to be positive and $\beta^* \in [0, 1]$. The parametric conditions for existence of the equilibrium are laid out in the appendix. Further, for retail pass-through issue to be "managerially significant," we also need that when the focal retailer charges the "regular" price, the *LV* customers (who are unsure of the benefits from searching) do not find it optimal to search other retailers. This results in incomplete market coverage (that is, some potential demand will be "lost") when a retailer acts opportunistically, thereby making manufacturer's intervention necessary.

from serving the *HV* segment is large, this has a positive impact on the retailer's profit. The down side is that increasing β increases customers' posteriors about ongoing trade promotions, which in turn increases their outside options and puts downward pressure on p_H. This has a negative impact on the retailer's profits. Indeed, in deciding how often to behave opportunistically, the retailer balances these two effects, and in equilibrium, $\beta \in (0, 1)$.

An argument can be made that in the program formulation P1, the retailer is somewhat myopic in deciding his pass-through policy because he does not explicitly recognize the impact of retail opportunism on his payoffs in future periods when there is no trade promotion. In the technical supplement, we consider two extensions incorporating retail forward-looking behavior and demonstrate the robustness of probabilistic pass-through strategy. The first extension is a one-period look-ahead formulation and shows that our results still hold. The second extension addresses a more conceptual issue: When is the optimal pass-through policy actually determined? In the model formulations P1 and the one-period look-ahead extension, the implicit assumption is that the decision on whether or not to pass through a trade deal is made when the retailer is actually faced with an ongoing trade promotion. An alternative approach might be to determine the trade promotion policy ex ante. Even in this formulation, with the needed modifications, we demonstrate that the retailer still prefers the probabilistic pass-through strategy.

3.3. Product-Market Characteristics and Retail Opportunism

In the proposed model, customer characteristics are captured by the parameter X that represents the fraction of *HV* customers in the market, the parameters ν and $\gamma\nu$ that represent the *LV* and *HV* customers' valuations and s and ψs that represent their respective search costs. The results pertaining to the impact of these parameters on retailer opportunism are now discussed (proofs in the technical supplement).

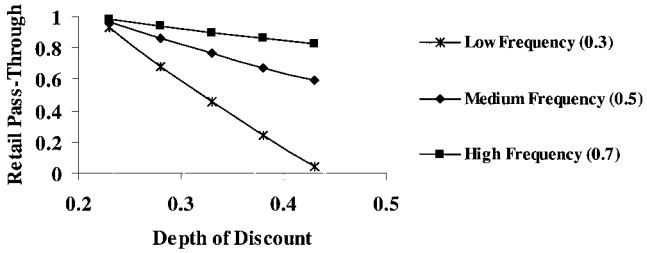
Result 1. *Retailer opportunism (β^*) is increasing in the proportion of HV segment (X).*

Notice that when the retailer acts opportunistically, he serves only the *HV* customers. As the relative size of this segment (X) increases the benefits from behaving opportunistically increase. Also, because the relative size of the *LV* segment ($1 - X$) decreases, the demand expansion resulting from reducing price to p_L will be smaller. Consequently, the retailer will tend to behave more opportunistically. This result is supported by the empirical findings in Curhan and Kopp (1988) and Walters (1989), who note high retail pass through to be associated with greater demand response to promotion. This result is also consistent with the main findings in Tyagi (1999), viz., pass through is increasing in demand elasticity.

Result 2. *Retailer opportunism (β^*) is increasing in the relative search cost of the HV customers (ψ) but decreasing in the search cost of the LV customers (s).*

The intuition behind these results revolves around the attractiveness of the *HV* customers vis-à-vis the *LV* customers. When the relative search cost of the *HV* customers (ψ) goes up, their outside options go down, enabling the retailer to extract a higher price (p_H) from them. Note that changes in ψ do not impact the willingness to pay of the *LV* segment. As a result, the retailer will find it optimal to behave more opportunistically if the relative search cost of the *HV* segment goes up. Similarly, when the search cost of the *LV* customers (s) goes up, their outside options go down, enabling the retailer to charge a higher price (p_L) from them. However, an increase in s also increases the search costs of the *HV* customers, thereby lowering their outside options. While this allows the retailer to increase both p_L and p_H, the marginal impact of an increase in s, on the profits from acting opportunistically is ψX. In contrast, the marginal impact of an increase in s, on the profits from serving the entire market is 1. To see this, suppose $X = 0.3$, $\psi = 1.5$ and $s = 0.25$. Consider the impact of a change in s (Δs) from 0.25 to 0.4 ($\Delta s = 0.15$). While the outside options of the *HV* customers decrease by 0.225 ($\psi \Delta s = 1.5 \times 0.15$), the outside options of the *LV* customers decrease by 0.15 ($\Delta s = 0.15$). This allows the retailer to increase p_H by 0.225 and p_L by 0.15. Although the increase in p_H is larger, this additional margin can be realized only from the *HV* segment.

Figure 2 Relationship Between Pass Through and Depth and Frequency of Promotions



Note: Parameters values used for this plot are: $\psi = 1.5$, $s = 0.3$, $X = 0.45$, while $\alpha = 0.3, 0.5, 0.7$ and δ was varied in the interval 0.23 to 0.43.

In contrast, the benefits from the increase in p_L can be realized from the entire market. In our example, this translates into an increase in profit of 0.0675 ($\psi \cdot \Delta s \cdot X$) when serving only the *HV* segment and an increase in profit of 0.15 (Δs) when serving both the *HV* and *LV* segments. This is true if $\psi X < 1$ holds. Consequently, if $\psi X < 1$, then retail opportunism will be decreasing in *s.* Since the condition $\psi X < 1$ is required for the existence of the equilibrium of interest (see Appendix for details), the retailer will find it optimal to decrease opportunistic behavior as the search cost of the *LV* customers increases.

RESULT 3. *Retailer opportunism (β^*) is increasing in the depth of discount (δ) but decreasing in the frequency of promotions (α).*

A deeper discount increases the retailer's margin when he acts opportunistically, serving only the *HV* segment. Therefore, the retail pass through will be lower when the trade promotion discounts are deeper. When trade promotions are less frequent, customers are more likely to believe that there is no ongoing trade promotion when they observe p_H (the regular retail price), compared to the case when trade promotions are more frequent. Consequently, when trade promotions are infrequent customers' outside options are low, which enables the retailer to charge a higher p_H. Therefore, the retailer will find it optimal to lower pass through when the frequency of trade promotion is low. These relationships are highlighted in Figure 2. These results are consistent with Armstrong's (1991) empirical findings highlighted in Table 1. First,

Table 1 Empirical Observations in Armstrong (1991)

Category	Total No. of Trade Promotions Offered (α)[a]	Retail Opportunism (β) (%)[b]	Mean Depth of Discount (δ) (%)
Coffee	174	48.55	15.87
Diaper	73	42.5	5.26
Tissue	282	18.5	14.76
Tuna	76	67.27	20.60

Notes: Table 1 has been constructed from data given in Armstrong (1991), Chapter 4. Interestingly, a regression of retail opportunism as the dependent variable with frequency and depth as the explanatory variables yields the following parameter estimates: intercept = 47.511, frequency parameter = −0.195, depth parameter = 1.748, and R^2 = 96.51%. While we recognize that statistical inference based on such a small sample (of aggregate data, however) needs to be made with care, the qualitative support of our findings is encouraging. Ideally, one would want to test these hypotheses using the disaggregate data in Armstrong (1991); however, such data are not readily available.

[a]Denotes the total number of trade promotions offered in a 2-year period (1985–1987).

[b]Denotes the fraction of trade promotions that did not result in any pass through.

notice that pass through is highest in the tissue category, which happens to be the category that is promoted most frequently. In contrast, tuna, one of the least frequently promoted categories, features the lowest pass through. Second, note that although there is no significant difference in the frequency of trade promotions between the tuna and diaper categories, retail pass through is significantly higher in the diaper category than in the tuna category. Following Result 3, retail opportunism is increasing in the depth of discount. This is consistent with retailers acting more opportunistically in tuna where the average depth of discount (20.60%) is significantly larger than the average depth of discount in diaper (5.26%).

4. Manufacturer's Advertising of Trade Deal

The results discussed above suggest numerous strategies that the manufacturer could adopt to control opportunistic behavior by the retailer. An obvious strategy could be to lower the depth of discount but offer trade promotions more frequently. However, be-

cause a manufacturer's promotional policy is influenced by the strategic interactions at the manufacturer level, enhancing retail cooperation by changing the frequency and depth of trade promotions, without explicitly recognizing their impact on manufacturer level competition may only present an incomplete view of the trade-offs facing the manufacturer. Another strategy may be to supplement the trade promotion with strict compliance requirements—a contractual agreement that requires the retailer to offer price reductions when the trade promotion is offered. Armstrong (1991) notes that this strategy of requiring strict compliance lowers retail acceptance of the trade promotion offer. She notes that even when retailers accepted trade promotions with compliance requirements retail opportunism was widespread. Our proposal below circumvents this issue without requiring the manufacturer to change its trade promotion policy—the mix of frequency and depth of promotion or requiring more stringent compliance requirements.

4.1. Manufacturer's Advertising of Trade Deal

We show that by complementing trade promotions with advertising that informs customers about ongoing promotions, the manufacturer can lower retailer opportunism. This is accomplished in our analysis by allowing the manufacturer to advertise before the retailer decides on his strategy. As a result, the sequence of moves in this part of the analysis is as follows:

- Manufacturer sets the fraction of the market, ϕ, that he wants to inform about ongoing trade promotions—the role of the advertisement is simply to inform customers that the manufacturer is currently offering a trade promotion.
- The retailer takes ϕ as given and determines the probability, β, with which he will behave opportunistically and sets p_H and p_L.
- Customers take ϕ and this opportunistic behavior by the retailer as given, observe the prices quoted by the retailer, and decide whether to buy or not.

4.2. Customers' Beliefs and Retail Pass-Through Strategy

Because firms' strategies depend on customer behavior, we start with a discussion of how manufacturer's advertising influences customers' beliefs and behavior. In this setup, customers can base their inferences about ongoing promotions not only on the retail prices but also on whether or not they observe manufacturer's advertising.

Customers' Beliefs. The manufacturer's advertisement informs a fraction ϕ of the market so that customers who are exposed to the advertisement become completely informed, while those who do not observe the advertisement remain uncertain about ongoing promotions. This situation results in four customer segments: informed *HV,* uninformed *HV,* informed *LV,* and uninformed *LV.* The informed segment—customers who observe the manufacturer's advertisement—does not have to rely on retail prices to make inferences about ongoing promotions. As a result, the posterior beliefs of informed customers about ongoing trade promotions are degenerate—they believe that the manufacturer is offering trade promotions with certainty, irrespective of the price posted by the retailer:

$$\begin{aligned}\mu' &= \Pr(w = w_L | p = p_L, \text{Ad}) \\ &= \Pr(w = w_L | p = p_H, \text{Ad}) = 1.\end{aligned}$$

Also, as in §3, posterior beliefs of uninformed customers (who were not exposed to manufacturer's advertisement) are degenerate when the retailer charges a low price ($p_L < v < w_H$) because such a price cannot be profitable if there are no trade promotions:

$$\mu_L' = \Pr(w = w_L | p = p_L, \text{No Ad}) = 1.$$

However, for uninformed customers observing the retailer charging the regular price, the uncertainty about ongoing promotion persists. These customers recognize that one of two events is possible:

(i) The manufacturer is not offering any trade promotion; or,
(ii) Despite the manufacturer advertising an ongoing trade promotion, the customers did not observe the advertisement.

Recognizing these possibilities, customers revise their beliefs in a Bayesian manner, and their posterior beliefs are given by

$$\mu'_H = \Pr(w = w_L | p = p_H, \text{No Ad}) = \frac{\alpha(1-\phi)\beta}{\alpha(1-\phi)\beta + (1-\alpha)}.$$

Given these beliefs, the outside options of the four customer segments can be computed by substituting for their beliefs in Equations (3) and (4). The impact of manufacturer's advertising intensity on customers' posterior beliefs is summarized in Lemma 2 (proof in the technical supplement).

LEMMA 2. *Uninformed customers' posterior beliefs (μ'_H) of ongoing promotions, when they observe the retailer charging regular price, are decreasing in manufacturer's advertising intensity (ϕ).*

When the manufacturer increases the advertising intensity (ϕ), the probability that a customer observes the advertisement when there is an ongoing promotion increases. This decreases the likelihood of an ongoing promotion when customers do not observe the manufacturer's advertisement but observe the retailer charging regular price (p_H).

Because the expected price at the outside option is decreasing in customers' beliefs about an ongoing promotion, customers outside options are decreasing in (ϕ). The manufacturer can use this mechanism to increase retailer's costs of acting opportunistically.

Retail Pass-Through Strategy. In contrast to the baseline setup, where the retailer served all the *HV* customers when acting opportunistically, in this setup the retailer will serve only the uninformed *HV* customers.[10] In this case, to determine the regular and sale price and the optimal pass-through policy, the retailer must solve the following problem:

$$\text{P2:} \quad \max_{\beta, p_H, p_L} \beta(1-\phi)(p_H - w_L)X + (1-\beta)(p_L - w_L),$$

subject to

$$\gamma\nu - p_H \geq U^O_{HV}(\nu, \gamma, \psi, \mu'_H | p = p_H, \text{No Ad}), \quad (\text{IC}_{HV})$$

$$\nu - p_L \geq U^O_{LV}(\nu, \mu'_L | p = p_L, \text{No Ad}). \quad (\text{IC}_{LV})$$

The first term in the objective function denotes the profit from acting opportunistically and serving just the uninformed *HV* customers. The second term denotes the profit from serving the entire market. The retailer maximizes its expected profits subject to two conditions. The first condition imposes a constraint on the high (regular) price that the retailer can charge when it acts opportunistically. In particular, at price p_H, the surplus that the uninformed *HV* customers derive from purchasing the product must exceed their outside options. The second condition imposes a similar constraint on low (sale) price p_L. Specifically, at price p_L, the surplus that the *LV* customers derive from purchasing the product must exceed their outside options. As before, these two conditions are binding at optimum retailer profits.

Solution to program P2 yields the equilibrium values of the prices and the probability that the retailer will act opportunistically and is summarized in the following proposition.

PROPOSITION 2. *When there is a trade deal, given manufacturer advertising intensity (reach) ϕ, the retailer maximizing its profits does not always pass through: charges high (regular) price $p_H(\phi)$ with probability $\beta^*(\phi)$ and low (sale) price $p_L(\phi)$ with probability $1 - \beta^*(\phi)$.*

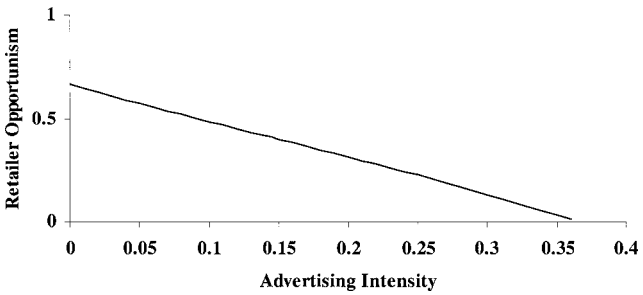
Explicit expressions for equilibrium values of retailer's randomization strategy as well as regular and sale prices, for any level of manufacturer's advertising are given in the appendix.

The optimal retailer opportunism characterized in Proposition 2 differs from that characterized in Proposition 1 in that β^* above is for a given choice of advertising intensity ϕ. The relationship between retailer opportunism and manufacturer's advertising intensity will critically affect the manufacturer's optimal strategy and is summarized as Result 4 (proof in the technical supplement).

RESULT 4. *If the mass X of HV customers is sufficiently*

[10]A partial-pooling equilibrium wherein the retailer, while acting opportunistically, serves all the *HV* customers when there is an ongoing promotion cannot exist. To see this, note that the outside option of informed *HV* customers is larger than that of the uninformed *HV* customers. Thus, in order to target the informed *HV* customers, the retailer must charge a lower price. However, this price would implicitly reveal that there is an ongoing promotion as the retailer will always defect to a higher price when there is no trade promotion (consistent with outside option of uninformed *HV* customers), thereby destroying such a partial-pooling equilibrium.

Figure 3 Retailer Opportunism and Manufacturer's Advertising Intensity



Note: Parameters were set to the following values: $\delta = 0.6$, $\psi = 1.5$, $s = 0.3$, $X = 0.45$, $\alpha = 0.5$, $w_H = 1$.

large, retailer opportunism (β) is decreasing in manufacturer's advertising intensity (ϕ).

The intuition behind this result is that as the manufacturer increases its advertising intensity infinitesimally, the fraction of uninformed customers in the retailer profit function decreases in proportion to the size of the *HV* customers. Consequently, there is a negative effect on demand when acting opportunistically, and hence a negative effect on β. Recall also from Lemma 2 that the uninformed *HV* customers' posteriors are decreasing in manufacturer's advertising intensity. This in turn lowers their outside options. Uninformed *HV* customers are therefore willing to pay a higher price when the manufacturer increases advertising intensity. This increases the margins from serving the uninformed *HV* customers, and hence, has a positive effect on β. The impact of increasing advertising intensity on retailer opportunism will depend on the net effect. Notice that the positive effect depends on how the outside options are affected by the change in customers' beliefs. The negative demand effect, however, depends only on the size of the *HV* customers. When the demand effect dominates the price effect, the retailer will find it optimal to reduce opportunistic behavior. This will happen when X is *sufficiently* large. Figure 3 depicts the relationship between retailer opportunism (β^*) and the intensity of manufacturer's advertising (ϕ). In the next section, we characterize the manufacturer's optimal advertising intensity that would prevent the retailer from acting opportunistically.

4.3. Characterization of Optimal Manufacturer's Advertising Intensity

As we show in Result 4, $\beta^*(\phi)$ is decreasing in the manufacturer's advertising intensity ϕ. This implies that the manufacturer can choose an advertising intensity, ϕ^*, so that the retailer always passes through when the manufacturer offers a trade deal, i.e., $\beta^*(\phi^*) = 0$. This is summarized in the following proposition (proof in the appendix):

PROPOSITION 3. *The manufacturer can align the incentives of the retailer, eliminating its opportunistic behavior, by informing customers about ongoing promotions via advertising with intensity (reach) $\phi^* = 1 - \{s/[X(\delta + \psi s)]\}$.*

Explicit expressions of ϕ^*, together with the expressions for the retailer's equilibrium strategy corresponding to ϕ^* are given in the third column of Table 2.

Why should manufacturer advertising reduce opportunistic behavior and improve the efficiency of trade promotions? The intuition for this result follows directly from Result 4. By informing a fraction of the customers about ongoing promotions, the manufacturer effectively decreases the size of the *HV* segment targeted by the retailer. This reduces the benefits from engaging in opportunistic behavior, and in equilibrium, the choice of ϕ is such that the retailer prefers (at least weakly) to serve the entire market rather than engage in opportunistic behavior.

For the parameter values used in plotting Figure 3: $\{\delta = 0.6, \psi = 1.5, s = 0.3, X = 0.45, \alpha = 0.5, w_H = 1\}$, $\phi^* = 0.365079$ and $\beta(\phi^*) = 0$. Notice 100% pass through $[\beta(\phi^*) = 0]$ is achieved here because advertising is assumed to be costless. Suppose instead that advertising costs were significant and convex: $A(\phi) = 0.5\phi^2$; then the manufacturer would set advertising intensity to solve the following problem

$$\phi^* \in \text{argmax}\{(1 - \alpha) \times X \times w_H + \alpha \times [\beta(\phi) \times (1 - \phi) \times X + (1 - \beta(\phi))] \times w_L - 0.5 \times \phi^2\}. \quad (9)$$

The solution to this problem yields, $\phi^{**} = 0.18874$ for the above parameter values, which, as expected, is lower than the advertising intensity computed earlier under the assumption of zero costs. Retail pass

Table 2 Mathematical Expressions of Customer Beliefs and Equilibrium Strategies (Programs P1 and P2)

	Manufacturer Intervention	
Expressions	No Advertising	With Advertising
Customers' posterior beliefs	$\mu_H = \frac{\alpha\beta}{\alpha\beta + (1-\alpha)}$	$\mu'_H = \frac{\alpha(1-\phi)\beta}{\alpha(1-\phi)\beta + (1-\alpha)}$
Manufacturer's advertising intensity	N/A	$\phi^* = 1 - \frac{s}{X(\delta + \psi s)}$
Retail opportunism	$\beta^* = \frac{(1-\alpha)}{\alpha}\left[\sqrt{\frac{\delta X}{s(1-\psi X)}} - 1\right]$	$\beta^* = 0$†
Regular price	$p_H^* = \psi s + w_L + \sqrt{\frac{\delta s(1-\psi X)}{X}}$	$p_H^* = w_H + \psi s$
Sale price	$p_L^* = w_L + s$	$p_L^* = w_L + s$

† *Note:* Recall that by construction, the equilibrium advertising intensity is designed to prevent any retail opportunism.

through in this case is $[1 - \beta(\phi^{**})] = 67\%$, which is significantly higher than the pass through achieved with no manufacturer intervention $[1 - \beta(\phi = 0)] = 34\%$. This suggests that while the retailer does act opportunistically, when advertising costs are high the manufacturer's equilibrium advertising intensity, regardless of the approach adopted to compute it, does lower retail opportunism. This result formalizes observations made by Walters (1989) and Curhan and Kopp (1988). Walters (1989) notes: ''Trade deals accompanied by manufacturer sales promotion such as media advertising, coupon drops, price packs and premiums will be supported to a greater degree than [those] that are not accompanied by consumer directed manufacturer promotional efforts. . . .''

Our findings suggest that manufacturers may target promotional advertising directly to the end customers to reduce retail opportunism, i.e., McDonald's advertisements that inform customers about ongoing promotions at participating restaurants, Vanguard's advertisements that inform customers of a special offer, automobile manufacturers' advertisements that inform customers about ongoing rebates at participating dealer. In fact, the genesis of this paper is a direct outcome of class discussions for the Harvard case ''Hartmann Luggage: Price Promotion Policy,'' dealing with Hartmann's ineffective trade promotions. In this case, Hartmann—a premium-positioned brand—does not announce its ongoing trade promotions in its national advertising campaigns that is in contrast to the policies followed by popular-positioned brands, Samsonite and American Tourister. While identifying the reasons for disappointing consumer response to Hartmann's promotions, several class participants make the point that because these promotions are not advertised, consumers may not be aware of them. As such, retailers may not be inclined to pass through such deals resulting in poor consumer response.

The need for manufacturer intervention is more acute in market conditions that are conducive to retail opportunism. Result 5 (proof in the technical supplement) summarizes our findings and provides guidelines to manufacturers about when a proactive role may be most warranted.

Result 5. *The manufacturer's advertising intensity (ϕ^*) is: (i) increasing in the proportion of the HV segment (X); (ii) increasing in the relative search cost of the HV customers (ψ) and decreasing in the search cost of the LV customers (s); and, (iii) increasing in the depth of discount (δ).*

The intuition behind these results follows directly from our earlier findings on the impact of market characteristics on retail opportunism (Results 1–3) and the interrelationship between retail opportunism and manufacturer's advertising (Result 4). Because re-

tail opportunism increases with the size of the *HV* segment (X), the manufacturer's optimal advertising intensity is increasing in X. Similarly, recall that retail opportunism is increasing in the relative search cost of the *HV* customers (ψ) but decreasing in the search cost of the *LV* customers (s). Hence, manufacturer's optimal advertising intensity is increasing in ψ but decreasing in s. Finally, because retail opportunism is increasing in the depth of the promotional discount (δ), manufacturers will benefit from increasing the advertising intensity when they offer deeper discounts.

In the next section, we analyze three extensions to our model. First, we consider the impact of retail differentiation on pass-through decisions. This analysis is intended to explore the impact of a retailer's relative quality positioning on pass-through decision. The second extension analyzes the implication of heterogeneity in consumers' knowledge about frequency of trade deal and shows that, even in this setting, the results remain qualitatively the same. Finally, we extend the baseline model by explicitly incorporating competition at the retail level. The main objective of this extension is to demonstrate that the equilibrium of the type characterized in the baseline model, where pass through occurs only occasionally, continues to exist even if competition is modeled explicitly. This is accomplished by including another retailer to the base setup.

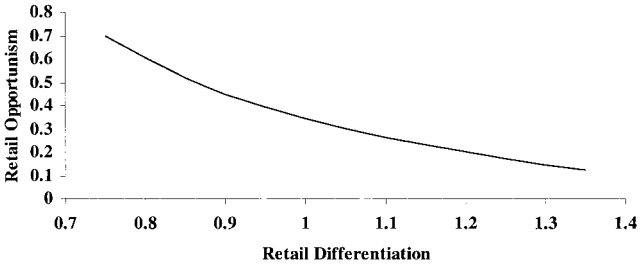
5. Model Extensions[11]

5.1. Retail Differentiation

We incorporate retail (vertical) differentiation in a reduced-form approach by allowing customers to have different valuations for the product at the focal and the outside retailers. With this exception, all model features are identical to that outlined in §2. We modify Equations (3) and (4) in the following manner to capture retail differentiation:

[11]All the analytical details pertaining to these extensions may be found in the technical supplement available at http://www.informs.org. We thank the editor and two anonymous reviewers for encouraging us to explore the robustness of our results to some key model assumptions.

Figure 4 Managerial Implications: Retail Opportunism and the Extent of Vertical Differentiation (θ)



Note: Parameters were set to the following values for this plot: $\alpha = 0.6$, $\gamma = 3$, $\nu = 1$, $s = 0.6$, $\psi = 1.5$, $\delta = 1$, and $X = 0.45$, and θ was varied between 0.75 and 1.35.

LV customers:

$$U^{O}_{LV}(p, \nu, b) = b(\theta\nu - w_L) - s, \qquad (3')$$

HV customers:

$$U^{O}_{LV}(p, \nu, \gamma, \psi, b) = \theta\gamma\nu - \psi s - [bw_L + (1 - b)w_H]. \qquad (4')$$

Notice that customers' valuation of the product at the outside retailers is now scaled by the parameter θ that is interpreted as resulting from vertical differentiation of the focal retailer. When $\theta < 1$ ($\theta > 1$), customers' valuation of the product is relatively higher (lower) at the focal retailer. This may arise because of differences in positioning of the focal retailer. For example, its outlet may differ in depth and breadth of assortment, in-store service, etc. The model analyzed earlier is the special case $\theta = 1$.

As expected, retail opportunism will now be influenced by the extent of vertical differentiation (θ) across the focal and outside retailers. The interrelationship between retail opportunism and the extent of vertical differentiation as formalized by the parameter θ is presented in Figure 4. In fact, Figure 4 reinforces our findings from the earlier analysis: The focal retailer can act more opportunistically when θ is small. In this example, $\beta = 0.99$ when $\theta = 0.65$. At $\theta = 1$, retail opportunism is 35% and decreases further to 18% at $\theta = 1.25$. This suggests that in a dif-

ferentiated retail market, retailers with higher relative quality positioning are less likely to pass through trade deals than weakly positioned retailers.

5.2. Consumer Heterogeneity in Knowledge of Trade Promotion Frequency

In this extension, we relax the assumption that all customers are perfectly informed about manufacturer's trade promotion frequency. Suppose instead that only a fraction f of the customers had accurate information, while a fraction $(1 - f)/2$ underestimates α as $\alpha_u = \alpha - \Delta$ and the remaining customers overestimate α as $\alpha_O = \alpha + \Delta$. While our results are not sensitive to this assumption, we set the fraction of customers who over/underestimate α to be the same so that the market on average has unbiased information. All other assumptions are identical to our baseline model. It is easy to see that as $f \to 1$, this extension reduces to our baseline setup. Therefore, let us assume that $f < 1$. Recall that outside options are increasing in customers' beliefs about ongoing promotions. Consequently, the outside option of customers who overestimate α is the highest, while that of customers who underestimate α is the lowest. This in turn implies that the retailer will need to charge a lower price to attract customers who overestimate α vis-à-vis attracting customers who have accurate information or customers who underestimate α. If f is sufficiently large, the retailer may prefer to forgo *HV* customers who overestimate α and just serve *HV* customers who have accurate information or underestimate α, when acting opportunistically. In this case, it can be shown that

$$\beta^* = \frac{(1 - \alpha)}{\alpha}\left[\sqrt{\frac{\delta X(1 + f)}{s[2 - \psi X(1 + f)]}} - 1\right]. \quad (10)$$

This is β^* characterized in the baseline model with X replaced by $X(1 + f)/2$. On the other hand, if f is sufficiently small, the retailer would prefer to serve all the *HV* customers when acting opportunistically—including those who overestimate α—albeit at a lower price. In this case, we show that

$$\beta^* = \frac{(1 - \alpha - \Delta)}{(\alpha + \Delta)}\left[\sqrt{\frac{\delta X}{s(1 - \psi X)}} - 1\right]. \quad (11)$$

This is β^* characterized in the baseline model with α replaced by $\alpha_O = \alpha + \Delta$. This helps demonstrate that our results are not sensitive to the assumption that all customers have accurate knowledge of manufacturer's trade promotion frequency.

5.3. Explicit Retail Competition

We consider a model with a single manufacturer selling through two retailers, who are geographically differentiated—think of retailer A in trading area A and retailer B in trading area B. Each area has X *HV* customers and $(1 - X)$ *LV* customers. The retail setup here is similar to Bester and Petrakis (1995). Customers in area j, $j \in \{A, B\}$ only know of the prices charged by retailer j, and are uncertain about the prices charged by the other retailer, $k \neq j$, where $k \in \{A, B\}$.

Customers in each area incur a shopping cost, s, to visit the local store and incur a cost, ηs, where $\eta > 1$, to visit the remote store, and by doing so learn the price charged by the other retailer. Heterogeneity in shopping costs is captured by assuming that s is independently and uniformly distributed across the population with support in the interval $[0, s_H]$. The reservation values of the two customer segments for the manufacturer's product are identical to the baseline setup—ν and $\gamma\nu$ for the *LV* and *HV* segments, respectively.

The manufacturer promotes with frequency α, charges w_L when the product is on promotion and advertises with intensity ϕ, when there is a trade promotion. With these assumptions in place, we proceed with the construction of a partial-pooling equilibrium, in which retailers act opportunistically despite competition.

When the manufacturer does not offer trade promotions, retailer's cost w_H exceed the valuation of the *LV* segment (by assumption, $w_H > \nu$). Consequently, the retailer has no incentive to serve the *LV* segment when there is no trade promotion. The retailer j, $j \in \{A, B\}$, will target the *HV* segment in both areas by charging p_{Hj}, if η is not too large. However, when the manufacturer does offer trade promotions, because of reasons discussed earlier, the retailers may choose to act opportunistically. Indeed the equilibrium we wish to construct is one where retailers serve the *LV* seg-

ment with probability strictly less than one, when the manufacturer offers a trade promotion. Specifically, the equilibrium strategies of the retailers in areas A and B, when the manufacturer offers trade promotions is the following: *Retailer A*: $\{p_{HA}, p_{LA}, \beta_A\}$; *Retailer B*: $\{p_{HB}, p_{LB}, \beta_B\}$. Given these assumptions one can derive the demand functions and solve for the equilibrium strategies of the two retailers.

Because of the complexity of the setup, we were unable to get closed-form expressions for the equilibrium values of the prices and retail opportunism. However, for a large region of parameter space, we were able to compute the equilibrium values. For instance, when $\alpha = 0.35$, $\phi = 0.65$, $\gamma = 2.5$, $\nu = 6$, $w_H = 10$, $\delta = 5$, $s_H = 10$, $\eta = 1.25$, $X = 0.10$, the equilibrium opportunism (β^*) is 0.64, while the regular (p_H^*) and sale (p_L^*) prices are 6.13 and 5.83, respectively. Hence, an equilibrium that involves opportunistic behavior by the retailer, $\beta^* \in (0, 1)$, exists even if retail competition is modeled explicitly.

In the technical supplement, we also consider an extension of our baseline model (§2), wherein we model the strategic behavior of the symmetric outside retailer. As in the baseline model, consumers within each segment (HV and LV segments) are homogeneous in their search costs. Our results in this setting have the flavor of Diamond's (1971) paradox: The discounted price p_L^* in equilibrium is equal to the valuation ν of the LV segment. In other words, the retailers can extract monopoly rents from the LV customers in spite of competition. The extension discussed earlier overcomes this undesirable feature by allowing heterogeneous search costs with some consumers having zero search costs.

6. Conclusion

In this paper, we have examined the strategic considerations that underlie the retailer's decision to pass through trade deals. Our analysis shows that the optimal strategy of the retailer entails passing through trade deals on certain occasions by offering consumer promotion while retaining deal money offered by the manufacturer and posting ''regular'' price on other occasions. This finding helps explain the observations in Chevalier and Curhan (1976), wherein on average retailers pass through the trade deal on 45% of the occasions and pocketed the trade deal on the other occasions. Other empirical studies, notably Curhan and Kopp (1988) and Walters (1989), find significant variations in retail pass through across categories. We argue that this variation can arise from differences in product-market characteristics or the characteristics of the trade promotion itself. Specifically, our analysis suggests that retail pass through is lower when the HV segment is large and/or their search cost is high. In addition, we find that retail opportunism is of particular concern to those manufacturers who follow a trade promotion strategy characterized by low frequency of promotion and high depth of discounts. These insights explain Armstrong's (1991) findings.

Our analysis also demonstrates how manufacturer advertising that informs customers about ongoing promotions can help enhance retail pass through. This suggests an alternative role of manufacturer advertisements that are commonly seen on television and other media—advertisements such as manufacturers informing customers about ongoing promotions at participating retailers. Our analysis suggests that by informing customers about the manufacturer's special offer, these advertisements may help regulate retail opportunism. The main managerial insights obtained from our analysis are summarized in Figure 5.

The top right corner of each cell in Figure 5 depicts the level of retail pass through (PT) in the absence of any manufacturer intervention. The bottom left corner prescribes the action that manufacturers should undertake to enhance retail pass through. For example, the cell corresponding to a large HV clientele with high relative search costs indicates that retail pass through under these conditions will be very low in the absence of manufacturer intervention. Consequently, the manufacturer should advertise with higher reach to enhance retail pass through. Similarly, the cell corresponding to low frequency of promotions and high depth of discount suggests that retail pass through would be very low under these conditions, and the manufacturer may benefit from advertising ongoing promotions with high intensity.

In summary, as noted in the industry press, despite

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Figure 5a **Customer Characteristics, Retail Pass Through, and Manufacturer Advertising**

Size of Retailer's High Valuation Clientele (X)	High Valuation Customers' Relative Search Costs (ψ): High	Low
Large	Low PT High Adv.	Moderate PT Moderate Adv.
Small	Moderate PT Moderate Adv.	High PT Low Adv.

Figure 5b **Trade Promotion Characteristics, Retail Pass Through, and Manufacturer Advertising**

Frequency of Promotions (α)	Depth of Discount (δ): High	Low
High	Moderate PT High Adv.	High PT Low Adv.
Low	Low PT High Adv.	Moderate PT Moderate Adv.

the inherent conflicts in the channel that give rise to ineffective use of trade promotion moneys, trade promotions are here to stay. The paper highlights market characteristics that affect retailer opportunism and offers prescriptions for manufacturers to coordinate the channel. Given the general findings of Jeuland and Shugan (1983a, 1983b) on channel coordination, it is not surprising that manufacturers would want to inform end-customers about their transfer price with their resellers.

This paper is an attempt at studying the effect of imperfect customer knowledge on channel behavior. We realize the limitations of the proposed framework that future work could address. For instance, explicit modeling of manufacturer-level competition might enable us to endogenously characterize manufacturer's optimal trade promotion policy while explicitly recognizing opportunistic behavior on part of the retailers. While in a model extension, we do consider vertical differentiation, albeit in a reduced-form specification, future research could explore other approaches to capturing retail differentiation. Also, more complete models with formal dynamics about forward-buying and other consumer dynamics such as brand inertia (Jeuland 1979) should be attempted but will likely be complex. We hope that the transparent intuition provided in this paper will be helpful to those who undertake these and other important extensions.

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Appendix: Proofs of Propositions 1–3

PROPOSITION 1. *When there is a trade deal, the retailer does not pass through with probability $\beta^* > 0$, thus charging a high (regular) price p_H (and serving only the HV segment), and charges a low (sale) price p_L (and serving the entire market) with probability $1 - \beta^*$.*

PROOF OF PROPOSITION 1. The retailer solves the following problem to determine the prices, p_H, p_L, and the probability with which it will act opportunistically, β^*:

$$\max_{\beta, p_H, p_L} \beta X(p_H - w_L) + (1 - \beta)(p_L - w_L),$$

subject to

$$\gamma v - p_H \geq U^O_{HV}[\mu(w_L|p_H)], \qquad (IC_{HV})$$

$$v - p_L \geq U^O_{LV}[\mu(w_L|p_L)]. \qquad (IC_{LV})$$

At equilibrium these constraints must be binding. We can then solve for p_H and p_L as a function of β and substitute these functions in retailer's objective function and maximize the reduced form profit function with respect to β. The necessary first-order condition is quadratic in β, and hence yields two roots:

$$\beta_1 = \frac{-(1-\alpha)}{\alpha}\left[1 + \sqrt{\frac{\delta X}{s(1-\psi X)}}\right], \tag{A1}$$

$$\beta_2 = \frac{-(1-\alpha)}{\alpha}\left[1 - \sqrt{\frac{\delta X}{s(1-\psi X)}}\right]. \tag{A2}$$

The roots are real if $(1-\psi X) > 0$ or $\psi X < 1$. Only β_2 can be positive and satisfy the sufficient second-order condition for a local maximum.

$$SOC|_{\beta=\beta_1} = \frac{2\alpha[s(1-\psi X)]^{3/2}}{(1-\alpha)\sqrt{\delta X}}, \tag{A3}$$

$$SOC|_{\beta=\beta_2} = \frac{-2\alpha[s(1-\psi X)]^{3/2}}{(1-\alpha)\sqrt{\delta X}}. \tag{A4}$$

Consequently, p_H^* and p_L^* are obtained by substituting the value of β^* in these constraints. To ensure that the equilibrium values of prices and retail opportunism are in the admissible range we require that the following conditions hold:

C1. $p_H^*(\beta) \le \gamma\nu \Rightarrow \gamma\nu - \left(\psi s + w_L + \sqrt{\frac{\delta s(1-\psi X)}{X}}\right) \ge 0,$

C2. $p_L^*(\beta) \le \nu \Rightarrow \nu - s - w_L \ge 0,$

C3. $\beta^* \ge 0 \Rightarrow X \ge \frac{s}{(\delta + \psi s)},$

C4. $\beta^* \le 1 \Rightarrow X \le \frac{s}{[(1-\alpha)^2\delta + \psi s]}.$

Finally, to make this equilibrium managerially interesting, we require that the parameters be such that when the focal retailer charges regular price $[p_H^*(\beta)]$, the LV customers are not served by any other store. This is guaranteed if $U_{LV}^O(\mu_H) = \mu_H(\nu - w_L) - s \le 0$ so that the outside options of the LV customers conditional on observing regular price at the focal retailer is negative. This makes manufacturer intervention desirable.

C5. $U_{LV}^O(\mu_H) \le 0 \Rightarrow \left[1 + \frac{s}{(\nu - w_L - s)}\right]^2 \ge \frac{\delta X}{s(1-\psi X)}.$ □

Proposition 2.

Proof of Proposition 2. For a given manufacturer advertising intensity ϕ, the retailer solves the following problem to determine the prices, p_H, p_L, and the probability with which to act opportunistically, β^*:

$$\max_{\beta, p_H, p_L} (1-\phi)\beta X(p_H - w_L) + (1-\beta)(X+Y)(p_L - w_L),$$

subject to

$$\gamma\nu - p_H \ge U_{HV}^O[\mu(w_L|p_H, \phi)], \tag{IC$_{HV}$}$$

$$\nu - p_L \ge U_{LV}^O[\mu(w_L|p_L, \phi)]. \tag{IC$_{LV}$}$$

Again, at equilibrium these constraints must be binding. We use them to solve for p_H and p_L as a function of β and substitute these functions in retailer's objective function and maximize the reduced-form profit function with respect to β.

The necessary first-order condition is quadratic in β and hence, yields two roots:

$$\beta_1 = \frac{-(1-\alpha)}{\alpha(1-\phi)}\left[1 + \frac{\sqrt{(1-\phi)\delta X}}{\sqrt{s - (1-\phi)\psi s X}}\right], \tag{A5}$$

$$\beta_2 = \frac{-(1-\alpha)}{\alpha(1-\phi)}\left[1 - \frac{\sqrt{(1-\phi)\delta X}}{\sqrt{s - (1-\phi)\psi s X}}\right]. \tag{A6}$$

The roots are real if $[1 - (1-\phi)\psi X] > 0$ or $\psi X < 1$. Only β_2 is positive and can satisfy the sufficient second-order condition for a local maximum.

$$SOC|_{\beta=\beta_1} = \frac{2\alpha(1-\phi)[s - (1-\phi)\psi s X]^{3/2}}{(1-\alpha)\sqrt{\delta X(1-\phi)}} > 0, \tag{A7}$$

$$SOC|_{\beta=\beta_2} = \frac{-2\alpha(1-\phi)[s(1-\phi)\psi s X]^{3/2}}{(1-\alpha)\sqrt{\delta X(1-\phi)}} < 0. \tag{A8}$$

The optimal solution β^* is a function of ϕ and, as a result, the low cost store's expected profits from randomizing between high and low prices will be a function of ϕ as well. Consequently, $p_H^*(\phi)$ and $p_L^*(\phi)$ are obtained by substituting the value of $\beta^*(\phi)$. To ensure that the equilibrium values of prices and retail opportunism are in the admissible range, we require that the following conditions hold:

C1′. $p_H^*(\beta) \le \gamma\nu \Rightarrow \gamma\nu - \left(\psi s + w_L + \sqrt{\frac{\delta s[1-(1-\phi)\psi X]}{(1-\phi)X}}\right) \ge 0,$

C2′. $p_L^*(\beta) \le \nu \Rightarrow \nu - s - w_L \ge 0,$

C3′. $\beta^* \ge 0 \Rightarrow X \ge \frac{s}{(1-\phi)(\delta + \psi s)},$

C4′. $\beta^* \le 1 \Rightarrow X \le \frac{s(1-\alpha\phi)^2}{(1-\phi)[(1-\alpha)^2\delta + \psi s(1-\alpha\phi)^2]},$

C5′. $U_{LV}^O(\mu_H) \le 0 \Rightarrow \left[1 + \frac{s(1-\phi)}{(\nu - w_L - s)}\right]^2 \ge \frac{(1-\phi)\delta X}{s[1-(1-\phi)\psi X]}.$ □

Proposition 3. *The manufacturer can align the incentives of the retailer, eliminating its opportunistic behavior, by informing customers about ongoing promotions via advertising with intensity (reach) $\phi^* = 1 - [s/X(\delta + \psi s)]$*

Proof of Proposition 3. Substituting $\beta^*(\phi)$ in the expected profit function of the retailer, we get the reduced-form profit function. We denote the reduced-form expected profit function as $\Pi_r^*(\phi; w_L)$. The manufacturer's objective is to increase market coverage when the product is on promotion ($w = w_L$). This can be achieved by choosing a ϕ such that the low cost retailer finds it more profitable to charge p_L and serve the entire market (offer 100% pass through) rather than randomize between high and low prices (offer pass through of $1 - \beta^*(\phi)$). The retailer's profit from serving the entire market is s. Furthermore, if

$$\Pi_r^*(\phi; w_L) \le s, \tag{A9}$$

then the retailer will find it more profitable to serve the entire market rather than adopt a randomized strategy. The manufacturer can achieve total pass through by setting ϕ, such that Constraint (A9) holds with equality. This will make the retailer indifferent between adopting a randomized strategy and serving the entire market. Therefore, the manufacturer's optimal advertising intensity, ϕ^*, will be the solution to the following equation:

$$\Pi_r^*(\phi; w_L) = s. \tag{A10}$$

The optimal $\phi^* = 1 - [s/X(\delta + \psi s)]$ ensures that there is 100% pass through when the product is on promotion. ϕ^* is also the solution to equation $\beta^*(\phi) = 0$. □

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