Price Discrimination Through a Distribution Channel: Theory and Evidence

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Price-discrimination practices are common, but they typically are analyzed in a framework in which firms sell directly to end users (Louis Phlips, 1981; Richard Schmalensee, 1981; Hal Varian, 1985; Gerstner and Holthausen, 1986). This direct-channel framework is valid for service industries such as entertainment and travel, where senior citizens buy reduced-price tickets to musical concerts, and children receive discounts on airfares and movie-theater tickets. In the packaged-goods and durable-goods industries, however, manufacturers sell to retailers who sell to consumers. In indirect channels like these, price discrimination occurs when manufacturers target "pull" discounts[1] to price-conscious consumers in the form of coupons and rebates. Consumers who do not use these discounts pay higher net prices. Because manufacturers cannot dictate consumer prices to retailers, analysis of price discrimination ought to take into account the pricing behavior of retailers (Michael Katz, 1987; Gerstner and Hess, 1991). While some researchers have studied coupons as a means for price discrimination (William Levedahl, 1984; Chakravarthi Narasimhan, 1984), they have done so in a direct-channel context and have ignored the role of retailers or other middlemen in the pricing and couponing process.

In this paper we study price discrimination within a channel of distribution consisting of a single manufacturer and competitive retailers. In the model, the manufacturer price-discriminates using a pull discount targeted at consumers with low reservation prices to reduce the net price these consumers pay for the product. Some consumers with higher reservation prices, who self-select not to use the discount, pay the full retail price for the product. The manufacturer chooses the wholesale price for the firm's product and the size of the price-discriminating pull discount, taking as given the markup percentage used by retailers. Joint determination of the manufacturer discount and retail markup is also considered.

The paper's major finding is that a higher retail markup percentage influences the manufacturer to use price discrimination in a less intensive way (i.e., to reduce the size of the equilibrium pull discount as well as the wholesale price). The intuition behind this result is as follows. The greater the retail markup percentage, for a given wholesale price, the greater will be the retail price. The greater the retail price, the larger the pull discount will have to be to keep the low-reservation-price consumers in the market. But the manufacturer bears the entire cost of the discount, and a larger discount induces more nontargeted customers to use it. These two effects make price discrimination less profitable when markup percentage increases, so the manufacturer reduces its pull discount and in-

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[1]Manufacturers who distribute products through retailers use "push" or "pull" techniques to increase sales. Under push, manufacturers offer inducements to retailers. When consumers shop for the product, the retailer has an incentive to promote the brand, thus pushing it through to consumers. Under pull, manufacturers offer incentives such as coupons or rebates directly to consumers. The manufacturers hope that demand will be pulled through the channel by consumers asking retailers for the promoted brand.

stead emphasizes push by reducing the wholesale price.

The model is tested using data from ten different cities. The empirical results strongly support this theory of channel price discrimination and show that retail markup percentage is a powerful variable for explaining the observed variation in coupon values across different product categories. The analytic framework of the model is described next.

I. The Model

Manufacturer.—A profit-maximizing monopolist manufacturer distributes its product to consumers through retailers, taking the retail markup percentage as given. The manufacturer sets the wholesale price, P_w, and attempts to price-discriminate between consumer segments by targeting a pull discount, D, directly to consumers with low willingness to pay, as explained below. Production costs are irrelevant for the analysis and are assumed to be zero.

Competitive Retailers.—Retailers distribute the product to consumers in competition with each other. For simplicity, we assume that all retailers use the same competitive retail markup percentage. The way in which this markup is determined is not critical for our purposes. One possibility is that many identical retailers compete in a Bertrand fashion (Joseph Bertrand, 1883) until profits are driven to zero, resulting in identical markups. Regardless of its determination, let m denote the common retail markup percentage and let P_r be the resulting retail price. The relationship between the retail and wholesale price is

$$P_r = P_w + mP_w. \tag{1}$$

Consumers.—There are two consumer segments, one with high and the other with low willingness to pay for one unit of the product (Highs and Lows, for short). Specifically, Highs are customers willing to pay a high reservation price, V_H, for the product. Lows are willing to pay V_L, which is below V_H. Each consumer will purchase either one or zero units of the product during the period under study. The size of the market is scaled to 1.0, and α and $1-\alpha$ denote the segment sizes of the Highs and Lows, respectively.

Price Discrimination.—The manufacturer can price-discriminate by targeting a pull discount to the Lows. Because the discount is targeted to the Lows, we assume that they can use the discount at no cost. Highs may take advantage of the discount, but they incur a transaction cost when doing so. Such differential transaction costs are achieved through distribution in selective geographical areas, media, or shopping locations, or because Highs have higher time costs for the activities required to take advantage of the discount. The incentive for price discrimination holds even if transaction costs for the Lows are positive as long as they are lower than those of the Highs.

All Lows will use the discount because their transaction costs of doing so are zero, but a High may or may not use the discount depending on transaction costs. Let T denote a High's transaction costs. We assume that T is distributed randomly across the population of Highs, letting $F(t)$ and $f(t)$ be the corresponding cumulative and density functions. A High customer takes advantage of the discount if his transaction cost does not exceed the discount, $T \leq D$. The proportion of Highs who use the discount is given by

$$\int_0^D f(t)\,dt = F(D). \tag{2}$$

This completes the description of the model. The equilibrium price-discriminating pull discount and retail markup percentage are derived next.

II. The Price-Discrimination Rule

To maximize its profit, the manufacturer adjusts wholesale price, P_w, and pull discount, D, taking the retailers' markup percentage, m, as given. Under price discrimination there are two relevant prices for customers: the retail price, P_r, and the retail price less discount, $P_r - D$. If the product is sold only to Highs, the most profitable retail price from the manufacturer's point of view is the Highs' reservation value, V_H. To reach the rest of the market, however, the retail price less the discount must equal the Lows' willingness to pay; that is, $P_r - D = V_L$. Combining this condition with equation (1) gives the retail and wholesale prices needed to induce all customers to buy when a discount of D is given:

$$(3) \qquad P_r = P_w + mP_w = V_L + D$$

$$(4) \qquad P_w = (V_L + D)/(1+m).$$

Equation (4) allows us to express the manufacturer's profit as a function of the discount, D, assuming that the wholesale price is adjusted according to this equation. When (3) holds, all customers buy the product, and the contribution to the manufacturer's revenue is $(V_L + D)/(1+m)$. The coupon usage is $\alpha F(D)$ for Highs and $1-\alpha$ for Lows (all Lows take advantage of the discount), so the total discount cost borne by the manufacturer equals $[\alpha F(D)+1-\alpha]D$. The resulting manufacturer's profit is

$$(5) \qquad \pi = (V_L + D)/(1+m) - [\alpha F(D) + 1 - \alpha]D.$$

There are costs and benefits to increasing the intensity of price discrimination. For every High who takes advantage of the discount rather than paying the full retail price, profit is reduced by D. As the discount, D, increases, more and more of the Highs use the discount. On the other hand, a higher D allows a higher retail price, and a proportion of the increase contributes to the manufacturer's profit. The optimal discount is derived by maximizing (5) with respect to D. If there is an interior solution, it must satisfy the following first-order condition:

$$(6) \qquad \frac{\partial \pi}{\partial D} = \frac{1}{1+m} - [(1-\alpha) + \alpha F(D)] - \alpha f(D)D = 0.$$

The optimal discount is implicitly defined by condition (6). Applying the implicit-function rule to (6) gives

$$(7) \qquad \frac{\partial D}{\partial m} = \frac{-1/(1+m)^2}{2\alpha f(D) + \alpha f'(D)D}$$

which is negative assuming the second-order condition holds. Expression (7) gives the manufacturer's price-discrimination rule, which can be stated as follows:

Price Discrimination Rule: The larger the retail markup percentage, the smaller will be the manufacturer's price-discriminating pull discount.

When retail markup percentage is larger, the optimal price discrimination is less intense for the following two reasons. First, the wholesale price is amplified by the larger markup percentage into a higher retail price, so to price-discriminate successfully the manufacturer must offer a larger pull discount to keep the Low segment in the market. Second, the resulting larger discount induces more nontargeted Highs to use it. These two effects make price discrimination less profitable for a larger markup percentage.

In the next section we test the price discrimination rule with cross-sectional data on manufacturer coupon values and supermarket markup percentages.

III. Empirical Evidence: Manufacturer Coupons and Supermarket Markups

According to Nielsen Clearing House Promotional Services (1993), over 300 billion manufacturer cents-off coupons were distributed in 1992, of which close to eight billion with a total value of about \$4.5 billion were redeemed.[2] Most of these (roughly 80 percent) were distributed through free-standing newspaper inserts. The most com-

[2]Manufacturers pay retailers the face value for each coupon redeemed.

mon product categories for which coupons are distributed are cereal and breakfast food; health and beauty aids; candy and gum; and pet food. Coupon values vary significantly from product to product, as illustrated in Figure 1. This figure shows the distribution of coupon values in free-standing inserts collected in three separate samples taken between April 1990 and October 1991 in ten different cities. The data closely resemble coupon values distributed nationally.

An empirical manufacturer coupon equation is implied by equation (6). Ideally the empirical equation explaining coupon value should include as explanatory variables retail markup percentage, the proportion of Highs in the market, parameters of the distribution of transaction costs, and retail price.[3] Unfortunately, measures of the proportion of Highs and parameters of the transaction-cost distribution are not observable. The data that are available are described next.

Data.—A large number of manufacturer cents-off coupons were collected during three different time periods along with matching retail markup percentages and other variables, as follows:

Coupon values: Coupons were collected from free-standing inserts in the Sunday newspapers of ten cities during the periods shown in Table 1. One sample of 427 coupons was collected in Raleigh, North Carolina, a second sample of 475 coupons involved ten cities across the United States, and a third sample of 211 coupons came from Boston, Massachusetts. During data-collection periods, all cents-off coupons were clipped and their dollar face values recorded.

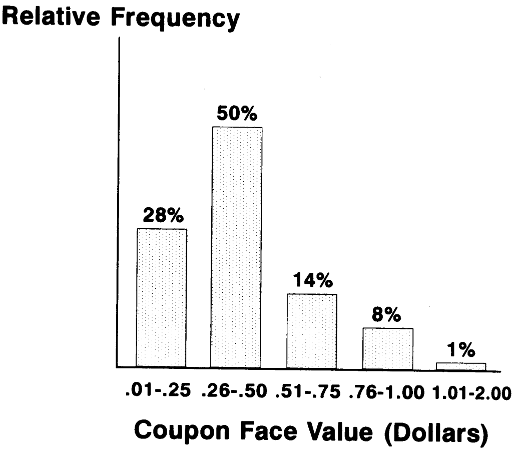

FIGURE 1. HISTOGRAM OF COUPON VALUES

Retail markup percentages: Gross margin percentages for over 300 grocery product categories are reported in *Supermarket Business*'s Annual Consumer Expenditures Studies (1990, 1991). Gross margin percentage, M, is the percentage of retail price earned by the retailer above wholesale price; $M = (P_r - P_w)/P_r$. Retail markup percentages, m, were calculated from the corresponding gross margin percentages as $m = M/(1 - M)$. One would expect some variation of brands' markup percentages within a product category, but because brand-specific markup percentages were not available, the retail markup percentage for each brand was approximated by the average retail markup percentage for its product category.

Retail prices: For the Raleigh sample, each product was priced at the two major supermarkets in the city, and average prices were calculated. For the Boston sample, products were priced in the largest supermarket chain in the city. For the ten cities, prices of the couponed brands were recorded in Raleigh to establish relative

[3]There are two theoretical reasons for entering retail price in the manufacturer-coupon equation. First, in the case of a corner solution to the manufacturer's optimization problem (5), the optimal discount is $V_H - V_L$, which implies a retail price of V_H. In this situation, an increase in V_H induces increases in both the discount and the retail price simultaneously. Therefore, there would be a positive association between retail price and coupon value, where retail price is a proxy for willingness to pay. The second reason follows from a less parsimonious model in which the low-value customers also have transaction costs. In this case, retail price shows up in the first-order condition analogous to (6), and the optimal discount is therefore a function of retail price.

TABLE 1—SUMMARY STATISTICS

	Means				Pooled sample		
Variable	Raleigh	10 Cities	Boston	Pooled	Standard deviation	Maximum	Minimum
Coupon value	0.41	0.49	0.50	0.46	0.25	2.00	0.10
Markup percentage	26.7	27.0	29.7	27.4	9.79	69.8	6.16
Retail price	2.20	2.76	3.16	2.62	1.55	16.19	0.30
New product	0.05	0.02	0.10	0.05	0.21	1.00	0.00

Notes: Total number of observations = 1,113: 427 coupons were collected in Raleigh, NC from February to April 1990; 475 coupons were collected in Baltimore, Boston, Chicago, Dallas, Houston, Kansas City, Knoxville, Raleigh, Sacramento, and Washington, DC in September 1991, 211 coupons were collected in Boston in October 1991.

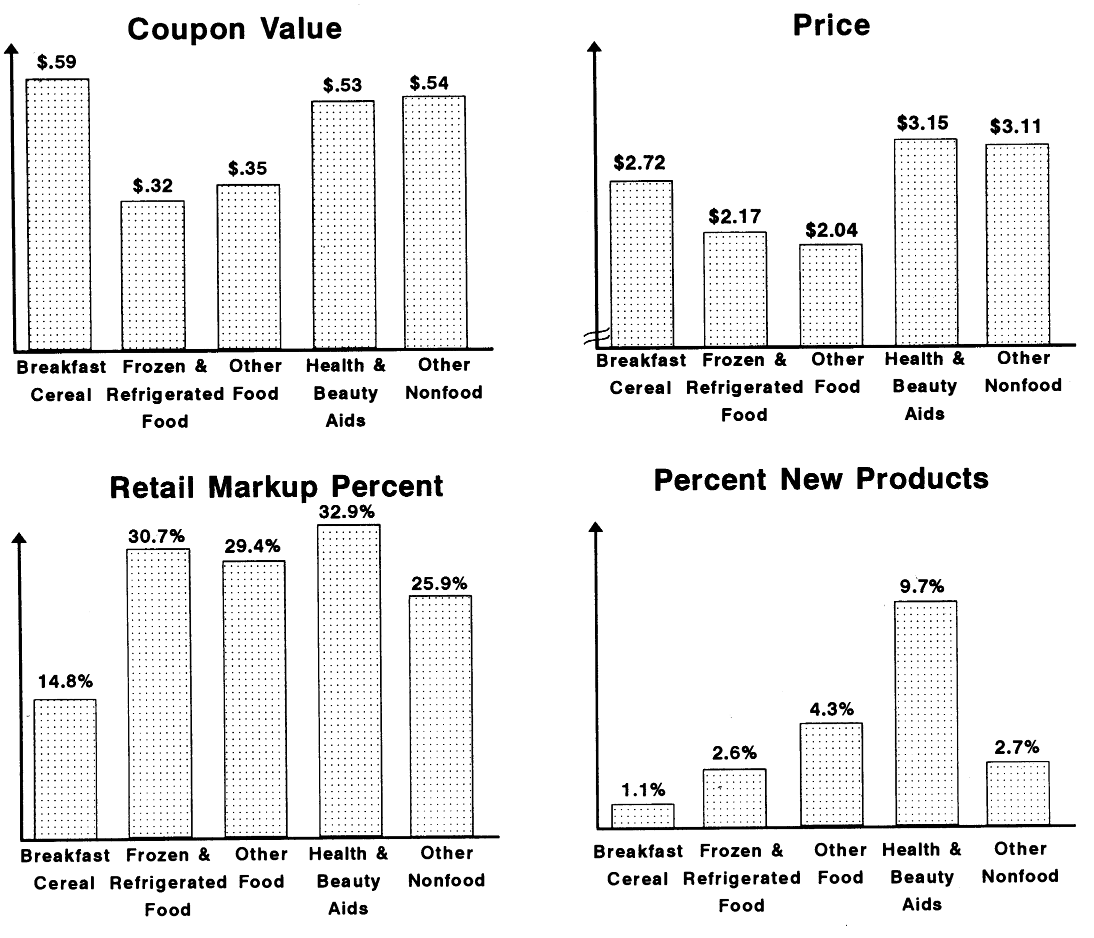

FIGURE 2. AVERAGE VALUES BY PRODUCT CATEGORY

prices and then adjusted to reflect the price level of the other cities using the foods-at-home component of the Consumer Price Index. When a coupon was valid for multiple sizes, the price of the smallest size was recorded.

New products: Consumers take a risk when trying new products, so a larger coupon may be needed to persuade them to buy. Although the theory does not formally specify the effect a new product has on coupon value, we decided to use a dummy variable to classify new-product coupons; the variable equals 1 for a new product and 0 otherwise. New products were those identified as such on the coupon or in the advertisement accompanying the coupon in the free-standing insert.

Mean values for each variable in each sample are given in Table 1 along with other summary statistics for the pooled sample. Some additional information about the data set is given in Figure 2 which shows the mean value of each variable by type of product. Coupons for breakfast cereals make up 16 percent of the sample, those for frozen and refrigerated foods account for 17 percent, other foods account for 25 percent, health and beauty aids account for 22 percent, and coupons for all other products make up the remaining 20 percent.

IV. Empirical Results

The price-discrimination rule predicts that less-valuable manufacturer coupons will be issued for products with larger retail markup percentages. As a visual demonstration of this rule, consider Figure 3, which plots average markup percentages by coupon values. The figure shows a strong inverse relationship between coupon value and markup percentage, as predicted. Of course, this figure does not control for price or other variables that may influence coupon values.

More generally, equation (6) describes the determination of manufacturer pull discount (coupon value). Because the relationship between coupon value and markup percentage is nonlinear in equation (6), a

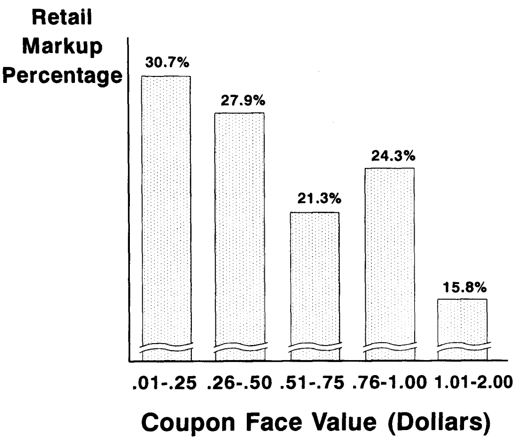

FIGURE 3. COUPON VALUE VERSUS MARKUP PERCENTAGE

loglinear model seems reasonable for the empirical specification (except for the new product dummy variable); other specifications give similar results. The equation to be estimated is

$$\log(\text{Coupon}) = a + b_1 \log(\text{Markup}) + b_2 \log(\text{Price}) + b_3 \text{New} + u \tag{8}$$

where u is the residual error term. Initially, ordinary least-squares analysis was used to estimate the coefficients in equation (8). Parameter estimates for each of the three samples plus the pooled sample are found in Table 2.

The estimates reported in Table 2 strongly support the price-discrimination rule. The coefficient for retail markup percentage is negative in every case, as predicted by the theory, and the t ratios are significant, using one-tailed tests, at the 0.005 level or better. The pooled equation predicts a decrease in coupon value of about 3 percent for every 10-percent increase in retail markup percentage. The signs of the retail-price and new-product coefficients are positive, as expected, indicating that higher coupon values

TABLE 2—ORDINARY LEAST-SQUARES COEFFICIENT ESTIMATES (DEPENDENT VARIABLE: LOG COUPON VALUE)

Independent variable	Raleigh	10 Cities	Boston	Pooled
Retail markup percentage	−0.369	−0.320	−0.184	−0.305
	(−6.33)	(−7.73)	(−2.72)	(−10.01)
Retail price	0.394	0.522	0.680	0.514
	(10.32)	(10.67)	(13.22)	(21.29)
New product	0.145	0.189	0.148	0.157
	(1.69)	(1.57)	(1.56)	(2.88)
Constant	−0.083	−0.285	−0.949	−0.355
	(−0.42)	(−1.87)	(−3.88)	(−3.34)
R^2:	0.334	0.328	0.529	0.393
Sample size:	427	475	211	1,113

Note: Independent variables are in log form except for the dummy variable representing new products. Numbers in parentheses are t ratios.

are associated with more expensive products and with new products.[4]

While these results give strong support to the theory, they are potentially biased because the retail markup percentage may not be exogenous even though it appears fixed from the manufacturer's point of view. If, as suggested earlier, retailers are highly competitive, they will drive the retail markup percentage down to the point where retail profit is zero. In equilibrium, the markup percentage would be determined simultaneously with the coupon value. To account for this possibility, we also used two-stage least-squares regression analysis to estimate the coefficients of the coupon equation.[5]

The first-stage instrumental variables used to predict retail markup percentage in the two-stage process were the retail price, the new-product dummy variable and two additional variables that are proxies for supermarket merchandising costs. Merchandising costs are important if retail profits are driven to zero through competition, because the size of the markup percentage would then be directly related to the size of the merchandising costs.

The variables used for proxies of supermarket merchandising costs were the product's purchase cycle and a dummy variable to indicate whether the product needs refrigeration or freezing. Purchase cycle is the average length of time (in days) between purchases for the product category. Products with long purchase cycles will have low turnover for a given shelf facing and therefore higher storage costs. Data on average purchase cycle by product category were taken from *The Marketing Fact Book* (1990). Food products that require refrigeration or freezing are more costly to merchandise than other products because of the cooling equipment and additional electricity costs. Location of the product in the supermarket enabled classification of products into the refrigerated or frozen category.[6]

[4]A regression of the squared residuals against each of the independent variables did not detect heteroscedasticity.

[5]As pointed out in footnote 3, retail price is in the manufacturer-coupon equation as a proxy for willingness to pay, which is exogenous. Retail price, however, may be endogenous, so there is a potential simultaneous-equation bias even in our two-stage estimates.

[6]Purchase cycle and the refrigerated/frozen dummy are valid as instruments because they influence the retail markup (as argued in the text), and they do not have any direct impact on coupon values. Manufacturers set coupon values taking into account demand conditions, retail markup percentages, and their own costs of manufacturing and distributing the product. Retailers' merchandising costs have no direct relevance for the manufacturer when making coupon-value decisions. Therefore, purchase cycle and the refrigerated/frozen dummy are properly excluded from the coupon-value equation.

TABLE 3—TWO-STAGE LEAST-SQUARES COEFFICIENT ESTIMATES (DEPENDENT VARIABLE: LOG COUPON VALUE)

Independent variable	Raleigh	10 Cities	Boston	Pooled
Retail markup percentage	−0.671	−0.627	−0.125	−0.596
	(−6.04)	(−10.00)	(−0.81)	(−10.89)
Retail price	0.329	0.433	0.693	0.454
	(7.47)	(8.11)	(11.72)	(17.03)
New product	0.165	0.274	0.149	0.184
	(1.86)	(2.14)	(1.56)	(3.22)
Constant	0.931	0.786	−1.157	0.637
	(2.48)	(3.50)	(−2.12)	(3.39)
R^2:	0.292	0.250	0.528	0.343
Sample size:	427	475	211	1,113

Notes: Independent variables are in log form except for the dummy variable representing new products. Numbers in parentheses are asymptotic t ratios.

The two-stage least-squares coefficient estimates are given in Table 3. These results are similar to the ordinary least-squares estimates and support the negative relationship between coupon value and retail markup percentage. The main difference between the ordinary least-squares and two-stage least-squares estimates is that the coefficients for retail markup percentage are about twice as large (in absolute value) using the two-stage least-squares procedure (except for the Boston data).

An alternative explanation for the negative relationship between coupon value and retail markup percentage is based on the well-known empirical tendency for low-priced products to have high markups. Since low-priced products also tend to have coupons with low values, a negative relationship between coupon value and markup percentage is the result. This argument is correct but does not explain why the strong negative relationship persists after controlling for the effect of price. Our theory does provide the explanation and is supported by the empirical results.

V. Conclusions

Although the vast majority of consumer goods are sold through independent middlemen, analysis of price discrimination traditionally has assumed that the manufacturer sells directly to final consumers. This paper specifically accounts for the channel of distribution in the price-discrimination paradigm.

According to our theory, retail markup percentage is of great relevance to a price-discriminating manufacturer. If this percentage increases and the manufacturer's wholesale price remains unchanged, the retail price of the product will necessarily increase. The manufacturer would then have to increase the size of its price-discriminating pull discount to keep the price-conscious segment of the market as purchasers. But this is not an attractive strategy for the manufacturer. From the manufacturer's perspective, the retailers keep a larger fraction of the higher retail price, while only the manufacturer pays for the larger pull discount required to keep the price-conscious consumers in the market. Thus, with a higher markup percentage, less profit from price discrimination filters back to the manufacturer, and the manufacturer's profit-maximizing response is to lower both the wholesale price and the pull discount.

We tested this implication of the model by estimating a manufacturer-coupon-value equation across a wide variety of supermarket product categories. The study's primary empirical finding is that manufacturers using coupons seem to follow a rule in which they are predicted to decrease coupon values by 3–6 percent if retail markup percentage increases by 10 percent. According to our model, larger coupons can be viewed as more intense price discrimination, and therefore the evidence is that a large retail markup percentage weakens price discrimination by manufacturers.

The empirical results attest to the importance of taking the pricing behavior of channel members into account when studying price discrimination through a distribution channel. We have scratched the surface of what should be a fruitful area for further research. In particular, a more comprehensive treatment would model the retail sector explicitly and might include multiple manufacturers since pull discounts can have competitive as well as price-discriminating properties. A more complete model also might study the dynamics of the market. In any such extensions of our model, we would expect retail markup percentage to continue to play a powerful role in explaining the size of pull discounts.

REFERENCES

Bertrand, Joseph. "Théorie Mathématique de la Richesse Sociale." *Journal des Savants*, September 1883, *48*, pp. 499–508.

Gerstner, Eitan and Hess, James. "A Theory of Channel Price Promotions." *American Economic Review*, September 1991, *81*(4), pp. 872–86.

Gerstner, Eitan and Holthausen, Duncan. "Profitable Pricing When Market Segments Overlap." *Marketing Science*, Winter 1986, *5*(1), pp. 55–69.

Katz, Michael. "The Welfare Effects of Third-Degree Price Discrimination in Intermediate Goods Markets." *American Economic Review*, March 1987, *77*(1), pp. 154–67.

Levedahl, William. "Marketing, Price Discrimination, and Welfare: Comment." *Southern Economic Journal*, January 1984, *50*(3), pp. 886–91.

Marketing Fact Book 1990. Chicago: Information Resources, 1990.

Narasimhan, Chakravarthi. "A Price Discrimination Theory of Coupons." *Marketing Science*, Spring 1984, *3*(2), pp. 128–47.

Nielsen Clearing House Promotional Services. *Worldwide coupon distribution and redemption trends*, Vol. 27. Chicago: Nielsen, 1993.

Phlips, Louis. *The economics of price discrimination*. Cambridge: Cambridge University Press, 1981.

Schmalensee, Richard. "Output and Welfare Implications of Monopolistic Third-Degree Price Discrimination." *American Economic Review*, March 1981, *71*(1), pp. 243–47.

Supermarket Business. "Annual Consumer Expenditure Study." September issues, 1990, 1991.

Varian, Hal. "Price Discrimination and Social Welfare." *American Economic Review*, September 1985, *75*(4), pp. 870–75.