

Price-matching refund policies, or offers by firms to match competitor's prices, are common in both consumer and industrial marketing. Much of the previous theoretical work in economics suggests that price-matching refunds are associated with higher prices. In contrast, the trade press postulates that price-matching policies are associated with lower prices. Given these inconsistent views regarding price-matching policies, the authors experimentally examine how consumers view and interpret such policies and then develop a model that incorporates these consumer interpretations as well as asymmetries across stores. In the model, the asymmetry across stores is the key to deriving the conditions under which a signaling equilibrium exists in the presence of price-matching policies. The critical point is that the competition-reducing and price discrimination effects, which seem to form the basis of most of the previous theoretical literature, can be counteracted by the presence of differentiated firms and uninformed consumers. The model suggests that under some conditions, price-matching policies can lead to more intense price competition. Furthermore, all firms will not find it profitable to offer refunds, and consistent with consumer expectations, the firms with lower prices will offer refunds.

An Experimental and Theoretical Analysis of Price-Matching Refund Policies

Consider situations in which firms (retailers or stores) offer consumers price-matching promises that take the form of refunds. The following examples illustrate the type of price-matching refund policies that are commonly found in the marketplace: "We promise to refund the difference if you find that you could have bought the same product cheaper locally at the time of purchase and call within 90 days"; "In the unlikely event that you find an identical item that you purchased here for a lower price at another store, we promise to refund the difference"; and "Our price-matching policy guarantees you the lowest price. If you ever see a product for sale, anywhere, for a lower price, we will gladly refund the difference."

Such price-matching refunds are a feature of both industrial and consumer markets. In industrial markets, such pricing policies are manifested in "meet the competition" clauses in trade agreements. This provision ensures a long-

term relationship between sellers and buyers, even in the absence of long-term contracts. Furthermore, it provides an assurance to buyers that should they be offered a lower price, the original seller will match that price, which thus protects the buyer from overpaying. In consumer markets, retailers—including electronic and appliance stores, grocery stores, hardware stores, and major department stores—frequently offer price-matching policies. It is also interesting to note that even within the same industry, both large and small stores offer price-matching refunds. Yet not all stores in an industry offer price-matching policies. What is the purpose of such pricing policies? It is not obvious that such pricing practices should occur outside a long-term sale contract (Png and Hirshleifer 1987).

Previous theoretical research on price-matching policies has focused primarily on two related explanations: oligopoly coordination and price discrimination. The oligopoly coordination explanation for price-matching policies is that such policies reduce firms' incentives to lower prices and thereby circumvent the prisoner's dilemma problem (Belton 1987; Kalai and Satterthwaite 1986; Salop 1986; Zhang 1995). Following Salop's (1986) seminal work, this research stream suggests that firms view price-matching policies as a means to raise prices to a level that maximizes joint profits. A price-matching policy can therefore be conceptualized as a collusive practice that helps oligopolists maintain monopoly prices (Hess and Gerstner 1991). This conceptualization

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implies that price-matching policies have an adverse effect on consumer welfare.

The price discrimination explanation for price-matching refunds is that such pricing policies can be used by firms to screen consumers on the basis of their cost of information (Png and Hirshleifer 1987). This rationale assumes that consumers differ in their search costs (or opportunity cost of time). Furthermore, the model assumes that consumers with high search costs are less price sensitive and are therefore willing to pay more. Because only consumers who can show that a lower price is available elsewhere can claim refunds (i.e., consumers who have a low cost of information and are therefore well informed), consumers with a high cost of information (i.e., consumers who are ill informed) are charged higher prices. Because high-cost consumers are assumed to be less price sensitive than low-cost consumers, a price-matching refund policy can help retailers sort between less and more price-sensitive consumers and thereby maximize profits.

Most of the prior research on price-matching refunds suggests that prices are higher in the presence of such policies. Research also suggests that all firms benefit by offering to match prices, because the presence of price-matching refunds always leads to higher profits. The view that price-matching refunds reduce price competition has become widely accepted in both the theoretical and managerial literature (e.g., Brandenburger and Nalebuff 1995; Thomas 1997) and has led to calls of antitrust action against firms that offer such policies (Edlin 1997).

In contrast to the predominant theoretical view, the trade press postulates that retailers offer price-matching policies to initiate price competition. Retailers that have a cost advantage or are trying to build market share may use such pricing policies to convince consumers of their low prices (Hess and Gerstner 1991). Accordingly, the adoption of price-matching policies by firms has been heralded as price wars by the press. For example, a headline in the *Financial Times* (1996, p. 1) read "Tesco Launches a New Price War," when Tesco, a British company, announced its decision to introduce a price-matching policy (cited by Hviid and Shaffer 1996). Consumers also seem to have a favorable opinion of such policies, as analysts have suggested that price-matching refunds are an effective way to increase consumer satisfaction (*Catalog Age* 1992). Finally, although most of the previous research suggests that all firms benefit from offering price-matching refunds, all firms do not offer such policies in practice.

It is perhaps because of these inconsistencies that some recent studies have questioned the dominant view that price-matching refunds necessarily reduce price competition. Hviid and Shaffer (1996) show that in the presence of hassle costs that consumers incur in claiming a refund, price-matching policies are not always effective in reducing price competition. Hviid and Shaffer's results, however, suggest that firms with high prices are more likely to offer refunds. Corts (1996) shows that price-matching policies can sometimes lead to lower market prices. He considers a model with two types of consumers: sophisticated and unsophisticated. The sophisticated consumers care only about prices and shop at the store with the lowest prices. This group invokes price-matching policies that may be offered by firms. In contrast, the unsophisticated consumers pay the

posted prices and thus ignore price-matching policies. These consumers consider not only the prices at stores but also other features while making their purchase decisions. Corts shows that if sophisticated consumers are more price sensitive than unsophisticated consumers, market prices can be lower when all firms offer refunds. Corts's primary focus is to show that when all firms offer refunds, prices can be lower than when all firms do not offer refunds. In particular, he shows that all firms weakly prefer to offer refunds. However, firms with the lowest prices are indifferent between offering and not offering refunds and therefore may sometimes choose not to offer refunds (i.e., there is no benefit for firms with low prices to offer price-matching policies). Corts's framework thus suggests that firms with higher prices generally offer refunds. This is inconsistent with the view that consumers seem to hold and the view espoused by the trade press that generally associates price-matching policies with stores that have low prices.

Motivated by these apparent contradictory views, we revisit price-matching policies in an attempt to provide a potential explanation as to why some empirical observations are inconsistent with the tenets of the existing theoretical literature. First, we conducted two experiments to examine the effect of price-matching policies on consumer perceptions of overall store prices, store choice, and perceptions of store quality. The experimental findings demonstrate that consumer perceptions of store prices are lower and choice proportions are higher when a store offers a price-matching policy than when it does not. However, the presence of a refund policy does not affect perceptions of store quality. Second, on the basis of the experimental findings, we develop a model that delineates the conditions under which price-matching policies are associated with lower store prices. In other words, our model incorporates consumer expectations and then derives the conditions under which these expectations are correct (i.e., stores offering price-matching refunds offer low prices) in equilibrium.

Our model differs from the previous models in two ways. First, unlike most of the prior literature we allow for the possibility that stores are differentiated. This is reasonable because stores differ in several characteristics, such as size, location, merchandise assortment, service quality, and so forth. Second, we consider two groups of consumers in our model. The first group of consumers is informed about both the prices at various stores and other store-related features and makes purchase decisions on the basis of this information. The second group of consumers, being uninformed about the prices and store-related features, tries to infer prices upon observing a price-matching policy. Our model shows that the competition-reducing and price discrimination effects, which seem to form the basis of most of the theoretical literature on price-matching policies, can be counteracted by the presence of differentiated firms and uninformed consumers. In other words, the results of the previous literature are not robust, because the impact of price-matching policies on competition may indeed be reversed when we consider these additional features. Specifically, the model identifies conditions under which only a subset of the stores offers price-matching policies and establishes conditions under which firms with low prices offers price-matching refunds.

The rest of the article is organized as follows. In the next section, we report two experiments that examine the effect of a price-matching policy on consumer perceptions of overall store prices, store choice, and perceptions of store quality. In the third section, we develop a model that identifies the conditions under which price-matching refunds increase price competition. Contrasting our results with previous work, we also identify conditions under which the previous results are valid. We next provide a numerical example to illustrate some of the results of the analytical model and then discuss some possible model extensions. We conclude the article by discussing the results and providing directions for further research.

SOME EXPERIMENTAL EVIDENCE

Given that previous research in economics primarily takes a firm perspective, the purpose here was to examine how consumers view and interpret price-matching policies. We examined the effect of price-matching policies on consumer perceptions in two experiments. In Experiment 1, we examined consumer perceptions of store prices and purchase intentions in the presence versus absence of a price-matching policy. In Experiment 2, we examined consumer store choice and perceptions of store and service quality when a target store in a choice set of two stores either offered or did not offer a refund.

EXPERIMENT 1

Method

We designed a simple experiment to examine whether the presence of a price-matching policy influences consumer perceptions of store prices and purchase intentions. We recruited 104 subjects to participate in a small questionnaire study. Forty-eight subjects were MBA students, and the other 56 were recruited at a major airport. A covariate analysis showed no influence of subject pool on the dependent measures and no interaction with the manipulated variable. Therefore, the two groups were combined for the analysis reported here.

Subjects were asked to imagine a purchase scenario in which they were shopping for a new television set. All the subjects had purchased consumer electronics previously, which provides some face validity in using this convenience sample. An equal number of subjects was randomly assigned to each of the two experimental conditions. They were then asked to read a description of an electronic and appliance store and respond to the dependent measures. The store was described as follows: "Electronic Mart is a new electronic and appliance store that has recently opened in town. It is located in the mall and thus parking is not a problem. The 'Grand Opening' banner is still being displayed in front of the store. A friend of yours, who had visited the store earlier, had indicated that Electronic Mart has a good selection."

The store description varied in terms of whether it offered a price-matching refund policy. When a price-matching refund policy was present, we added another statement to the store description: "Electronic Mart has been advertising its price-matching policy, which reads, 'If you buy a product at Electronic Mart and see the same product for sale within 90 days for a lower price, we will gladly refund the difference.'" Given that most price-matching policies are accompanied by explicit claims about low prices (e.g., "Nobody beats our prices"), our manipulation was relatively conservative. After reading the scenario, subjects were asked to respond to several dependent measures, including

price expectations, confidence of finding low prices at the store, purchase intentions, and perceptions of the operating costs of the store.

Price expectations. Overall expectation of store prices was measured by averaging the ratings of three items (Cronbach's alpha = .82): "My overall expectations about the prices at Electronic Mart are ..." (1 = not at all expensive, 7 = very expensive); "I expect the prices at Electronic Mart to be ..." (1 = low, 7 = high); and "Compared to other electronic stores, the prices at Electronic Mart are most likely to be ..." (1 = much lower than average, 7 = much higher than average).

Confidence of finding low prices. Subjects' confidence of finding low prices was measured by taking an average of two items (correlation = .77): "How certain are you that Electronic Mart has low prices?" (1 = very certain, 7 = not at all certain) and "I am quite confident that Electronic Mart's prices are one of the lowest" (1 = strongly agree, 7 = strongly disagree).

Purchase intentions. Purchase intention was measured by averaging two items (correlation = .72): "What is the likelihood that you would buy the television from Electronic Mart?" (1 = very high, 7 = very low) and "I would definitely consider buying the television from Electronic Mart" (1 = strongly agree, 7 = strongly disagree).

Perceptions of operating costs. Subjects' perceptions of the operating costs of the store were measured by one item: "The operating costs for Electronic Mart must be substantial" (1 = strongly agree, 7 = strongly disagree).

Results

The means of the four dependent measures are displayed in Table 1. Measures for confidence of finding low prices, purchase intentions, and perceptions of operating costs were reverse scaled. As Table 1 clearly shows, the presence of a price-matching refund policy had a significant influence on subjects' perceptions of overall store prices, confidence of finding low prices, and purchase intentions. The overall price expectations in the presence of a price-matching policy were significantly lower than in its absence (means = 3.50 and 4.24; $F(1, 102) = 16.77, p < .0001$). Confidence of finding low prices was also higher when the price-matching policy was present than when it was absent (means = 4.06 and 2.99; $F(1, 102) = 12.77, p < .0005$). Furthermore, purchase intentions were significantly higher in the presence than in the absence of a refund policy (means = 4.53 and 3.75; $F(1, 102) = 10.03, p < .002$). However, perceptions of the operating costs of the store were not significantly

Table 1
EXPERIMENT 1: MEANS OF DEPENDENT MEASURES

Dependent Measures	Price-Matching Refund	
	Present	Absent
Price expectations	3.50 (.71)	4.24 (1.09)
Confidence of finding low prices	4.06 (1.48)	2.99 (1.55)
Purchase intentions	4.53 (1.32)	3.75 (1.18)
Perceptions of operating costs	4.54 (1.33)	4.79 (1.67)

Notes: Lower numbers indicate lower price expectations, lower confidence in finding low prices, lower purchase intentions, and lower perceptions of operating costs. Standard deviations are shown in parentheses.

affected by the price-matching policy (means = 4.54 and 4.79; $F(1, 102) = 1.22$, n.s.).

These results clearly demonstrate that price-matching refund policies influence consumer perceptions of store prices. Moreover, consumers' confidence of finding low prices at the store and likelihood of purchasing were higher in the presence of a refund policy. To the extent that consumers believe that stores with price-matching policies have low prices, it is possible that because of perceived positive price-quality associations, they may associate stores with low prices with low service quality and therefore lower operating costs. However, the data do not support this conjecture, as subjects' perceptions of the operating cost of the store did not vary with price-matching policy. These results suggest that though consumers draw inferences about store prices by observing a price-matching policy, they do not appear to draw inferences about other store features, such as service quality.

EXPERIMENT 2

In Experiment 2, we examined the effect of price-matching policies on store choice and directly assessed whether the presence of such policies affects perceptions of other aspects of the store, such as overall quality and service quality.

Method

The study used a hypothetical purchase scenario, in which subjects shopping for a new digital video disc (DVD) player compared two stores. The two stores were described as follows:

Store A is an electronic and appliance store that has been in business for about ten years. Store A offers an extensive selection of electronic merchandise and home appliances. The store includes listening stations where you can sample different components. The store is part of a shopping complex that has a variety of other stores as well. While the shopping complex has adequate parking, it can get quite crowded during the weekends.

Store B is an electronic and appliance store that has been in business for 14 years. Store B offers an extensive selection of electronic merchandise and appliances. It has a special acoustics room where one can test different audio components. It also sells new and used CD's and tapes. It is located in the downtown area that, due to recent renovations, has become a very active place during weekends.

Given that the store descriptions were presented together, we varied them to make the task meaningful for the subjects. We recruited 115 subjects at a major airport to participate in this study that consisted of three conditions including the

control condition. In the control condition, neither store offered a refund. In Condition A, only Store A offered a price-matching refund; in Condition B, only Store B offered a refund. The treatment conditions, A and B, were created by adding the following statement to the appropriate store description: "Store A (B) has also been advertising its price-matching refund policy: 'If you buy a product at our store and find the same product for sale within 90 days for a lower price, we will gladly refund the difference.'" Because the control condition was the baseline, any differences between the control condition and each of the treatment conditions could be attributed to the price-matching policy.

After reading the store descriptions, subjects were first asked to make a store choice ("If you had to purchase the DVD from one of the two stores, which one would you choose?"). They were then asked to indicate the store most likely to have lower prices ("Which store is most likely to have overall lower prices?"). Perceptions of store quality and service quality were assessed by two items: "Which store is most likely to have higher overall quality?" and "Store A is likely to have higher service quality than Store B" (1 = strongly disagree, 7 = strongly agree).

Results

Table 2 shows that subjects were more likely to choose a store that offered a price-matching policy ($\chi^2(2) = 31.79$, $p < .001$). In particular, when Store A offered the refund, its choice proportion was higher (marginally significant) than in the control condition (77.5% [31/40] and 58.33% [21/36]; $\chi^2(1) = 3.15$, $p < .07$). Similarly, in Condition B, in which Store B offered the price-matching policy, its choice proportion was significantly higher than in the control condition (84.6% [33/39] and 41.67% [15/36]; $\chi^2(1) = 13.39$, $p < .0003$). Furthermore, the store with the price-matching policy was perceived as most likely to offer the lower prices ($\chi^2(2) = 17.46$, $p < .001$). Specifically, the number of subjects who indicated that Store A was most likely to offer lower prices was higher in Condition A, in which Store A offered a refund, than in the control condition, in which neither store offered a refund (70% [28/40] and 47.22% [17/36]; $\chi^2(1) = 3.99$, $p < .04$). In Condition B, the number of subjects who perceived Store B as the most likely to offer lower prices was significantly higher than in the control condition (76.9% [30/39] and 52.78% [19/36]; $\chi^2(1) = 4.67$, $p < .03$).

However, as we show in Table 2, the perception of the store most likely to have higher overall quality did not vary significantly across the three conditions ($\chi^2(2) = .98$, n.s.). Furthermore, an analysis of variance revealed that subjects' perceptions of service quality were not affected by the presence of a price-matching policy ($F(1,112) = .74$, n.s.).

Table 2
EXPERIMENT 2: DEPENDENT MEASURES

	Control Condition	Store A Offers a Refund	Store B Offers a Refund
Store choice	21/15 (58.33)	31/9 (77.50)	6/33 (15.38)
Store likely to have lower prices	17/19 (47.22)	28/12 (70.00)	9/30 (23.08)
Store likely to have overall higher quality	14/22 (38.89)	16/23 (41.03)	12/27 (30.77)
Relative perceived service quality	4.22 (1.44)	3.92 (1.44)	4.28 (1.30)

Notes: For the first three measures, the two numbers represent the number of subjects who chose Store A and Store B, respectively, and the number in parentheses is Store A's percentage. For the fourth measure, the number in parentheses is the standard deviation.

Summary of Experimental Findings

Together, Experiments 1 and 2 highlight two key points. First, the presence of price-matching policies significantly influences consumer perceptions of store price image. Relatedly, purchase intentions and the likelihood of store choice were significantly higher in the presence of a refund. Second, consumers do not seem to draw inferences about other aspects of the store, such as its overall quality and service quality, on the basis of the presence or absence of a price-matching policy. This suggests that as far as consumer beliefs are concerned, price-matching policy is independent of store quality or service quality.

MODEL

In the previous section, we show that consumers infer low prices when price-matching policies are present. Our approach in developing the model is to determine sufficient conditions under which price-matching refund policies are associated with low prices. In other words, on the basis of the experimental findings, we assume consumer beliefs and identify conditions under which the consumer beliefs are correct in equilibrium—that is, the Nash equilibrium, in which firms offering price-matching refunds are indeed the firms with lower prices. This is the usual approach taken in articles on consumer search (e.g., Macminn 1980; Reinganum 1979; Stahl 1989; Stigler 1961).¹

Model Structure

We assume that at the beginning of the game, all firms simultaneously decide whether to offer price-matching refund policies and what prices they will charge.² All consumers observe the price-matching refund offers, which are advertised.³ However, only a fraction of the consumers observes the prices at all stores. Consumers subsequently make their purchase decisions on the basis of price, refund offers, and their preferences for other store-related features.

As mentioned previously, there are two groups of consumers in the model. The first group consists of consumers who are informed about prices and other store-related features, whereas the second group comprises consumers who are uninformed about prices and other store-related features. A similar classification of consumers has been used previously by several authors (e.g., Png and Hirshleifer 1987; Varian 1980). We discuss the demand function for each group separately.

Demand from the Informed Consumers

The first group comprises expert consumers who are informed about prices at various stores and other store-related features (e.g., service). These consumers care about both the prices and the store-related features and make their

purchase decisions on the basis of this information. Note that this implies that these consumers are not only aware of but also sensitive to differentiating store features, such as store credit, free delivery, free gift wrapping, and so forth. For the informed consumers, the aggregate demand for Firm i when no firm offers a refund is thus given by $D_i(p_i, \mathbf{p}_{-i})$, where p_i is the posted price of Firm i and \mathbf{p}_{-i} is the vector of the posted prices of all other stores. Now consider the case in which Firm i offers a refund and no other firm does. In this case, if Firm i does not have the lowest prices, all informed consumers who buy from i will claim a refund and pay the lowest price in the market, say, p .⁴ Thus, the demand function for Firm i from the informed consumers is $D_i(p, \mathbf{p}_{-i})$. In other words, when Firm i offers a refund, the relevant price for the informed consumers is not its posted price p_i . Rather, the effective price that Firm i charges the informed consumers is the lowest price in the market, that is, p . If other firms also offer a refund, the relevant price for the informed consumers for these firms is again the lowest price.

We assume that the demand function of the informed consumers is from a special family of demand functions. Restricting the nature of the demand function of the informed consumers enables us to investigate issues such as the impact of price-matching policies on prices and show that situations in which only a subset of stores offer refunds can arise in equilibrium. Specifically, we assume that the demand for a Firm i from the informed consumers is

$$(1) \quad D_i(p_i^e, p_{-i}^e) = \alpha_i - p_i^e + \psi \left(\sum_{j \neq i} p_j^e \right),$$

where $\psi' > 0$ and $\psi'' \leq 0$, and p_i^e and p_j^e are the effective prices that firms i and j charge; that is,

$$(2) \quad p_i^e = \begin{cases} p & \text{if firm } i \text{ offers a refund} \\ p_i & \text{otherwise} \end{cases},$$

where p is the lowest posted price in the market and p_i is the posted price for Firm i . To ensure that own-price effects are stronger than cross-price effects (for empirical support, see Carpenter et al. 1988), we assume that $\psi'(x) < 1/(n-1) \forall x$. Note that this assumption ensures that a unit increase in price by all firms will strictly decrease Firm i 's demand and the total demand of all firms. Without loss in generality, we also assume that $\alpha_1 \leq \alpha_2 \leq \dots \leq \alpha_n$, where n is the number of firms in the market.

The quasi-linear demand function is similar to the linear demand function used by other authors when modeling n -person oligopolies (e.g., Raju, Sethuraman, and Dhar 1995; Shubik and Levitan 1980, pp. 89, 133). The $\psi(\cdot)$ term reflects the competitive effect on a firm's demand. Intuitively, as the price for the competitor's product increases, the demand for the firm's product increases. We have made an additional assumption that the firm's demand

¹An alternative approach is to model consumer uncertainty about specific firm-level parameters. This approach places a heavier burden on the informational requirements for consumers. Our model, however, can be modified to take this approach. Details are available from the authors on request.

²An alternative model specification is to assume that firms first decide whether to offer refunds and then decide on the prices. However, to be consistent with the prior literature, we assume that firms simultaneously decide on refunds and prices. The main results of the article hold, even in the alternative specification.

³It is only necessary for one uninformed consumer to observe at least one of the price-matching refund offers.

⁴In practice, it is plausible that some of the informed consumers may choose not to claim refunds. We have followed the prior literature, which assumes that all informed consumers claim refunds. This enables us to compare our results more directly with the prior literature. We revisit this issue in the Model Extension section.

is affected by the sum of prices of all the competitors. This assumption is equivalent to the assumption that a firm's demand increases as the average prices of the competitors increase.⁵ The parameter α represents the base demand of a store and may be viewed as a measure of a store's loyal consumer base that is affected by aspects such as merchandise selection, availability of store credit, free parking, and other dimensions of service quality. Notice that we assume that these store-related factors affect only the base demand and not the price sensitivity of consumers. Alternatively, we could assume that as α increases, consumers should also become less price sensitive. This alternative assumption, however, would only strengthen our main results (see n. 14). This simplified linear demand function comes with a loss in generality and does not capture all aspects of service quality. However, it helps us develop an analytically tractable framework to study the impact of price-matching refunds on firms' prices.

Demand from the Uninformed Consumers

The second group consists of uninformed consumers who are unaware of the specific prices at stores. These consumers are also unaware of store-related features at the various stores. This implies that such features do not affect their store choice. These consumers visit only one store and decide whether to buy the product and, if appropriate, how many units to buy.⁶ The characteristics of uninformed consumers are that they are casual, unplanned shoppers in the product category; are not aware of and are less concerned with store-related features, such as service; and enter the market only if the price is right.⁷ The uninformed consumers, however, observe the price-matching refunds and may use them to form inferences about prices at various

⁵This can be obtained by defining $\psi(x/n) = \psi(x)$, and then we can replace $\psi(\cdot)$ with $\psi(\cdot/n)$ in the demand function. Because n is exogenous, the analysis remains unchanged. Note that the demand function does not necessarily lead to an increase (or decrease) in a firm's demand as the number of competitors increases. The $\psi(\cdot)$ function is sufficiently general to allow for either. In this article, however, we keep n exogenous.

⁶Empirical studies show that even for major purchases, many consumers visit only one store (Wilkie and Dickson 1985).

⁷Note that in our model, the informed consumers take store-related features into account while making their purchase decisions, whereas the uninformed consumers only consider prices while making their purchase decisions. Conceivably, informed consumers are more likely to be involved in the product category and therefore consider relevant features, such as store credit policy, free gift wrapping, free servicing, and so forth, in making their purchase decisions. Alternatively, the informed group may be thought of as experts who are aware of the relevance of some store-related features in making the correct purchase decision. For example, experts may recognize that a store that has slightly higher prices but offers free servicing periodically (or free gift wrapping) provides a better deal than a store that has lower prices but does not provide such services. As such, the informed consumers are likely to be more aware of these features than the uninformed consumers. Conversely, uninformed consumers can be thought of as non-experts who are not aware of the relevant store features on which to make their purchase decisions. Their store choice is thus based primarily on observable attributes such as price (price-matching refund policy), and store-related features do not affect their choice simply because they are unaware of these. In summary, expert consumers (i.e., informed consumers in our model) incorporate not only prices but also store-related features in their decision process, whereas nonexpert consumers incorporate only a store's price when making their purchase decisions. This conceptualization of consumers is consistent with previous research that suggests that experts incorporate more information into their decision-making process than non-experts (e.g., Alba and Hutchinson 1987; Maheswaran and Sternthal 1990).

stores. We assume that the aggregate demand for Firm i from these consumers is given by $Q(p_i)$, where $Q(0) < \infty$, $Q'(\cdot) < 0$, and $Q''(\cdot) < 0$.

If no store offers a price-matching policy, uninformed consumers randomly choose a store. We assume that there are $n \geq 2$ stores in the market, and therefore the demand from the uninformed consumers in this case is $Q(p_i)/n$.⁸ If all stores offer refunds, consumers cannot infer any information about prices at a specific store.

Now consider the case in which at least one firm offers a price-matching refund. To specify the demand of the uninformed consumers fully, we need to consider how they view price-matching refunds. Uninformed consumers could ignore such refunds and make no inferences about store prices from such offers. Alternatively, consumers could infer store prices on the basis of a store's price-matching policy. There is a large variety of possible consumer beliefs. We use our experimental findings to specify the beliefs that consumers form upon observing a price-matching policy. The experiment clearly demonstrates that consumers associate price-matching policies with low prices. We assume these consumer beliefs and determine sufficient conditions under which price-matching refunds are indeed associated with low prices. We denote the set of stores that offers price-matching refunds by S and the set of stores that does not offer such policies by \bar{S} . We assume that consumer beliefs are

$$(3) \quad E(p_i) = \begin{cases} \gamma_1 & \text{if } i \in S \\ \gamma_2 & \text{if } i \in \bar{S} \end{cases}$$

where $\gamma_1 < \gamma_2$ and E is the expectation operator. In other words, uninformed consumers expect the prices at a store that offers a price-matching policy to be lower than those at a store that does not offer a refund.⁹ Therefore, these consumers will visit a store that offers a refund. Note that Equation 3 is a fairly weak assumption on consumer beliefs. It only requires that consumers believe that firms offering price-matching refunds have lower prices on average. These beliefs are consistent with our experimental findings. Let m be the number of firms offering refunds. The demand from the uninformed consumers for Firm i is then given by

$$(4) \quad Q_i(p_i) = \begin{cases} Q(p_i)/n & \text{if } m = 0 \text{ (no firm offers a refund)} \\ Q(p_i)/m & \text{if } i \in S \text{ and } m \geq 1 \\ 0 & \text{if } i \in \bar{S} \text{ and } m \geq 1 \end{cases}$$

Profit Functions

The profit for Firm i when no store offers a price-matching refund or when all stores offer refunds is given by

⁸This splitting of demand function among firms for the uninformed consumers can be justified by the following argument. Normalize the total number of uninformed consumers to \bar{Q} . If there are n firms that these consumers randomly choose from, each firm gets \bar{Q}/n of the potential consumers. Assume that each consumer has a different demand function that is indexed by a parameter k , which varies across the population according to a continuous cumulative distribution $F(k)$. The demand at the individual level is therefore $q(p, k)$, and the total demand for each firm is $\int (\bar{Q}/n)q(p_i, k)dF(k) = Q(p_i)/n$. Note that the demand function $q(p)$ may well be such that it only takes values of 0 or 1.

⁹ γ_1 and γ_2 could vary across consumers. The only important aspect for our analysis is the inequality $\gamma_1 < \gamma_2$.

$$(5) \quad \Pi_i(p_i, \mathbf{p}_{-i}) = \left[\alpha_i - p_i^e + \psi \left(\sum_{j \neq i} p_j^e \right) \right] (p_i^e - c_i) + \frac{Q(p_i)}{n} (p_i - c_i),$$

where p_i is the posted price of Firm i , p_i^e is the effective price of Firm i , \mathbf{p}_{-i} is the vector of posted prices of all other stores, and c_i is Firm i 's marginal costs. We assume that the marginal costs of all stores are equal and without loss in generality are equated to zero. Note that we have assumed that stores are symmetric except for the parameter α that varies across stores. The parameter α captures the base demand of each store and may be viewed as a measure of a store's loyal consumer base that is affected by aspects such as merchandise selection and service quality.¹⁰ Stores may differ in many other ways, including different price sensitivities, different marginal costs, and so forth. Our purpose here is not to develop a general model that incorporates all sources of asymmetries. Rather, we have a more modest goal of modeling asymmetric stores and examining whether the results of prior research continue to hold and whether the inclusion of store asymmetry helps us provide a potential explanation for the inconsistencies between the extant theory and the empirical observations discussed previously.

Model Intuition

Before deriving the formal results, we discuss the intuition for our results and explain why they differ from the prior literature. To understand how a price-matching refund can intensify price competition, we first examine the reasons to the contrary suggested by the prior literature. Salop (1986) shows that when firms offer price-matching refunds, price loses its power to attract consumers from other firms. The rationale is that a price reduction by only one firm leads to a lower price for all consumers. Consumers have no additional reason to buy from the firm that lowers prices, because they can get the lower price from all firms that offer refunds. As a consequence, no firm has an incentive to lower prices, and firms can coordinate their prices at the monopoly level. Relatedly, Png and Hirshleifer (1987) show that firms can price discriminate between informed and uninformed consumers by offering a price-matching refund. In equilibrium, informed consumers effectively pay a lower price, and uninformed consumers are charged a higher price. Both these explanations suggest that price-matching refunds lead to higher prices and that in equilibrium, all firms (weakly) prefer to offer refunds.

Our model differs in two ways. First, we assume that stores are differentiated, and thus informed consumers care

about prices and other store-related features.¹¹ Second, we assume that uninformed consumers may infer prices upon observing a price-matching refund policy.

It is the differentiation aspect in our model that is the key to understanding why price-matching refunds can also lead to lower prices. For the moment, assume that all consumers are informed. Because firms are differentiated, they prefer to charge different prices. However, when all firms offer refunds, the lowest price charged by a firm is what all consumers pay. Thus, all firms end up charging the same price, and firms (except the weakest firm) cannot impose their preferred price. The impact of differentiation on firms' prices is thus lost when all firms offer price-matching refunds. In contrast, when no firm offers a refund, firms charge different prices. As the differentiation among firms decreases, prices are higher in the presence of price-matching refunds, because the Salop effect enables firms to coordinate prices (see also Zhang 1995). But as the differentiation among firms increases, the price that can be sustained when all firms offer refunds remains the same, whereas the price that can be charged when no firm offers a refund can be higher. The critical point is that though prior work shows that price-matching refunds make it unattractive for firms to compete on prices, we show that price-matching refunds also make store differentiation irrelevant and thus take away the ability of firms to charge higher prices on the basis of non-price-related features. This aspect of price-matching refunds can lead to higher price competition and make it unattractive for some firms to offer a refund.

To complete the picture, we now include the uninformed consumers. We assume that the uninformed consumers infer that firms offering price-matching refunds have lower-than-average prices. These consumers therefore patronize firms that offer price-matching refunds. A firm's potential demand thus increases if it offers a refund. However, if there is sufficient differentiation, this increased demand comes at the cost of lower prices. Therefore, in equilibrium, only a subset of the firms may choose to offer price-matching refunds.

Results

Let m denote the number of stores that offer refunds. The stores that offer refunds then have a demand $Q(p)/m$ from the uninformed consumers. In contrast, stores that do not offer refunds have no demand from the uninformed consumers. We have the following result:

Lemma 1: If consumer beliefs are as specified in Equation 3, stores offering the lowest price in the market will offer price-matching refunds in equilibrium.¹²

The reason for the lemma is easy to understand. The store with the lowest price can always do better by offering than not offering a price-matching refund, because the refund enables the store to sell to the uninformed consumers. The

¹⁰It is possible that firms with higher α s also have higher costs. If firms with high α s have higher fixed costs, our results remain unchanged. Furthermore, even if the high- α firms also have higher marginal costs, the main results of our article continue to hold. Indeed, the assumption of equal costs is a conservative assumption, and the main results would be stronger if firms with higher α have higher marginal costs. However, the analysis will be considerably more complicated.

¹¹This is an important difference between our model and Corts's (1996) model. Corts assumes that all consumers are aware of prices but only sophisticated consumers use price-matching refunds. However, he assumes that these sophisticated consumers do not care about store-related features. In our model, we assume that consumers are differentially informed about prices and the informed consumers use information on store-related features along with price information in making their decisions.

¹²Proof of this result and all others can be obtained from the authors on request.

store with the lowest price thus always benefits from offering a refund. Note that the result implies that in a duopoly, if only one store offers a refund, that store will have the lowest price, consistent with consumer beliefs.

We next consider the symmetric case in which all firms have the same α parameter. Before discussing the proposition, we need to consider the issue of the multiple Nash pricing equilibrium that is common in all models with price-matching refunds (see Hviid and Shaffer 1996). We follow the usual convention and use the Pareto-dominance criterion to choose equilibria.¹³ We have the following:

P₁: Let $\alpha_i = \alpha \forall i$. In this case, the prices and profits of stores are higher when all stores offer price-matching refunds as opposed to when no store offers refunds. Furthermore, the case in which all firms offer refunds is a Nash equilibrium of the game.

P₁ reinforces the result from prior research that price-matching refunds can lead to higher prices and profits. Note however that our result is more general, because we consider differentiated stores in an oligopoly. In particular, we show that a situation in which all firms offer refunds is an equilibrium, even if the firms are differentiated, as long as they are symmetric. Next we consider the case in which stores are asymmetric; that is, stores have different α s. We have the following result:

Lemma 2: Let $\alpha_1 \leq \alpha_2 \dots \leq \alpha_n$. In this case, if all stores do not offer a price-matching refund, in equilibrium $p_1 \leq p_2 \dots \leq p_n$. Furthermore, the equilibrium profits are also similarly ordered; that is, $\Pi_1 \leq \Pi_2 \dots \leq \Pi_n$. The weak inequalities are replaced by strong inequalities when there is a strong inequality in the corresponding α terms.

This lemma shows that there is price dispersion in the market when stores are asymmetric. The result indicates that stores with a larger value of α will charge higher prices. This is intuitive, because stores with a larger α have a higher base demand and less incentive to charge lower prices.

We now consider the impact of a price-matching refund when the asymmetry among stores increases. We make an additional technical assumption that the equilibrium solutions are locally strictly stable (for a similar assumption, see Bulow, Geanakoplos, and Klemperer 1985; Lee and Wilde 1980; Reinganum 1985). We first define two terms that are useful for the next proposition:

$$(6) p_1^m = \operatorname{argmax}_{p_1} (p_1 Q(p_1) \nu_n + p_1 (\alpha_1 - p_1 + \psi[(n-1)p_1])).$$

Thus, p_1^m is the price Firm 1 would charge to maximize its profits if all firms were offering refunds and charging an effective price p_1^m . We also define

$$(7) \hat{p} = \operatorname{argmax}_{p_i} Q(p_i) p_i.$$

Thus, \hat{p} is the optimal price that a firm would charge if it were to sell only to the uninformed consumers.

P₂: Assume that $\hat{p} < p_1^m$ and normalize $\alpha_1 = 1$; there exists an α_n^* such that if $\alpha_n > \alpha_n^*$, all firms charge a higher price and make higher profits when no firm offers a price-matching refund than when all firms offer a price-matching refund.

P₂ establishes that prices and profits can indeed be lower for some or all stores when they offer refunds than when they do not. To understand the intuition, first consider the case in which no firm offers refunds. When stores are sufficiently asymmetric, in a Nash equilibrium with no refunds, stores with high values of α will charge higher prices. As α of one firm increases, the firm can charge higher prices, as can be seen from Lemma 2. By strategic complementarity of prices, this increase in α of one store enables all stores to set higher prices. Thus, when no firm offers refunds, prices increase as firms become more asymmetric. However, when all stores offer refunds, the effective price charged from the informed consumers is the optimal price for the store with the lowest value of α (which can be regarded as the weakest store), that is, p_1^m . The other stores would prefer to charge a higher price but cannot do so because of their commitment to match prices. Note that p_1^m is independent of all α_i , $i > 1$. Thus, when all stores offer refunds, the optimal price depends only on α_i and not on the relative asymmetry of stores. In this case, an increase in α_i , $i > 1$ will have no effect on the equilibrium prices. In other words, price-matching refunds take away the price competition-reducing aspect that comes with differentiation. Thus, price-matching refunds could lead to lower prices and lower profits.¹⁴ This result thus provides some justification for the commonly held notion that price-matching refunds are associated with intense price competition. The result also suggests that the absence of price-matching refund policies may reduce price competition. This is particularly true in markets in which stores are widely differentiated. For example, consumer electronics are sold by different stores that range from department stores to discount stores to specialized consumer electronics stores, and each has its own positioning.¹⁵ In such situations, price-matching refunds may indeed be associated with lower prices and should not be viewed as an anti-competitive tactic to raise prices.

Next, we examine the case in which only a strict subset of stores in the market offers refunds. We have the following result:

¹⁴Note that these results will even be stronger if α were to affect not only store base demand but also consumer price sensitivity. In particular, stores with larger α also have lower price sensitivities. For example, a store's demand function can be

$$D_i(p_i^e, p_{-i}^e) = \alpha_i - \phi(\alpha_i) p_i^e + \psi \left(\sum_{j \neq i} p_j^e \right),$$

where $\phi(\cdot)$ is a monotonically decreasing function. In such situations, stores with large α will have even more incentives to charge a higher price, and by strategic complementarity, the market prices with no price-matching refunds will be even higher. Similar arguments also show that **P₃** and **P₄** will be stronger if we allow α to affect price sensitivity.

¹⁵A caveat is that for some product categories (e.g., electronics, mattresses), it is sometimes difficult to find two retailers that carry the same exact model (see Bergen, Dutta, and Shugan 1996). Despite the practice of putting different model numbers on identical models, a considerable number of products are common across different retailers.

¹³Fudenberg and Tirole (1983, 1985), Harsanyi (1964), and Harsanyi and Selten (1988) provide justification for the use of Pareto-dominance as a reasonable criterion for equilibrium selection.

P_3 : If there exists a Nash equilibrium in pure strategies, for sufficiently large α_n the equilibrium must involve only a strict subset of firms in the market that offers price-matching refunds.

The intuition of the proposition is easy to understand in view of the previous result. When stores are sufficiently asymmetric, the presence of price-matching refunds increases price competition. In such cases, at least one store will benefit from not offering a refund. However, from Lemma 1 we know that a refund will be offered by at least one store. Therefore, if an equilibrium exists, it must involve only a strict subset of stores that offers a refund. This proposition formally shows that when we consider differentiated stores, the commonly observed situation in which not all stores offer refunds can arise in equilibrium. This is in contrast to most of the prior research, in which all stores offer refunds.¹⁶

P_3 , however, assumes that a pure strategy equilibrium exists. It is difficult to develop a general result to ensure the existence of a pure strategy solution in an n store scenario. We therefore provide results for a duopoly. The next proposition also delineates conditions that are sufficient to ensure that consumers in equilibrium consistently believe that the prices at stores that offer refunds are lower than prices at stores that do not offer refunds. Mathematically, we call consumer beliefs consistent when $\gamma_1 < \gamma_2$ is valid in equilibrium. We have the following:

P_4 : In a duopoly, for sufficiently large α_2 there exists a pure strategy Nash equilibrium in which Firm 1 offers a price-matching refund and charges a lower price, whereas Firm 2 does not offer a refund and charges a higher price. Thus, in equilibrium consumer beliefs are consistent.

This result shows that when stores are sufficiently asymmetric, situations in which only a strict subset offers refunds will arise in equilibrium. Furthermore, consistent with consumer beliefs, stores offering refunds will have lower prices. We should note, however, that though our results suggest

that stores with a higher value of α are less likely to offer price-matching refunds, this is not a general result. It is easy to show that situations in which stores with a higher α offer price-matching refunds and stores with a lower α do not offer refunds can arise in equilibrium.¹⁷ The role of α in our model is limited in that it represents the notion that stores are asymmetric. Our model does not predict the specific characteristics that are associated with stores that offer refunds and those that do not. This may be viewed as a limitation of our model but may also be its virtue. A casual examination of types of stores that offer refunds suggests that it is difficult to find a common pattern. Stores offering a price-matching refund vary from high-end department stores to discount chains.

Note that P_4 can also be modified to consider a model in which price-matching refunds can be a signal of lower prices in a Perfect Bayesian Nash equilibrium.

NUMERICAL EXAMPLE

We provide a numerical example that illustrates some of the results of our model. Tables 3 and 4 show the prices and profits of each firm if there are four firms in the market. The demand specifications and the parameters that we chose are also provided in Tables 3 and 4. We emphasize that the demand specification, the parameters, and the specific examples were not chosen to illustrate generic forms of equilibria. Rather, our purpose is to illustrate the various possibilities that could arise and contrast them with the results of the prior literature.

Let us first consider the situation illustrated in Table 3. In this case, Firms 3 and 4 are identical, whereas Firms 1 and 2 have lower α s. We determine the equilibria in the game by examining the different equilibria that can arise and by checking whether they satisfy the conditions for a Nash equilibrium. As shown in Table 3, there are four Nash equilibria in the game: (1) All firms offer refunds; (2) Firms 1, 2, and 3 offer refunds; (3) Firms 1, 2, and 4 offer refunds; and (4) Firms 1 and 2 offer refunds. It is not possible to select one equilibrium among these as the unique equilib-

¹⁶An exception is Hviid and Shaffer (1996), who also show that in an asymmetric duopoly, only one store may offer a price-matching refund. However, they find that, in general, the stores with higher prices will offer refunds. In contrast, we establish conditions under which consumer beliefs will be consistent and stores with lower prices offer refunds.

¹⁷In such cases, however, there will also exist an equilibrium in which the stores that offer refunds will have lower α s than the stores that do not offer refunds. The point is that stores in S and \bar{S} cannot be distinguished in terms of α .

Table 3
NUMERICAL EXAMPLE 1

Case	P_1	P_2	P_3	P_4	Π_1	Π_2	Π_3	Π_4
1. No refunds	.767	.959	1.151	1.151	.720	1.124	1.618	1.618
2. All offer refunds	.923	.923	.923	.923	.615	1.076	1.538	1.538
3. Firms 1, 2, and 3 offer refunds	.855	.855	.855	1.214	.704	1.131	1.559	1.473
4. Firms 1, 2, and 4 offer refunds	.855	.855	1.214	.855	.704	1.131	1.473	1.559
5. Firms 1 and 2 offer refunds	.814	.814	1.238	1.238	.846	1.253	1.534	1.534

Notes: Cases 2, 3, 4, and 5 are the four possible equilibria.

Demand Functions:

$$D_i(p_i^e, p_{-i}^e) = \alpha_i - p_i^e + \beta \sum_{j \neq i} p_j^e$$

and

$$Q(p_i) = \theta(1 - \gamma p_i).$$

where $\alpha_1 = 1$, $\alpha_2 = 1.5$, $\alpha_3 = 2.0$, $\alpha_4 = 2.0$, $\beta = 1/6$, $\theta = 4/3$, $\gamma = 2/3$.

Table 4
NUMERICAL EXAMPLE 2

Case	P_1	P_2	P_3	P_4	Π_1	Π_2	Π_3	Π_4
1. No refunds	.764	.907	1.193	1.193	.975	1.372	2.373	2.373
2. All offer refunds	.857	.857	.857	.857	.857	1.286	2.143	2.143
3. Firms 1, 2, and 3 offer refunds	.828	.828	.828	1.457	1.066	1.481	2.308	2.122
4. Firms 1, 2, and 4 offer refunds	.828	.828	1.457	.828	1.066	1.481	2.122	2.308

Notes: Cases 3 and 4 are the two symmetric equilibria.

Demand Functions:

$$D_i(p_i^e, p_{-i}^e) = \alpha_i - p_i^e + \beta \sum_{j \neq i} p_j^e$$

and

$$Q(p_i) = \theta(1 - \gamma p_i),$$

where $\alpha_1 = 1$, $\alpha_2 = 1.5$, $\alpha_3 = 2.5$, $\alpha_4 = 2.5$, $\beta = 1/6$, $\theta = 4$, $\gamma = 2/3$.

rium—at least not on the basis of commonly used selection criteria. For example, none of the equilibria pareto-dominates the others. We do not address which of these equilibria will be chosen. Rather, we study the properties of each of the different equilibria with the implicit assumption that the players have some mechanism by which they arrive at one of these focal equilibria (Schelling 1980).

Consider the equilibrium in which all firms offer refunds. In this equilibrium, the prices of Firms 2, 3, and 4 are lower than when no firm offers a refund. Furthermore, all firms make strictly higher profits if they commit to not offering price-matching refunds. In this case, the presence of price-matching policies indeed leads to more intense price competition and lower profits for all firms. This is in contrast to the results in the prior literature and provides support for the notion that price-matching refunds may be associated with intense price competition. Now consider the equilibrium in which Firms 1, 2, and 4 offer refunds but Firm 3 does not. Notice that in this case, Firms 1, 2, and 4 are strictly better off than when all firms offer refunds. In other words, in contrast to claims made by some authors that price-matching refunds increase the profitability of competitors, this example shows that this is not necessarily true. Furthermore, note that Firms 1, 2, and 4 have lower prices than Firm 3, which does not offer refunds. This again is in contrast to previous research that associates higher prices with price-matching refunds.

In Table 4, we again have two symmetric firms, 3 and 4, and two firms, 1 and 2, that have lower α s. In this case, however, we have more asymmetry among firms, because $\alpha_3 = \alpha_4 = 2.5$ as compared with 2 in the previous example. In this case, there are two symmetric equilibria: (1) Firms 1, 2, and 3 offer price-matching refunds and (2) Firms 1, 2, and 4 offer refunds. This example shows that it is possible in equilibrium that identical stores choose different strategies: One chooses to offer a refund policy, and the other chooses not to offer a refund. The example also illustrates a situation in which only a subset of stores offers a price-matching refund in equilibrium. Finally, the example also shows that the firms that offer refunds have lower prices than the firm that does not offer refunds. Note that these facts are consistent with common observations but are inconsistent with previous research.

MODEL EXTENSIONS

Price-Matching Refund Affects α

We have assumed in our model that a firm's base demand is not affected by price-matching refunds. In effect, offering a refund does not have an impact on the base demand. However, price-matching policies can affect the α parameter of the firm if consumers perceive it to be an additional dimension of service, and therefore this may encourage loyalty among the informed consumers. Conversely, stores not offering refunds may be perceived to be lacking on that dimension and may therefore be penalized. In other words,

$$(8) \quad \alpha_i^e = \begin{cases} \alpha_i + \delta & \text{if Firm } i \text{ offers refunds} \\ \alpha_i - \delta & \text{otherwise} \end{cases}$$

where α_i^e is the modified effective α that the firm faces and $\delta > 0$. In this case, offering a price-matching refund becomes more attractive for firms, because refunds increase demand. Thus,

P₅: In a duopoly with asymmetric firms, it is an equilibrium for both firms to offer a price-matching refund as long as $\alpha_2 < \alpha_2^*$. If $\psi < 2/3$, the critical value α_2^* is increasing in δ .¹⁸

The proposition shows that in this situation, firms will offer price-matching refunds for a wider range of parameters. Analogously, it can be shown that P₄ will still hold. In other words, there exists α_2^{**} such that if $\alpha_2 > \alpha_2^{**}$, Firm 1 will offer refunds and Firm 2 will not offer refunds. Furthermore, Firm 1 will have lower prices. However, as δ increases, the critical value of α_2^{**} for which only Firm 1 will offer a refund will increase, and therefore the range of parameter values for which P₄ holds will decrease.

Multiproduct Firms

Our model considers the situation in which firms sell only one product. Stores usually sell many different product categories and typically offer to match prices for all their products. The model can be extended to account for multiproduct firms in a straightforward manner. More important, the

¹⁸The condition $\psi < 2/3$ is stronger than necessary. It ensures that second-order effects of δ are smaller than first-order effects.

results remain unchanged qualitatively. To show this, we assume that there are n firms each selling m products. Let the demand for Firm i 's j th product be

$$(9) \quad D_i(p_{ij}^e, p_{-ij}^e) = \alpha_i + \beta_j - p_{ij}^e + \psi \left(\sum_{k \neq i} p_{kj}^e \right)$$

where p_{ij}^e is Firm i 's effective price for the j th product. The additional term β_j represents a product-specific demand parameter. Similarly, we can define the demand from the uninformed consumers as

$$(10) \quad Q_{ij}(p_{ij}) = \begin{cases} Q(p_{ij})/n & \text{if } m = 0 \text{ (no firm offers a refund)} \\ Q(p_{ij})/m & \text{if } i \in S \text{ and } m \geq 1 \\ 0 & \text{if } i \in \bar{S} \text{ and } m \geq 1 \end{cases}$$

Note that the price-matching refund applies to all products sold at the store. If price-matching refunds could be selectively offered for each product, our previous results remain unchanged. In particular, from P_4 , for a duopoly there would exist critical values α_{2j}^* for the j th product such that if $\alpha_2 + \beta_j > \alpha_{2j}^*$, Firm 2 will not offer a refund for the j th product, and Firm 1 will offer a refund. Furthermore, Firm 1's prices will be lower than Firm 2's prices, consistent with consumer beliefs. We define the following:

$$(11) \quad \bar{\alpha}_2 = \max_j (\alpha_{2j}^* - \beta_j)$$

and

$$(12) \quad \underline{\alpha}_2 = \min_j (\alpha_{2j}^* - \beta_j)$$

If $\alpha_2 > \bar{\alpha}_2$, Firm 2 will find it profitable not to offer a refund on all its products, and therefore P_4 continues to hold. Also, if $\alpha_2 < \underline{\alpha}_2$, the equilibrium proposed in P_4 cannot be sustained, because Firm 2 will find it profitable to deviate from the proposed equilibrium. The critical α_2^* for which Firm 1 offers a refund and Firm 2 does not must lie between $\underline{\alpha}_2$ and $\bar{\alpha}_2$. Analogously (using the result of P_5), there would exist a critical value α_2^{**} such that if $\alpha_2 < \alpha_2^{**}$, both firms will offer refunds. It is interesting to note that in this case, Firm 2 may offer refunds even though it is profitable to do so for only some of its products. For other product categories, it may be more profitable not to offer a refund. However, because price-matching policies are typically offered for all products, the firm may offer refunds if the benefit of offering a refund for some products exceeds the loss that the firm incurs on its other products. This strategy is similar to the strategy of "loss leaders" that firms often employ.

Some Informed Consumers Do Not Claim Refunds

Our model assumes that all informed consumers claim refunds. In practice, some informed consumers may forgo the refund if the perceived cost of claiming the refund is relatively high. Taken to the extreme, none of the informed consumers may claim the refund. In this case, Hviid and Shaffer (1996) show that price-matching refunds are not effective. This is because the traditional argument for price-matching refunds relies on the ability of refunds to coordinate prices to the monopoly levels. This coordination is only feasible because consumers claim refunds. If consumers did

not claim refunds, price-matching policies would not be a credible way to reduce price competition. The results of the previous literature thus depend on consumers claiming refunds. The results are considerably weakened if some consumers choose to forgo refunds.¹⁹

In our model, we consider differentiated stores. The reason a firm may not choose to offer refunds in our framework is that price-matching refunds take away its ability to charge higher prices on the basis of non-price-related features. However, if some informed consumers do not claim refunds, a firm can continue to offer a refund and price discriminate between consumers who claim refunds and those who do not by having a posted price that is higher than the lowest price in the market. This is similar to the price discrimination among informed and uninformed consumers proposed by Png and Hirshleifer (1987). Nevertheless, as long as some consumers in the market claim refunds, the ability of a firm to charge higher prices on the basis of the differentiation parameter is restricted. Therefore, the basic insight of our model continues to hold in this case.

However, the overall impact of incorporating consumers who do not claim refunds on price-matching policies is ambiguous. On the one hand, offering a refund becomes less attractive when the market consists of informed consumers who do not claim refunds, because firms lose the capability of coordinating prices. On the other hand, offering a refund becomes more attractive, because it helps firms price discriminate among different types of informed consumers.

CONCLUSION

In this article, we attempt to provide a potential explanation for the discrepancy between extant theoretical explanations and the more popular view regarding price-matching policies. Although the extant literature suggests that price-matching policies are associated with higher prices, the trade press as well as consumers associate such policies with aggressive price competition and lower prices.

Toward this goal, we first conducted two experiments that showed that consumer perceptions of store prices were lower whereas purchase intentions and the likelihood of store choice were higher in the presence (versus absence) of a price-matching policy. Consumer perceptions of the overall store quality and service quality, however, did not vary with price-matching policy. On the basis of these experimental findings, we then developed a model that derives the conditions in which price-matching policies can lead to intense price competition. By considering imperfectly informed consumers and asymmetries across stores, we show that the commonly held view in the literature that price-matching refunds are a ploy to reduce price competition does not necessarily hold. Rather, under some conditions, price-matching refunds are associated with low prices and more intense price competition. Furthermore, in contrast to the previous literature, our model shows that only a subset of the stores may have an incentive to offer a price-matching policy and that stores offering refunds are indeed the stores with lower prices.

In general, our model provides some justification for the view of the trade press and consumers that price-matching

¹⁹With undifferentiated stores, even if a small proportion ϵ of informed consumers does not claim refunds, price-matching refunds are not effective in achieving price coordination.

refund policies are aggressive pricing tactics rather than ploys to reduce price competition. The results are also consistent with the empirical observation that all firms do not offer price-matching policies.

Our results have several managerial and public policy implications as well. Although the previous literature suggests that firms are always better off offering price-matching policies, our results provide some caveats. Specifically, when stores are highly differentiated, they may prefer not to offer a price-matching policy, because it can intensify price competition and thus lower profits. When stores are relatively undifferentiated, price-matching policies can reduce price competition. The experimental findings also suggest that price-matching policies can be used as effective mechanisms to influence consumer price expectations. Because a typical store carries an assortment of products, a price-matching refund can serve as a signal of store price image.

From a public policy perspective, although previous studies suggest that price-matching policies are likely to be associated with reduced price competition and higher prices (e.g., Salop 1986), our results suggest that when some consumers are imperfectly informed about prices and stores are sufficiently differentiated, such policies instead can increase price competition and lead to low prices, which perhaps improves consumer welfare.

There are several possible avenues for further research. It should be recognized that a price-matching refund is only one of the many devices that firms can use to convey their price image. Other instruments include dissipative advertising (Bagwell and Ramey 1994) and advertising a subset of prices (Simester 1995). Firms commonly use price advertising and price-matching policies simultaneously to signal price image. It is important to examine the conditions under which using different signaling instruments is more effective.

Finally, there is a need to compare empirically the prices of stores that offer price-matching refunds with those of stores that do not. Such a study will no doubt have important implications not only for theoreticians but also for regulatory agencies.

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