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Why do manufacturers issue coupons? An empirical analysis of breakfast cereals

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and

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We explore the relationship between shelf prices and manufacturers' coupons for 25 ready-to-eat breakfast cereals. We find that shelf prices are lower during periods when coupons are available. This result is inconsistent with static monopoly price discrimination under a broad range of assumptions. We present evidence that is inconsistent with both dynamic theories of price discrimination and explanations of couponing based on the vertical relationship between manufacturers and retailers. We find support for models of price discrimination in oligopoly settings as well as suggestions that firmwide incentives may induce managers to use coupons and price cuts simultaneously. Finally, lagged coupons have a positive effect on current sales, suggesting that coupons are used to induce repurchase.

1. Introduction

■ Economists have devoted substantial theoretical and empirical work to analyzing advertising decisions, while the other predominant form of short-run nonprice competition—promotions—has received almost no attention. According to a 1993 survey, the typical nondurable goods manufacturer spent more money on promotions than on advertising.¹ The costs of couponing are by far the largest component of promotion budgets.² In 1996, manufacturers of consumer packaged goods distributed 268.5 billion coupons, of which 5.3 billion (2%) were redeemed. The average face value for coupons redeemed by consumers in 1996 was 69 cents, so consumers used coupons worth approximately \$3.5 billion.³

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¹ Donnelly Marketing Inc., *16th Annual Survey of Promotional Practices*, reports that trade promotions accounted for 46.9% of the typical promotion budget, consumer promotions 27.9%, and media advertising 25.2%. We will focus on consumer promotions.

² Manufacturers circulate coupons in newspapers, magazines, or direct mailings. If a customer clips a coupon, brings it to a store, and buys the designated product, he or she is entitled to a discount. Other forms of consumer promotions include in-store displays or samples.

³ These statistics were collected by NCH Promotional Services and reported in several publications, including *Marketing News*, March 31, 1997, p. 26.

This article considers coupons for ready-to-eat (RTE) breakfast cereals, one of the most heavily couponed products.⁴ The time spanned by our study includes a rapid escalation in couponing, and preceded attempts by some of the manufacturers to stop issuing coupons. We assess whether the relationship between coupons and shelf prices is consistent with the widely expressed view that coupons are primarily a tool to allow price discrimination. Finding that it is not, we exploit the richness of our data to document couponing patterns across brands and cities and over time. By supplying as many descriptive statistics as possible, we seek to provide insight on the empirical relevance of other theories for why manufacturers use coupons.

We draw on a three-dimensional panel dataset with information on shelf prices and available coupons for 25 RTE breakfast cereal products in up to 65 cities for every quarter from the beginning of 1989 until the end of 1992. For example, in a given quarter we might observe some cities in which there was a coupon distributed for a particular brand and other cities in which a coupon was not distributed for that brand. We compare shelf prices under the two scenarios. The static monopoly price discrimination theory predicts a (weakly) positive correlation under a broad set of assumptions. Since coupon and price decisions are made simultaneously, it is necessary to control for common shocks to demand or costs that may affect both decisions. We do so by exploiting the panel nature of the dataset.

We find that shelf prices are generally lower when there is a coupon available, and this result holds as we add a number of fixed effects to control for unobserved changes in demand and costs. Next we evaluate the patterns of coupons across brands, cities, and time to gather some suggestive evidence on a number of possible explanations for the negative relationship between coupons and shelf prices. We find support for models of price discrimination in oligopoly settings that suggest interbrand competition can cause all prices to be lower than the uniform (nondiscriminatory) price (Corts, 1998). We also find evidence suggesting that coupons are used most intensively at the end of manufacturers' fiscal years, which differ across manufacturers. This suggests that brand managers have incentives to use coupons and price cuts simultaneously to, for example, meet market share targets. We find less support for theories suggesting that the vertical relationship between manufacturers and retailers affects the correlation between shelf prices and coupons.

Finally, to evaluate the dynamic impact of coupons we examine a vector auto-regressive (VAR) model. The results are inconsistent with dynamic models (Sobel, 1984) that predict lower prices could accompany coupons after periods of low demand. We find that lagged coupons are positively correlated with current sales, suggesting that coupons might be used to encourage repeat purchases.

Existing work on couponing has contributions from several disciplines, including economics and marketing. Some researchers, primarily economists, have chosen to explore the potential price-discriminatory effects of coupons. The empirical work has uncovered patterns consistent with the price-discrimination interpretation of coupons, showing for instance that coupon users have more elastic demand than nonusers (Narasimhan, 1984). Only one other article of which we are aware looks directly at the relationship between shelf prices and coupons.⁵ Other researchers have addressed the promotional dimensions of couponing and emphasize, for instance, how coupons might affect the likelihood that a consumer will try a new product, or how coupons might shift the point in time when a consumer decides to purchase a product (Blattberg and Neslin, 1990).

This article also adds to the literature on the RTE breakfast cereal industry. The industry has attracted the attention of both academic economists and the antitrust authorities because it is a highly concentrated, stable oligopoly. Several dimensions of the industry have been analyzed,

⁴ For example, in 1993 there were more coupons redeemed for breakfast cereals than any other group of consumer goods except "health and beauty aids" (*Brandweek*, March 21, 1994, p. 44). Industry sources estimate that 38% of cereal is purchased with some sort of coupon (*Wall Street Journal*, January 21, 1993, p. B1).

⁵ Levedahl (1986) uses individual transaction-level data to show that prices for paper towels are higher for transactions that involve coupons, controlling for brand and geographic area effects. He does not control completely for aspects of the transactions, such as the size of the purchase or the store at which the purchase was made, which may be correlated with the decision to use a coupon.

including product positioning (Schmalensee, 1978; Scherer, 1979) and pricing (Nevo, 2001). Our article provides an analysis of manufacturers' short-run, nonprice strategies.

The article is organized as follows. In Section 2 we review various theoretical reasons why manufacturers might issue coupons and the relations they imply between coupons and prices. We start with a model of static monopoly price discrimination and then describe how changes to some of its assumptions alter its key predictions. In Section 3 we describe our data. Section 4 uses these data to shed light on the relevance of the different theories, and Section 5 concludes.

2. Potential relationships between coupons and shelf prices

■ **Static monopoly price discrimination.** Couponing is a canonical example of price discrimination. See, for example, Pindyck and Rubinfeld (2000) and Carlton and Perloff (2000). A monopolist may profitably charge discriminatory prices if he can separate consumers with different elasticities. If only more price-sensitive customers bother to clip, save, and use coupons, manufacturers can use coupons to sort customers into groups with distinct price elasticities. If a monopolist can separate its customers into two groups, it will charge the group with the less elastic demand a higher price than the group with the more elastic demand, and, under certain assumptions, the less elastic group's price will be (weakly) higher than the uniform price.

To formalize the last statement, denote by $\pi(p_1, p_2)$ the profit when the consumers are faced with prices p_1 and p_2 , in markets 1 and 2, respectively. Markets 1 and 2 are the coupon market and the full-price market, into which the consumers can self-select. Assume that the profit function, $\pi(p_1, p_2)$, is continuous and twice differentiable with (a unique) optimum at (p_1^*, p_2^*) . Denote the uniform price function as $\pi^u(p) (\equiv \pi(p, p))$. We make the following assumptions:

Assumption 1. The uniform price function, $\pi^u(p)$, is single peaked, i.e., there exists a price p_u^* such that for $p < p_u^*$, $\pi^u(p)$ is strictly increasing and for $p > p_u^*$, $\pi^u(p)$ is strictly decreasing.

Assumption 2.

$$\frac{\partial^2 \pi(p_1, p_2)}{\partial p_1 \partial p_2} \leq - \frac{\partial^2 \pi(p_1, p_2)}{\partial^2 p_j}$$

at all (p_1, p_2) s.t. $p_i = p_i^*$, $p_1^* \leq p_j \leq p_2^*$ for $i = 1, 2$, $j = 3 - i$.

Assumption 1 allows us to consider local (i.e., derivative) conditions in order to prove the result below. The assumption is made directly on the profit function and is not easy to translate to assumptions on demand and cost functions. Although quite general, this assumption does restrict the admissible cost and demand functions. With constant marginal cost and common demand functions, this assumption will be satisfied. A similar assumption is required even if the consumers cannot self-select and the monopolist can perfectly separate the markets (Nahata, Ostaszewski, and Sahoo, 1990). Once we allow for self-selection we have to add an additional assumption. Assumption 2 restricts the cross-price derivative along two line segments. If the profit function is concave (at least along the two segments we consider in Assumption 2), then this assumption requires that the expression on the left-hand side of the inequality not be "too" positive.

The following example clarifies the economic intuition for what these assumptions require. Assume constant marginal costs, consumers buy at most one unit, and they differ in how much they are willing to pay for the product and in their disutility from using a coupon. If coupons are available (i.e., $p_2 > p_1$), then a marginal increase in either price will affect two types of consumers: those on the willingness-to-pay margin and those on the disutility-of-using-a-coupon margin. Assumption 1 places restrictions on the (marginal) distribution of willingness to pay. For example, it will be satisfied if the hazard rate, $f(p)/(1 - F(p))$, is nondecreasing for all p , where $F(\cdot)$ and $f(\cdot)$ are the cumulative distribution and probability density functions of consumers' willingness to pay. Assumption 1 alone is not enough to provide the desired result. Informally, this is because a marginal increase in p_2 will cause some of the consumers buying the product without a coupon to switch to buying the product with a coupon, whereas under uniform pricing they would simply continue to purchase the product. If there are "more" consumers on the

disutility-of-using-a-coupon margin than on the willingness-to-pay margin, then demand could be more price sensitive when a coupon is available than when one is not. Therefore, Assumption 2 (implicitly) places restrictions on the joint distribution of willingness to pay and the disutility from using a coupon. It requires that they roughly align: high willingness to pay implies a high disutility from the coupon. A characterization of the exact condition required for this to hold is left for future work.

Both these assumptions are satisfied if, for example, the willingness to pay is uniformly distributed and is perfectly and positively correlated with the disutility of using a coupon (Shepard, 1991). It is possible to come up with examples (where these assumptions are violated) in which the theorem below does not hold. But since all of these examples require very particular assumptions on the distribution of consumers' valuations and cost of using a coupon, we assume them away (especially since we are considering consumers across multiple locations and brands).

Proposition 1. Given Assumptions 1 and 2, if p_u^* maximizes $\pi^u(p)$, then $p_1^* \leq p_u^* \leq p_2^*$.

Proof. $\pi^u(p)$ is a continuous function, and therefore it obtains a maximum on the compact set $[p_1^*, p_2^*]$. To show that this maximum is global, we note that from Assumption 1 all we have to prove is that $\partial\pi^u(p)/\partial p$ is positive at $p = p_1^*$ and negative at $p = p_2^*$. Note that $\partial\pi(p_1, p_2)/\partial p_1 = 0$ and $\partial\pi(p_1, p_2)/\partial p_2 = 0$ at (p_1^*, p_2^*) . Assumption 2 implies that $\partial\pi(p_1, p_2)/\partial p_1 + \partial\pi(p_1, p_2)/\partial p_2 \geq 0$ at (p_1^*, p_1^*) and $\partial\pi(p_1, p_2)/\partial p_1 + \partial\pi(p_1, p_2)/\partial p_2 \leq 0$ at (p_2^*, p_2^*) , which proves the result. *Q.E.D.*

A number of empirical studies have found indirect evidence suggesting that coupons allow sellers to price discriminate. Studies have demonstrated (1) that coupon users have higher price elasticities of demand (Narasimhan, 1984), (2) that low-priced generic products have lower market shares if the brand-name manufacturers coupon heavily (Sethuraman and Mittelstaedt, 1992), and (3) that a larger percentage of consumers use coupons for brands with higher shelf prices (Vilcassim and Wittink, 1987). All these studies address the question of whether manufacturers *could* use coupons to price discriminate.

We, on the other hand, are interested in describing manufacturers' main motivations in issuing coupons. Therefore, we examine the implications of Proposition 1 directly, and consider whether coupons and shelf prices are positively correlated. Our main econometric challenge is to control for demand and cost conditions between markets with coupons and those without (Lott and Roberts, 1991).⁶ Existing empirical studies of price discrimination with coupons have generally relied on broad cross-sectional comparisons and have done little to account for other possible explanations of observed patterns.⁷ As we discuss in detail below, we exploit the panel structure of our data to improve on these studies.

A positive correlation between coupons and shelf prices does not prove they are being used to price discriminate, since coupons may be associated with factors that increase demand for a product at all prices. Many marketing articles consider the demand and advertising effects of coupons.⁸ Increases in demand will lead to higher prices if the suppliers face upward-sloping marginal cost functions or if demand becomes less elastic and suppliers raise markups.⁹

⁶ For example, we find that coupons are more frequently disseminated in large cities, where shelf prices are higher. Simply looking at cross-city differences would suggest that shelf prices and coupon availability are positively correlated. It is plausible, however, that delivery or retailer costs are higher in large cities while the cost of distributing coupons is lower.

⁷ For instance, Gerstner, Hess, and Holthausen (1994) compare the number of coupons issued by broad product category and relate it to retailers' average margins by product category.

⁸ The marketing literature on coupons is broad, and we by no means purport to provide a comprehensive summary of it. For one, we focus on studies that have some implications for the relationship between shelf prices and coupons. For examples, see Lee and Brown (1985), Neslin and Clarke (1987), Neslin (1990), Chiang (1995), Srinivasan, Leone, and Mulhern (1995), and LeClerc and Little (1997).

⁹ Quantity information will not necessarily help separate the price discrimination and advertising effects of coupons. Since price discrimination allows the supplier to price below the valuation of a larger number of customers, it might also be associated with higher sales.

□ **Other models describing the effects of coupons.** For several reasons, the static monopoly price discrimination paradigm is unlikely to describe couponing for breakfast cereal. As we discuss below, cereal manufacturers are not monopolists, they may have dynamic considerations, they do not set the shelf price to retail consumers, and the employees who set cereal manufacturers' coupon policies may not fully internalize shareholders' profit-maximizing incentives. The following paragraphs describe how each of these effects may influence the relationship between coupons and shelf prices, and they outline how we plan to assess the empirical validity of each explanation. The predictions and empirical approaches are summarized in Table 1.

Price discrimination with strategic interaction effects. Recent work has extended the theory of price discrimination to oligopolistic industries (Katz, 1984; Borenstein, 1985; Holmes, 1989; and Corts, 1998). Holmes (1989) shows that under certain symmetry assumptions, the unambiguous prediction that discrimination will lead to higher profits extends to an oligopoly setting. Corts (1998), however, points out that Holmes's symmetry assumptions are not innocuous. He derives conditions under which price discrimination may lead to lower profits and, more important for our purposes, to lower prices for all consumers.

Corts's logic is best demonstrated through a simple example.¹⁰ Suppose there are two types of cereal buyers, students and professors, and two types of cereal, Kellogg's Raisin Bran and General Mills Cheerios. At equal prices students prefer Cheerios, but professors prefer Raisin Bran. Assume that both cereals are manufactured at zero marginal cost. Also suppose that students cut coupons and professors do not. Without coupons (i.e., if the sellers are constrained to charge uniform prices), there is a plausible set of assumptions under which the Cheerios price would be lower than the optimal price to students and higher than the optimal price to professors, and the uniform Raisin Bran price would be higher than a student-only price and lower than a professor-only price.

Ignoring for a moment strategic responses to the other firm's prices, it is clear that Cheerios has no incentive to offer coupons, but Raisin Bran can profitably use coupons to try to set a lower price for students. If Raisin Bran issues a coupon, which given our assumptions is used solely by students, Cheerios will want to lower its price to students, which will result in a lower shelf price, and potentially a coupon, for Cheerios. If the Cheerios shelf price is lowered enough, this will generate competition for Raisin Bran in the professor markets, thus in turn generating a response from Raisin Bran. In the end, both Raisin Bran and Cheerios shelf prices may be lower with coupons.

There are several assumptions that this example embodies, but only one that is central to Corts's result. Prices will only fall for all consumers if the coupon users and nonusers have different brand preferences. (In the example, professors preferred Raisin Bran and students preferred Cheerios.) Corts labels this condition "best-response asymmetry." It is hard to make a convincing case for or against the applicability of this assumption to the RTE cereal market based only on theoretical considerations.

Although the example shows prices going down when coupons are introduced, depending on the relative magnitude of various effects, Corts's model is consistent with both positive and negative correlation between prices and coupons. Therefore, we cannot test it by simply looking at this correlation. Empirically, we can assess the influence of strategic interaction effects by considering whether the relationship between a given brand's price and the coupons for that brand are influenced by the presence of coupons for competing brands.

Dynamic demand effects. A manufacturer's decision to issue a coupon may be correlated with the expected state of demand in a market. For instance, Sobel (1984) develops a model in which suppliers periodically discount goods to clear the market of low-valuation consumers. The model assumes two types of consumers—high valuation and low valuation. Sobel also assumes that consumers arrive in the market over time and that low-valuation consumers are willing to postpone their purchases. He demonstrates that sellers will periodically find it optimal to lower prices

¹⁰ This example is similar to the one presented by Corts in his Section 2.

TABLE 1 Alternatives to the Static Monopoly Price Discrimination Theory

Theory	Prediction		Empirical Support?
Oligopoly price discrimination	Negative correlation between prices and competitors' coupons.	Yes	Table 4
Dynamic effects —Sobel's model	1. Coupons issued after low demand; 2. Negative correlation between past coupons and current demand.	No No	Table 6 and Figure 2
Dynamic effects —Repeat purchase	Positive correlation between past coupons and current demand.	Yes	Table 6 and Figure 2
Retailers' objectives	1. Correlation between coupons and structure of retail sector; 2. Difference in correlation between coupons and retail/wholesale prices.	No No	Table 5 Discussion on p. 332
Retailer or manufacturer costs—demand fluctuations	Seasonal patterns in coupons.	No	Discussion on p. 330
Retailer or manufacturer costs—agency theories	End of fiscal-year effects for coupons.	Yes	Discussion on p. 331

to clear out low-valuation consumers. An extension of his model¹¹ might suggest that sellers periodically use coupons to clear out low-valuation consumers and leave shelf prices unchanged at the high consumers' valuation.¹² (Sellers may only use coupons periodically if there are costs to distributing and processing them.) If only low-valuation consumers are willing to use coupons and there are only two types of consumers, this would predict zero correlation between shelf prices and coupons. A slight augmentation of this model might suggest that sellers periodically use both coupons and price reductions to clear out low- and very-low-valuation consumers. Note, however, that for some distributions of consumer types, periodic coupons could permit higher shelf prices.

These models predict that coupons are issued in response to intertemporal patterns in demand—in this case the accumulation of low-valuation consumers. Such changes in demand are difficult to measure empirically, though we attempt to corroborate these stories in several ways. For one, these stories predict distinct patterns in the relationship between the volume of cereal sold and coupons. The quantity demanded would be lower following a period when coupons were issued, and coupons would tend to follow periods of low-volume sales.

Sellers may also temporarily use coupons to lure new buyers if the new buyers, having tried the product, are willing to repurchase it in the future at the full price. We provide evidence on this theory by testing whether current quantity is positively affected by past couponing practices.

Retailers' objective functions. To this point, we have abstracted from the fact that most goods for which coupons are issued are sold to the final consumers by a retailer and not by the manufacturer. (This is clearly the case for breakfast cereals.) While the manufacturers issue coupons and set wholesale prices, retailers set the shelf prices. Under the static monopoly theory, the manufacturers will increase the wholesale price when they issue a coupon. If the retail sector is perfectly competitive, the retailers will increase the retail price. If retailers have some market power, they might still pass some, or all, of the increase in wholesale price to consumers. They might increase

¹¹ A full derivation of such an extension is beyond the scope of our article.

¹² Pesendorfer (2002) finds support for intertemporal demand effects and their impact on temporary price reductions. Various marketing studies also lend support to the hypothesis that coupons are used to target consumers who are willing to substitute demand intertemporally. Neslin, Henderson, and Quelch (1985) find that coupons encourage people to accelerate their purchases, and Eppen and Lieberman (1984) find that discounts encourage consumers to stockpile goods.

the price even further to take advantage of the segmentation of consumers (Gerstner and Hess, 1991). The same logic might apply if the manufacturers, due to the dynamic or strategic reasons we discussed above, reduce the wholesale price when issuing a coupon. In principle, the retailers' actions might offset the cut in the wholesale price.

Since all supermarkets provide baskets of goods, however, it is possible that the supermarkets take advantage of the advertising effects of coupons and use the couponed brand as a loss leader (Lal and Matutes, 1994). If the coupons inspire customers to put a good on their shopping lists, supermarkets may then discount the couponed good (and advertise the discount) to lure people into their store, anticipating that they will also purchase high-margin products. This effect might occur for cereal in particular, since it is a staple that a large fraction of consumers are likely to buy on a trip to a grocery store. In this case the retailers, despite an increase in the wholesale price by the manufacturers, might actually lower the retail price.

Empirically, we assess the relevance of this theory by using data on wholesale prices to examine whether our results on shelf prices are driven by retailer or manufacturer behavior.

Retailer or manufacturer costs. It is possible that the manufacturers' and/or the retailers' costs drive the correlation between prices and coupons. For instance, managing fluctuating inventory levels may be costly to either the retailer or manufacturer. In periods when demand is expected to be low (for instance, due to seasonal effects), manufacturers may simultaneously issue coupons and reduce prices to generate more sales.¹³ In the absence of cost data, we can look for suggestive evidence of cost-driven couponing only by considering seasonal patterns.

Also, within the cereal-manufacturing firms, the people making decisions about pricing and coupons may face incentives to sustain or increase market share or volume sales. For instance, brand managers may have market share goals they are trying to meet within a certain time frame, such as by the end of the company fiscal year.¹⁴ The cheapest way for the brand managers to increase sales might be to offer discounts to everyone, but bigger discounts through coupons to some people.¹⁵ Since some of the cereal producers have different fiscal years, we can separate fiscal-year effects from seasonal patterns.

3. Data

■ We explore the empirical relationship between coupons and shelf prices using data from two main sources. The cereal price data were obtained from the IRI Infoscan Data Base at the University of Connecticut.¹⁶ These data were collected by Information Resources, Inc. (IRI), a marketing firm in Chicago, using scanning devices in a national random sample of supermarkets in metropolitan areas and rural towns. Weekly data for UPC-coded products are drawn from a sample, which represents the universe of supermarkets with annual sales of more than \$2 million, accounting for 82% of grocery sales in the United States. In most cities the sample covers more than 20% of the relevant population, and due to the importance of the sample to its customers, IRI makes an effort to make the sample representative. This is confirmed by unpublished analysis conducted by the U.S. Bureau of Labor Statistics.

In the Infoscan Data Base the data are aggregated by brand (for example, different-sized boxes are considered one brand), city,¹⁷ and quarter. The data cover up to 65 different cities (the exact number increases over time) and range from the first quarter of 1989 to the last quarter of

¹³ See Aguirregabiria (1999) for a theoretical and empirical analysis of the dynamics of price cuts and retail inventory costs.

¹⁴ For example, Oyer (1998) documents that manufacturing firms' sales are higher at the end of the fiscal year.

¹⁵ We distinguish this explanation from the intertemporal price discrimination story because agency relationships in the firm may make it optimal for brand managers to lower prices and issue coupons to meet market share goals, even if such decisions are not profit maximizing from the firm's perspective. We hypothesize that managerial incentives to issue coupons may have nothing to do with past or even current demand, unlike the intertemporal price discrimination explanation.

¹⁶ We are grateful to Ronald Cotterill, the director of the Food Marketing Center at the University of Connecticut, for making these data available.

¹⁷ As IRI defines most of them, "cities" are similar, but not identical, to metropolitan statistical areas.

1992. The price variable was created by dividing the dollar sales by the number of pounds sold, so it reflects a weighted average price across different box sizes. Dollar sales reflect the price paid by consumers at the cashier excluding discounts due to manufacturer coupons. Therefore, the resulting variable is the city-brand-quarter average precoupon transaction price per pound.

The coupon data were obtained from Promotion Information Management (PIM), a research company that tracked coupons and other promotional strategies.¹⁸ (For example, General Mills might have hired PIM to keep track of Kellogg's couponing and vice versa.) PIM collected data on coupons issued in 69 major metropolitan areas, including all 65 of the IRI areas.¹⁹ For each region, PIM obtained information on coupon free-standing inserts in the local newspapers, on coupons run in the newspapers themselves (run-of-press), and on coupons in magazines. PIM also hired local residents to attempt to get on mailing lists to receive direct mailings, often containing coupons. Where they overlap, the PIM regions are closely aligned with IRI's geographic markets. Since most coupons are issued through inserts in newspapers, however, PIM's markets are defined by the circulation of the local newspaper and not strictly by the counties covered, as are IRI's markets. As a result, we may have measurement error, to the extent people in, for instance, Hartford, Connecticut buy the Boston Globe instead of the Hartford Courant. We believe, however, that these measurement problems are limited.

We obtained information from PIM on coupons issued for every brand produced by the top five cereal manufacturers from 1989 through 1992.²⁰ The information consisted of the face value of the coupon, the cities where it was distributed, the distributor, the date on which it appeared, and its expiration date. The description of the coupons also characterizes the requirements that must be met by the customer to redeem the coupon, indicating, for instance, if the customer needed to buy two boxes of cereal to get a discount, or send in proof-of-purchase labels to get a rebate. (See Nevo and Wolfram (1999) for a detailed description of the PIM data.)

We matched the price and coupon data by city, brand, and quarter. If a coupon spanned more than one quarter (for instance, if it was distributed in mid-February but did not expire until the end of December), we assigned the coupon to the quarter in which it was first issued. Previous research has found that over 60% of coupons are used in the first two months after they are issued (Blattberg and Neslin, 1990). If more than one coupon was available during a given quarter for a given city, we took the mean value of the offered discounts.²¹ Also, some of the coupons in the PIM data were not attributed to individual cities but rather were defined as national coupons with a certain percent coverage. We examined several assumptions, described in Nevo and Wolfram (1999), about how to attribute these coupons to cities. In general, our results are robust to a number of different assumptions. We further assume that the coupon is valid for all box sizes reflected in the weighted-average price. (See Nevo and Wolfram (1999) for a discussion of the sensitivity tests we ran to ensure that this assumption did not bias our results.) Finally, if a coupon can be used for several brands, we enter it as a separate coupon for each brand. In less than .2% of our observations the only coupon available was a multibrand coupon, so it is not surprising that our results are robust to different treatments of these joint coupons (for example, treating these observations as if there were no coupon). Altogether, we have 23,350 observations reflecting information on 25 brands of cereal over 16 quarters from 51 to 65 cities. (Over the time period we are considering, IRI's coverage expanded, so that at the beginning of the sample we have information for only 51 cities, but by 1992 we have information for 65.)

¹⁸ Since we contacted them, PIM was bought by Wallace Marx.

¹⁹ PIM covers the Virginia cities of Richmond and Norfolk separately, though for purposes of comparison with the IRI data, we aggregate the two cities.

²⁰ The top five producers during this period were Kellogg, General Mills, Post, Quaker Oats, and Nabisco.

²¹ We obtain very similar results to those reported in Section 4 if we instead use the total value of all outstanding coupons or the maximum value.

4. Empirical estimates of the relationship between prices and coupons

■ Empirically, we model the relationship between prices and coupons with the following equation:

$$SHELF\ PRICE_{bct} = \gamma_{b(c)} + \phi_{c(t)} + \delta_{t(b)} + \theta DOLLARS\ OFF_{bct} + \varepsilon_{bct}, \quad (1)$$

where $SHELF\ PRICE_{bct}$ is the average shelf price for cereal brand b in city c during quarter t and $DOLLARS\ OFF_{bct}$ is the expected value of the coupon available for cereal brand b in city c during quarter t .²² $DOLLARS\ OFF_{bct}$ takes on a value of zero when there is no coupon available. We also estimate versions of equation (1) in which we substitute $PROB\ OF\ COUPON_{bct}$, which reflects the probability that there is a coupon for a given city, brand, and quarter. γ_b and ϕ_c capture brand- and city-specific factors that affect demand or the cost of selling cereal. δ_t is included to capture the trend in cereal prices over the time period we consider. We also present estimates that allow the brand-fixed effects to vary by city (we estimate γ_{bc}), the city-fixed effects to vary across quarters (we estimate ϕ_{ct}), and the quarter effects to vary by brand (we estimate δ_{bt}).

Table 2 summarizes the variables we analyze. The average shelf price in our sample is about three dollars per pound. The bulk of the variation in shelf prices is across brands. The average discount offered through coupons is about 50 cents, and they are available in 85% of the observations we consider, though as we discuss in Nevo and Wolfram (1999), we suspect that the mean of this variable is high. The average face value of available coupons (i.e., the conditional mean) is about 55 cents. The source of the variation in shelf prices and coupon face values differs. While the variation in prices is largely explained by brand, city, and quarter dummy variables, this is not the case with coupons. We shall return to this point below when we discuss the explanatory power of our results.

Before we present the results, it is useful to consider how our empirical specification identifies the relationship between prices and coupons. Ideally, we would like to have exogenous, or randomly assigned, variation in the brand-city-quarter combinations when coupons are offered. If this were the case, we could identify the causal effect of couponing by comparing, for example, the price of a brand in a certain city where a coupon was issued to the price of the same brand in other cities where no coupons were issued. It is unlikely that firms make couponing decisions so haphazardly. Instead, we use our panel dataset to control for a number of fixed effects and hope that most of the unobservable variation in prices likely to be correlated with couponing decisions is captured by the fixed effects. We also explore the effects of unobservable variables by using instrumental-variable methods.

We do not interpret the estimated coefficients as structural parameters. Under the null hypothesis of monopoly price discrimination (see Proposition 1), the optimal price is increasing in dollars off. Similarly, the optimal value of dollars off is increasing in price. Therefore, if the error terms in the two equations describing these relations are uncorrelated, as might be the case with added fixed effects, then the estimated coefficient, θ , in equation (1) should be positive. We will not claim that this estimated coefficient is the structural parameter of either the optimal pricing or couponing equations. We only claim that under the null hypothesis it should be positive.

Table 3 presents several estimates of equation (1). Each column reports coefficients from separate specifications that use either $DOLLARS\ OFF$ or $PROB\ OF\ COUPON$ as the independent variable. Both specifications in a column include the same fixed effects except the specifications in column 1, which do not include any fixed effects. To determine which fixed effects should be included in equation (1), we compare fixed- and random-effects specifications. A random-effects specification assumes that the excluded effects are uncorrelated with the independent variables

²² As we explained above, not all of the coupons in our dataset could be directly linked to a given city, so we developed the probability that a given city had a coupon. Hence, $DOLLARS\ OFF$ is the expected value of the coupon reduction. The methodology we used for developing the probabilities is described in Nevo and Wolfram (1999).

TABLE 2 Summary Statistics

Description	Mean	Median	Standard Deviation	Brand Variation	City Variation	Quarter Variation
<i>DOLLARS OFF</i> (\$)	.50	.49	.22	13.1%	5.6%	6.2%
<i>PROB OF COUPON</i>	.85	.96	.30	10.7%	3.7%	4.1%
<i>SHELF PRICE</i> (\$/lb)	2.97	2.94	.63	78.3%	7.6%	7.4%

so that a regression without these effects will yield consistent but inefficient estimates, as will a fixed-effects estimator. If, on the other hand, the excluded effects are correlated with the couponing measure, then a random-effects estimator will be biased. This is the basis of a Hausman test for the null that the effects are not systematically correlated with the independent variables (Hausman, 1978).

We perform Hausman tests on six sets of fixed effects: city, quarter, brand, city-brand, city-quarter, and brand-quarter. In all cases save one, the data do not reject the equality of the random-effects and fixed-effects estimators, suggesting that couponing is not correlated with the fixed effects. The one case where the Hausman test rejects the null is for city-brand effects. This suggests that only specifications of equation (1) that include the interacted city-brand dummies are unbiased.²³ We include column 1, with no fixed effects, to describe the raw correlation between prices and couponing. We include column 2, with city, brand, and quarter effects, to point out that the difference between using city and brand effects and city-brand effects (as in column 3) is small.

Except for the coefficient on *PROB OF COUPON* in column 1, the results in columns 1 through 4 suggest that shelf prices are negatively correlated with coupons.²⁴ Column 5 uses the most flexible definition of fixed effects allowable in our dataset, and the results there suggest essentially no relationship between prices and coupons. 93% of the variance in the dependent variable, however, is explained simply by including the brand, city, and quarter dummy variables, and 98% is explained by the time we add all the fixed effects (there are nearly $25 \times 65 + 25 \times 16 + 65 \times 16 = 3,065$ estimated in total) in column 5.

We also repeat the regressions reported in Table 3 instrumenting for the couponing variable. The instrumental variable we use is the regional average, excluding the city being instrumented, of the couponing variable for the brand. This instrumental variable is valid if we assume that we have included enough fixed effects in the pricing equations so the error-terms are not correlated across cities in the same region. The instrument will have power if we assume that regional promotion activity is correlated (as is suggested by the results of the first-stage regressions in which the coupon variable is correlated with the instrument even once we control for the various fixed effects). For example, this correlation can be a result of a regional brand manager determining regional promotion activity. The point estimates from this instrumental-variable regression are essentially identical to those of Table 3, although the standard errors are higher.

If we interpret the estimated coefficients as structural parameters, the effect suggested by the results in Table 3 is small. The largest coefficient on *DOLLARS OFF* (column 2) suggests that the shelf price decreases by 3.5 cents (less than 2% of the average price) when a coupon for 55 cents (the average coupon size in our data) is introduced. However, it is likely that due to the aggregation of the data, the independent variable is measured with some error, suggesting the coefficients are biased toward zero. It is well known that this bias is augmented by the use of within estimators. Following Griliches and Hausman (1986), we are able to use the panel structure of our data to both test for measurement error and also correct the bias (under certain assumptions). For example,

²³ The Hausman tests also provide us with guidance in interpreting the additional explanations for coupons, suggesting that explanations that predict systematic differences in couponing practices for brands by city are more valid than explanations that, for instance, predict systematic differences for brands over time.

²⁴ The negative relationship between prices and *PROB OF COUPON* is statistically insignificant in column 4.

TABLE 3 The Relationship Between Shelf Price and Coupon Value.
Dependent Variable: *SHELF PRICE*

	Specification				
	(1)	(2)	(3)	(4)	(5)
<i>DOLLARS OFF</i>	-.009 (.031)	-.065 (.008)	-.050 (.008)	-.023 (.008)	-.001 (.007)
Adjusted R^2	<.01	.93	.95	.98	.99
<i>PROB OF COUPON</i>	.098 (.020)	-.040 (.006)	-.037 (.006)	-.007 (.006)	.0001 (.005)
Adjusted R^2	<.01	.93	.95	.98	.99
Fixed-effects estimated	None	Quarter, city, brand	City-brand, quarter	City-brand, brand-quarter	City-brand, brand-quarter, city-quarter
Number of observations	23,350	23,350	23,350	23,350	23,350

Note: Standard errors are in parentheses, are robust to the presence of heteroskedasticity, and are adjusted for correlation in the errors within a brand of cereal in a particular city.

first-difference estimation of the coefficient on *DOLLARS OFF* in column 5 of Table 3 yields a coefficient of $-.02$, while an eight-quarter difference estimator yields a coefficient of $-.09$. This pattern is consistent with the existence of measurement error. Using the formula proposed by Griliches and Hausman (1986) to correct for this bias we obtain a coefficient of $-.22$. We conclude that the effects are not as small as they might seem.

Taken together, the results in Table 3 and the results from the instrumental-variable regressions reported in the text suggest that coupons do not have a positive effect on prices, at least for the brands, years, and cities that our data cover. If one is willing to accept that the fixed effects control for all potential endogeneity problems, then these results suggest that manufacturers' conduct is not consistent with the static models of monopoly price discrimination. It is possible, however, that even in the most unrestricted specification there is still a systematic component in the error term that is correlated with the couponing decision. In other words, there might be additional factors that vary by city-quarter-brand and jointly influence pricing and couponing decisions. Even if the results presented in Table 3 do not fully rule out this possibility, they strongly suggest that if these additional factors exist, then their effects dominate the effects of price discrimination. So to understand why manufacturers issue coupons, we have to understand the negative correlations between prices and coupons.

The remainder of this section documents a number of patterns across brands, across cities, and over time, the very effects Table 3 controls for. While we attempt to organize the discussion around possible explanations for the results in Table 3, we also document trends and leave formulation and testing of specific hypotheses for future research.

□ **Cross-brand effects.** Couponing use varies across the five manufacturers in our dataset, and there seems to be a relationship between industry market share and couponing. Kellogg and General Mills issued almost twice as many coupons per brand during our sample period as Nabisco, the smallest manufacturer in our dataset. Couponing is largely consistent across segment, though there are slightly fewer coupons for "kids" cereals and more coupons for "family" cereals.

Couponing increased significantly for all the brands in our sample over the four-year period we consider. In aggregate, there were nearly 60% more coupons issued in 1992 than in 1989. Surveys of coupon practices across all consumer-goods manufacturers also document increases

between 1989 and 1992, though not quite as dramatic as for cereals (CMS, Inc., 1994). We see no distinct pattern in couponing across quarters.^{25,26}

One possible brand-time relationship deserves mention: the negative relationship between coupons and prices could reflect manufacturers, facing particularly intense competition from generic manufacturers, that both couponed heavily and reduced prices.²⁷ To evaluate that hypothesis, we obtained additional data on sales of generic products (Wongtrakool, 1994), including information on the market shares of the ten leading generic brands in 1991 and 1992. Two of these generic products compete directly with cereals that are not in our sample (apple cinnamon toasted oats and bran flakes), but the rest provide competition for nine of the brands in our sample.²⁸ While brands with heavy generic competition tended to coupon more, brands that do not face heavy generic competition showed higher increases in the number of coupons issued over the period we consider. Also, couponing within the brands facing strong generic competition was negatively correlated with increases in generic sales.

It is also possible that the promotion activities of other branded manufacturers influence the competitive environment within which couponing decisions are made. As discussed in Section 2, price discrimination in an oligopoly setting can, under certain assumptions, cause all prices to fall. To evaluate this theory, we estimated specifications similar to those reported in Table 3 and included an interaction between *PROB OF COUPON* and a variable indicating whether or not competitors had valid coupons for similar products.²⁹ The results are reported in Table 4.

The results in columns 2 through 4 suggest the same interpretation.³⁰ They suggest that prices are high, and approximately equal, when a manufacturer has a valid coupon but his competitor does not or vice versa, and that prices are low, and again about equal, when both manufacturers coupon at the same time and when neither manufacturer coupons.³¹ Coupons introduced independently of competitors' coupons have the effect on prices predicted by theories of monopoly price discrimination. The positive coefficients on *COMPETITORS' COUPON* could be consistent with a model in which a competitor's coupon lures the lower-valuation, and more price-sensitive, consumers, thus increasing the optimal price for the remaining customers. When both manufacturers are couponing, optimal shelf prices are again low. The results suggest that the negative coefficients in Table 3 are driven by the interaction between manufacturers' and their competitors' couponing.³²

Although the interpretation we offer in the previous paragraph is intriguing, we offer it with some trepidation. First, the figures in Table 4 are at best reduced-form correlations, and one has to be cautious about interpreting them as behavioral parameters. Second, the product categories are admittedly somewhat ad hoc, although the coefficients on the interaction terms are insensitive to small changes in the categories. Third, it is possible that the coefficient on the interaction term is picking up an omitted variable that influences all manufacturers' decisions to coupon. Such an

²⁵ This result is consistent with the findings for this industry of Chevalier, Kashyap, and Rossi (2000), who study short-lived price reductions and seasonality.

²⁶ The patterns discussed in this paragraph and the preceding one are described in tabular form in Nevo and Wolfram (1999).

²⁷ Estimates of equation (1) using the variation between brand-quarters, however, yield positive θ 's, a fact that is inconsistent with this hypothesis.

²⁸ The brands facing strong generic competition are Cheerios, Corn Flakes, Frosted Flakes, Rice Crispies, Raisin Bran (both Kellogg's and Post's), Lucky Charms, Froot Loops, and Honey Nut Cheerios.

²⁹ "Similar products" are defined as cereals classified in the same segment (e.g., kids or health). *COMPETITORS' COUPON* is equal to the (unweighted) mean of *PROB OF COUPON* across competing manufacturers' brands in the same segment during the same quarter in the same city. The mean of the variable across all observations is .85. The mean of the interaction between *COMPETITORS' COUPON* and *PROB OF COUPON* is .73. The results are similar if we use a sales-weighted mean to compute *COMPETITORS' COUPON*.

³⁰ As with Table 3, the fixed effects leave little variation to be explained in column 5, and all the coefficient estimates are insignificant.

³¹ This interpretation takes the extreme cases where the probabilities of couponing are equal to either zero or one.

³² It is important to note that the specifications in Table 4 evaluate pricing under four different scenarios, whereas the results in Table 3 evaluate (conditional) prices under two different scenarios. In other words, the omitted category is different across the two tables, complicating their comparability.

TABLE 4 The Relationship Between Shelf Price and Coupon Value in the Presence of Competitors' Coupons.
Dependent Variable: *SHELF PRICE*

	Specification				
	(1)	(2)	(3)	(4)	(5)
<i>PROB OF COUPON</i>	.036 (.084)	.087 (.019)	.077 (.019)	.071 (.021)	.003 (.019)
<i>COMPETITORS' COUPON</i>	-.250 (.088)	.091 (.022)	.075 (.022)	.047 (.024)	-.008 (.020)
<i>PROB OF COUPON * COMPETITORS' COUPON</i>	.082 (.093)	-.154 (.023)	-.138 (.023)	-.094 (.023)	-.005 (.022)
Adjusted R^2	<.01	.93	.95	.98	.99
Fixed-effects estimated	None	Quarter, city, brand	City-brand, quarter	City-brand, brand-quarter	City-brand, brand-quarter, city-quarter
Number of observations	23,350	23,350	23,350	23,350	23,350

Note: Standard errors are in parentheses, are robust to the presence of heteroskedasticity, and are adjusted for correlation in the errors within a brand of cereal in a particular city.

effect is harder to reconcile with the results that include extensive fixed effects. Finally, looking at the simple correlation in couponing activity by city-quarter, we find more correlation across brands within a manufacturer than across manufacturers within segments. For example, Kellogg's Raisin Bran is much more likely to have a coupon in a given city at the same time as Kellogg's Froot Loops than at the same time as Post Raisin Bran.³³

We also considered patterns in each manufacturer's couponing activity over time. In conversations with us, brand managers for several consumer products indicated that coupons are often used to provide short-term boosts in market share, in order, for instance, to meet goals set by the firm. To confirm this, we considered patterns in couponing approaching the end of each company's fiscal year. Conveniently, the five companies in our sample had fiscal years that ended in three different months.³⁴ Fiscal-year-end effects were most evident for General Mills and Kellogg, as Kellogg issued 15% more coupons in the last quarter than in any other quarter, and General Mills issued from 10 to 15% more in the first and second quarters. Post was most active in the fourth quarter before its December fiscal year end, although the increase over other quarters is not substantial. Fiscal year end effects were not evident for Quaker and Nabisco, perhaps because we observe coupons for a small number of their brands. We observed similar patterns in advertising (and, generally, advertising expenditures and couponing are positively correlated) consistent with manufacturers using coupons, and other promotional devices, for short-run sales boosts.

□ **Cross-city effects.** As discussed in Section 2, one possible explanation for the failure of the static monopoly price discrimination theory is that manufacturers do not set the shelf prices. To assess whether prices go down because wholesale prices decline or because the retailers changed their margins, we obtained data from Dominick's Finer Foods. This dataset contains information on the weekly price of cereal in Dominick's stores across Chicago. More important for our

³³ This correlation is not driven by coupons that can be used for several brands of the same manufacturer. As was pointed out in Section 3, coupons of this type are rare in our data (given our definition of brands).

³⁴ Kellogg, Post (at the time a subsidiary of the Philip Morris Companies, Inc.), and Nabisco (at the time a subsidiary of RJR Nabisco) all had fiscal years ending in December. General Mills' fiscal year ended in May, and Quaker's fiscal year ended in June.

purposes, the data contain the average acquisition cost (AAC), which measures the average wholesale price paid for the inventory the retailer currently holds. There are two main differences between the current wholesale price faced by the retailer and the AAC. First, a cut in the wholesale price affects the AAC only gradually. Second, when the wholesale price is low, the retailer might stockpile the product and not buy for a while. This will cause the AAC to remain constant while the wholesale price might have gone back up.³⁵

We aggregate these data across stores to obtain the average (retail) price and AAC for each brand in each week during the four years for which we have data. We match these data to the coupon data and find, as we did in Table 3, a negative correlation between retail prices and coupons. For example, in the regressions including brand and quarter fixed effects, the coefficient on *DOLLARS OFF* is $-.019$, with a standard error of $.009$, and the coefficient of *PROB OF COUPON*, in a separate regression, is $-.010$, with a standard error of $.006$. When we run the same regressions using the AAC as the dependent variable, we find a slightly larger negative effect of coupons. For example, in the same regressions just reported, using the cost of inventory as the dependent variable, the coefficient on *DOLLARS OFF* is $-.030$ and the coefficient of *PROB OF COUPON*, in a separate regression, is $-.017$, with standard errors of $.009$ and $.006$, respectively. Therefore, at least at the average Dominick's store, the shelf price declines less than the AAC, suggesting that the negative correlation between shelf prices and coupons is driven by the wholesale price.

These results, of course, only reflect pricing at one supermarket chain in a single city. Our dataset demonstrates considerable heterogeneity across cities both in the number of coupons issued and in the average discount offered per coupon. For example, residents in Dallas were exposed to about 33% more coupons than were residents of Little Rock.³⁶ The average discount reflected on coupons issued in Los Angeles was 42 cents, while the average discount in Dallas was 70 cents. To assess whether the differences in couponing practices across cities are systematically related to city attributes, Table 5 analyzes the relationship between several city-level variables and both the percent of brand-quarters during which a coupon was available in a given city (columns 1, 2, and 3) and the average price for cereal across the 25 brands (column 4).³⁷ In column 1, *PROB OF COUPON* is positive only if there is an unrestricted coupon available, while columns 2 and 3 consider patterns in all types of coupons. Column 3 considers the subsample of cities for which we have price data over all four years.³⁸

The first two variables, % *SUPERMARKETS* and *GROCERY CR4*, measuring broad differences in the organization of the retail sector, are not significant.³⁹ The absence of a relationship between couponing and the retail market structure suggests that retail competition does not affect pricing responses to coupons.

We included *STORES DOUBLING* in the regressions of Table 5 because managers suggested to us that they were more likely to coupon in cities where the local stores were willing to take steps to ensure that promotions successfully increased market share. Confirming this, the variable is positively correlated with the total number of coupons (restricted plus unrestricted) a city receives, although it is negatively correlated with the number of unrestricted coupons cities receive. Most restricted coupons (e.g., buy one, get one free) are not doubled, so it is possible that *DOUBLING*

³⁵ The data and an exact description of this variable can be found at <http://gsbwww.uchicago.edu/research/mkt/MMProject/DFP/DFPHomePage.html>.

³⁶ Chicago, where the Dominick's Fine Foods data were generated, had slightly more coupon issues than the median city.

³⁷ We also use the city-fixed effects (taken from column 2 in Table 3) as the dependent variable in a GLS regression, and the results are essentially identical to those of column 4.

³⁸ Specifications in all four columns also include the log of the number of households in a city, separate measures of the fraction of low-income and high-income households in the city, the median age and average family size in the city, the fraction of each city's population that is Hispanic (Green (1997) suggests that Hispanic-Americans are less likely to use coupons than Anglo-Americans), as well as dummy variables for six geographic regions (the seventh is omitted). Results omitting the region dummies are similar to those reported in the table.

³⁹ The lack of correlation is not due to collinearity between the retail market structure and other city-level attributes, because the variables are not significant in univariate specifications.

TABLE 5 Cross-City Coupon and Price Patterns

Dependent Variable:	PROB OF COUPON (1)	PROB OF COUPON (Including Restricted)		PRICE (4)
		(2)	(3)	
% SUPERMARKETS	-.733 (.451)	.018 (.059)	-.020 (.061)	1.19 (.82)
GROCERY CR4	.026 (.034)	-.011 (.011)	-.011 (.014)	-.139 (.161)
STORES DOUBLING	-.011 (.018)	.011 (.005)	.009 (.006)	.142 (.072)
NEWSPAPER DUOPOLY	-.033 (.027)	.011 (.006)	.009 (.007)	.037 (.108)
R ²	.48	.55	.58	.42
Number of observations	64	64	51	51

Notes: This table reports coefficients from OLS estimates. Robust standard errors are in parentheses.

proxies for other steps that local stores will take to push brands, and manufacturers avoid inflicting the direct costs of unrestricted coupons on those stores.

□ **Dynamic effects.** We next investigate the dynamic effects of couponing. Up to this point we have focused the discussion on why manufacturers issue coupons rather than on why they *might want* to issue coupons. At best the results below can demonstrate that the preconditions for particular uses of coupons are satisfied. In Section 2 we considered two dynamic theories. Since our goal is to describe the dynamic relations between the endogenous variables, we employ a panel vector autoregressive (VAR) model and try to impose as little structure on the data as possible.

Let the dynamic relations between the probability of a coupon,⁴⁰ shelf price, and quantities sold be described by the (reduced-form) VAR model

$$Y_{bct} = C + \sum_{\ell=1}^m \Phi_{\ell} Y_{bc,t-\ell} + \gamma_{bc} + \gamma_t + \varepsilon_{bct}, \quad (2)$$

where

$$Y_{bct} = \begin{bmatrix} \text{PROB OF COUPON}_{bct} \\ \text{SHELF PRICE}_{bct} \\ \text{VOLUME}_{bct} \end{bmatrix}$$

and $E(\varepsilon_t \varepsilon_{\tau}) = \Omega$, if $t = \tau$, and zero otherwise. This system consists of a couponing equation, a pricing equation, and a demand equation. Note that in the reduced form the contemporaneous effects of the endogenous variables are absorbed in the variance matrix of the errors (Hamilton, 1994).

Without the city-brand specific effects, equation (2) can be estimated using ordinary least squares. Once the equation includes city-brand fixed effects, ordinary least squares no longer yield consistent estimates. Furthermore, it is known that adding city-brand specific dummy variables to the estimated equations will not solve the problem (Chamberlain, 1983). Below we follow Holtz-Eakin, Newey, and Rosen (1988) by first differencing the data and using lagged levels of

⁴⁰ We also examined a system of equations in which we modelled the discounts offered by a coupon rather than the probability of a coupon. The results are qualitatively similar and therefore not reported.

TABLE 6 VAR Estimates of the Dynamics of Coupon Existence, Shelf Price, and Volume

Dependent Variable	(1) <i>PROB OF COUPON_t</i>	(2) <i>SHELF PRICE_t</i>	(3) <i>VOLUME_t</i>
<i>PROB OF COUPON_{t-1}</i>	-.025 (.040)	-.019 (.015)	.011*** (.003)
<i>PROB OF COUPON_{t-2}</i>	.126*** (.030)	-.019* (.011)	.007*** (.002)
<i>PROB OF COUPON_{t-3}</i>	-.023 (.017)	-.029*** (.007)	.005*** (.001)
<i>PROB OF COUPON_{t-4}</i>	.047*** (.012)	-.023*** (.005)	.006*** (.001)
<i>SHELF PRICE_{t-1}</i>	-.080 (.224)	.470*** (.121)	.055** (.028)
<i>SHELF PRICE_{t-2}</i>	-.225*** (.078)	.167*** (.043)	.020** (.010)
<i>SHELF PRICE_{t-3}</i>	-.123*** (.031)	-.065*** (.018)	.014*** (.004)
<i>SHELF PRICE_{t-4}</i>	-.119*** (.032)	.158*** (.020)	.013*** (.004)
<i>VOLUME_{t-1}</i>	.259 (.448)	.222 (.225)	-.129 (.191)
<i>VOLUME_{t-2}</i>	.174 (.243)	-.157 (.123)	-.078 (.140)
<i>VOLUME_{t-3}</i>	.056 (.147)	.003 (.077)	-.159 (.100)
<i>VOLUME_{t-4}</i>	.078 (.132)	-.101 (.067)	.172** (.084)
Fixed-effects estimated	City-brand, quarter	City-brand, quarter	City-brand, quarter
Variance-covariance of residuals			
<i>PROB OF COUPON</i>	.0899		
<i>SHELF PRICE</i>	-.0040	.0215	
<i>VOLUME</i>	.0012	-.0010	.0011
<i>R</i> ²	—	—	—
Number of observations	15,375	15,375	15,375

Note: Asymptotic robust standard errors are in parentheses.

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

the variables as instrumental variables. The results are presented in Table 6. The columns present the results for each of the endogenous variables, allowing for four lags in each of the variables, city-brand effects, and quarterly dummy variables.

To discuss the economic interpretation of the results, we examine the $MA(\infty)$ representation of the VAR model, which is given by

$$Y_t = \varepsilon_t + \Psi_1 \varepsilon_{t-1} + \Psi_2 \varepsilon_{t-2} + \dots = \sum_{\ell=0}^{\infty} \Psi_{\ell} \varepsilon_{t-\ell}. \quad (3)$$

The matrix Ψ_ℓ measures the effect of a shock to $\varepsilon_{t-\ell}$ on the rest of the system holding everything else constant, i.e., $\Psi_\ell = \partial y_{t+\ell} / \partial \varepsilon_t'$. A plot of the Ψ_ℓ over ℓ is called the impulse-response function, and it captures all the information on how the shocks $\varepsilon_{t-\ell}$ affect the evolution of the endogenous variables in the system described by equation (2). The matrices Ψ_ℓ can be computed recursively from the estimates of the reduced-form VAR (Hamilton, 1994).

The impulse-response function based on equation (3) ignores the correlation between the shocks in the various reduced-form VAR equations, since it measures the effect of one shock holding everything else fixed. Therefore, we can also examine the effect of a shock to the (orthogonal) structural error on the endogenous variables. To do that, we need to recover the structural parameters, in particular the contemporaneous effects. Without additional assumptions, these effects cannot be identified. To construct the impulse-response functions presented below, we assume that the system is recursive, which implies that the structural VAR coefficients are uniquely determined by the Cholesky decomposition of the variance matrix of the residuals. We order the variables so that *PROB OF COUPON* at time t is not affected by the value of either *SHELF PRICE* or *VOLUME* at time t , *SHELF PRICE* is only a function of *PROB OF COUPON*, while *VOLUME* is a function of both the other variables. Figures 1, 2, and 3 display the impulse-response functions based on this assumption. Each graph displays the effects of a one-standard-deviation positive shock to the various error terms on the three different variables. We also explore additional sets of assumptions that allow us to identify the contemporaneous effects.⁴¹ The results are qualitatively similar to those presented below, which is not surprising since the variance matrix of the residuals, presented at the bottom of Table 6, is nearly diagonal. In all cases the structural parameter on *PROB OF COUPON* in the pricing equation is nearly identical to those presented in Table 3.

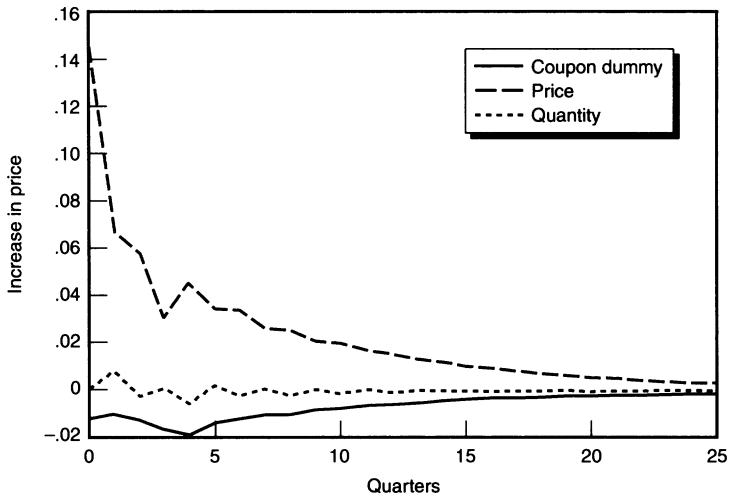
Table 6 and Figures 1–3 suggest that coupons and prices Granger-cause volume but not vice versa or, in other words, that manufacturers' decisions to coupon are not a function of previous quantities sold.⁴² Lagged values of quantity do not increase either the likelihood of introducing a coupon or the face value of the coupon (the F -test of joint significance of all the quantity variables in the couponing equation is .19). This result is contrary to one of the predictions of a Sobel-like theory of intertemporal price discrimination. A second implication of this theory is that, everything else equal, fewer past price cuts (whether in the form of lower prices or coupons) lead to higher current demand. To evaluate the relevance of this theory, we examine the volume equation and the corresponding impulse-response functions. All lags of both *PROB OF COUPON* and *SHELF PRICE* are correlated with current volume. However, the effect of price is decreasing over time, so longer lags are of smaller economic significance, whereas for coupons the effect is roughly constant. The signs of the coefficients suggest that a price decrease embodied in a coupon has the opposite effect of a reduction in the shelf price. Everything else constant, lower past shelf prices imply lower current demand, a result that is generally consistent with the Sobel (1984) theory of the timing of sales. A past discount offered by a coupon has the opposite effect on volume and therefore is not consistent with this theory. The relative magnitude of price and coupon effects on volume is hard to interpret in this regression, since one is measured in dollars and the other varies between zero and one. The results (not reported) from an equivalent regression that instead of *PROB OF COUPON* includes *DOLLARS OFF*, suggest that the relative effect of price lagged one quarter is roughly five times that of a coupon lagged one quarter. Lagged four quarters, however, the relative effects are roughly equal.

The dynamic effects of coupons are consistent with the final dynamic effect discussed in Section 2: Coupons may induce consumers to try new brands, making them more likely to purchase the product in the future. Both the facts that coupons have a different effect on volume than price cuts, and that their impact on volume lasts over several quarters, are consistent with this theory. Most of the brands in our sample are well established, suggesting that coupons remind customers

⁴¹ In particular, we explored sign restrictions on the various coefficients. These assumptions were not sufficient to identify the parameters, but they allow us to bound the admissible parameter space. The bounds are tight.

⁴² This is not necessarily inconsistent with the finding above that coupons are used to boost sales at the end of the fiscal year, if fiscal year targets are to expand market share, not simply make up for lost ground.

FIGURE 1
RESPONSE OF PRICE TO A SHOCK IN THE COUPON, PRICE, OR VOLUME EQUATION



of an existing product rather than encouraging them to purchase a new product. For different products and categories, the new product effect might be more important. As we pointed out at the beginning of this section, this type of evidence is at best an indicator of the relevance of this theory, and by no means conclusive proof. Further insight could probably be gained from consumer-level data.

5. Concluding comments

■ This article documents the patterns of prices and coupons in the RTE cereal industry. Both the negative correlation between prices and coupons and the dynamic results suggest that neither static nor intertemporal monopoly price discrimination considerations are predominant. We consider several additional explanations for coupons. The results suggest that coupons are driven by some

FIGURE 2
RESPONSE OF QUANTITY TO A SHOCK IN THE COUPON, PRICE, OR VOLUME EQUATION

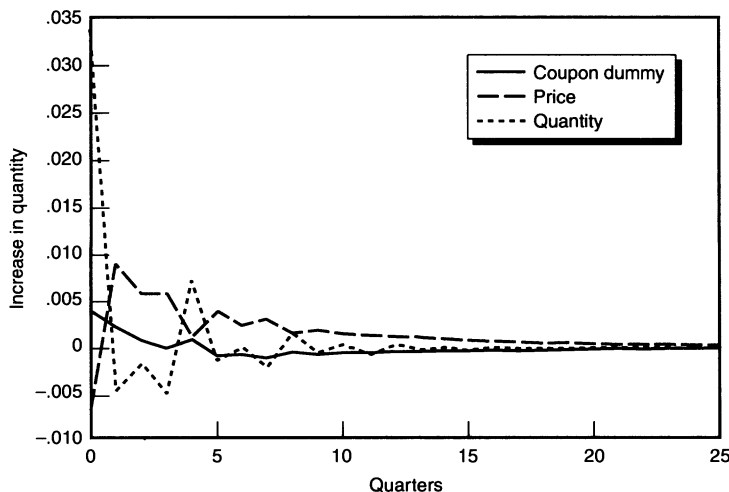
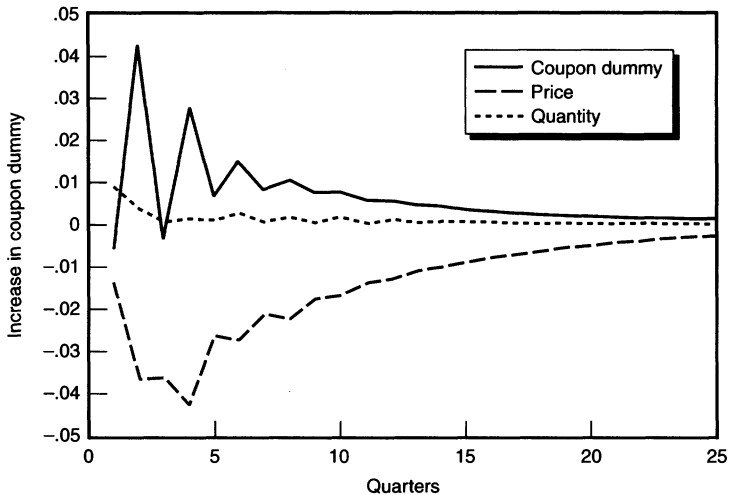


FIGURE 3
RESPONSE OF COUPON DUMMY TO A SHOCK IN THE COUPON, PRICE, OR VOLUME
EQUATION



combination of (1) strategic interactions between manufacturers, (2) incentives given to the people within firms who make decisions about coupons, and (3) the effects of coupons on repeat purchases. We are less convinced that explanations based on the vertical relationship between cereal manufacturers and retailers are important.

The number of coupons issued by all consumer-goods manufacturers grew at over 10% a year between 1980 and 1995. As our data demonstrate, cereal manufacturers contributed to this growth. In the mid-1990s, however, a number of manufacturers tried to curtail or stop couponing. In 1995, for instance, General Mills announced that it would no longer issue coupons but would instead commit to “everyday low prices.” The commitment did not last, however, and General Mills resumed issuing coupons. (No other cereal manufacturer followed General Mills in 1995.) In 1996, Procter & Gamble and nine other consumer products manufacturers stopped issuing coupons in three cities in upstate New York. Consumers met this announcement with revolt, staging boycotts of Procter & Gamble’s products and persuading local politicians to take on the issue. The companies resumed couponing and eventually paid \$4.2 million to settle charges that they had colluded to stop issuing coupons.

The fact that manufacturers seem to dislike coupons lends credence to our finding that coupons are not jointly profit-enhancing price-discriminatory mechanisms. (Procter & Gamble’s senior vice president for advertising and market research told the *Wall Street Journal* (Narisetti, 1997), “I don’t like couponing. Period.”) General Mills’ claim that it would lower shelf prices when it stopped couponing appears inconsistent with our findings, but it may reflect the long-run costs of couponing or be a public-relations gesture more than a new pricing policy.

There are many possible extensions to our work. Since our results suggest that seller decisions about prices and coupons are inconsistent with the simple textbook view of coupons as price-discrimination tools, there is scope for more theoretical work on the rationales for coupons. We have tried to supply as many descriptive statistics as possible to motivate such work.

Appendix

■ This Appendix contains more details on the city-level variables used in Table 5. For a general description of the coupon data used throughout Section 4, see Nevo and Wolfram (1999).

The source for all the independent variables used in Table 5, except *DOUBLING*, was the IRI Infoscan Data Base at the University of Connecticut Food Marketing Center. We obtained the information to construct *DOUBLING* from personal correspondence with IRI. Except where noted, we have annual information for all variables between 1989 and © RAND 2002.

1992. We do not have information about *DOUBLING* in Shreveport, Mississippi, so we limit the cross-city comparisons to 64 cities. Definitions and summary statistics for the city-level variables are as follows (means precede standard deviations in parentheses):

% *SUPERMARKETS*: Measures the percent of food sold through supermarkets, where a supermarket is defined as a full-line, self-service food store with annual volume of \$2 million or more. (.74, .04)

GROCERY CR4: Measures the four-firm concentration ratio across owners of both grocery stores and supermarkets. (.65, .13)

STORES DOUBLING: Measures the percent of sales volume through stores that offer to double and/or triple manufacturers' coupons. For each city, we take the average information over the last three quarters of 1992, the earliest dates for which we have information. (.42, .34)

NEWSPAPER DUOPOLY: A dummy variable equal to one if the city is served by more than one Sunday newspaper. We constructed this variable based on the major newspapers tracked by PIM. (.09, .29)

NUMBER HH: Measures the number of households in the city. (938,000, 997,000)

% *LOW INCOME*: Measures the percent of households with incomes below \$10,000 per year. (.15, .03)

% *HIGH INCOME*: Measures the percent of households with incomes above \$50,000 per year. (.24, .06)

MEDIAN AGE: Measures the median age within the city. (33.2, 2.2)

FAMILY SIZE: Measures the median household size. (2.6, .13)

% *HISPANIC*: Measures the fraction of each city's population that is Hispanic. (.07, .12)

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