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In this article, the authors use an economic model to show that it may be optimal to lower the retail price during a coupon event when marginal consumers have moderate hassle costs of coupon redemption. Results from the model offer predictions on the relationships among coupon redemptions, shelf price, and coupon face value. The authors test these predictions on a large data set of hundreds of coupon events across six packaged goods categories. The data show that when a small coupon face value is offered, the shelf price is likely to be reduced. They also find that coupon efficiency increases when there is a lower retail price. The results are of interest to managers planning a promotion calendar and deciding whether to coordinate price promotions with coupon events, and they contribute to economic theory. When a firm moves from uniform pricing (e.g., no coupons) to second-degree price discrimination (e.g., coupons), all consumers may face a lower price. This finding has public policy implications because second-degree price discrimination may increase the welfare of every consumer.

Coordinating Price Reductions and Coupon Events

An important issue for marketing managers is whether to coordinate price reductions with coupon events. Theories of targeted couponing (i.e., segmented pricing) argue that a monopolist should raise the shelf price during a coupon event to price discriminate optimally between high and low value consumers. This argument implies that a firm should never lower the price of and offer a coupon for a product in the same period. But consider the fall 2001 storewide sale at Carson Pirie Scott department store (see the Appendix, Figure A1). On October 14, 2001, the store placed a one-page newspaper advertisement that listed several price promotions or "sale" items. The same advertisement contained six coupons that offered an "extra 15% off any sale item" and emphasized in bold letters that the coupon would not be available in the store. Why would a firm simultaneously lower the retail price and offer a coupon? Furthermore, when and why is this strategy optimal?

Unlike targeted coupons, which are available to specific consumers, all consumers have access to the Carson Pirie Scott coupons.[1] In this article, we offer an economic rationale for why it may be optimal to lower the shelf price when coupons are available to all consumers. Furthermore, we show that this strategy is most likely to be optimal when marginal consumers have moderate hassle costs of redeeming coupons. Marginal consumers are those who debate about whether to pay full price or use a coupon. Hassle costs are critical because they affect the coupon face value and which consumers redeem the coupon.

The intuitive argument for combining coupons with price reductions is as follows: Consider a firm that wants to reach price-sensitive customers who currently do not buy and who are willing to pay $1 less than the shelf price. A $1 coupon may attract some of these customers but also may attract customers who are willing to pay full price. In the coupon literature, the term "leakage" (Farris and Quelch 1987) refers to this opportunity cost. One way the firm can reduce leakage is to reduce the face value of the coupon, which reduces the coupon benefits. However, a smaller coupon face value raises the net price (shelf price minus coupon) and may result in an opportunity cost of lost sales among the price-sensitive segment the firm is trying to reach. To

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[1]Offering coupons to all consumers is an example of called second-degree price discrimination. There also are two types of targeted price discrimination. First-degree or perfect price discrimination refers to the targeting of individual consumers, whereas third-degree price discrimination refers to the targeting of segments.

balance these opportunity costs (leakage and lost sales), the firm might combine a coupon with a lower price, as in the case of a $.50 coupon and a $.50 price reduction.

Hassle costs determine whether this strategy is optimal. If consumers have low hassle costs, coupons cannot be used to price discriminate and firms would choose not to issue a coupon. When coupons can be used to price discriminate, the hassle costs of consumers who decide whether to buy with or without a coupon is critical. If these marginal consumers have high hassle costs, coupons effectively segment the market (i.e., no leakage); the optimal strategy then is to raise the price when offering a coupon, which is analogous to targeted marketing. If marginal consumers have moderate hassle costs, controlling leakage is a concern. To control this opportunity cost, it may be optimal to decrease both the price and the coupon face value.

To test our model, we use a unique data set that contains hundreds of coupon events for six consumer packaged goods categories. We find that the retail price during a coupon event is positively related to the coupon face value. That is, when a brand issues a smaller coupon face value, the brand's retail price tends to be lower. In practice, managers often use the metric of coupon efficiency to evaluate the success of a coupon event. This metric is simply the ratio of incremental redemptions (new purchases) to total coupon redemptions for a coupon event (Leclerc and Little 1997). Our model predicts that the efficiency of a coupon event increases with a lower retail price, and we find support for this in the data.

Our investigation of coupons and price is part of a broader question about the degree of coordination among elements of the marketing mix. Managers at a leading packaged goods firm were unsure whether coupons and temporary price reductions (TPRs) should be coordinated. In contrast, the FSI Council (2001) claims that "using coupons and trade promotion does not have to be an either/or strategy. There is a synergistic effect of aligning coupons and trade promotion tactics together." Our research shows that benefits from coordinating price reductions and coupon events are more likely when marginal consumers have moderate hassle costs.

We also provide an important contribution to economic theories of price discrimination. It is natural to assume that when a firm price discriminates, some consumers are worse off because they face higher prices, which is always the case with targeted pricing. However, we find that this result does not always hold for second-degree price discrimination (i.e., when consumers self-select). In related work, Nevo and Wolfram (2002) consider optimal coupon policies for a monopolist and provide assumptions for the profit function, which may not always hold, such that it is optimal to raise prices during coupon events. In contrast, we explicitly model self-selection and derive conditions on consumer hassle costs for which a price reduction during a coupon event is optimal.

Our research shows that all prices may decrease with second-degree price discrimination, which also has implications for public policy. Social welfare must strictly increase if it is optimal for a firm to decrease all prices, which makes this a sufficient condition for increased welfare. Note that producer surplus must increase by construction (i.e., it is optimal to lower all prices), and consumer surplus must increase because every consumer faces a lower price. If the price of some offers increases while the price of others decreases, as must happen with targeted pricing, the change in welfare is ambiguous without further information about the quantity sold. Furthermore, it is costly for policymakers to measure and monitor both price paid and quantity sold. In contrast, whether a second-degree pricing mechanism leads to lower prices for all consumers is relatively easy to measure and monitor; by definition, all consumers face lower prices.

Vast literature in marketing shows that coupons may serve many purposes, such as consumer trial (Neslin and Clarke 1987), brand switching (Neslin 1990), maintenance and/or creation of brand loyalty (Tybout and Scott 1983), or increased category consumption (Ailawadi and Neslin 1998; Ward and Davis 1978). Much of this literature has focused on coupons as mechanisms to acquire incremental sales, which is defined as sales that would not have occurred in the absence of the coupon. According to this perspective, coupons are a means of price discrimination in which nonredeemers pay full price and coupon redeemers pay the net price.[2]

Evidence about whether coupons are effective at price discrimination is mixed. In the detergent category, Chiang (1995) finds that coupon users are less brand loyal. Similarly, Bawa and Shoemaker (1987) note that activist shoppers are less brand loyal and relatively coupon prone. These studies suggest that coupons attract less loyal consumers, as is consistent with economic theories of price discrimination. In contrast, Neslin (2002, p. 49) reports on several studies that find that brand-loyal consumers are disproportionately likely to be coupon redeemers. These studies raise questions about whether coupons are an effective means of price discrimination.

Although the empirical evidence is mixed, we focus on coupons as a means of price discrimination. Whether it is valuable to coordinate price reductions with coupon drops depends on the opportunity costs. Therefore, it is not surprising that the empirical evidence on synchronizing coupons and price is mixed. In the coffee category, Vilcassim and Wittink (1987) show that shelf price is greater among firms that offer coupons. In contrast, for breakfast cereals, Nevo and Wolfram (2002) show that shelf price is lower when coupons are offered. Our model contributes to this literature by delineating the conditions in which each may be optimal.

We organize our article as follows: In the next section, we present an example that illustrates the intuition for our model, which we then formalize in an economic model. We then develop hypotheses that we test using a large data set of coupon events. We conclude with a discussion of the limitations and managerial applications.

EXAMPLE

We identify three effects that a firm must trade off when determining its price and coupon strategy (see Table 1) and illustrate these effects with an example. We benchmark each effect relative to the case in which a firm does not price discriminate (uniform pricing). The first effect is the additional profit gained from consumers who purchase, either with or without a coupon, but who would not have purchased at the

[2]If coupons lead to increased consumer consumption of a brand, they also may be analogous to a nonlinear price scheme or price discrimination within a consumer.

Table 1
TRADE-OFFS THAT DETERMINE OPTIMAL COUPON AND PRICE STRATEGY

Effect	*Description*
New customer effect (positive)	Additional profits from customers who buy but would not purchase at the uniform price.
Trading down effect (negative)	Lost profits from customers who redeem a coupon but are willing to pay the noncoupon price.
Regular price effect (positive or negative)	Profit increase (or decrease) due to change in margin of noncoupon price.

uniform price (new customer effect).[3] This effect is a necessary condition for a firm to lower the shelf price when offering a coupon, because if sales volume is unchanged, it can never be optimal to lower the shelf price and offer a coupon. The second effect is the lost profit due to nonincremental coupon redemptions, which reflects the customers who redeem the coupon but would be willing to pay the noncoupon price (leakage costs, or trading down effect). The third effect is the change in profit of the noncoupon alternative; this effect may be either positive or negative (regular price effect). If the regular (noncoupon) price increases, the effect is positive; if the regular price decreases, it is negative. As we show next, a firm can adjust the price and coupon face value to balance these effects.

Consider a single firm that sells one product to the three segments of consumers shown in Table 2. The 600 customers in Segment A are willing to pay $21 for the product; in contrast, the 800 customers in Segment C are willing to pay just $12. We assume that the firm's marginal cost per unit is $5. Coupon hassle cost is the disutility from using a coupon, and the coupon face value must exceed this value for a customer to redeem a coupon. A customer who redeems a coupon is willing to pay, at most, the sum of his or her product valuation, hassle cost, and coupon face value. Thus, if the face value of a coupon is $10, a customer in Segment A is willing to pay at most $25 ($21 – $6 + $10) when redeeming the coupon (Scenarios 2 and 3).

Because we view coupons as a price-discrimination instrument, we emphasize their sorting role. Therefore, we assume that hassle costs are positively correlated with product valuations; customers with higher product valuations incur greater hassle costs. The effectiveness of coupons at sorting customers depends on the difference in hassle costs between these segments. In this example, the key segments are B and C. Customers in Segment C have lower product valuations and zero hassle costs. In Segment B, the hassle cost is $2 in Scenario 2 and $4 in Scenario 3. The example illustrates how varying the hassle cost of customers in Segment B affects whether it is optimal to raise or lower the price when offering a coupon.

We compute the optimal strategy for each scenario and report the results in Table 3. In Scenario 1, the firm does not offer a coupon, the optimal price is $17, and the firm sells to Segments A and B. Although Segment C is large, the opportunity cost of selling to it is too great with a single price strategy. In Scenarios 2 and 3, the firm offers a coupon, which makes it profitable to sell to Segment C. In Scenario 2, the optimal strategy is to offer a coupon with a large face value ($6) and a high price ($18), so both Segments B and C use the coupon (recall that the coupon value must exceed $6 for Segment A to redeem). In Scenario 3, the optimal strategy is to offer a coupon with a small face value ($4) and a low price ($16), in which case only Segment C uses the coupon. Relative to the control case of no coupon (i.e., Scenario 1), the price increases in Scenario 2 but decreases in Scenario 3.

Now consider the three effects in Table 1 that determine the optimal price and coupon strategy. The coupon may enable the firm to sell to new customers, as is captured by Segment C. The trading down effect is captured by Segment B in Scenario 2; these customers have a high willingness to pay but redeem a coupon. The regular price effect is the change in the price paid by non-coupon users and may be positive or negative. In Scenario 2, non-coupon users in Segment A pay a higher price ($18 versus $17), so the effect is positive. In Scenario 3, nonusers in Segments A and B

[3]If consumers can purchase multiple units, the new customer effect can include additional sales to the same consumers.

Table 2
PARAMETERS FOR EXAMPLE

Segment	*Product Valuation*	*Segment Size*	*Scenario 2: Coupon Hassle Cost*	*Scenario 3: Coupon Hassle Cost*
A	$21	600	$6	$6
B	$17	600	$2	$4
C	$12	800	$0	$0

Notes: In Scenario 1, no coupon is offered.

Table 3
OPTIMAL PRICES AND COUPON FACE VALUES

Scenario	*Optimal Price*	*Optimal Coupon Face Value*	*Profit*	*Total Units Sold*	*Coupon Units Sold*
1 No coupon	$17	n.a.	$14,400	1200	n.a.
2 Raise price	$18	$6	$17,600	2000	1,400
3 Lower price	$16	$4	$18,800	2000	800

Notes: n.a. = not applicable.

pay a lower price ($16 versus $17), so the effect is negative. The magnitude of these three effects appears in Table 4.

In Scenario 2, the trading down effect is large (–$3,000), but the profit gained on new customers and the increased noncoupon margin compensates for this loss. Eliminating leakage is prohibitively costly because Segment B's hassle cost is $2, which implies a maximum coupon of $2 for zero leakage; to attract Segment C, the firm must lower the price by $3, which results in an opportunity cost of $3,600. In Scenario 3, Segment B has a hassle cost of $4, and a coupon face value of $4 eliminates leakage. To attract Segment C, the firm lowers the price to $16 and incurs an opportunity cost of $1 on each consumer who buys without a coupon ($1,200 total).

This example demonstrates that it is possible for the optimal shelf price to either increase or decrease when a coupon is offered. Furthermore, we isolate the source of this effect to a change in consumer hassle costs. We also identify three effects that a firm trades off as it adjusts the coupon face value and retail price. In the next section, we formalize this example in an economic model.

MODEL

In this section, we describe our assumptions of firm and consumer behavior and then develop a model of coupons. To determine the optimal coupon strategy, we establish a benchmark for the optimal price when no coupon is offered. We then determine the optimal price and face value when a firm offers a coupon. Similar to our example in the preceding section, we show that the shelf price may decrease when a firm offers a coupon, which is likely when marginal consumers have moderate hassle costs.

Assumptions

Consider a single firm that sells one product with a marginal cost per unit equal to w. The firm sells to a unit mass of consumers of type $\theta \in (0, 1)$, where θ is uniformly distributed, $\theta \sim U(0, 1)$. We normalize the utility of not buying to zero (i.e., $\overline{U} = 0$). A consumer who purchases without a coupon has utility $U_N = \alpha + \theta q - p$, where p is the shelf price, and α and q are positive scalars. If the consumer uses a coupon, he or she has utility $U_C = U_N - H + c$, where H is the hassle cost of using a coupon with face value c. In our model, coupons price discriminate between customers with low and high willingness to pay (Gerstner and Hess 1991; Shaffer and Zhang 1995). We assume that the disutility from using a coupon is positively correlated with a customer's willingness to pay. A rationale for this assumption is that consumers with higher valuations have a greater opportunity cost of time, which increases their hassle costs (Blattberg et al. 1978; Narasimhan 1984). We assume that $H = 0$ for a fraction β of consumer types $\theta > X$ and for all consumer types $\theta \le X$; for all other consumers, $H = h$. If $\beta = 0$, hassle costs are perfectly correlated with valuations; if $\beta = 1$, all consumers have zero hassle costs, and coupons are not offered. The case in which $1 > \beta > 0$ corresponds to leakage and must be small for couponing to be profitable.

Under these assumptions, there are three relevant inequalities to consider. First, consumers for whom $U_N \ge 0$ are willing to purchase without a coupon. This inequality simplifies to $\theta \ge (p - \alpha)/q$, which we label P_N, or participation constraint with no coupon. Second, consumers for whom $U_C \ge 0$ are willing to purchase but require a coupon. This inequality simplifies to $\theta \ge (p - \alpha)/q - (c - H)/q$, which we label P_C, or participation constraint with coupon. Third, consumers prefer to purchase with a coupon, rather than without, if $U_C \ge U_N$, which simplifies to $c \ge H$, or the incentive compatibility condition (IC).

The IC constraint implies that only consumers for whom the face value exceeds the hassle cost prefer buying with a coupon. In our model, the largest hassle cost is h, and therefore the face value must be less than or equal to h. Consumers for whom H = 0 consider redeeming the coupon, and other consumers do not redeem coupons.

We offer two comments on our assumptions. First, an alternative formulation of our model assumes a correlation between price sensitivity and hassle costs, such that more price-sensitive customers receive more utility from coupons.[4] The results of this model are similar, and details are available from the authors. Second, inclusion of channel intermediaries, competition, and coupon redemption costs would make the model more similar to a real-world setting. However, this expansion also introduces new effects that make it difficult to isolate the contributions of this article. By focusing on a monopolist in a vertical channel, we demonstrate that the reason a firm may lower its shelf price and offer a coupon simultaneously is due to its desire to price discriminate optimally. In contrast, consider Corts (1998), who models competing firms that may target one another's loyal customers when they price discriminate. The reduction in retail prices in Corts's (1998) model is due to a competitive reaction. Shaffer and Zhang (1995) offer a similar finding and show that targeted couponing can be a prisoner's dilemma. Because adding a vertical channel to our model may introduce analogous effects, we purposefully construct a parsimonious theoretical model to isolate a new effect (Shugan 2002).

Analysis

When no coupon is offered, the probability that a type θ consumer buys at price p is as follows:

$$\text{(1)} \qquad \Pr\left(\theta > \frac{p - \alpha}{q}\right) = 1 - F\left(\frac{p - \alpha}{q}\right) = \left(1 - \frac{p - \alpha}{q}\right).$$

If there is a unit mass of customers, the firm's profit function is as follows:

$$\text{(2)} \qquad \pi = (p - w)\left(1 - \frac{p - \alpha}{q}\right).$$

The optimal price, p^{NC}, and optimal profit, π^{NC}, are

$$\text{(3)} \qquad p^{NC} = \frac{\alpha + q + w}{2}$$

[4]A model with heterogeneity in price sensitivity and identical hassle costs is also possible.

Table 4

SOURCES OF GAINS IN LOSSES WHEN COUPONING

Effect	*Scenario 2*	*Scenario 3*
New customer effect	$5,600	$5,600
Trading down effect	($3,000)	$0
Regular price effect	$600	($1,200)
Total change in profit	$3,200	$4,400

and

$$(4) \qquad \pi^{NC} = \frac{(\alpha + q - w)^2}{4q},$$

and consumers located at $\theta > (q + w - \alpha)/(2q)$ purchase one unit each.

If the firm offers a coupon, it must consider whether any consumers are willing to purchase with a coupon (P_C) and whether it is optimal to redeem a coupon (IC). The relationship between X and the non–coupon participation constraint (P_N) leads to two unique cases, provided $h < \tilde{h}$ (we define $\tilde{h}$ subsequently). We maintain this assumption in the theoretical analysis to ensure uniqueness.

Case 1. In this case, X is less than or equal to the participation constraint of non-coupon users: $X \le (p - \alpha)/q$. As we show in Figure 1, a fraction $(1 - \beta)$ of high value customers buy without a coupon. All customers who redeem a coupon have low hassle costs; some have moderate product valuations and are unwilling to pay full price, whereas others are willing to pay full price $(\theta \ge [p - \alpha]/q)$ but find the coupon offer more attractive. Customers with low hassle costs but low valuations do not buy.

Demand without a coupon is determined by $(1 - \beta)\Pr(\theta > [p - \alpha]/q)$, and demand with a coupon is determined by $\Pr([p - \alpha - c]/q < \theta \le X)$ and $\beta \Pr(\theta > X)$. The firm's constrained profit maximization problem is as follows:

$$(5) \qquad \max_{p,c} \pi^C(p, c) = (1-\beta)(p-w)\left(1 - \frac{p-\alpha}{q}\right) + (p - w - c)\left[\left(X - \frac{p - \alpha - c}{q}\right) + \beta(1 - X)\right]$$

$$\text{subject to } \frac{p - \alpha - c}{q} \ge 0,$$

$$\frac{p - \alpha}{q} - X \ge 0, \text{ and}$$

$$h - c \ge 0.$$

Case 1 has seven solutions, which are provided in the Appendix. Let $\tilde{h} = \min\{(1 - X)(1 - \beta)q/2, (-\alpha + w + q)/2, (\alpha - w)/2 + (X - \beta + \beta X)q/2, qX\}$. If $h < \tilde{h}$, the unique solution for Case 1 is as follows:

$$(6) \qquad c_1^* = h,$$

$$(7) \qquad p_1^C = \frac{w + \alpha}{2} + \frac{2h + q[1 + X(1 - \beta)]}{4 - 2\beta},$$

and

$$(8) \qquad \pi_1^C = \Big((1-\beta)^2[(qX + \alpha - w)^2 + 4qh(1 - X)] + (1 - \beta)\{2(\alpha - w)[q(1 + X) + (\alpha - w)] - 4h^2 + 2Xq^2\} + (\alpha - w + q)^2\Big)\Big/[4q(2 - \beta)].$$

The difference between the optimal price in Case 1 and the optimal price from the base case of no coupon offer is represented by the following:

$$(9) \qquad \Delta p_1 = p^{NC} - p_1^C = \frac{(1 - X)(1 - \beta)q - 2h}{4 - 2\beta}.$$

We note that $(1 - X)(1 - \beta)q/2 \ge \tilde{h} > h$ implies that $\Delta p_1 > 0$; therefore, the price in Case 1 decreases relative to the base case. The change in profit relative to the base case is

$$(10) \quad \Delta\pi_1 = \pi_1^C - \pi^{NC} = \Big\{(1 - \beta)[(qX + \alpha - w)^2 + 4qh(1 - X)] + [(\alpha - w)(2qX + \alpha - w) - q^2(1 - 2X) - 4h^2]\Big\}\left[\frac{(1 - \beta)}{4q(2 - \beta)}\right].$$

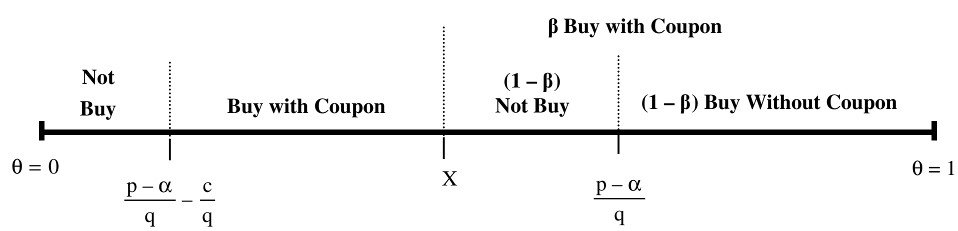
Taking the derivative of $\Delta\pi_1$ with respect to h, we can show that the change in profit reaches a maximum at $(1 - X)(1 - \beta)q/2 = h$. Furthermore, solving for $\Delta\pi_1(h) = 0$, we obtain two roots: $h = (1 - X)(1 - \beta)q/2 + \sqrt{\{(2 - \beta)[(qX + \alpha - w)^2 - \beta q^2(1 - X)^2]\}}/2$. The second-order condition of this function is negative, which implies that the function reaches a maximum, and therefore profits are greater when the firm offers a coupon, provided h is in this interval.

In our prior example, we discussed three effects that drive the change in profits. First, the firm may acquire new customers who are unwilling to pay p^{NC} but who purchase under the new offer: p_1^C and c_1^*. In Case 1, the firm offers both a lower price and a coupon and, unlike our prior example, attracts new customers because of both these effects. That is, some new customers buy at the promoted price but do not redeem a coupon. Other new customers purchase with the coupon but would not have purchased without a coupon. Therefore, the total new customer effect is as follows:

$$(11) \quad NCE = NewCustomerEffect = \left[\left(X - \frac{p_1^C - \alpha - h}{q}\right) + \beta\left(\frac{p^{NC} - \alpha}{q}\right) - X\right](p_1^C - w - h) + (1 - \beta)\Delta p_1 \frac{p_1^C - w}{q}.$$

Figure 1

CUSTOMERS WHO BUY WITH AND WITHOUT A COUPON (CASE 1)



The term in brackets reflects demand from customers who purchase with a coupon but would not purchase at the uniform price. The last term reflects customers who do not use a coupon but purchase because of the lower price.

Second, some customers who are willing to pay full price purchase with a coupon (trading down effect). Trading down occurs only when there is leakage and $1 > \beta > 0$. Margin is lost on these customers because of the coupon (h) and the price promotion (Δp_1). The complete trading down effect is as follows:

$$\text{(12)}\quad \text{TDE} = \text{TradingDownEffect} = -\beta\left[1 - \frac{(p^{NC} - \alpha)}{q}\right](\Delta p_1 + h).$$

Third, by offering a lower price than the noncoupon price, the firm incurs an opportunity cost (regular price effect). Only the $(1 - \beta)$ customers with high hassle costs buy without a coupon, and the lost margin is Δp_1, which explains the first and last terms in the following expression:

$$\text{(13)}\quad \text{RPE} = \text{RegularPriceEffect} = -(1-\beta)\left(1 - \frac{p^{NC} - \alpha}{q}\right)\Delta p_1.$$

The sum of these three effects, (NCE + TDE + RPE), equals $-\Delta\pi_1$.

Finally, our model enables us to calculate total coupon redemptions (R_1) and incremental coupon redemptions (Inc_1) for Case 1. These are as follows:

$$\text{(14)}\quad R_1 = \beta(1 - X) + X + \frac{h(1-\beta)}{q(2-\beta)} + \frac{(\alpha - w)}{2q} - \frac{1 + X(1-\beta)}{2(2-\beta)}, \text{ and}$$

$$\text{Inc}_1 = (1-\beta)\left[X + \frac{(\alpha - w)}{2q} + \frac{h}{q(2-\beta)} + \frac{(1 - \beta + X)}{2(2-\beta)}\right].$$

Case 2. In this case, X is greater than the participation constraint of non-coupon users: $X \geq (p - \alpha)/q$. As we show in Figure 2, among the high value customers, a fraction $(1 - \beta)$ with high hassle costs buys without a coupon. Among the low-hassle-cost customers who purchase with a coupon, some have low product valuations and would otherwise not purchase. However, the β high valuation customers and all customers for whom $(p - \alpha)/q \leq \theta \leq X$ are willing to pay full price but trade down to the lower priced coupon offer. Again, customers with low hassle costs but very low product valuations do not buy.

Demand with a coupon is determined by $\Pr[(p - \alpha - c)/q < \theta < X]$ and $(\beta)\Pr(\theta > X)$, whereas the demand without a coupon is determined by $(1 - \beta)\Pr(\theta > X)$. The firm's constrained profit maximization problem is as follows:

$$\text{(15)}\quad \max_{p,c} \pi^C(p,c) = (p - w)(1 - X)(1 - \beta) + (p - w - c)\left[X - \frac{p - \alpha - c}{q} + \beta(1 - X)\right]$$

subject to $(p - \alpha - c)/q \geq 0$,

$X - (p - \alpha)/q \geq 0$, and

$h - c \geq 0$.

We show in the Appendix that there are five feasible solutions to Equation 15. Two solutions are identical to Case 1 and are not feasible if hassle costs are small (i.e., $h < \tilde{h}$). Two other solutions are dominated by the following equilibrium, in which the market is not fully covered and the IC constraint is binding. The optimal coupon face value, price, and profits for this solution are as follows:

$$\text{(16)}\quad c_2^* = h,$$

$$\text{(17)}\quad p_2^C = \frac{(w + q + \alpha)}{2} + h,$$

and

$$\text{(18)}\quad \pi_2^C = \frac{(\alpha - w + q)^2}{4q} + h(1 - X)(1 - \beta).$$

The difference between the price in Case 2 and the price in the base case of no coupon offer is as follows:

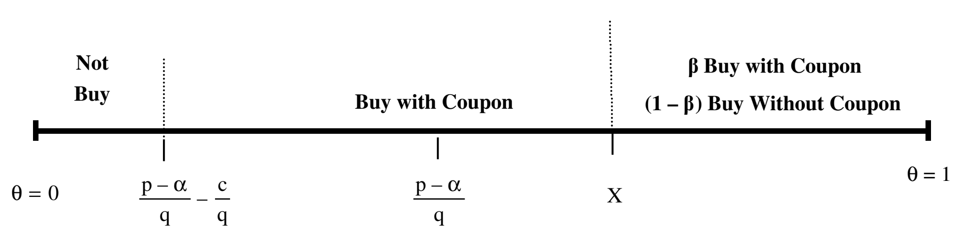
$$\text{(19)}\quad \Delta p_2 = p^{NC} - p_2^C = -h.$$

Because hassle costs are always positive, $\Delta p_2 < 0$, which implies that prices strictly increase for non-coupon users. Notice that coupon users' net price is $p^C - c$, which equals p^{NC}. Therefore, the number of customers buying is unchanged relative to the base case of not couponing. However, coupons enable the firm to charge premium prices to consumers with high valuations and high hassle costs. The profit increase relative to the base case is given by the following equation:

$$\text{(20)}\quad \Delta\pi_2 = \pi_2^C - \pi^{NC} = h(1 - X)(1 - \beta).$$

As hassle costs increase, the firm is able to increase the coupon face value and charge an even larger premium to

Figure 2
CUSTOMERS WHO BUY WITH AND WITHOUT A COUPON (CASE 2)



non-coupon users, which explains why the difference in profits increases in h. As the number of consumers with low hassle costs increases, fewer customers buy without a coupon at the premium price, and profits decrease.

In Case 2, there are no new customers, and therefore the new customer effect is zero. A fraction $\beta(1 - X)$ of customers is willing to pay the full price but redeem the coupon, and h is lost on each of these customers. Thus, the trading down effect is $-h\beta(1 - X)$. The increased margin on non-coupon users is h, and therefore the regular price effect is $+h(1 - X)$. The sum of these three effects equals $-\Delta\pi_2$. The total number of coupons redeemed in Case 2 is $R_2 = \beta + X(1 - \beta) + (\alpha - w - q)/(2q)$, and the total number of incremental coupons is 0.

To summarize, Case 1 and Case 2 are the unique solutions, given $h < \tilde{h}$, that demonstrate that the shelf price can either increase or decrease when a coupon is offered. We emphasize that it is possible for the price to decrease (or increase) for other model solutions; we provide additional details in the Appendix.

Results

In Case 1, the retail price is lower than the no coupon case, but in Case 2, the retail price increases relative to the no coupon case. Our first result identifies conditions with respect to hassle costs that ensure that retail price decreases when a coupon is offered.

Result 1. For an intermediate level of hassle costs ($\underline{h} < h < \bar{h}$), there exist parameters (β, X, α, q, and w), such that couponing is profitable and the price with couponing is less than the price without couponing; the bounds on h are as follows:

$$(21)\quad \underline{h} = \max \left\{ \frac{(1-X)(1-\beta)q}{2} - \frac{\sqrt{(2-\beta)[(qX+\alpha-w)^2 - \beta q^2(1-X)^2]}}{2}, \frac{(3X-1)q}{2} + (\alpha - w) + \frac{\beta(w-\alpha-qX)}{2} \right\}$$

$$\bar{h} = \min \left\{ \tilde{h}, \frac{q[1+X(1-\beta)] - (\alpha - w)(2-\beta)}{2(1-\beta)} \right\}.$$

Proof: By construction, the terms for $\underline{h}$ are determined by $\Delta\pi_1 > 0$ and the condition $(p_1^C - \alpha)/q \geq X$. The condition that eliminates Case 2, $(p_2^C - \alpha)/q > X$, is a subset of the condition that ensures that Case 1 exists. The terms for $\bar{h}$ are determined by $\tilde{h}$, which eliminates alternative solutions to Case 1, and $(p_1^C - \alpha - c)/q \geq 0$, which ensures that a demand constraint is not violated. At the parameter values ($\beta = .05$, X = .25, $\alpha = .7$, q = 1, and w = .5), the inequality is satisfied for $h \in [.065, .21]$. Q.E.D.

Result 1 shows that price may decrease when a firm offers a coupon and when marginal consumers have moderate coupon hassle costs. The decline of the regular price when a coupon is offered is surprising and stands in stark contrast to targeted pricing (i.e., some consumers face higher prices, and others face lower prices).[5] If Result 1 holds, all consumers and the firm benefit from price discrimination.

The result shows that h must have an intermediate value for prices to decrease; two extreme cases help illustrate this intuition. When h is low (near zero), coupons do not effectively sort high and low value customers and so cannot be used to price discriminate. When h is high, the firm can offer a large coupon and reach customers with a low willingness to pay. However, the coupon attracts too many low value customers, and the optimal strategy is to raise the price. This strategy, which is analogous to targeted pricing, excludes some low value customers and increases the profit margin on all customers. When h is moderate, a smaller coupon can be offered, but the firm may want to attract more customers who have a low willingness to pay. To reach these customers, the firm lowers the price, which attracts new customers at the expense of lost margins on existing customers. To link this back to the "Example" section, we recognize that h in our analytical model is analogous to the hassle cost of the marginal consumer. In Scenario 2, the marginal consumer who does not redeem a coupon has a hassle cost of $6, and the results parallel targeted pricing (high price, high coupon face value). In Scenario 3, the marginal consumer has a hassle cost of $4, and a low price/low coupon face value is optimal.

A numerical example further clarifies Result 1. At the parameter values in the proof of Result 1, $p^{NC} = 1.10$, demand is $q(p^{NC}) = .60$, and X = .25. All consumers for whom $\theta < .40$ do not purchase, and X is significantly less than this value. To sell to customers with low hassle costs ($\theta < X$), the net retail price (after a coupon) must be considerably lower than 1.10. The firm can reach this segment of low valuation customers through a combination of a lower price and a coupon. For example, if h = .15, at the parameter values in the proof of Result 1, the new customer effect is +.09. Because β is small, there is little loss in profits because of the trading down effect (–.01). Finally, the retail price decreases to .99, which results in a regular price effect of –.06. Thus, the intuition behind Result 1 is that by offering both a lower price and a coupon, the firm can profitably sell to new customers who have low product valuations if the additional profits on these customers compensate for the opportunity costs incurred.

Result 2. (a) The price is weakly increasing in h, X, and β; (b) total redemptions and incremental redemptions are weakly increasing in h and X and are decreasing in the price.

Proof: See the Appendix.

As hassle costs increase, the firm offers a larger coupon face value, which increases coupon redeemers' willingness to pay. The optimal response to this demand shift is to raise price, which leads to a positive relationship between coupon face value and price.[6] We also find that as X increases, the product valuation of the marginal consumer who redeems a coupon also increases, which enables the firm to increase the price. Both h and X shift demand, which explains why prices increase. Finally, leakage costs (β) are purely dissipa-

[5]Provided the profit function is concave, this difference is always true. Nahata, Ostaszewski, and Sahoo (1990) show that if the profit function is not concave, all prices can decrease.

[6]We thank an anonymous reviewer for pointing out that this effect also holds in a manufacturer–retailer channel. Coupons create incremental sales for a retailer (demand shift), which creates an incentive to raise the retail price. For example, if a manufacturer offers a trade deal with a coupon, the retailer may pass through less of the trade deal.

tive and discourage all forms of couponing. Firms respond to increased leakage by raising the price, which raises the margin on coupon sales and reduces the cost of trading down.

Total redemptions increase in h because the firm offers a larger coupon. As X increases, there are more consumers with zero hassle cost, which increases the total redemptions. Holding face value constant, a price increase reduces purchases both with and without a coupon. The comparative statics on incremental redemptions are only relevant in Case 1, because in Case 2 incremental redemptions are always zero. In Case 1, an increase in h raises the coupon face value, which attracts customers with a lower willingness to pay. Because the value of X is less than $(p_1^C - \alpha)/q$ and $p_1^C < p^{NC}$, an increase in X attracts incremental coupon buyers who would not purchase at p^{NC}.

EMPIRICAL IMPLICATIONS AND TEST

Our model demonstrates that it can be optimal to lower the shelf price when a coupon is offered and that this combination is more likely when marginal consumers have moderate hassle costs. Our model also offers comparative static predictions for the relationship among price, coupon face value, and coupon redemptions. In this section, we use a large database of hundreds of manufacturer coupon events to test the model predictions.

As we discussed previously, our parsimonious model abstracts from a vertical channel and competition to isolate a new effect. The empirical test may introduce additional real-world phenomena that are not part of our model. If this introduces competing effects that countervail, we are less likely to find support for our model, which suggests that our empirical test is conservative. Alternatively, if it introduces effects that are confounded with our predictions, support for our model should be interpreted cautiously. In summary, our empirical approach is to test for consistency between our model and the data to determine whether there is preliminary support for our model.

Hypotheses

Result 1 demonstrates that it is possible for the price to decrease when a firm offers a coupon and that this is more likely when hassle costs are moderate. When hassle costs are low, a firm is likely not to offer a coupon; for high hassle costs, a firm is likely to raise the price when a coupon is offered. Thus, we expect to observe coupons only at moderate and high values of hassle cost. We cannot observe hassle costs directly, but in equilibrium they are equal to the coupon face value. We use this variable as a proxy. To determine whether a price increases or decreases when a coupon is offered, we benchmark the price relative to prices in noncoupon periods (i.e., before the coupon event). Combining these insights and Result 1 leads to our first hypothesis.

> H_1: As a coupon face value increases (decreases), the price during a coupon period increases (decreases) relative to the noncoupon price.

On the basis of our comparative static results, we develop two more hypotheses. Result 2a predicts a relationship between the price offered during a coupon period and the hassle cost h. Therefore,

> H_2: As a coupon face value increases (decreases), the price during a coupon period increases (decreases) relative to other coupon prices.

H_2 follows from Result 2a and c = h. Note that the difference between H_1 and H_2 is the benchmark for a price change. In H_1, we measure the price change relative to the noncoupon price, but in H_2, we measure the price change relative to other prices when coupons are offered.

Our final hypothesis is based on the observation that, in practice, firms evaluate the effectiveness of a coupon event by comparing the number of incremental coupon redemptions with the number of total coupon redemptions. Incremental coupon redemptions represent customers who redeem a coupon but who would otherwise not have purchased. The ratio of these metrics is referred to as the efficiency of a coupon event, defined as follows:

$$(22) \qquad \text{Efficiency} = \frac{\text{incremental coupon redemptions}}{\text{total coupon redemptions}}.$$

This is a standard metric that Information Resources Inc. (IRI) uses to evaluate coupon events in the packaged goods industry, and it has been used in previous academic studies (Leclerc and Little 1997). Using Result 2b, we derive the following prediction about the relationship between efficiency and price:[7]

> H_3: The efficiency of a coupon event weakly increases (decreases) as the price during the coupon period decreases (increases).

In H_3, a price increase decreases efficiency because the change in total coupon redemptions is due to the loss of incremental consumers. A price increase causes some consumers with low product valuations and low hassle cost to not purchase, but leakage is unchanged because the high value/low-hassle-cost consumers continue to redeem coupons.

Empirical Test

To test these hypotheses, we collected a data set with eight packaged goods categories and more than 400 freestanding insert (FSI) coupons. Although targeted coupons, such as those offered by the retail check-out coupon distributor Catalina, are gaining in popularity, more than 81% of all package goods coupons are distributed by FSIs (NCH 2000). We analyzed each coupon in our database using a commercial service, CouponScan of IRI, and the efficiency metric is an output of this analysis. In conversations with a manager at Valassis, a company that distributes FSI coupons, we learned that manufacturers typically offer identical coupons in multiple markets (i.e., a national coupon event). Managers are interested in the overall efficiency of a coupon; thus, the efficiency metric reported by IRI is for a national coupon event (for a brief discussion, see Little 1994). The data set also contained the face value of the coupon issued and the fuse length of each coupon event (Leclerc and Little 1997). We also obtained physical copies of each of the coupons, and we used them to verify the coupon face value and record the coupon expiration date, brand, and applicable package size of each coupon.

We were not given any information about the average price during a coupon event. However, each coupon was offered between March 19, 1989, and February 20, 1994, which overlaps with data available from the University of Chicago's Dominick's database (http://gsbwww.uchicago.

[7]We can show that the relationship between efficiency and price holds for all undominated solutions in our model. A proof is available on request.

edu/research/mkt/Databases/Databases.html). Because Chicago is one of the markets used by IRI for CouponScan, we use this as a proxy for price during the national coupon event. Because our price metric is informative but noisy, it is less likely that we will find any effect for this variable.

We merged this database with our coupon database to collect price information before and during the coupon period. Some observations from the original coupon database were lost from two nonoverlapping categories (dog food and butter are not in the Dominick's data) and nonoverlapping time periods. We also dropped coupon events for which we had only one observation for a brand, because we include brand fixed effects in our models. After merging the databases, we were left with a total of 6 categories (analgesics, cereal, cookies, crackers, juice, and soap), 68 different brands, and 222 coupon events. To compute a brand price from Universal Product Code (UPC) prices, we weighted each UPC price by within-brand market share. For the UPC market shares, we used static, long-term share over the entire sample.

Our data set contains the following variables: $\text{PriceRatio}_{i,t}$, or $\text{PriceCoupon}_{i,t}$ divided by $\text{PriceNoCoupon}_{i,t}$; $\text{PriceCoupon}_{i,t}$, or the average price for brand i during coupon event t; $\text{PriceNoCoupon}_{i,t}$, or the average price for brand i ten weeks before coupon event t; $\text{efficiency}_{i,t}$, or the incremental redemptions divided by the total redemptions for brand i and coupon event t; $\text{FaceValue}_{i,t}$, or the face value of brand i and coupon event t; and $\text{Fuse}_{i,t}$, or the fuse length for brand i and coupon event t.

To determine the coupon price ($\text{PriceCoupon}_{i,t}$), we used the average price during the entire coupon event. For the price during noncoupon periods ($\text{PriceNoCoupon}_{i,t}$), we used the average price ten weeks before the coupon event. When constructing this variable, we did not have a full ten weeks of price data for 23 coupon events. For these observations, we used data after the coupon event to construct the variable. $\text{PriceRatio}_{i,t}$ is the ratio of these variables. We provide summary statistics for these variables in Table 5.

To test the hypotheses, we estimated three models with brand fixed effects, which implies that the parameter estimates are based on within-brand variation. There is within-brand variation in face value for 44 brands and 154 coupon events.[8] For the 44 brands, we computed the maximum face value minus the minimum face value for each brand. The average of this variable is \$.40, which indicates that there is a large amount of within-brand variation in face value. Coupons often include size restrictions (e.g., "12 count not included") and multiple-unit requirements (e.g., "buy two"), but neither affects our analysis. We find minimal within-brand variation in size restrictions, and therefore brand intercepts control for this effect. Including a dummy variable that identifies multiple-unit coupons does not affect our model results. Therefore, we do not include additional control variables for either size restrictions or multiple-unit requirements. Our final model specifications are as follows:

$$\text{(23)} \quad \text{Model 1: } \ln(\text{PriceRatio}_{i,t}) = \theta_1 \ln(\text{FaceValue}_{i,t}) + \theta_2 \ln(\text{Fuse}_{i,t}) + \sum_{i=1} \alpha_i \text{Brand}_i + \varepsilon_{i,t}.$$

$$\text{(24)} \quad \text{Model 2: } \ln(\text{PriceCoupon}_{i,t}) = \gamma_1 \ln(\text{FaceValue}_{i,t}) + \gamma_2 \ln(\text{Fuse}_{i,t}) + \sum_{i=1} \alpha_i \text{Brand}_i + \varepsilon_{i,t}.$$

$$\text{(25)} \quad \text{Model 3: } \ln\left(\frac{\text{efficiency}_{i,t}}{1-\text{efficiency}_{i,t}}\right) = \beta_1 \ln(\text{Price}_{i,t}) + \beta_2 \ln(\text{FaceValue}_{i,t}) + \beta_3 \ln(\text{Fuse}_{i,t}) + \sum_{i=1} \alpha_i \text{Brand}_i + \varepsilon_{i,t}.$$

Our specification of Model 3 is analogous to Leclerc and Little's (1997). We report the ordinary least square results for each model with White's standard errors in Table 6.

In Model 1, our theory predicts that $\theta_1 > 0$, which implies that when a small coupon face value for a brand is offered, the shelf price of the brand is likely to be reduced. The empirical result is consistent with our prediction because the coefficient of the face value is positive and significant ($p < .10$). This finding shows that prices are lower when the face value is small but does not immediately imply that prices are below the regular price. For example, all prices may increase during a coupon event, but the increase may be proportional to the face value. However, the summary statistics in Table 5 and the predicted values in Model 1 suggest that prices are below the regular price. Except for cookies, the price during a coupon event decreases relative to the previous price (Table 5). In Model 1, the predicted price ratio is .96 (4% decrease) for a \$.35 coupon (25th percentile).[9] If coupon face values are small, the price tends to be lower than the precoupon price.

[8]When we ran our models with only these 154 observations, the results were similar.

[9]We use a 12-week fuse length (50th percentile) and the average brand intercept (–.12) in this computation.

Table 5
SUMMARY STATISTICS

					Average Price/Unit		
Category	*Coupon Events*	*Number of Brands*	*Average Face Value*	*Average Efficiency*	*Before Coupon*	*During Coupon*	*Price Ratio*
Analgesics	38	9	.52	.28	.039	.039	1.00
Cereal	64	26	.62	.60	.160	.158	.98
Cookies	16	3	.42	.47	.131	.132	1.01
Crackers	21	7	.38	.49	.132	.130	.99
Juice	38	10	.38	.46	.039	.037	.95
Soap	45	13	.41	.55	.104	.103	.99
Total	222	68	.48	.49	.103	.101	.99

Notes: The price of analgesics is per tablet; other categories are price per ounce.

Table 6

MODEL RESULTS

	Model 1: Price Ratio Model	*Model 2: Price Model*	*Model 3: Efficiency Model*
ln(PriceCoupon)			–1.44 (.46)
ln(FaceValue)	.047 (.026)	.064 (.036)	.47 (.25)
ln(Fuse)	.053 (.017)	.042 (.020)	–.017 (.21)
Fixed Effects	Brand fixed effects	Brand fixed effects	Brand fixed effects
Adjusted R^2	.67	.95	.30
Observations	222	222	222

In Model 2, our theory predicts that $\gamma_1 > 0$, which implies that the price during a coupon period increases when the coupon face value increases. We find support for this prediction because the coefficient of FaceValue is positive and significant ($p < .10$). We illustrate the magnitude of the relationship between price and coupon face value in Model 2 with an example. If the coupon face value increases from $.25 to $.50, Model 2 predicts that the shelf price will increase 6%. If the retail price is $3.00, this implies a $.18 price increase. Together, Models 1 and 2 paint a consistent picture. When a low coupon face value is offered, the price during a coupon event is more likely to be low relative to both previous brand prices (Model 1) and other coupon prices for a brand (Model 2).

In Model 3, our theory that efficiency has a negative relationship with price, $\beta_1 < 0$, is supported ($p < .01$). In addition, we find that higher face values ($p < .10$) increase the efficiency of a promotion. To illustrate the effect size for price, we computed the impact of a 1% price cut, and we find that it increases efficiency by .74%. This effect varies by category and is greatest for analgesics (1.05%) and smallest for cereals (.58%). A manufacturer that plans a retail price cut of 10% should expect an increase in efficiency of 7.4%.

We reach three conclusions from our empirical analysis. First, if coupon face values are low, prices during a coupon event are more likely to decrease relative to noncoupon prices. Second, the brand price during a coupon event tends to be lower when a lower coupon face value is offered. Third, lowering the retail price and increasing the coupon face value increases coupon efficiency. These data add to our understanding of coupons and pricing in packaged goods and offer preliminary support for our model.

However, a limitation of our approach is that our empirical test does not discriminate among alternative theories. Manufacturers may coordinate coupons and trade deals for other reasons, such as the behavioral perception of receiving two deals: a price reduction and a coupon (Thaler 1985). In addition, detailed trade promotion data are needed to investigate theories of passthrough, which may confound our empirical results.

CONCLUSION

We show that when marginal consumers have moderate hassle costs, there may be benefits to firms offering lower prices during a coupon event. Moderate hassle costs require the firm to offer smaller coupon face values, which limits its ability to attract price-sensitive customers. However, the firm can attract these customers by lowering the price and offering a small coupon; this practice implies benefits from coordinating price reductions with coupon events. Our model predicts a positive relationship between coupon value and price and a negative relationship between coupon efficiency and price. We find support for these predictions using a large database of hundreds of coupons.

If it is optimal to lower the retail price when a coupon is offered, the implications for marketing managers differ depending on whether coupons are offered periodically or for every purchase occasion. When coupons are offered periodically, a lower retail price implies a TPR during a coupon event. For a manufacturer in the packed goods industry, trade allowances and coupon events should overlap in the promotion calendar. If coupons are originated by the retailer (e.g., Carson Pirie Scott), a coupon and price promotion should be offered at the same time. In contrast, when coupons are available on every purchase occasion, the model suggests that the retail price should be lower than the case of not offering any coupons. The model still implies synergies between coupons and a lower shelf price, but because the retail price is low in all periods, we do not interpret it as a price promotion.

Our results contribute to economic theory, because we show that when a monopolist moves from uniform pricing (e.g., no coupons) to second-degree price discrimination (e.g., coupons), all consumers may pay a lower price. Unlike other models (Corts 1998; Shaffer and Zhang 1995), we obtain this surprising result without competition and while maintaining standard assumptions about demand and profits. Our model illustrates that efficient price discrimination between high and low value customers can lead to lower prices for all consumers.

When our results are interpreted in the broader context of second-degree price discrimination, they have public policy implications. If it is optimal for firms to lower prices for all consumers, consumer welfare must increase under second-degree price discrimination. This result may be particularly relevant for natural monopolies that cannot increase competition (e.g., utilities). Our finding implies that offering a menu of pricing alternatives to consumers, such as various telephone calling plans, can reduce all prices and increase welfare. Again, policymakers must understand that it is possible, but by no means guaranteed, that prices will decrease.

Coordinating elements of the marketing mix is a challenging but critical task for marketing managers. Our theoretical model delineates when the coordination of price reductions with coupon offers is optimal. In addition, the empirical results offer preliminary support that retailer prices are lower when firms offer small coupons. For marketing managers, this is an important step toward better understanding potential synergies in the marketing mix.

APPENDIX

From the Kuhn–Tucker conditions for the constrained maximization problem in Equations 5 and 15, there are seven possible solutions for Case 1 and five possible solutions for Case 2. Four solutions in Case 2 are identical to Case 1, leaving eight possible solutions to the model. We provide the optimal price and coupon offers for these solutions in Table A1.

The assumption $h < \tilde{h}$ eliminates solutions 1–4 because $c > h$, and solutions 7 and 8 are dominated by solutions 5 and 6. For solution 6, the constraint $X \geq (p - \alpha)/q$ implies that $h \leq qX + (\alpha - w - q)/2$. Thus, solutions 5 and 6 are the unique solutions for $h < \tilde{h}$, and we focus our analysis on these cases. (Detailed analyses are available from the authors.)

Figure A1
CARSON PIRIE SCOTT EXAMPLE: PRICE PROMOTION AND STORE COUPON

Notes: The images were part of the same full-page newspaper advertisement for Carson Pirie Scott.

Table A1
OPTIMAL PRICES AND COUPON OFFERS

Solution Number	*Solution Holds in*	*c*	*p*
1	Case 1	$(1 - X)(1 - \beta)q/2$	p^{NC}
2	Case 1	$(-\alpha + w + q)/2$	p^{NC}
3	Cases 1 and 2	$(\alpha - w)/2 + (X - \beta + \beta X)q/2$	$qX + \alpha$
4	Cases 1 and 2	qX	$qX + \alpha$
5	Case 1	h	p_1^C
6	Case 2	h	$p^{NC} + h$
7	Cases 1 and 2	h	$\alpha + h$
8	Cases 1 and 2	h	$qX + \alpha$

Proof of Result 2

a. Algebra.
b. Using algebra, it is straightforward to derive the relationship among incremental redemptions, total redemptions, h, and X. Using the following definitions, we obtain the derivatives with respect to price in Case 1:

$$\text{(A1)} \quad R_1 = \text{CouponsRedeemed} = \beta(1 - X) + X + \frac{\alpha + c - p_1^C}{q}.$$

$$\text{Inc}_1 = \text{IncrementalCoupons} = X(1 - \beta) + \frac{\beta(p^{NC} - \alpha) + \alpha + c - p_1^C}{q}.$$

In Case 2, there is an analogous expression for R_2 and $\text{Inc}_2 = 0$.

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