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Abstract

Are price-matching guarantees anticompetitive? This paper examines the incentives for price-matching guarantees in markets where information about prices is costly. Under some conditions the conventional explanation of price-matching announcements as facilitating collusion finds support, and is even strengthened. But our model provides an additional explanation for the practice. A price-matching guarantee may be a credible and easily understood means of communicating to uninformed consumers that a firm is low-priced. The credibility of the signal to uninformed consumers is assured by the behaviour of informed consumers. We contrast the testable implications of our model with those of the anticompetitive theories and discuss supportive evidence from an illustrative sample of retailers.

1 Introduction

In many retail markets, sellers not only set prices but announce a guarantee that they will match the lowest advertised price that a customer can find in the market. Price matching is observed in markets for sporting goods, personal computers, books, consumer electronics, luggage, tires, and many others.[1] Price-matching guarantees, or meeting-competition clauses as they are sometimes called, would appear to be pro-competitive. Customers do not complain about getting guaranteed low prices.[2] Investment analysts have viewed announcements of such guarantees as an increase in the intensity of competition.[3]

In the economics and antitrust literatures, however, price-matching guarantees have a bad name. These guarantees are seen as a way to collude. The argument is that the guarantees facilitate cartel pricing by removing the incentive to undercut (Hay 1982, Salop 1982). The firm offering a price-matching commitment to buyers is in fact guaranteeing to its competitors that any lower price by them would be matched immediately—eliminating the gains from the price cut. A second theory explains price matching as a means of price discriminating among consumers (Png and Hirshleiffer 1988). Firms offering price-matching guarantees provide discounts selectively to customers who shop for and are aware of lower prices in the market while charging a high list price for non-searchers. Edlin (1997) uses this argument to suggest that the market-wide impact of the practice is to limit the disciplining power of active shoppers on market prices: whereas price searchers usually provide a positive externality to non-searching customers by driving the price down for everyone, in a

[1] Edlin (1997) and Arbatskaya, Hviid and Shaffer (1999). A well-publicized example of a price matching guarantee is Gateway's announcement on May 30, 2001 that it would match key competitors' prices on comparable PC's. The Gateway Guarantee promises customers that if they "present a current ad from Compaq, Hewlett-Packard, Dell, IBM, Sony or Toshiba for a new PC or server with specifications at least equal to Gateway's specifications," then Gateway will sell them a comparable PC "for as much as $1 less than the advertised price of its rivals" (*The Wall Street Journal*, May 31, 2001). The press release accompanying the announcement notes that the guarantee will be launched "with broadcast and cable TV advertising, as well as a full-page ad in *USA Today* and dozens of local daily newspapers across the country."

[2] For example, see the consumer reactions to the Gateway Guarantee in Geek.com (May 30, 2001).

[3] Investment analysts viewed Gateway's announcement of price matching as a step up in the P.C. price war (*The Wall Street Journal*, *Ibid;* TheStreet.com, July 11, 2001).

market with price-matching guarantees, the pro-competitive benefits of active price shopping are limited to the active shoppers themselves. A firm need not lower price to all consumers just to capture the searchers. The theory of price matching as anti-competitive is thus extended to markets with large numbers of sellers.

Neither of the theories of anticompetitive price matching is compelling as an explanation of the wide range of markets in which the guarantees are observed. Prices do not appear to jump to monopoly levels when price-matching guarantees are offered,[4] and the large number of firms in the markets where the practice is observed is also inconsistent with the basic cartel theory. The price discrimination theory accounts for the observation of price matching in markets with large numbers of firms. It also accounts for the fact that in most cases only some firms in a market offer the guarantees. But this theory requires that the price-matching firms set higher list prices than at least some non-price matching firms. This prediction is inconsistent with the limited evidence available.[5] Moreover, the price discrimination theory requires that a substantial number of consumers actually invoke their rights under the guarantee. No evidence of a significant rate of cashing-in of the guarantees has been offered by the theory's proponents. Our own data (discussed below) show redemption rates of 5% or less for most price-matching firms in an illustrative sample and much lower for some price-matching firms in the sample.[6]

This paper examines the incentives for price matching guarantees generated by

[4] For example, Hess and Gerstner (1991)'s study of grocery stores in the Raleigh, North Carolina market found a 1.6% increase in market prices when one of the supermarkets adopted a price-matching policy. Given that the supermarkets in question collectively had 92% of the market, and the products in question are largely staples, this price increase seems too small to suggest a cartel.

[5] Arbatskaya, Hviid, and Shaffer (1999) examine advertised tire prices across the U.S., and find a statistically significant lower price for dealers offering low-price guarantees (although only for price-beating dealers; for price-matching dealers the results are inconclusive). Second, consumers believe that price-matching firms are lower priced than non-price-matching firms (Jain and Srivastava 2000; Srivastava and Lurie 2001). These papers report results from simulated shopping experiments where consumers were asked about their perceptions of, and shopping preferences between, price-matching and non-price-matching stores. They find that (1) subjects perceive price-matching stores to be lower priced than non-price-matching stores, (2) they are more likely to choose to shop at price-matching stores than at non-price-matching stores, and (3) they are more likely to stop searching, by as much as 25 percent, after they have been to a price-matching store than after they have been to a non-price-matching store. Consumers can be wrong, of course, but in general the observed behaviour of economic agents deserves some weight.

[6] For other theories of price-matching see Hviid and Shaffer (1999), Jain and Srivastava (2000) and Chen, Narasimhan and Zhang (2001).

three assumptions about retail markets. Our first central assumption is that information about prices is costly (Stigler 1961, Salop and Stiglitz 1977). These costs, which vary across consumers, are interpreted very generally as the costs of obtaining, organizing and memorizing information on the prices of hundreds of products offered at different retailers. Our second assumption is that, unlike prices, a firm's pricing *policy*—whether it offers a price-matching guarantee or not—is easily observed by consumers. The third assumption is that firms are heterogenous in a way that is reflected in variety in optimal prices.

We propose that price matching guarantees are a credible way to communicate to high information-cost consumers that "we are a low-priced outlet." This signal is valuable to the firm because it increases the firm's demand. The signal is credible because of the vigilance of the low time-cost consumers, the consumers who are directly informed about prices. Where optimal prices vary across firms, a high-priced store that offered a price-match guarantee would be delegating its pricing decision for informed consumers to its rival. It would thus be forced to offer a low (and suboptimal) price to informed consumers.

By directing busy consumers towards low-priced firms, price matching allows the low prices induced in the market by low-time-cost customers to be shared by busy customers. Thus price matching guarantees can *facilitate* the positive search externalities that active shoppers provide in markets with imperfect consumer information and transactions costs. This is the opposite of Edlin's argument that price matching limits the extent of these externalities.

We start our analysis of price-matching guarantees by re-examining the cartel-facilitating theory of price matching in a traditional duopoly model with homogeneous products and zero transactions costs. We then add, in sequence: product differentiation (or travel costs), consumer heterogeneity in price information costs, and firm heterogeneity in optimal pricing. Surprisingly, the explanation of price-matching as a facilitating device is strengthened under some conditions along this path. The full set of assumptions, however, supports our theory of price-matching as conveying information about prices. We contrast the testable implications that emerge from our theory with those flowing from the two theories of price matching as anticompetitive and compare the predictions with the facts flowing from an illustrative sample of retailers. In the conclusion, we discuss a Grossman-Stiglitz (1980) paradox that emerges when one endogenizes consumers' choices between active shopping, investing in information about prices, and inference shopping, relying solely on announced price policies in decisions about where to shop.

2 The Model

2.1 Assumptions

We list at the outset the full set of assumptions of our model. This is the simplest set of assumptions that supports our theory of price matching as information conveyance. We will invoke various subsets of these assumptions as we reexamine the traditional theory of price matching as a facilitating device and extend it, in steps, to markets where consumers face information costs.

1. Two firms, located at opposite ends of a unit line segment, compete in prices for the sale of a physically identical product.

2. Consumers are uniformly distributed along the line segment, with unit density. A consumer's location is indexed by s.

3. Consumers bear a common travel cost, t, that is independent of the quantity purchased.

4. Consumers have a common, quasi-linear utility, $u(q)+e$, where q is the amount of the product consumed and e is expenditure on other goods. $u(.)$ is strictly increasing and concave. Travel costs are independent of q, so the net surplus for a consumer at s travelling to, say, firm 1 and purchasing at price p is $v(p)-st$ where $v(\cdot)$ is the indirect utility function corresponding to $u(\cdot)$. We assume that $v(0)$ is finite. A consumer's demand function upon reaching a firm is $q(p)=-v'(p)$.

5. Firms face random, independent draws on unit costs of production: c_L with probability λ and c_H with probability $(1-\lambda)$; $c_L < c_H$.

6. After the simultaneous realization of costs, observed by both firms, the firms simultaneously decide whether or not to announce price-matching guarantees. A price-matching guarantee means that any consumer of a firm who has information as to the price charged by the other firm can obtain the same price at the price-matching firm. After the price-matching guarantee decisions, firms simultaneously decide on list prices.

7. A fraction α of the consumers at any location are uninformed about the list prices charged at the firms.[7] The remaining fraction, $1-\alpha$, are informed about list prices. Price-matching guarantees, however, are observed by all consumers.[8]

8. After prices are decided upon, consumers decide from which firm to purchase. Uninformed consumers condition their expectations of prices at the two firms on the firms' price-matching decisions, and purchase where their expected consumer surplus net of transportation costs is higher. Once inside a store, they pay list prices. With respect to informed consumers, we must distinguish between list prices and transaction prices. The transaction price at a store that has announced price-matching is, for informed consumers, the minimum of its list price and the list price of its rival; the transaction price at a store that has not announced price matching is its list price.

9. When $\alpha = 0$, total profits are concave in the common price charged by both firms, and individual profit functions satisfy strategic complementarity, and the contraction-mapping property.[9]

[7] We emphasize that we are exploring the *consequences* of costly price information, but do not explain in the model *why* this information is costly. In reality, there are thousands of retail prices to keep track of at each outlet and price information costs are largely the time costs of organizing and retaining this information; in our model, however, each store sells a single product at a single price.

[8] In keeping with the assumption of bounded consumer rationality, we assume that consumers can remember only whether or not a firm has announced that it will *at least* match prices. Price *beating* policies, such as "we will refund 110 percent of any price difference" are therefore not considered.

[9] This regularity condition on the demand functions is extended to the case of $\alpha > 0$ below,

2.2 Price-matching as a facilitating device

To develop the theory of price-matching guarantees as supporting cartel pricing consider two firms selling an identical product with identical costs, c, which decide simultaneously whether to announce price-matching guarantees prior to competing in prices. In terms of the above set of assumptions, $t = 0$, $\alpha = 0$ and the distribution of costs is degenerate at c. Let m denote the monopoly price given demand $q(p)$ for the product, and let "PM" and "no-PM" refer to decisions to announce PM and not to announce PM, respectively.

Proposition 1 *If $t = 0$, $\alpha = 0$ and $c_L = c_H \equiv c$, then in the subgame following {PM,PM}, any $p \in [c, m]$ can be supported as the Nash equilibrium transaction (and list) price for both firms. For the entire game, the set of subgame-perfect Nash equilibria includes PM adopted by both firms, PM adopted by only one firm, and PM adopted by neither firm.*

The first part of this proposition follows from the facts that if each firm chooses $p \in [c, m]$ as its list price, following {PM, PM}, then neither has a positive incentive to increase its list price since this will leave its transaction price unchanged; and either firm would lose by dropping its list price because this would decrease the transaction prices of both firms.[10] The only equilibrium of the pricing subgame following {no-PM, no-PM} is clearly the Bertrand equilibrium (c, c). Following PM by only one firm (say, Firm 1), the best response of Firm 2 to any $p_1 \in [c, m]$ is to match p_1: above p_1, Firm 2 faces payoffs from (p_1, p_2) identical to those of the unrestricted Bertrand game and will therefore not price higher than p_1 under Assumption 9, and Firm 2 will not

after the introduction of necessary concepts. Strategic complementarity means that each firm's best response is a strictly increasing function of its rival's price; the contraction mapping property is that the slope of the reaction function is strictly less than 1. The conditions on demand that are sufficient for these properties are the following: Given the parameters t, c_L,and $q(\cdot)$: for all $s_u \in (0, 1)$ and all $p_1, p_2 \in (c_L, 1)$, the demand D_1 facing Firm 1 satisfies: (1) $\frac{\partial^2 \ln D_1(p_1,p_2;s_u)}{\partial p_1 \partial p_2} > 0$, (2) $\left|\frac{\partial \ln D_1(p_1,p_2;s_u)}{\partial p_1}\right| > \frac{\partial \ln D_1(p_1,p_2;s_u)}{\partial p_2}$, and (3) $\left|\frac{\partial^2 \ln D_1(p_1,p_2;s_u)}{\partial p_1^2}\right| > \frac{\partial^2 \ln D_1(p_1,p_2;s_u)}{\partial p_1 \partial p_2}$ and similarly for the demand facing Firm 2.

[10] In addition, the pair of transactions prices $\{m, m\}$ can be supported by a Nash equilibrium in which one firm sets a list price m and the other firm sets any list price above m.

undercut p_1 since it knows that any price drop would be matched automatically by its rival. Firm 1, however, will always undercut any price higher than c on the part of Firm 2. Therefore (c, c) is the only equilibrium of this pricing subgame, as well. From this characterization of the equilibria in the subgames, it follows that {PM,PM} is part of a subgame-perfect Nash equilibrium (e.g. the equilibrium in which (m, m) follows {PM, PM}). The action pairs {no-PM, PM} and {PM, no-PM} are supported as actions of one subgame-perfect Nash equilibrium by the selection of (c, c) as the equilibrium of the pricing subgame following {PM, PM}. This selection leaves neither firm with the incentive to match a PM strategy. Finally, the pair {no-PM, no-PM} is part of a subgame-perfect Nash equilibrium (whatever the equilibrium selected for the pricing subgame under {PM, PM}) since a unilateral move by one firm to PM has no impact on subsequent prices.

Thus, if we restrict ourselves to the conventional equilibrium concept, subgame-perfect Nash equilibrium, the claim that cartel pricing can be supported by price-matching guarantees finds relatively weak formal support. It is one possible outcome of the appropriate game, but only one. Decisions on the part of both firms to refrain from price-matching is always an equilibrium. Moreover, even when price matching is adopted by both firms, it may be followed by the competitive, Bertrand prices that would emerge without price matching.[11]

2.3 Price matching with product differentiation

The extension to product differentiation is captured by a single change in assumptions: let $t > 0$. Spatial models are often used to represent product differentiation in general (Eaton and Lipsey (1989)). In our context of retail markets, we have in mind a literal interpretation of travel costs, with the location of a consumer representing the relative

[11] The multiplicity of equilbria under price matching was pointed out, first, we believe, by Chen (1995) in a model with no product differentiation, no heterogeneity among firms, and perfectly informed consumers. He invokes a refinement of Nash equilibrium to support monopoly pricing as the only equilibrium, as we will do, but he uses a forward induction argument rather than our approach, which uses trembling-hand perfection. The elimination of other equilibria in Chen's model requires both another transaction cost—that firms incur a fixed cost in announcing a low price guarantee—and the assumption that firms can implement price-*beating* guarantees just as easily as price-matching guarantees.

convenience to the consumer of one store versus the other to purchase an identical good. Retail shopping is not costless and it is natural to ask how these costs affect the use of price matching guarantees as a facilitating device.

Proposition 2 *If $t > 0$, $\alpha = 0$ and $c_L = c_H \equiv c$, then in the subgames following no-PM by at least one firm, the unique Nash equilibrium has both firms listing the Bertrand price p^B, which satisfies $c < p^B < m$. In the subgame following {PM, PM}, any $p \in [c, m]$ can be supported as the Nash equilibrium transaction (and list) price for both firms. For the entire game, the set of subgame-perfect Nash equilibria includes PM adopted by both firms, PM adopted by only one firm, and PM adopted by neither firm.*

The proposition reads identically to Proposition 1, except that $t > 0$, and the proof is the same. But in this case of product differentiation, price matching carries the threat to the firms of making the market *more* competitive: the equilibrium list price in the subgame following {PM, PM} could be less than p^B, the Bertrand price without any price matching whatsoever. The threat of greater competition can rationally—i.e., as part of a subgame-perfect equilibrium—deter a firm from matching its rival's PM strategy. Product differentiation introduces the "strategic uncertainty" that PM can lead to more intense competition, weakening the power of price matching as a facilitating device.

To the extent, however, that one is willing to trust a refinement of the sub-game equilibrium concept, the theory of PM as a facilitating device is sustained. Suppose that in the subgame under {PM, PM}, in either the traditional case or the product differentiation case, we assume that an individual player is unsure of which price its rival going to play. Contrary to the assumptions of Nash equilibrium, the player does not know with certainty which action the rival is going to take but instead perceives the rival as having a "trembling hand," setting each price with positive probability. Then each player would adopt the monopoly price as its list price: whatever the realization of its rival's strategy, the player is never worse off by adopting m rather than any other price $\widehat{p}$, since if the rival's price is below $\widehat{p}$ the rival's price determines the same transactions price for both firms whether m or $\widehat{p}$ is played whereas if the rival's price is above $\widehat{p}$, then the play of m ensures a higher set of transactions prices (but not higher than m) and therefore yields a higher payoff. The requirement that a Nash equilibrium be robust in this sense is captured by the refinement of "normal form trembling–hand perfection".[12] In a trembling–hand perfect equilibrium, the (m, m) price pair is ensured following price matching by both players since m is the only price that is not weakly dominated.

Moving up the game tree to the price matching decisions requires another application of trembling–hand perfection. The pair of actions in which neither player is adopting PM is part of a subgame-perfect Nash equilibrium since unilateral adoption of PM has no impact on payoffs. Again, however, the attribution to each player of the anticipation of a "tremble" on the part of the rival leads to {PM,PM} as the predicted outcome since no-PM is for each player weakly dominated by PM. In sum:

Proposition 3 *If $\alpha = 0$, $t \geq 0$, and $c_L = c_H \equiv c$, the only trembling–hand perfect equilibrium in the pricing subgame following {PM,PM} is (m, m). The normal-form trembling–hand perfect equilibrium for the entire game yields {PM,PM} and (m, m).*

2.4 Price matching with uninformed consumers

The next transaction cost ingredient along the path towards our full set of assumptions is heterogeneous consumer information about prices. We now assume $\alpha \in (0, 1)$: some consumers are uninformed about prices. While uninformed consumers do not observe prices, they can observe the price-matching policy of the firm. This captures in extreme form the ease with which price-matching policies are observed relative to prices. We shall see that even an arbitrarily small number of uninformed consumers *strengthens* the facilitating-device theory of price-matching guarantees. Whereas the prediction of cartel pricing following price-matching previously required a refinement of the Nash equilibrium concept, with even a small number of uninformed consumers, this outcome arises as an equilibrium in strictly dominant strategies.

[12] Define a totally-mixed strategy as a mixed strategy that puts positive probability on each element in a strategy set. A normal form *trembling-hand perfect equilibrium* is a strategy pair (σ_1, σ_2) that is the limit of some sequence (σ_1^n, σ_2^n) of totally mixed strategies with σ_i being a best response to σ_j^n for all n and $j \neq i$ (Selten 1975).

Demand and profit functions: First we characterize the firms' demand functions. Informed consumers choose stores based on their list prices and on their price-matching policies; uninformed consumers choose stores based on their expectations of list prices at the two stores (which can be a function of the observed price-matching policies). The uninformed consumers' price expectations result in a marginal uninformed consumer, s_u. Uninformed consumers to the left of s_u buy from Firm 1; uninformed consumers to the right of s_u buy from Firm 2. It is important to note that at the stage of the game when the two firms compete in prices, each is taking its set of uninformed consumers as an exogenous endowment, over which it has monopoly power.

Suppose neither firm offers a price-matching guarantee. Then list prices and transaction prices are the same for everyone. Given list prices (p_1, p_2), the demand facing Firm 1 is given by

$$D_1(p_1, p_2; s_u) = [(1-\alpha)s_I(p_1, p_2) + \alpha s_u] \cdot q(p_1) \tag{1}$$

where $s_I(p_1, p_2) \equiv (1/2) + [v(p_1) - v(p_2)]/2t$ is the marginal informed consumer. Note that the elasticity of demand flowing from the uninformed consumers is solely from $q(.)$, the *market* demand. All consumers who purchase from a particular firm purchase the same amount, by Assumption 4. We denote profits as $\pi_1(p_1, p_2; s_u) = (p_1 - c_1)D_1(p_1, p_2; s_u)$. It is also convenient to define $\pi_1^I(p_1, p_2) = (p_1 - c_1)s_I(p_1, p_2)q(p_1)$ as Firm 1's profits per unit density of informed consumers. Similarly $\pi_1^U(p_1; s_u) = (p_1 - c_1)s_u q(p_1)$ so that $\pi_1(p_1, p_2; s_u) = \alpha\pi_1^U(p_1; s_u) + (1-\alpha)\pi_1^I(p_1, p_2)$.

If both firms offer price-matching guarantees, then Firm 1's demand function is

$$D_1(p_1, p_2; s_u) = (1-\alpha)(1/2)q(\min(p_1, p_2)) + \alpha s_u q(p_1) \tag{2}$$

In this case, $\pi_1(p_1, p_2; s_u) = \alpha\pi_1^U(p_1; s_u) + (1-\alpha)\pi_1^I(\min(p_1, p_2), \min(p_1, p_2))$.

Finally, if Firm 1 is the only one to offer a price-matching guarantee, then its demand function depends on whether its list price is greater or less than Firm 2's list price.

$$D_1(p_1, p_2; s_u) = \begin{cases} [(1-\alpha)s_I(p_1, p_2) + \alpha s_u] \cdot q(p_1) & \text{if} \quad p_1 \le p_2 \\ (1-\alpha)s_I(p_2, p_2)q(p_2) + \alpha s_u q(p_1) & \text{if} \quad p_1 > p_2 \end{cases} \tag{3}$$

In the region $p_1 \leq p_2$, Firm 1's demand function is the same as its demand function when neither firm offers a price-matching guarantee, and its profit function is $\pi_1(p_1, p_2; s_u) = \alpha\pi_1^U(p_1; s_u) + (1-\alpha)\pi_1^I(p_1, p_2)$. In the region $p_1 > p_2$, Firm 1's profit function is $\pi_1(p_1, p_2; s_u) = \alpha\pi_1^U(p_1; s_u) + (1-\alpha)\pi_1^I(p_2, p_2)$.

Firm 2's demand and profit functions are defined analogously.

To characterize the pricing outcomes, we first extend the regularity assumptions on demand (Assumption 9) to the price games induced by arbitrary s_u:

9A. The demand functions conditional upon arbitrary s_u yield total profits that are concave in a common price charged by both firms, and individual profit functions that satisfy strategic complementarity and the contraction-mapping property.[13]

Proposition 4 *If* $\alpha > 0$ *and* $c_L = c_H \equiv c$ *(whether* $t = 0$ *or* $t > 0$*), then in the subgame following {PM,PM},* (m, m) *is a dominant strategy equilibrium.*

Equilibrium in strictly dominant strategies is the strongest form of prediction in game theory, stronger in particular than Nash equilibrium in that it relies simply on the assumption that each player chooses a strategy that *guarantees* strictly higher payoffs than any other strategy (regardless of the strategy chosen by its rival). With $\alpha > 0$, following {PM,PM}, each firm's payoff now includes both the payoff from selling to informed consumers in competition with the other firm, as well as the payoff as a monopolist selling to half of the α uninformed consumers. The price m is a weakly dominant strategy with respect to the game played for the demand of informed consumers, but is a strictly dominant strategy with respect to the uninformed consumers. Adding the payoffs from selling to the two groups of consumers yields m as a strictly dominant strategy, for arbitrarily small α, proving the proposition.

This result contrasts sharply with Hviid and Shaffer (1999) who argue that even an epsilon amount of transactions costs of a different kind—costs of redeeming a

[13] The conditions that must be satisfied by the demand functions are given in footnote 7. These have been verified for a wide range of numerical parameters for the model, but are violated in some ranges, where only mixed strategy equilibria exist. In considering the range of parameters where payoffs are well-behaved, we follow a long tradition in the economics of spatial models (see Eaton and Lipsey (1989)).

price-matching offer—moves a price equilibrium following price-matching from collusive pricing to marginal cost pricing.[14] The mere presence of an epsilon of high-transactions cost consumers in our model serves to strengthen, not weaken, the cartel-facilitating role of price-matching in that it eliminates completely the coordination problem that arises when there is a continuum of equilibria between marginal cost and monopoly price. As a general matter, the impact of even an arbitrarily small amount of transactions costs on market organization can be very sensitive to the nature of the transactions costs.

2.5 Price matching as information provision

The final ingredient in our transactions cost theory is firm heterogeneity. Any source of firm heterogeneity that leads to differences in optimal prices across firms will do. Possible sources of heterogeneity in reality include vertical differentiation, e.g., choice of an up-market location versus an inconvenient but low-rent location, a difference in the service levels provided by stores, or cost differences between firms. The key is that whatever the source of heterogeneity, a high-priced firm would find it costly to *delegate* its pricing decision to a low-priced firm because their interests differ. Price-matching inherently involves delegation of the decision on transaction prices to the firm that is, in equilibrium, lower priced. Market conditions that make it costly for a high-priced store to delegate its transaction prices to a low-priced store means that a high-priced store will not mimic the price-matching behavior of a low-priced store, and thus provide some foundation for a theory of price-matching as signaling low prices. We adopt the simplest source of such market conditions, namely a random difference in the unit cost of the two firms.

We thus have the full set of assumptions laid out at the beginning of this sec-

[14] When firms sell undifferentiated products even a penny of consumer transactions cost in redeeming a price-matching offer is enough to allow a firm profitably to undercut the prevailing price, making the entire collusive arrangement unravel. This is because consumers, having observed an undercutting firm, would prefer to buy from the undercutting firm rather than incur the transaction cost of invoking his or her rights under the price-matching guarantee at the higher priced store. This argument, however, depends upon firms being completely identical from the perspective of each consumer and hence is ruled out if one recognizes an additional transaction-cost based feature of retail markets, that a consumer finds some stores more convenient to shop at than others.

tion. We look for the perfect Bayesian Equilibrium in the game described by these assumptions. The equilibrium consists of price match and pricing strategies (for firms) that are rational given expectations of uninformed consumers; purchase decisions of informed and uninformed consumers that are rational given the expectations of the uninformed consumers; and an expectational distribution of prices for each uninformed consumer, as to the price set by each firm, given the firms' observable price-matching decisions, that satisfies Bayes' law (along the equilibrium path of the game) given the equilibrium price-match decisions by firms and the probability λ.

The equilibrium that we have described cannot be solved for via backwards induction since there are no proper subgames (subgames not linked by uninformed consumers' information sets).[15] However, the simple demand structure of the model provides an approach to solving the game, which involves finding expectations that are self-realizing.

Consider an arbitrary set of price expectations on the part of uninformed consumers, i.e., an expected price at each outlet for each combination of price-match decisions. Let $\widehat{V} = (\widehat{v}_{00}, \widehat{v}_{01}, \widehat{v}_{10}, \widehat{v}_{11})$ represent the surplus expected from Firm 1 by each uninformed consumer, gross of transportation costs, in each of the consumer's information sets. $\widehat{v}_{01}$, for example, is the consumer's expected surplus following the consumer's observation that Firm 1 has not announced price-matching and Firm 2 has announced price-matching. Expected surplus from Firm 2 is given symmetrically.

These expectations determine a partition of the set of uninformed consumers, some going to Firm 1, the others to Firm 2. This partition, in turn, determines for each firm a measure of "captive" uninformed consumers, each with demand $q(p)$, over which the firm has monopoly power: uninformed consumers have rational price expectations in equilibrium but do not respond, in their decisions of where to shop, to (off-equilibrium) changes in a firm's price. Let (i, j) represent the pair of price matching decisions, with $i = 1$ if Firm 1 has announced price-matching, etc. Following symmetric price-match decisions by the two firms, the partition is $[0, 1/2]$ and $[1/2, 1]$; following asymmetric price-match decisions, such as $(1, 0)$, the partition is $[0, \widehat{s}_u]$ and $[\widehat{s}_u, 1]$, where $\widehat{s}_u$, the marginal uninformed consumer, satisfies $\widehat{v}_{10} - \widehat{s}_u t = \widehat{v}_{01} - (1 - \widehat{s}_u)t$,

[15] By contrast, in the previous section, the pricing subgames were proper subgames because consumers there were as as well-informed about the firms' costs as the firms themselves.

i.e., $\widehat{s}_u = \frac{1}{2} + (\widehat{v}_{10} - \widehat{v}_{01})/2t$. The impact of the game's history at the point of simultaneous decisions on prices is summarized by these captive consumers, as well as by which of the two firms are competing under the constraint of a binding price-matching agreement. We refer to the pricing game that is induced by an arbitrary set of expectations as an *induced price game.*

Consider the induced price games generated by the expectations vector $\widehat{V}$ for a given pair of cost realizations. For each pair of price-match decisions, our assumptions guarantee a unique equilibrium in the induced price game. These equilibria, in turn, define a set of payoffs for each firm for each pair of price-match decisions. The mapping from pairs of price-match decisions to payoffs determines the equilibrium price-match decisions of each firm given a pair of cost realizations. Extending this procedure to each pair of cost realizations, a mapping from pairs of cost realizations to pairs of equilibrium price-match decisions, and, finally, to pairs of equilibrium price distributions is defined. This mapping, in conjunction with λ, determines a set of "actual" expected surpluses at each firm for the uninformed consumers. In other words, this procedure defines an operator Φ, via $\Phi(\widehat{V}) = V$, on the possible set of surplus expectations in R^4. A fixed point of Φ, V^*, yields a Perfect Bayesian equilibrium of the entire game.

In fact, the fixed-point problem admits an even simpler representation. Given that what matters at the price competition stage is the marginal uninformed consumer determined by the uninformed consumers' expectations, the fixed-point problem is to find an $\widehat{s}_u$ such that the vector of marginal consumers following the four possible combinations of price match decisions, $(1/2, 1 - \widehat{s}_u, \widehat{s}_u, 1/2)$, induces price games that rationalize this vector. In other words, the task is to find price-matching decisions and pricing decisions that are individually rational for the firms given an $\widehat{s}_u$, and which in turn *generate* $\widehat{s}_u$ as rational on the part of consumers.[16]

We shall show that it is possible to find a $\widehat{s}_u > 1/2$ that has this property. That is, we will show that uninformed consumers expecting to pay equal prices at the two firms following symmetric price-matching decisions, and a lower price at the price-matching firm following asymmetric price-matching decisions, can be rational given

[16] The summary of expectations by a single parameter, in the search for self-realizing expectations, allows us to use the simplest of all fixed-point theorems, namely the intermediate value theorem.

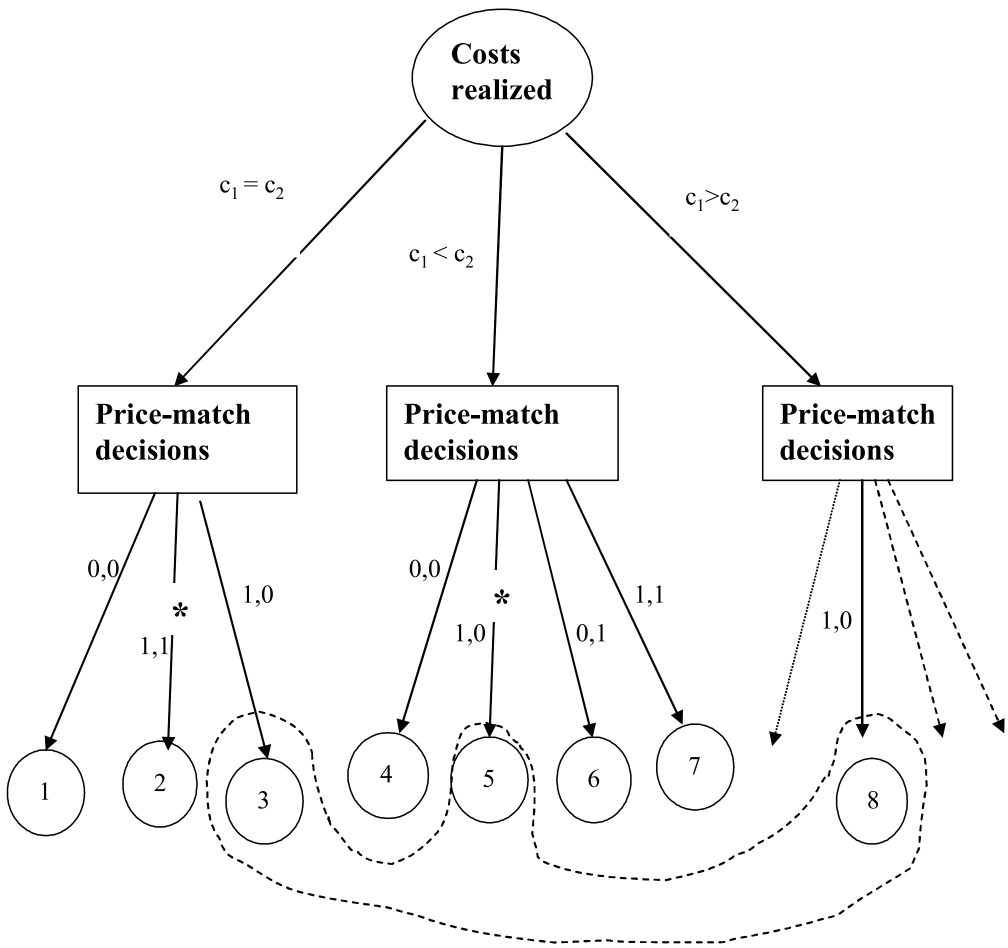
the firms' optimal responses to these expectations.

Induced price games

Figure 1 depicts the game tree in a substantially summarized form. At the top of the tree, nature draws random costs for each firm from $\{c_L, c_H\}$. The four possibilities are summarized in the diagram by the outcomes of symmetric costs ($c_1 = c_2$), and the asymmetric cost outcomes $c_1 < c_2$ and $c_1 > c_2$. Following the cost realization, firms make price-match decisions, which then result in expectations that induce a vector $(1/2, 1-\widehat{s}_u, \widehat{s}_u, 1/2)$. The price games following price match decisions $(1,0)$ are grouped in an "information set," which (again, in summary form) corresponds not to the information of players taking decisions at the nodes in the set but rather to the information of consumers. Consumers cannot distinguish among these three nodes. The price games in this information set are induced by the same $s_u > 1/2$, the single parameter summarizing consumer expectations; the remaining price games depicted in the diagram follow symmetric price-match choices and are induced by $s_u = 1/2$. After a symmetric cost realization, it is enough to keep track of three price-match histories: both firms choose 1, both choose 0, or only one firm (say, firm 1) chooses 1. After asymmetric cost realizations, however, we must keep track of both asymmetric price match decisions, $(1,0)$ and $(0,1)$. In sum, there are ten induced price games that must be solved for. Symmetry allows us to reduce these to the eight games labelled 1 through 8 in Figure 1.

We discuss the equilibria in the induced price games in the following order, in pairs: {1, 4}, {2, 7}, {3, 5}, {6, 8}. The induced price game at node 1 is simply the Bertrand game with symmetric costs and $s_u = 1/2$. The equilibrium price is between cost and the monopoly price; it reflects the endowment by each firm of half of the captive (uninformed) consumers. The equilibrium at node 4 is also a Bertrand equilibrium, conditional upon $s_u = 1/2$, but with asymmetric costs.

The games at node 2 and node 7 are also induced by $s_u = 1/2$. At node 2, we get cartel pricing, (m, m). In fact this is a dominant strategy equilibrium per Proposition 4. The equilibrium at node 7 also yield monopoly prices, (m_1, m_2). At this node, the low-cost firm, Firm 1, sets its monopoly price as its list price since this maximizes both its profits from informed consumers (for which this firm has been effectively



Price-match decisions: "1,0" : price-matching by firm 1 only
"1,1": price-matching by both firms, etc.

Induced price game: n

Figure 1: Summary of price-matching game

"delegated" the pricing decision) and its profits from uninformed consumers. The high-cost firm, Firm 2, delegates its pricing for informed consumers to the low-cost firm, and simply sets its own (higher) monopoly price as its list price for uninformed consumers. Firm 2 has no incentive to reduce its price within the range (m_1, m_2) since this only lowers its profits from uninformed consumers, and has no incentive to lower its price below m_1 since this price drop would be automatically matched by Firm 1 with a consequent drop in Firm 2's profits.

Turning now to node 3, if $s_u \geq 1/2$, only a mixed-strategy equilibrium exists with support $[p_1^B(s_u), m]$. To see this, note first that Firm 2's transaction price for all consumers is its list price. Its best response function is $BR_2(p) = p$ for all $p \in [p^B, m]$ where p^B is the Bertrand equilibrium price that would set in a price game induced by the same s_u but without price-matching. This is because (a) Firm 2 knows that any price cut below p will be automatically matched for its informed consumers by Firm 1, and since $\pi_2(p, p)$ is decreasing in p in this range such undercutting does not pay; and (b) under the regularity conditions (9A) on demand, $\pi_2(p, p_2)$ is decreasing in p_2 for $p_2 \geq p \geq p^B$ so responding with a price $p_2 > p$ would not be profitable. (To summarize (a) and (b), were it not for the price-match guarantee, it would pay Firm 2 to undercut any price $p \in (p^B, m]$ by Firm 1, but facing a price-match guarantee, the best that Firm 2 can do is match Firm 1.) Firm 1's profits, however, are always higher by setting m than by matching any price p less than m since by raising its price to m Firm 1 collects maximum profits from the captive uninformed consumers without affecting its price p (obtained under the price-matching guarantee) to informed consumers. It follows that the only possible pure strategy equilibrium is (m, m). But this pair is not an equilibrium: $BR_1(m) < m$ because the elasticity of D_1 at (m, m) exceeds the elasticity of the demand curve $q(p)$ (as seen from equation (1)); i.e. it pays Firm 1 to undercut Firm 2 at this price pair.

A mixed strategy equilibrium exists per Glicksberg's (1952) theorem since the payoff functions of the firms are continuous. Using a conventional argument, we can show that under the regularity assumptions on demand, the strategy subset $[0, p^B)$ can be eliminated through iterated strict dominance.[17] Moreover for Firm 2, $(m, \infty]$ is

[17] To prove that the strategy subsets $[0, p_1^B)$ and $[0, p_2^B)$ can be eliminated through iterated strict dominance under the price game following price-matching by Firm 1 only, note first that these subsets

strictly dominated by m since $\pi_2(p_1, p_2)$ is decreasing in p_2 for any p_1 and any $p_2 > m$ and similarly for Firm 1. Thus only the strategy subset $[p^B, m]$ for each player survives iterated elimination of strictly dominant strategies. The supports of mixed strategy equilibrium strategies are always contained within strategy sets surviving the iterated elimination of strictly dominant strategies. In sum, the induced price game at node 3 yields a mixed strategy equilibrium with supports in $[p^B, m]$.

At node 5, if $s_u \geq 1/2$, note first that p_1^B may or may not be greater than p_2^B: $s_u \geq 1/2$ encourages $p_1^B > p_2^B$ while $c_1 < c_2$ encourages $p_1^B < p_2^B$. If $p_1^B < p_2^B$, there are two possibilities for an equilibrium: a pure-strategy equilibrium or a mixed-strategy equilibrium. If a pure strategy equilibrium exists, it is the same as the asymmetric-cost Bertrand equilibrium in node 4. But a pure-strategy equilibrium will not exist if Firm 1's best response to $p_2^B(s_u)$ is to raise its list price to m_1, thus charging the monopoly price to its share of uninformed consumers and leaving the transaction price for its informed consumers at p_2^B $(> p_1^B)$. The condition determining whether

can be eliminated through iterated strict dominance of the unconstrained pricing game because under the regularity conditions in assumption 9A, this game has a unique Bertrand equilibrium and satisfies strategic complementarity. The results of Milgrom and Roberts (1990) imply that in any strategic complementarity (more generally, supermodular) game with a unique equilibrium, the equilibrium can be solved via iterated elimination of strictly dominated strategies. Next, the same iterated elimination procedure eliminating the strategy subsets $[0, p_1^B)$ and $[0, p_2^B)$ in the unconstrained pricing game continue to hold in the game following price-matching by Firm 1 only. For Firm 2, if a particular interval $[0, P_2]$ is eliminated from Firm 2's strategy set because any $p \in [0, P_2]$ is dominated by some $\widehat{p} > P_2$, then $\widehat{p}$ continues to dominate p in the price-game following price-matching by Firm 1, because raising price from p to $\widehat{p}$ now not only increase's Firm 2's own price but possibly its rival's price as well. To make the analogous argument for Firm 1, let $p \in [0, P_1]$ is dominated by some $\widehat{p} > P_1$. Raising price from p to $\widehat{p}$ is still dominant against any $p_2 < p$ since this would increase price for the uninformed consumers while leaving the price for the informed consumers unchanged; if raising price to $\widehat{p}$ were profitable in the unconstrained game, an increase to this price must be profitable for only the uninformed consumers. Raising price from p to $\widehat{p}$ is dominant against any $p_2 > \widehat{p}$ is profitable since over this range the profit of Firm 1 is unaffected by the price-match constraint. Finally, consider any $p_2 \in [p, \widehat{p}]$. Raising price from p to p_2 is profitable for Firm 1 in the unconstrained game because assumption 9A ensures the concavity of profits in price for Firm 1 in this game; the same increase is profitable in the price-match game since over this range Firm 1's profits are unaffected by the constraint. Raising price further from p_2 to $\widehat{p}$ is profitable since this increase has no effect on the price paid by informed consumers but does increase the price paid by uninformed consumers. Thus p continues to dominated by $\widehat{p}$ in the price-match game. Since the iteration of strictly dominant strategies eliminates $[0, p_1^B)$ and $[0, p_2^B)$ in the unconstrained game, it eliminates these sets in the pricing game following price-match by Firm 1 only.

the pure strategy equilibrium will emerge is the inequality in

$$\begin{aligned} \pi_1(p_1^B, p_2^B; s_u) &= \alpha\pi_1^U(p_1^B; s_u) + (1-\alpha)\pi_1^I(p_1^B, p_2^B) \\ &\geq \alpha\pi_1^U(m_1; s_u) + (1-\alpha)\pi_1^I(p_2^B, p_2^B) = \pi_1(m_1, p_2^B; s_u) \end{aligned} \tag{4}$$

The first term on the right hand side of this inequality is greater than the first term on the left hand side; Firm 1 gains profits from the uninformed consumers by raising its price. But the second term decreases moving from the left hand side to the right hand side: $p_2^B > p_1^B$, and the best response to p_2^B with respect to π_1^I is less than p_1^B (which is the best response with respect to π_1) since the demand from informed consumers alone is more elastic than the total demand. The inequality is satisfied if α is sufficiently small or the cost difference, $c_H - c_L$, is sufficiently large. Since small α and large cost differences will be required for our main proposition, we focus on the case where condition (4) is satisfied.[18] (If condition (4) is violated, then only a mixed strategy equilibrium with supports $[p_1^B(s_u), m_1]$ and $[p_2^B(s_u), \max(m_1, BR_2(m_1))]$ exists.)

Finally, at node 6, where only Firm 2, the high-cost firm, offers a price-matching guarantee, $p_1^B < p_2^B$ when $s_u \leq 1/2$. The equilibrium when $s_u \leq 1/2$ may involve the monopoly prices (m_1, m_2) that arise when both firms offer price-matching. Clearly, Firm 1 has no incentive to deviate at these prices. Firm 2, however, may have an incentive to undercut m_1: Firm 2's profit at its (Bertrand) best response to m_1 may exceed its profit from accepting transaction prices m_1 and m_2 in response to m_1. In this case, only a mixed strategy equilibrium with supports $[p_2^B(s_u), m_1]$ and $[p_2^B(s_u), m_2]$ exists. Similarly for node 8 with $s_u \geq 1/2$. This completes the characterization of equilibria in the induced price games.

Equilibrium price-match decisions

Suppose $s_u = 1/2$ at node 3 (as well as at nodes 1 and 2) in Figure 1. By Proposition 4, now both firms will choose price-matching in a subgame-perfect Nash equilibrium. In other words, node 3 will not be reached in equilibrium under $s_u = 1/2$. The same applies when $s_u > 1/2$ at node 3: now Firm 2, by adopting price matching, can increase its share of captive consumers from less than 1/2 to 1/2.

If $s_u > 1/2$ following $(1, 0)$, then the information set drawn is also not reached

[18] Small α and large $c_H - c_L$ also rule out $p_1^B \geq p_2^B$.

through node 8. To see this, consider node 9, the induced price game following $c_2 < c_1$ and $(1,1)$; this induced price game yields equilibrium prices (m_1, m_2) just as node 7 does, but at node 9, $m_2 < m_1$. At node 8, as argued above, there are two possibilities for the price equilibrium: a pure-strategy equilibrium (m_1, m_2), or a mixed-strategy equilibrium with supports $[p_1^B(s_u), m_1]$ and $[p_2^B(s_u), m_2]$. In the former case, Firm 2's profits are $\pi_2(m_1, m_2; s_u > 1/2)$; in the latter case, they are less than $\pi_2(m_1, m_2; s_u > 1/2)$ because there is a positive probability that Firm 1 will price below m_2 when Firm 2 prices at m_2. By matching Firm 1's price-match announcement and moving to node 9, Firm 2 *ensures* the prices (m_1, m_2). In addition, it gains uninformed consumers. Together these two effects yield $\pi_2(m_1, m_2; s_u = 1/2) > \pi_2(m_1, m_2; s_u > 1/2)$. Node 8 is thus not reached in equilibrium if $s_u > 1/2$.

To find a Perfect Bayesian Equilibrium of the entire game, it remains to show that (a) at the single node, 5, remaining in the information set, self-fulfilling expectations on the part of the uninformed consumer can support a marginal uninformed consumer $s_u > 1/2$; and (b) (1,0) is the optimal price-match decisions following a cost realization in which Firm 1 alone has a low cost. To show (a), consider the marginal informed consumer, s_I, that results from the price game at node 5 by an arbitrary s_u, and define the functional relationship between s_u and s_I by $s_I = G(s_u)$. To find self-fulfilling expectations, it is sufficient to find a fixed point s_u^* of G, i.e., a marginal uniformed consumer that elicits an identical marginal informed consumer, since then assigning as expectations to the uninformed consumers the prices that actually result from s_u^* will result in prices that confirm these expectations.[19] Stated differently, in equilibrium, uninformed consumers infer the same prices that the informed consumers observe. To this end, note that G is a strictly decreasing function, since a shift in the share of captive consumers from Firm 1 to Firm 2 will lower p_1 and raise p_2 in the induced price game, thus inducing more informed consumers to shop at Firm 1. Note further that G is continuous and, since $c_1 < c_2$, $G(1/2) > 1/2$. The three properties of G suffice, by the intermediate value theorem, to show that G has a fixed point $s_u^* > 1/2$.

The final ingredient is the demonstration that (1,0) can be individually rational

[19] Here we take advantage of the assumption that informed and uninformed consumers have the same travel cost, t.

price-match decisions for the two firms following a cost realization (c_L, c_H), when $s_u > 1/2$. In this case, as discussed above, a pure-strategy equilibrium $(p_1^B(s_u), p_2^B(s_u))$ exists when $c_H - c_L$ is sufficiently large and α is sufficiently small. Firm 1, by choosing price-matching, is responding optimally to no-price-matching on the part of Firm 2, since the only impact of its price-match announcement is to attract more captive consumers to a Bertrand price game. As for Firm 2, given $c_2 >> c_1$ and $1 - \alpha \approx 1$, Firm 2 will only lose profits by matching Firm 1.[20] To see this, select an extreme cost difference: suppose that the cost difference is so large that $m_1 < c_2$. In this case, by matching Firm 1's price-match announcement, Firm 2 causes its transaction price to informed consumers to fall below its cost. If the proportion of informed consumers is large, then Firm 2 clearly loses from this strategy. In sum:

Proposition 5 *Under assumptions 1 to 9A, if $c_H - c_L$ is sufficiently large and α is sufficiently small, ceteris paribus, then a Perfect Bayesian Equilibrium exists in which under an asymmetric cost realization only the low-cost firm adopts price matching.*

The critical parameter separating the case of price-matching emerging as a strategy signalling a low price from the role of price-matching as a cartel-facilitating device is the cost difference in the two firms. The logic of this proposition hinges on the *delegation aspect* of price-matching: when invoked by a high-cost firm, a price-matching guarantee essentially delegates to the low-cost firm the pricing decision for the informed consumers. Such delegation has the attraction that the price will be set closer to the cooperative level than the Bertrand price of the high-cost firm. However, the cooperative price that the low-cost firm sets will be *its* monopoly price. When cost differences are large, this price may be too low for the high-cost firm. In contrast, by not offering a price-matching guarantee, the high-cost firm controls its own destiny, albeit in a Bertrand game. So when the number of informed consumers is large and the cost difference between the two firms is large, uninformed—but rational—consumers know that the behavior of informed consumers in invoking their

[20] Now, there are clearly parameters in the model for which Firm 2 will respond by matching Firm 1's price-match announcement. Specifically, if the possible cost difference between the firms is sufficiently small and the proportion of uninformed consumers is sufficiently large, then the only equilibrium is the collusive equilibrium (m_1, m_2).

price-matching rights would penalize the high-cost firm if the latter offered a price-matching guarantee. These consumers know, therefore, that the announcement of price-matching signals a relatively low-cost, low-price firm.

The proof of the proposition, as outlined, adopts an extreme cost difference, resulting in $m_1 < c_2$. A cost difference this large, however, is not necessary for the equilibrium described to emerge. Moreover, we have in mind that the group of firms that are interacting strategically face some competition from possibly close substitutes outside the model, i.e., $q(p)$ is very elastic, so that even a moderate cost difference brings the "monopoly" price of the low-cost firm near the cost of the high-cost firm.

Now that we have established that price-matching can play the role of signalling a low price, the question arises as to the impact of price-matching on prices in the market. The following proposition shows that, surprisingly, the impact of price-matching, when it is used to signal a low price, is to increase the price of the firm adopting price-matching.

Proposition 6 *Compared to the equilibrium of the game in which price-matching is not allowed, the effect of price-matching, when it is adopted in equilibrium by the low-cost firm only (following an asymmetric cost realization), is to increase the price of the price-matching firm and to decrease the price of the non price-matching firm.*

The proposition describes a second surprising effect of price-matching. The impact of adopting the practice is to decrease a rival's price. In the conventional model of price-matching as a facilitating device the very point of a price-match announcement by a firm is to induce its competitors to maintain high prices. In our model, however, uninformed, captive consumers are reallocated to the price-matching firm in the move from the non-price-matching game to the price-matching game. This leads to the convergence of the two prices under price-matching relative to the non-price-matching equilibrium because of the direct effect of the respective changes in price elasticity of demand caused by changes in the quantities of captive consumers (see equation (1)). The direct effect of the change in the own-elasticity of demand for each firm is mitigated, but not completely offset, by the change in the rival's price under strategic complementarity.

The allocative effects of price-matching in the market are two-fold: the effect of the information conveyed by the price-matching announcement on uninformed consumers' decisions of where, and if, to buy; and the effect of the price changes on the purchases of all consumers. The first of these impacts can only be a positive impact on overall welfare since consumers shop under full information. The second impact on welfare is mixed—but being a price impact on welfare is only of second order. As the parametric example in the following subsection illustrates, the overall welfare impact of price-matching in this model is positive for a wide range of parameters. We caution, however, that a third allocative effect of price matching, its impact on consumers' incentive to invest in information about prices (i.e., to price shop) is missing in the simple model. This effect is discussed in the conclusion.

2.6 Example

Assume a linear demand function $q(p) = 1 - p$. Then $v(p) = (1/2) - p + p^2/2$, and the monopoly prices are

$$\begin{aligned} m_L &= 0.55, \\ m_H &= 0.77. \end{aligned}$$

Let $t = 0.2$, $\alpha = 0.2$, $c_L = 0.1$, and $c_H = 0.54$.

Suppose the cost realization is $c_1 = 0.1$, $c_2 = 0.54$, and we are at node 5 in Figure 1 where only Firm 1 offers a price-matching guarantee. The equilibrium in the induced price game, given a $s_u > 1/2$, is simply the Bertrand prices when neither firm offers a price-matching guarantee. The demand functions for the two firms are given by (1), and it is easy to see that the profit functions satisfy Assumption 9A. The first-order conditions defining price choices yield cubic equations. Solved numerically, they yield the Bertrand prices $p_1^B(s_u)$, $p_2^B(s_u)$ as functions of s_u. In turn, these Bertrand prices define a mapping from s_u to s_I via $s_I(s_u) = (1/2) + (v(p_1^B(s_u)) - v(p_2^B(s_u)))/2t$.

We calculate the fixed point to be $s_u = 0.809$. The equilibrium (Bertrand) prices are

$$\begin{aligned} p_1^B &= 0.417, \\ p_2^B &= 0.695, \end{aligned}$$

and the firms charge these transactions prices to both informed and uninformed consumers (Firm 1's price-matching guarantee has no force given that its list price is lower). The two firms' profits are calculated to be

$$\begin{aligned} \pi_1 &= 0.149, \\ \pi_2 &= 9.032 \times 10^{-3}. \end{aligned}$$

Note that $v(.417) - (.809)(.2) > 0$: consumers at 0.809 would get a positive surplus by traveling to Firm 1, a necessary condition for an equilibrium. In addition, we need to check that neither firm would want to deviate unilaterally to a different price-matching policy. Firm 1 would not want to withdraw its price-matching guarantee because at node 4 Bertrand prices prevail once again but with fewer captive consumers for Firm 1 ($s_u = 1/2$). Would Firm 2 deviate unilaterally to a price-matching policy? Suppose it did. This will lead to the price game at node 7 with $s_u = 1/2$. At node 7, as discussed previously, both firms will list their respective monopoly prices, so Firm 2's uninformed consumers will pay $m_H = 0.77$ and its informed consumers will pay $m_L = 0.55$. Its profit, given $s_u = 1/2$, will be 7.09×10^{-3}, which is less than what it gets at node 5. So Firm 2 will not deviate to a price-matching policy, and we have a Perfect Bayesian Equilibrium.

Are consumers better off in this equilibrium vis-a-vis the situation where neither firm offers a price-matching guarantee? In the equilibrium, both informed and uninformed consumers split between the two firms according to $s_u = s_I = 0.809$. The prices are as given above, so aggregate consumer welfare is given by

$$\begin{aligned} & \left[\int_0^{.809} (v(.417) - ts)ds + \int_{.809}^{1} (v(.695) - t(1-s))ds\right] \\ = \quad & 0.077. \end{aligned}$$

How does this compare to the situation when price-matching guarantees are not allowed? Without price-matching guarantees, uninformed consumers have no basis for choosing between the two firms. Therefore, they split evenly between the two firms, and the firms' prices are the Bertrand prices corresponding to $s_u = 1/2$. These prices are $p_1^B(.5) = .409$, $p_2^B(.5) = .709$. The marginal uninformed consumer shopping at Firm 2 ends up with negative overall surplus, $v(.709)-(.5)(0.2) = -.058$, even though she expected positive surplus at each store a priori (provided $\lambda > .407$). Note that the informed consumers observe prices, and $s_I = (1/2) + (v(p_1^B(s_u)) - v(p_2^B(s_u)))/2t = .831$. Aggregate consumer welfare is given by

$$\begin{aligned} & (0.2)\left[\int_0^{.5}(v(.409)-t.s)ds+\int_{.5}^{1}(v(.709)-t.(1-s))ds\right]+ \\ & (1-0.2)\left[\int_0^{.831}(v(.409)-t.s)ds+\int_{.831}^{1}(v(.709)-t.(1-s))ds\right] \\ = \; & 0.0756. \end{aligned}$$

In short, consumers are in aggregate better off with Firm 1 offering a price-matching guarantee compared to the situation where neither firm is allowed to offer a price-matching guarantee.

3 Empirical Implications

How can we distinguish our signalling theory from the other two main theories in the literature, collusion and price discrimination? The testable implications of the three theories, as summarized in Table 1, are discussed and evaluated against existing and new evidence in this section. To preview the first three implications, for example: the observation of a significant proportion of consumers actually invoking price-matching rights is consistent only with the price discrimination theory, and required by that theory; the adoption of price matching by all firms in the market is consistent only with the collusion theory; the adoption of price matching only by the lowest priced firms in the market is consistent only with the theory of price-matching as a signal of low prices.

	Implication	Collusion theory	Price discrimination	Price-matching as signal
1	Significant percentage of customers invoke PM rights	**X**	✓	**X**
2	PM adopted by all firms in the market	✓	**X**	**X**
3	PM firms are the lowest-priced in the market	**X**	**X**	✓
4	PM increases prices of PM-adopting firms	✓	✓	✓
5	PM increases prices of non-PM-adopting firms	✓	✓	**X**
6	PM profitable with large number of firms	**X**	✓	✓
7	PM policy terminates consumer search	**?**	**X**	✓
8	PM adopted only by firms with small market shares	**X**	✓	**X**

Table 1: Summary of testable implications

The number of customers invoking price-matching rights

If price matching is used for the purpose of price discriminating, then a significant number of customers must exercise their rights under the guarantee to obtain lower prices from the price-matching firm. Gateway, for example, would not incur the expenses of an advertising campaign to advertise its price-matching guarantee in order to offer selective discounts to, say, 2 or 3 percent of its customers. On the other hand, if price matching is a cartel coordinating device, then the guarantee of matching discounts is a credible threat which the theory predicts will not be exercised in equilibrium, and if price-matching is a signal of low prices, then its purpose is solely as a credible signal that is costly for higher-priced (and higher cost) firms to duplicate. Since it is offered by only the lowest-priced firms in the market, the rights under the guarantees are again not exercised. In short, the observation that none or very few customers invoke the guarantee to obtain lower prices from the price-matching firm is consistent with the cartel theory and the signalling theory but not with the price discrimination theory.

How many consumers redeem price-matching guarantees? Surprisingly, there are

	#	# with low price guarantee	# with PM guarantee	% redeeming guarantee (median)	% redeeming guarantee (range)
Department store	8	5	4	5.0	.001–25
Electronics	14	7	5	5.0	0–10
Office supplies	9	5	3	2.0	1-5
Sporting goods	6	4	4	5.0	1-10
Cameras	9	1	1	7.5	7.5
Total	46	22	17	5.0	0–25

Table 2: Summary of data

no published data on this question. Accordingly, we surveyed 46 prominent retailers in the U.S. and Canada, from five categories: department stores (e.g., Sears, Bloomingdales), electronics stores (e.g., Radio Shack, Audio Accessories), camera stores (e.g., Central Camera, B&H Photo/Video), sporting goods (e.g., Oshman's, Academy Sports), and office supply stores (e.g., Office Max, Goeller's Office and Art Supplies).[21] Each of these retailers was asked a series of questions about their price matching policies: whether they offered a low price guarantee, and if so, whether it was a price-matching or a price-beating guarantee, percent of customers redeeming a low price guarantee, and whether the redemption rate reported was based on a study by the firm or a "best guess." In addition, we have information on whether the retailer is a "chain store" (one outlet of a multi-outlet retailer) or not.[22] Not all retailers with a low price guarantee reported a redemption rate—four of the 22 retailers offering a low price guarantee refused to divulge their redemption rate—and fifteen of the eighteen retailers who did report, acknowledged that the redemption rate was a "best guess" rather than based on an internal company study. Table 1 summarizes the data.

[21] This was not a random sample of retailers. Our aim, however, is to show that examples of price matching that can be plausibly explained only by the signalling motivation are found in actual retail markets.

[22] In general, we spoke with people in middle or senior management: the most common rank of person surveyed, among the chain stores, was vice-president, and among the non-chain stores, store manager.

Percentage of customers redeeming guarantee	Number of stores
0	1
0.001	1
1	2
1.5	1
2	1
5	7
7.5	2
10	3
25	1

Table 3: Reported Frequency of Redemption of Guarantee

The average reported redemption rate across the 18 retailers who offered a low price guarantee is 5.8% and 12 of the 18 reported redemption rates of 5% or less. Critically, among the four retailers whose reported redemption rates were based on internal studies rather than managers' perceptions, the redemption rates were .001%, 1%, 2% and 10%. The 3 cases of redemption rates of 10%, and 1 case with 25%, are perhaps consistent with the price discrimination story (assuming, of course, that the reporting is accurate). But the majority of the cases are not. At a minimum, it seems highly unlikely that these retailers are using their low price guarantees to price discriminate between informed and uninformed consumers if only 5 percent or less of consumers are redeeming. Certainly, in 3 of the 4 most reliably reported data points, the price discrimination theory is not plausible. On the basis of this empirical implication alone, we are left with the price signalling theory and the cartel facilitation theory to explain the majority of cases in our data set.

Universality of price-matching within a market

The cartel theory, as it has been developed in the literature, predicts that all firms in the market offer price matching. In the absence of some asymmetries in the incentives for firms to cheat on a cartel price, there is no reason for the device to be adopted by only some firms within a given (product and geographic) market. An extension to the theory would allow a high-cost firm to offer a price-matching guarantee in order to deter a lower-cost firm from cheating: lower-cost firms generally have more incentive to cheat on cartels than higher-cost firms. The signalling theory predicts, by contrast, that *only* the lower-cost firms adopt price-matching. The price-discrimination theory is also inconsistent with all firms adopting price-matching, since a firm can use price-matching as a price discrimination device only if some other firm charges a lower price in equilibrium. This theory predicts, as well, that the higher-cost firm would have a greater incentive to offer a price-matching guarantee since higher-cost firms would like to charge higher prices than lower-cost firms. In sum, the adoption of price-matching by all firms in a market is consistent only with the cartel theory, and to the extent not all firms do so, the signalling theory predicts that only the lower-cost firms would offer them, whereas the other theories predict the opposite.

Our data clearly show that not all retailers in a given market offer price-matching guarantees. For instance: among electronics retailers, Best Buy offers a price-matching guarantee, but Radio Shack does not; among department stores, Dillards offers a price-matching guarantee, but Bloomingdale's does not; among office supply stores, Staples offers a price-matching guarantee, but Berger Brothers Office Supply (in Wilmington, Delaware) does not; among sporting goods retailers, Oshman's offers a price-matching guarantee, but Academy Sports does not; among camera stores, all except one retailer (Merkle Camera in Toronto) does not offer a price-matching or a price-beating guarantee.

Who invokes price-matching?

What distinguishes the retailers who offer a low price guarantee from those who do not? We would like to have direct measures of costs, or indices of prices for similar products across the sample of stores. Instead, we suggest that the status of a store as a chain store outlet is negatively correlated with price. In Table 2 we show a cross-tabulation of the retailer's low price guarantee policy and whether or not it is a chain store. Clearly, whether the retailer is a chain store or not matters (Pearson's $\chi^2(1) = 19.01$, $p < .001$). Since chain-store retailers are likely to have lower costs than non-chain-store retailers, this supports the signalling theory, but not the cartel or price discrimination theories.

Moreover, the evidence examined on the rate of redemption of price-matching

	Chain store	**Not a chain store**
Low price guarantee	21	1
No guarantee	8	16

Table 4: Cross-tabulation of low price guarantee provision and whether or not the retailer is a chain-storer

guarantees shows that in a substantial number of cases the rate is very small, suggesting that in these cases the price-matching firms are at or near the low-price point of the market.[23]

Impact of price-matching on prices of price-matching firms

If one is examining prices in a given product market across a variety of geographic markets or areas, or comparing prices in a given region before and after price-matching is adopted, then the prediction of the cartel theory is that price-matching causes the prices of the price-matching firms to increase. After all, the purpose of the instrument is to protect cartel pricing in this theory. Under the price discrimination theory, the list prices of a firm will also rise with the adoption of price-matching as the firm avails itself of the opportunity to charge higher prices to consumers with more inelastic demands. (The average transactions price, net of price-matching refunds, may rise or fall.) In the signalling theory, where the purpose of price-matching is to

[23] Edlin (1997) offers an argument as to why the price-matching firms might not be the *highest* priced in the market:

"Another reason that price will vary among sellers and that only some sellers should be expected to adopt price matching is that sellers often have different costs. When costs differ, the monopoly price for a low-cost seller will be lower than for a high-cost one. The low-cost seller will have no reason to raise its price above its own monopoly price, but the high cost seller will typically charge a higher price. If a seller has costs so high that it is unprofitable to sell at the price of low-cost firms, it will abandon its matching policy and specialize in selling to uninformed buyers. . .Thus, in practice, we should not necessarily expect every firm to post the same price, nor every firm to offer a matching policy." (footnote deleted). However. in Edlin's model, the only basis for price-matching is price discrimination, under which theory the *lowest* firms in the market have no incentive for invoking the practice.

signal a low price, the impact of price-matching on the prices of the firms adopting the practice is, ironically, to increase prices (Proposition 6). The direction of price change by price-matching firms offers no test for distinguishing among the theories (although it does offer a test of the theories collectively). The magnitude of the price increase, however, may offer a distinguishing test. However, we are not aware of any study that performs such a test. Hess and Gerstner's (1991) observation of a 1.6% increase in supermarket prices in the Raleigh, North Carolina market from "before" to "after" is based on *market* data—average prices across price-matching and non-price-matching stores.[24] Since the supermarkets in question had over 92% of the relevant market, and the products in question were generally leading-market-share brands in staple categories (ketchup, mayonnaise, milk, etc), this seems too low to represent a plausible move from competitive to cartel pricing. Anecdotally, they provide some evidence against the price discrimination theory in their study. One of the supermarkets offering a price-matching guarantee has a policy of lowering its *shelf-price* when a customer reports a lower price at a competitor.

Impact of price-matching on prices of non-price-matching firms

The signalling theory predicts that in a market where a single firm adopts price-matching, the impact is to lower the prices of other firms (Proposition 6). On the other hand, in the cartel theory (if plausibly extended to a model with asymmetries in incentives to invoke price-matching), the very purpose of the instrument is to provide rivals with the incentive to set or maintain high prices. The price discrimination theory would also predict an increase in non-price-matching rivals' prices via strategic complementarity since we have argued earlier that price-matching firms under this theory will increase their prices. Hess and Gerstner's (1991) study finds a 2.7%

[24] Strictly speaking, what they observe is a 1.6% increase in the ratio of "included market prices" to "excluded market prices." Here, "included" ("excluded") refers to a basket of goods covered (not covered) by the price-matching guarantee. Given that the "included" and "excluded" products were different—for example, perishable store brands figured prominently in the latter basket, but not in the former—there is a possibility that different cost and demand dynamics applied to the numerator and denominator of the ratio. Furthermore, the "before"-"after" comparison in the study is not a pure comparison: one of the supermarkets had a price-matching policy in force even in the "before" period.

increase in the prices of one of three non-price-matching firms after the introduction of price-matching by a store, but this finding is subject to several caveats as discussed above.

Profitability in a market with many firms

Notwithstanding the theory that price-matching facilitates cartel pricing, cartels are realistic only for markets with specific structural features: small number of firms, some barriers to entry, relatively stable costs, transparent prices. The price discrimination theory does not require a small number of firms (Edlin 1997). The signalling theory is developed in this paper in a model with only two firms, but this is not necessary for the theory. The explanation could plausibly be extended to the case of a large number of firms in a market as long as there is price dispersion, arising from variation in costs or variation in consumer search costs or in tastes with respect to the trade-off between lower prices and higher quality or service. Firms at the lower end of the price distribution could offer price-matching as a signal of low prices.

Impact of price-matching on consumer search

In the price discrimination theory, the discovery by a consumer that a store has a price-matching policy is evidence to the consumer that other stores are charging even lower prices. This evidence should, if anything, encourage the consumer to search further. In the cartel theory, a consumer might search further in response to the discovery of a price-matching policy if the consumer believed that the practice was being invoked by a "pocket" of colluding firms selling close substitutes within a broader, differentiated product market; or a consumer, having read the literature, might infer that all firms are cartelized, so further search would be futile. The impact on consumer search is ambiguous. In the signalling model, a price-matching announcement would tell the consumer that the firm was relatively low-priced and that further search was unlikely to be optimal. Srivastava and Lurie (2001) find experimental evidence that consumers are less likely to search after encountering a firm with a price-matching policy. They expose consumers to several simulated shopping environments in a controlled experiment and ask them about their perceptions of the price-matching and the non-price-matching stores. They find that subjects are more likely to stop searching, by as much as 25 percent, after they have been to a price-matching store than after they have been to a non-price-matching store.[25]

4 Conclusion

Our results show that the addition of an arbitrarily small percentage of imperfectly informed consumers can strengthen the traditional argument that price-matching can facilitate cartel pricing.[26] When product differentiation is recognized, this arbitrarily small transaction cost changes price-matching from a strategy that carries the threat (for the firms) of increasing competition to a strategy that ensures cartel pricing as a dominant strategy equilibrium.

But the model yields another explanation for price-matching: that the announcement communicates a firm's position as the lowest-priced in the market. The signal has value because price-matching policies are clear, easily understood messages that are much easier to remember than a firm's complete list of prices. The signal has credibility because heterogeneity across firms means heterogeneity in optimal prices, and because price-matching entails delegation. A high-priced firm that mimiced the price-matching announcement of a low-priced firm would be delegating its pricing, for informed consumers, to a rival whose optimal price is different than its own. The credibility of the signal to uninformed consumers is ensured by the behavior of

[25] In addition to the data described here, anecdotal evidence of the use of price-matching by stores that are well-known to be among the lowest-priced in the market (and perhaps of low service as well) has been suggested to us. These examples include cases of firms with small market shares, but generally these are the exceptions (implication 8 of Table 1). As observed in Table 4, the stores offering price-matching policies tend to be the larger ones. For instance, price-matching policies are widely observed among "big box" retailers like Best Buy and Circuit City—firms that provide a minimal level of service and low prices, and enjoy substantial economies of scale.

[26] The discontinuity is reminiscent of the Diamond Paradox that an arbitrarily small degree of (universal) search costs can leave the monopoly price as the only possible outcome of a market with frictions (Diamond 1971).

informed consumers.

A rich set of implications distinguishes the cartel theory, a price discrimination theory (which is also a theory of price-matching as anticompetitive in that it implies that the strategy allows the containment of competition-enhancing search externalities), and the price matching-as-information theory. Price matching is far too common, and retail market structures far too competitive, to be explained by the cartel theory. In a substantial number of cases from a sample of prominent retailers the discrimination theory can be rejected. In particular, the rate of redemption of price-matching guarantees is of the order of 5%. Also, the empirical literature suggests that consumers view price-matching stores as more competitive than non-price-matching stores. Price matching in our model accords with the business person's view of price-matching as a way to compete.

We have assumed in this paper that the only variation among firms that could be reflected in price differences is cost variation. In reality, in many retail markets, firms have access to very similar technologies, but end up choosing technologies of different costs. For example, firms may choose to adopt a low-cost distribution strategy to sell products at the low-price, low-quality, low-service end of the market in order to attract customers with such preferences (e.g., Wal-Mart) or choose a high-cost distribution strategy to sell products at the high-price, high-quality, high-service end of the market (e.g., Bloomingdales). Many models with consumer heterogeneity predict vertical differentiation even where firms face identical technological choice sets. We believe that the theory of price-matching policies as signals of low prices could be extended to such models.

In our model price-matching by conveying information about prices allows a more efficient allocation of consumers to firms. The low-cost firm achieves a higher market share under price-matching. In a model extended to vertical differentiation, price-matching would also allow a more efficient match of consumers to firms based on quaility preferences. But another extension of the model yields an important qualification to efficiency claims. Suppose that consumers decide endogenously whether to become informed about prices (and be "active shoppers") or to shop on the basis of inferences drawn from stores' price-matching policies (thus remaining "inference shoppers"). A Grossman-Stiglitz paradox arises. If inference shopping is less costly, no consumers will want to become active shoppers. But the presence of some active shoppers is necessary for information conveyance by price-matching – and inference shopping – to be possible in equilibrium. This paradox can be resolved in a "noisy rational expectations" framework, in which the price-matching policy conveys some but not all information about prices.[27] The resolution, however, reveals a qualification to the efficiency of price-matching in directing consumers towards low-cost firms: price matching encourages many consumers to become inference shoppers rather than active shoppers. Since only active shopping or search disciplines prices in a market, a potential effect of price matching in this extended model is a reduction in the competitive discipline that search imposes on prices.

[27] One can assume, for example, that price-matching is decided after the realization of "long-term" costs, but a short-term cost shock (such as the amount of excess inventory) is realized after the price-match decision but before prices are set.

References

[1] Arbatskaya, M., M. Hviid, and G. Shaffer (1999),"Promises to Match or Beat the Competition: Evidence from Retail Tire Prices," *Advances in Applied Microeconomics* 8: 123-138.

[2] d'Aspremont, C., Gabszewicz, J.J. and Thisse, J.F. (1979), "On Hotelling's stability in competition," *Econometrica*, 47:1145-1150

[3] Chen, Z. (1995),"How Low is a Guaranteed-Lowest-Price?," *Canadian Journal of Economics*, 28: 683-701.

[4] Chen, Y., C. Narasimhan and Z. J. Zhang (2001), "Consumer Heterogeneity and Competitive Price-Matching Guarantees," *Marketing Science,* 20 (Summer).

[5] Diamond, Peter A (1971), "A Model of Price Adjustment," *Journal of Economic Theory*, 156-168.

[6] Eaton, B.C. and R. Lipsey (1989), "Product Differentiation," in *Handbook of Industrial Organization*, R.Schmalensee and R.Willig, eds., North-Holland.

[7] Edlin, A. S. (1997), "Do Guaranteed-Low-Price Policies Guarantee High Prices, and Can Antitrust Rise to the Challenge?" *Harvard Law Review*, 111 (December), 528-575.

[8] Edlin, A. and E.Emch (1999), "The Welfare Losses from Price-Matching Policies," *Journal of Industrial Economics*, 47: 145-167.

[9] Glicksberg, I. L. (1952), "A Further Generalization of the Kakutani Fixed Point Theorem with Application to Nash Equilibrium Points," *Proceedings of the National Academy of Sciences,* 38, 170–174.

[10] Grossman, S. and Stiglitz, J. E. (1980), "The impossibility of informationally efficient markets," *American Economic Review*, June, 393-408.

[11] Hay, G. (1982), "Oligopoly, Shared Monopoly, and Antitrust Law," *Cornell Law Review* 28: 439-481.

[12] Hess, J.D. and Eitan Gerstner (1991), "Price-matching Policies: An Empirical Case," *Managerial and Decision Economics*, 12: 305-315.

[13] Hviid, M. and G. Shaffer (1999), "Hassle Costs: The Achilles Heel of Price-Matching Guarantees," *Journal of Economics and Management Strategy* 8: 489-522.

[14] Iyer, G. (1998), "Coordinating Channels Under Price and Nonprice Competition," *Marketing Science,* 17: 0338-0355.

[15] Jacquemin, A. and Slade, M. (1989), "Cartels, Collusion and Horizontal Merger," in *Handbook of Industrial Organization*, R. Schmalensee and R. Willig, eds, North-Holland.

[16] Jain, S. and J. Srivastava (2000), "An Experimental and Theoretical Analysis of Price-Matching Refund Policies," *Journal of Marketing Research* XXXVII (August): 351–362.

[17] Katz, M. (1989), "Vertical Contractual Relations," in Handbook of Industrial Organization, R. Schmalensee and R. Willig, eds, North-Holland.

[18] Salop,S. (1982), "Practices that (Credibly) Facilitate Oligopoly Coordination," published in J.Stiglitz and F. Mathewson, eds., *New Developments in the Analysis of Market Structure*, Cambridge, MA: The MIT Press (1986).

[19] Srivastava, J. and N. Lurie (2001), "A Consumer Perspective on Price-Matching Refund Policies: Effect on Price Perceptions and Search Behavior," *Journal of Consumer Research* 28 (September): 296–307.