ON THE USE OF LOW-PRICE GUARANTEES TO DISCOURAGE PRICE-CUTTING: A TEST FOR PAIRWISE-FACILITATION

by

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Abstract

This paper formulates a novel test to assess whether, and to what extent, the use of low-price guarantees in practice is consistent with firms using them to discourage rivals from cutting prices. The test is based on a comparison of paired observations of prices on identical items set by firms with and without low-price guarantees. Using data on tire prices advertised in newspapers, we find that the majority of observations involving price-matching guarantees are consistent with their use as a device to discourage price-cutting (we cannot rule it out), whereas the majority of observations involving price-beating guarantees are not. The evidence also supports claims made in recent theoretical studies that low-price guarantees that apply only to advertised prices should be distinguished from low-price guarantees that apply to actual selling prices.

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1 Introduction.

Retailers often advertise that they will not be undersold. Some firms promise to match a lower price by a competitor (price-matching guarantee), while others promise to beat a competitor's lower price by some percentage of the difference (price-beating guarantee). Examples include some of the largest companies in retailing, and the scope of coverage ranges from tires and office products on the one hand to electronics, grocery items, and general merchandise on the other.[1]

Although it would be difficult to find a consumer who has not heard of these guarantees, and although consumers may say they like them, it is not obvious that they make consumers better off. On the one hand, low-price guarantees are seemingly pro-consumer. If one firm has a lower price and its rival has a low-price guarantee, consumers can ask that the lower price be matched or beaten. Consumers who are unaware of the rival's low-price guarantee are no worse off, while consumers who are aware of the rival's low-price guarantee are weakly better off—a Pareto-improvement.[2] On the other hand, since a firm with a weakly lower price may have less to gain from lowering its price when its rival has a low-price guarantee than when it does not (because if asked its rival would be committed to matching or beating the price), one would not expect the firm's prices to be the same in the two states of the world all else equal. To the extent that low-price guarantees alter the incentive structure of the game and discourage price-cutting, consumers may be worse off.

In this paper we formulate a test to assess whether, and to what extent, the use of low-price guarantees in practice is consistent with firms using them to discourage price-cutting. The test is based on a comparison of paired observations of prices on identical items set by firms with and without low-price guarantees. There are two possible outcomes. Either the firm without the low-price guarantee has a higher price than the firm with the low-price guarantee, or it has a weakly lower price. If the latter is the case, then we cannot rule out the possibility that the low-price guarantee

[1] See the low-price guarantees of Tire Kingdom, Staples, Circuit City, Tesco, and Sears to name a few.

[2] Consumers are strictly better off if they buy from the rival and request that the firm's price be matched or beaten.

is inhibiting the rival firm from lowering its price. In this case, we say that the observation is consistent with the use of low-price guarantees to discourage price-cutting. However, if the firm without a low-price guarantee has a *higher* price than the firm with a low-price guarantee, then the gain to the first firm from lowering price below its current level is either unaffected or increased by its rival's low-price guarantee all else equal.[3] In this case, we say that the observation is not consistent with the use of low-price guarantees to discourage price-cutting (the rival's low-price guarantee cannot be said to be keeping the firm's price higher than it would be otherwise).[4]

Using data on tire prices advertised in U.S. Sunday newspapers, we pair price quotes on identical items (same tire make and model number) in the same city on the same day, where one price quote comes from a firm with a low-price guarantee and the other price quote comes from a firm without a low-price guarantee. If low-price guarantees have no effect on observed advertised prices, then we would expect the assignment of which firm has the higher price in each paired observation to be random. Not surprisingly, this hypothesis can be rejected at the 5% significance level whether we look at the sample of all low-price guarantees, the sample with price-matching guarantees only, or the sample with price-beating guarantees only. However, our results suggest that whether the firms with low-price guarantees tend to have higher or lower prices than the firms without low-price guarantees *does* depend on the particular sample. We find that the majority of pairwise observations involving price-matching guarantees are consistent with their use as a device to discourage price-cutting, while the majority of pairwise observations involving price-beating guarantees are not.

Our results imply that firms with price-matching guarantees tend to have weakly higher advertised prices than firms without guarantees while firms with price-beating guarantees tend to have

[3]The comparison is between the rival having a low-price guarantee versus having no guarantee holding fixed all advertised prices. The idea is that the low-price guarantee will either have no effect on selling prices, or it will decrease one or more selling prices, increasing the incentive of the firm without a low-price guarantee to lower its price.

[4]The argument implicitly assumes that the first firm's profit function is concave. Concavity implies that if lowering price below the current level were profitable, then the firm without the low-price guarantee should either lower its price until it reaches its unconstrained maximum, or until the rival's low-price guarantee begins to have bite.

lower advertised prices. These results are surprising because they suggest that price-matching and price-beating guarantees might be serving different purposes in practice (previous literature often fails even to distinguish between price-matching and price-beating guarantees). The results are also surprising because one might have thought that, if anything, price-beating guarantees would be more effective at discouraging price-cutting than price-matching guarantees, not less effective.

The data also suggests that there is a difference between low-price guarantees that apply to firms' selling prices and low-price guarantees that apply to firms' advertised prices. We find that low-price guarantees that apply to firms' selling prices (whether of the price-matching or price-beating kind) are more likely to be consistent with their use as a device to discourage price-cutting than low-price guarantees that apply only to advertised prices. Moreover, within the sample of paired observations in which the low-price guarantee applies to advertised prices only, the difference between price-matching and price-beating guarantees is insignificant. These results support the claims made in recent theoretical studies (Edlin, 1997; Kaplan, 2000) which suggest that the key distinction in determining whether low-price guarantees can facilitate high prices is knowing whether the low-price guarantees apply only to advertised prices or whether they also apply to selling prices. Theory suggests that the former are less likely to be anticompetitive, and our results are supportive.

The rest of the paper is organized as follows. Section 2 provides an overview of related literature. Section 3 proposes a test to assess whether low-price guarantees are discouraging price-cutting. Section 4 applies the test to paired observations of prices on identical items advertised by tire retailers on the same day and in the same newspaper. We focus on the differences between price-matching and price-beating guarantees, and between advertised and selling prices. Section 5 concludes.

2 Background on related literature

Since our purpose in this paper is assess the empirical relevance of the common view that low-price guarantees can discourage price-cutting, we focus on the strand of literature that began with

Hay (1982) and Salop (1986).[5] In the simplest anticompetitive story, two firms sell a homogeneous product to fully informed consumers and there are no hassle costs. In the absence of price-matching guarantees, Bertrand competition leads to marginal-cost pricing for the usual reasons. However, with price-matching guarantees, there exists an equilibrium in which each firm adopts a price-matching guarantee and prices at the monopoly level. Collusive prices are supportable because neither firm has an incentive to undercut the other since each is committed to matching the lowest price. This result has been extended to n firms (Doyle, 1988) and price-beating guarantees (Dixit and Nalebuff, 1991). It has been shown to be robust to whether the guarantees and prices are chosen simultaneously or sequentially (Chen, 1995), and to whether the products are homogeneous or asymmetrically differentiated (Logan and Lutter, 1989). And it has been applied to address important issues relating to product variety (Zhang, 1995) and free entry (Edlin and Emch, 1999).[6]

More recently, a debate has arisen over whether price-beating guarantees are more or less effective than price-matching guarantees in facilitating high prices by discouraging price-cutting. Sargent (1993) argues that price-beating guarantees will be more effective because they have the potential to deliver more severe punishment. Corts (1995) and Hviid and Shaffer (1994) disagree. Corts posits a model with homogeneous firms and shows that the way to undercut a rival is to adopt a price-beating guarantee and post a *higher* price. The difference in posted prices causes the firm's guarantee to be invoked, resulting in a lower effective price. For this reason, Corts argues that Salop's insight is not robust, and that marginal-cost pricing is the only equilibrium. Hviid and Shaffer extend Corts' result to a model with asymmetrically differentiated firms and find that low-price guarantees have no effect on equilibrium prices when price-beating guarantees are feasible.

However, subsequent literature has shown that the Corts and Hviid and Shaffer results implicitly

[5] Other branches of the literature look at the use of low-price guarantees as a means of price discrimination (Png and Hirshleifer, 1987; Corts, 1997; and Chen et al, 2001), and as a signal of low-prices (Jain and Srivastava, 2000; and Moorthy and Winter, 2002). We will discuss our results in the context of these other models in section 4.

[6] There are also a couple of papers that look at less common varieties of price-beating guarantees such as 'Beat or Pay' guarantees (Baye and Kovenock, 1994; Arbatskaya, 2001). We do not consider these varieties.

assume that the low-price guarantees apply to advertised prices and not to selling prices. For example, the firm that adopts the price-beating guarantee and raises its advertised price in Corts' model can only achieve a lower effective price provided its rival's low-price guarantee is not activated, which is the case only if its rival's low-price guarantee is limited to advertised prices. As Edlin (1997) and Kaplan (2000) argue, the ability of low-price guarantees to support supracompetitive prices is restored if the guarantees apply to selling prices. Our finding that low-price guarantees that apply to selling prices are more likely to be consistent with discouraging price-cutting than low-price guarantees that only apply to advertised prices provides some support for this view.

The empirical evidence on low-price guarantees is thin. Part of the problem is that it is difficult to construct the counterfactual 'what would each firm's price be if no firm had a low-price guarantee.' Hess and Gerstner (1991) come the closest to this ideal, as they have data on prices before and after a local supermarket adopted a price-matching policy.[7] They show that price-matching guarantees result in greater conformity in prices and slightly higher market-average prices for products included in the guarantee, relative to those not covered by the guarantee. It is unknown to what extent these findings reflect the specific institutional features of the market they study.[8]

Arbatskaya et al (1999a) conduct a cross-section study (across multiple markets and cities) to analyze the effects of low-price guarantees on the retail tire prices of a particular tire, P185/75R14. They find that although a tire retailer's own price-matching or price-beating guarantee has no significant effect on the retailer's advertised tire price, an increase in the percentage of firms in the same market announcing low-price guarantees tends to raise the firm's advertised tire price. They do not consider relative prices between firms that have low-price guarantees and firms that do not,

[7] One of the supermarkets in their study had a price-matching guarantee throughout the period of study, which complicates the interpretation of their results. For example, it may be that most of the price-raising effects of low-price guarantees occur when the first firm adopts a guarantee, and that subsequent adoption raises prices very little.

[8] The supermarkets studied by Hess and Gerstner matched the prices of the low-price supermarket, *Food Lion*, by automatically lowering the shelf prices of their products. They also regularly published extensive price lists for the products included under their guarantees (over 9,000 items). These factors may have helped facilitate price coordination between firms irrespective of the low-price guarantees. In most other industries, though, firms do not publish extensive price lists, and they match or beat lower prices selectively—only for consumers who ask for refunds.

nor does their paper distinguish between low-price guarantees that apply to advertised prices and low-price guarantees that apply to selling prices, which are the key features of our analysis.

Arbatskaya et al (1999b) document the incidence and variety of low-price guarantees and suggest that there are important differences in the language of price-matching and price-beating guarantees with respect to the number of restrictions imposed and how much search consumers are allowed, e.g., whether consumers are allowed a grace period of 30 days or more to request a refund. Our paper differs in that we have data on prices and can directly test for price differences between firms. Our finding that firms might be using price-beating and price-matching guarantees for different purposes is consistent with their finding of important language differences in these guarantees.

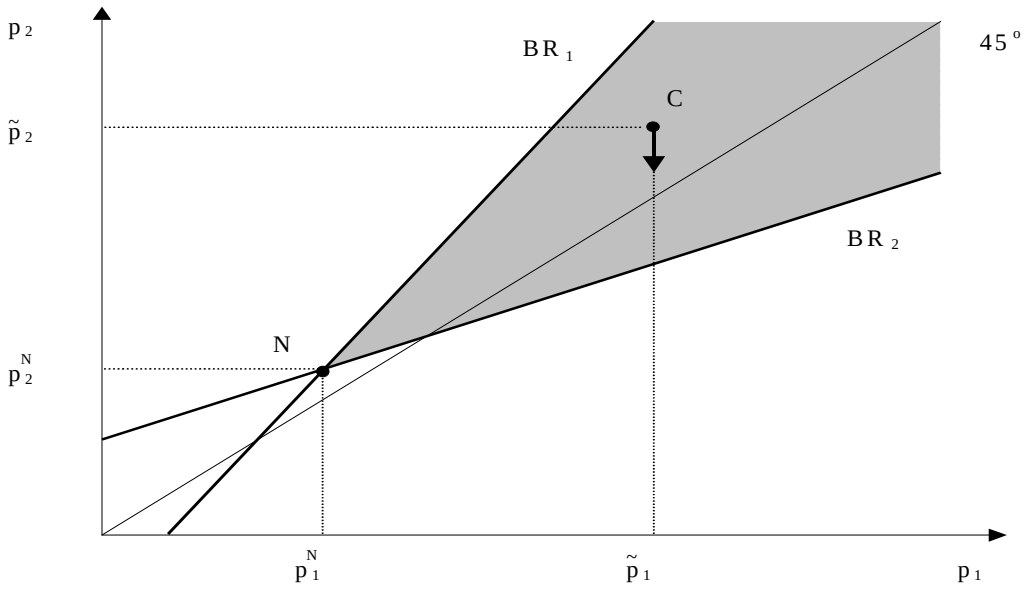
3 Theory

We begin with a stylized fact. In many retail markets, one can find firms that have low-price guarantees and firms that do not have low-price guarantees. This is the case, for example, in the U.S. retail tire market we consider. In these markets, theory has shown that the firms with low-price guarantees necessarily must have weakly higher prices than the firms without low-price guarantees if supracompetitive prices are to be supported (e.g., see Hviid and Shaffer, 1999).[9]

We use this insight to formulate an indirect test to assess whether a firm's low-price guarantee may be discouraging its rival from cutting prices (henceforth we will call this effect *pairwise facilitation*). The test is based on prices advertised by the firm and its rival. Before providing a formal definition of pairwise facilitation, we discuss the concept informally. Consider the following two scenarios that can arise when one firm has a low-price guarantee and the other does not. In the first situation, the firm with the low-price guarantee posts a price of \$65 and the firm without a low-price guarantee posts a price of \$60. In the second situation, the prices are reversed. What can

[9] Asymmetric outcomes in which some firms have low-price guarantees and others do not also arise in Logan and Lutter, 1989; Corts, 1997; Jain and Srivastava, 2000; Chen et al, 2001; and Moorthy and Winter, 2002.

Figure 1: Best-Response Functions of Firms 1 and 2



we conclude about the ability of the low-price guarantee to discourage price-cutting in each case?

If the price of the firm without a low-price guarantee is \$60 and its rival's price is \$65, then we cannot say for sure whether it would have wanted to price at \$59 but for its rival's guarantee. It may be, for example, that consumers incur hassle costs of \$5 to invoke a guarantee, in which case, they may not be willing to invoke the rival's guarantee when the price difference is \$5 but they would be willing to invoke the rival's guarantee if the difference were \$6. On the other hand, if the firm's price is \$65 and its rival's price is \$60, then we definitely know that it is not constrained in cutting price by \$1. Indeed, the firm would be able to lower its price by as much as \$5 before its rival's low-price guarantee is even eligible to be invoked. In this case, we can reject the hypothesis that the rival's low-price guarantee is facilitating the firm's price. Figure 1 illustrates these points.

In what follows, we assume that all consumers are perfectly informed about each firm's price and low-price guarantee policy, and that demand functions are continuous and differentiable in each

firm's selling price. Then Figure 1 depicts the conventional best-response functions of firms competing simultaneously in prices. Their intersection, point N, denotes the Bertrand-Nash equilibrium. If neither firm has a low-price guarantee, equilibrium prices are (p_1^N, p_2^N) in a static non-cooperative price game. Without low-price guarantees, theory suggests that each firm has an incentive to reduce its price in the shaded region between the firms' best-response functions. However, when one firm has a low-price guarantee, theory suggests that some of these points may be sustainable, depending on market asymmetries, the hassle costs of requesting refunds, and which firm has the higher price.

In particular, theory suggests that supracompetitive prices can only be sustained if the firm with the low-price guarantee has a weakly higher price than the firm without a low-price guarantee. To see this, suppose to the contrary that there exists an equilibrium with supracompetitive prices in which only firm 1 has a low-price guarantee and firm 1's price is lower than firm 2's price, as depicted by the point $(\tilde{p}_1, \tilde{p}_2)$ in the shaded region between the firms' best-response functions and above the 45^o line $(\tilde{p}_2 > \tilde{p}_1)$. We want to know if such a point is sustainable. The answer is no because with $\tilde{p}_2 > BR_2(\tilde{p}_1)$, firm 2 would find it profitable to reduce its price while still maintaining its price above that of firm 1 so as not to activate firm 1's low-price guarantee. This contradicts the supposition that prices $(\tilde{p}_1, \tilde{p}_2)$ are mutual best-responses for the firms and form an equilibrium.

These arguments are next formalized for markets with an arbitrary number of firms. We propose the following test for pairwise facilitation: if a firm adopts a low-price guarantee to discourage its rival from cutting prices, then the firm should have a weakly higher advertised price than its rival.

3.1 Preliminaries

In order to formally define pairwise facilitation in an oligopolistic market, it is helpful to introduce the following notations. Denote a set of $n \geq 2$ firms in a market by $I = \{1, ..., n\}$. The firms play a low-price guarantee—price game by choosing low-price guarantee policies g_i, $i \in I$ and advertised prices $p_i \in [0, \infty)$. Whether firms make both decisions simultaneously or sequentially (first selecting

low-price guarantee policies and then prices) does not matter for the analysis below. The set of low-price guarantee policies we consider includes price-matching and price-beating guarantees.

Since our purpose is to critique, or find evidence consistent with, the Hay (1982) and Salop (1986) anticompetitive story of low-price guarantees in which price-cutting is discouraged, we adopt the assumptions of this line of literature and assume that all consumers are fully informed about all prices and low-price guarantees and, for now, that consumers incur no hassle costs when requesting refunds. These assumptions ensure that each firm's advertised price maps into a single selling price.

We can write firm i's selling price as a function of the advertised prices and low-price guarantee policies of all firms in the market, $s_i = s_i(p; g) \in [0, \infty)$, where p is the vector of advertised prices and g is the vector of low-price guarantee policies. For example, if firm i does not have a low-price guarantee, its selling price is equal to its advertised price, $s_i = p_i$. If firm i promises to match any advertised price, its selling price is equal to the minimum of all advertised prices in the market, $s_i = \min(p_1, ..., p_n)$, and if firm i promises to beat any lower advertised price by λ percent of the difference, then $s_i = p_i - \lambda(p_i - \min(p_1, ..., p_n))$. The expression for s_i is more complicated if firm i's guarantee applies to selling prices, and some assumption then needs to be made to ensure that selling prices converge, but in all cases, we have $s_i \leq p_i$ if firm i adopts a low-price guarantee.

The profit function of firm j depends on the selling prices of all firms: $\Pi_j(s(p, g))$, $j \in I$. We assume the profit function is twice continuously differentiable in selling prices and such that selling prices are strategic complements: $\partial^2 \Pi_j(s)/\partial s_i \partial s_j > 0$, $i \neq j$. We assume that there exists a unique profit-maximizing price for firm j, p_j, for any vector of rival prices p_{-j} and vector of low-price guarantees, g. Then, we can define pairwise facilitation and form a test for it as follows: let

$$BR_j(p_{-j}, g) \equiv \arg\max_{p_j} \Pi_j(s(p, g)) \tag{1}$$

Given the assumptions on the profit function, the best-response function is well-defined.

Definition: Firm i's low-price guarantee *facilitates* firm j's price in an equilibrium (p^*, g^*) if

$$p_j^* \equiv BR_j(p_{-j}^*, g^*) > BR_j(p_{-j}^*, g^{*i}), \tag{2}$$

where $g^{*i} = (g_1^*, ..., g_i = \varnothing, ..., g_n^*)$, $i \neq j$, and $\varnothing$ means no guarantee.

In other words, firm i's low-price guarantee facilitates firm j's price in an equilibrium if in the absence of the low-price guarantee firm j can profit from lowering its price, holding all other advertised prices and low-price guarantees fixed. We will refer to this situation as pairwise facilitation.

3.2 Test for Pairwise Facilitation

Having defined pairwise facilitation, we can now describe a test for it based on observations of prices and low-price guarantees chosen by pairs of firms. Consider two competing firms selling an identical item, one with a low-price guarantee (firm i) and the other without (firm j). What should be true about the relationship between the firms' advertised prices, p_i and p_j? On the one hand, if low-price guarantees are randomly adopted and have no effects, then we would expect p_i to be higher or lower than p_j with equal probability. On the other hand, if firms are using low-price guarantees to facilitate high prices, then we would expect firm i's guarantee to be facilitating firm j's price most of the time. We will now show that if the low-price guarantee of firm i is facilitating firm j's price, then it must be the case that firm i has a weakly higher advertised price than firm j.

Proposition 1: Consider an equilibrium (p^*, g^*) to the low-price guarantee–price game with n firms. Suppose firm i has a low-price guarantee and firm j does not. If firm i's low-price guarantee is facilitating firm j's price then firm i must be advertising a weakly higher price, $p_i^* \geq p_j^*$, $i \neq j \in I$.

Proof. To say that firm i's low-price guarantee is facilitating firm j's price implies, using (1) and (2), that

$$\arg\max_{p_j} \ \Pi_j(s_1^*, ..., s_j, ..., s_n^*) > \arg\max_{p_j} \ \Pi_j(s_1^{*i}, ..., s_j, ..., s_n^{*i}), \tag{3}$$

where $s_k^* = s_k(p_1^*, ..., p_j, ..., p_n^*; g^*)$, $s_k^{*i} = s_k(p_1^*, ..., p_j, ..., p_n^*; g^{*i})$, $k \neq j$, $k \in I$. The proof is by contradiction. Suppose that firm j's price is facilitated but in the equilibrium the relative prices are reversed, $p_i^* < p_j^*$. This means that, under the supposition, (i) firm j does not have the lowest advertised price in the market, (ii) firm j does not have the lowest selling price in the market, and (iii) all other firms' selling prices are independent of firm j's advertised price, and hence also of firm j's selling price. Points (i) and (ii) are obvious and need no explanation. Point (iii) follows by noting that if firm k, $k \neq j$, $k \in I$, does not have a low-price guarantee then $s_k^* = p_k^*$, which is independent of p_j, and if firm k does have a low-price guarantee then it is committed to matching or beating the lowest advertised or selling price in the market, neither of which belong to firm j.

Note that (i), (ii), and (iii) hold whether or not firm i has a low-price guarantee, and that (iv) for fixed advertised prices, the existence of firm i's low-price guarantee can only (weakly) reduce all selling prices in the market. Under the assumption of strategic complementarity of selling prices, (i), (ii), (iii), and (iv) imply that firm j would not choose to increase its selling price (which is the same as firm j's advertised price) in response to firm i's adoption of a low-price guarantee. This contradicts the supposition that firm i's low-price guarantee facilitates firm j's price. Q.E.D.

Proposition 1 gives a necessary condition for firm i's low-price guarantee to facilitate firm j's price. However, it should be emphasized that this condition is not sufficient. To see this, suppose two firms produce a homogeneous product at constant marginal cost c. Then, $p_i^* = p_j^* = c$ is an equilibrium whether or not firm i has a low-price guarantee because given p_i^*, firm j has no incentive to change its price, and vice versa. In this case we have an example in which the condition in Proposition 1 is satisfied but firm i's low-price guarantee is not facilitating firm j's price.[10] Thus, Proposition 1 and the test below that is based on it should be interpreted with caution. Evidence

[10]To show that the condition in Proposition 1 is not sufficient even when $p_i^* > p_j^*$, suppose there exists firm k, $k \neq i, j$, with price $p_k^* < p_j^*$. Then (i), (ii), (iii), and (iv) from the proof of Proposition 1 hold, implying that firm j would not choose to increase its selling price in response to firm i's adoption of a low-price guarantee.

is either consistent with pairwise facilitation or not, where 'consistent' means we cannot rule it out.

Test for Pairwise Facilitation: An observation is *not* consistent with pairwise facilitation if the firm with a low-price guarantee advertises a lower price than the firm without a guarantee. An observation is consistent with pairwise facilitation in the sense that we cannot rule it out if the firm with a low-price guarantee advertises a weakly higher price than the firm without a guarantee.

The test for pairwise facilitation is a direct application of Proposition 1. Thus, we can reject the notion of pairwise facilitation if the firm with a low-price guarantee advertises a lower price than the firm without a guarantee. However, we know from the discussion above that the converse is not necessarily true. If the firm with a low-price guarantee instead advertises a weakly higher price than the firm without a guarantee, then pairwise facilitation may or may not be satisfied.

The test is simple and yet it can be used in a wide variety of environments. Notice that the statement in Proposition 1 holds regardless of the number of firms in the market and whether or not there are asymmetries. Therefore, to apply the test for pairwise facilitation we do not need to have information on the number, cost and demand characteristics of the firms in the market.[11]

4 Evidence from Retail Tire prices

We collected data from advertisements placed by automobile tire retailers in sixty-one Sunday newspapers dated between September 29 and December 8, 1996. The newspapers were back issues of unsold stock at a national retail chain and represented twenty-seven different cities in the U.S. The twenty-seven newspapers are representative of the top fifty U.S. Sunday newspapers according to 1996 circulation figures reported in the *Wall Street Journal Almanac*, 1998.[12] We chose to study the U.S. tire market because: (1) tire dealers advertise frequently in the U.S. Sunday newspapers:

[11] We have assumed that consumers can costlessly obtain low-price guarantee refunds. This can easily be relaxed, leading to a more stringent test of pairwise facilitation. For example, if consumers must incur a hassle cost, $h > 0$, to obtain a refund, then $p_i^* > p_j^*$ must be satisfied for firm i's low-price guarantee to facilitate firm j's price.

[12] We applied the t-test for equal means to the U.S. Sunday newspaper circulation figures of 1996.

all but three newspapers had at least one ad from a tire dealer, and all but seven had two or more ads; (2) each advertisement typically contains a large number of price quotes; (3) the model numbers on tires are standardized, allowing for easy price comparisons and ensuring the applicability of low-price guarantees; (4) low-price guarantees are frequently adopted in this market and their features vary across firms, which enables us to study how this affects their ability to facilitate prices.

We collected information from all advertisements by tire dealers, whether or not a low-price guarantee was offered by the advertising firm. Of the two-hundred thirteen tire ads collected, ninety eight contain a low-price guarantee. For each low-price guarantee, we gathered information about the actual wording of the guarantee, classifiying it as either price-matching or price-beating.

An example of a price-matching guarantee is "We have the lowest prices in town—guaranteed" and "We won't be undersold." We classified these as price-matching because the firm makes no promise to beat a rival's lower price. Other firms do make this promise. An example of a price-beating guarantee is the advertisement from Just Tires, *Baltimore Sun*, September 29, 1996:

> Find a lower *advertised* price in your local newspaper on any tires you purchased from us within 30 days of purchase, and we'll refund 125% of the difference.

Almost 61 percent of the low-price guarantees in the tire ads are of the price-beating kind (60/98), and all of the ones in our study promise to beat by the percentage of the difference in prices. In the above guarantee, Just Tires promises to beat any competitor's lower price by 125% of the difference in price. We also have low-price guarantees in which the percentages are 110% and 150%.

Edlin (1997) and Kaplan (2000) suggest that whether a firm's guarantee applies only to advertised prices or also to selling prices is important. The low-price guarantee above is an example of the former because it explicitly states that the guarantee only applies to advertised prices. In contrast, Tires Plus' low-price guarantee "150% Best Price Guarantee—We'll Meet or Beat *any* Tire Price" is an example of a guarantee that applies to the rival's best deal, or selling price.

Although the majority of low-price guarantees are easily classified as one or the other, in some cases, the guarantees are ambiguously worded, neither explicitly referring to the rival's advertised price nor making it clear that the guarantee applies to the rival's best deal. The claim "We won't be undersold' is a classic example. This type of guarantee accounts for almost 37 percent of our total (36/98). In all, 80 percent of the price-beating guarantees are based on advertised prices (48/60), while the majority of the price-matching guarantees are ambiguously worded (26/38).

To ensure the applicability of a firm's guarantee, we gathered price observations from competing firms for the same tire.[13] A 'tire match' is defined as a pair of price quotes on the same tire make and model from two competing tire dealers advertising in the same city on the same date.[14] When one firm in the tire-match offers a low-price guarantee and the other does not, we denote the case as 'No LPG - LPG.' We have one-hundred and forty-three 'No LPG - LPG' tire matches.

4.1 Testing for Randomness

A good place to start in analyzing the data is to see whether low-price guarantees have *any* directional effect on advertised prices, or whether, when tire prices differ, the assignment of which firm has the higher price in each tire match is random. For example, if low-price guarantees are not affecting advertised prices in any way, then we would expect a firm with a strictly higher price in a No LPG - LPG tire match to be equally likely to have a low-price guarantee as not. That is, we would expect the LPG firm to be as equally likely as the non LPG firm to have the higher price.

Hypothesis 1 (H1: Randomness). When tire prices differ in a No LPG - LPG tire-match, the firm with a low-price guarantee has the same probability as its rival of having the higher price.

To test for randomness, we employ a Fisher sign test. The test has a number of advantages over

[13]The tire prices reflect only the cost of tires and not the cost of other services, such as mounting.

[14]We implicitly assume that two tire dealers advertising in the same newspaper are competitors when one of them has a low-price guarantee. This is justified because the guarantee itself, and the fact that the advertisements are in the same newspaper, links the two firms even if they would not otherwise be competitors. When one firm has a guarantee, each firm must account for the other's price because all consumers have to do to invoke the guarantee is to present evidence (obtained from reading the newspaper) that a lower price exists elsewhere on an identical item.

Table 1. Testing for Randomness

Low-Price Guarantee Type	Alternative Hypotheses		
	H1a: $\pi \neq 0.5$	H1b: $\pi > 0.5$	H1c: $\pi < 0.5$
All LPGs	0.025*		0.012*
Price-Matching LPG	0.029*	0.014*	
Price-Beating LPG	0.000**		0.000**

other statistical methods. It is non-parametric – it does not rely on any distributional assumptions – and the population from which each pair of observations is drawn does not have to be the same for it to be valid. This is important since in our data tire matches are gathered in different markets and for different tires. The sign test is an exact test and it can be applied in small samples.[15]

To apply the test to our data we look at the sign of the difference between the prices of the two firms for each pair of price observations. The sign statistic is the number of positive price differences (i.e., the number of cases where the firm with the low-price guarantee (LPG firm) has a higher price than the firm without a low-price guarantee (non-LPG firm)). A large test statistic suggests that an LPG firm is more likely to have a higher price than a non-LPG firm, while a small test statistic indicates that an LPG firm is more likely to have a lower price. For sufficiently large or small signed rank statistic we can reject the two-sided null hypothesis H1. The zero values for price differences (price ties) are discarded and the sample size is redefined accordingly.

Since ties are omitted from the sample, the null hypothesis can be stated as: The probability of a positive price difference between the prices of LPG and non-LPG firms is 0.5:

$$H1 : \pi \equiv \Pr\left(p_{LPG} - p_{noLPG} > 0\right) = 0.5.$$

Table 1 shows that the sign test allows us to reject the null hypothesis H1 in favor of the two-sided alternative H1a: $\pi \neq 0.5$ for the population of all No LPG - LPG tire matches, the population of price-matching guarantees only, and the population of price-beating guarantees only.[16] The p-

[15] See Hollander and Wolfe (1999) for further details on the sign test.

[16] Table 1 reports the p-values for the test of the null hypothesis H1 against alternatives H1a, H1b, and H1c. A single asterisk denotes significance at the 5 percent level; a double asterisk denotes significance at the 1 percent level.

values for the first two are significant at the 5 percent level and the p-value for the third is significant at the 1 percent level. Thus, we find that in each of the three populations, the probability of a positive price difference is not equal to the probability of a negative price difference. The evidence indicates that the LPG and non-LPG firm are not equally likely to have the higher price.

Surprisingly, however, it is not possible to say which firm is more likely to have the higher price without knowing whether the LPG firm has a price-matching or price-beating guarantee. One-sided sign tests reveal that for tire-matches with price-matching guarantees, the LPG firm is more likely to have a higher price, while the reverse is true for tire-matches with price-beating guarantees. In particular, the sign test allows us to reject the null hypothesis H1 in favor of the one-sided alternative H1b: $\pi > 0.5$ for the population of price-matching guarantees, and it allows us to reject the null hypothesis H1 in favor of the one-sided alternative H1c: $\pi < 0.5$ for the population of price-beating guarantees. The p-value for Upper-Tail test is significant at the 5 percent level. The p-value for the Lower-Tail test is significant at the 1 percent level. These are our first indications that price-matching and price-beating guarantees may be serving different purposes in practice.

4.2 Testing for Pairwise Facilitation

The common view of low-price guarantees is that they are adopted to discourage price-cutting. However, most of the literature fails to distinguish between price-matching and price-beating guarantees, and between guarantees that apply to rivals' advertised prices and those that apply to rivals' selling prices. Table 1 above suggests that this lack of distinction may not be innocuous with respect to the type of LPG, and recent theoretical claims by Edlin (1997) and Kaplan (2000) suggest that whether the guarantees apply to advertised or selling prices will also be important.

In this subsection, we look for evidence of pairwise facilitation. We say that an observation is consistent with pairwise facilitation if the price of the LPG firm is weakly higher than the price of the non-LPG firm. Table 2 presents the raw data with the ambiguously worded LPGs and LPGs

Table 2. Incidence of Pairwise Facilitation.

No LPG - LPG Type	Consistency with Pairwise Facilitation	Number of Tire Matches
No LPG - Price-Matching LPG	75.00%	44
No LPG - Price-Beating LPG	40.40%	99
No LPG - Advertised-Price LPG	31.65%	79
No LPG - Not Advertised-Price LPG	75.00%	64
No LPG - Advertised-Price **PM**	25.00%	8
No LPG - Not Advertised-Price **PM**	86.11%	36
No LPG - Advertised-Price **PB**	32.39%	71
No LPG - Not Advertised-Price **PB**	60.71%	28

that apply to rivals' selling prices lumped together in the category 'Not Advertised-Price LPG.' As we will show in the appendix, our qualitative results are broadly similar if the ambiguously worded LPGs are instead lumped together with LPGs that apply only to rivals' advertised prices.

Table 2 shows that a firm with a price-matching guarantee has the weakly higher price in 75 percent of the cases in which it is compared with a firm that does not have an LPG, whereas a firm with a price-beating guarantee has the weakly higher price in only 40.4 percent of the cases. In the second set of rows, we see that low-price guarantees that apply to advertised prices are consistent with pairwise facilitation in 31.65 percent of the cases, whereas low-price guarantees that are not restricted to advertised prices are consistent with pairwise facilitation in 75 percent of the cases. In the third set of rows, consistency with pairwise facilitation ranges from a low of 25 percent in the population of price-matching guarantees that apply to advertised prices to a high of 86.11 percent in the population of price-matching guarantees that are not restricted to advertised prices.

If an observation is equally likely to be consistent or not with pairwise facilitation, then we would expect to observe consistency in 50 percent of the cases. We formalize this as follows.

Hypothesis 2 (H2: Pairwise Facilitation). Tire prices in a No LPG - LPG tire-match are equally likely to be consistent with pairwise facilitation as not.

To test for pairwise facilitation, we employ the same sign test as before, assigning a positive

Table 3. Testing for Pairwise Facilitation.

Low-Price Guarantee Type	Alternative Hypotheses		
	H2a: $\tilde{\pi} \neq 0.5$	H2b: $\tilde{\pi} > 0.5$	H2c: $\tilde{\pi} < 0.5$
Price-Matching LPG	0.001^{**}	0.001^{**}	
Price-Beating LPG	0.070		0.035^{*}
Advertised-Price LPG	0.001^{**}		0.001^{**}
Not Advertised-Price LPG	0.000^{**}	0.000^{**}	
Advertised-Price **PM**	0.289		0.145
Not Advertised-Price **PM**	0.000^{**}	0.000^{**}	
Advertised-Price **PB**	0.004^{**}		0.002^{**}
Not Advertised-Price **PB**	0.185	0.092	

number to tire matches that are consistent with pairwise facilitation and a negative number to tire matches that are not consistent with pairwise facilitation. The null hypothesis to be tested is

$$H2 : \tilde{\pi} \equiv \Pr\left(p_{LPG} - p_{noLPG} \geq 0\right) = 0.5.$$

Table 3 shows that the sign test allows us to reject the null hypothesis H2 in favor of the two-sided alternative H2a: $\tilde{\pi} \neq 0.5$ for the population of price-matching guarantees only, the population of low-price guarantees that apply only to rivals' advertised prices, and the population of low-price guarantees that are not restricted to rivals' advertised prices.[17] More importantly, Table 3 shows that for tire-matches with price-matching guarantees, the LPG firm is more likely to have the weakly higher price, whereas the reverse is true for tire-matches with price-beating guarantees. In particular, the sign test allows us to reject the null hypothesis H2 in favor of the one-sided alternative H2b: $\tilde{\pi} > 0.5$ for the population of price-matching guarantees, and it allows us to reject the null hypothesis H2 in favor of the one-sided alternative H2c: $\tilde{\pi} < 0.5$ for the population of price-beating guarantees. The p-value for the Upper-Tail test is significant at the 1 percent level. The p-value for the Lower-Tail test is significant at the 5 percent level. Simply put: price-matching guarantees are consistent with pairwise facilitation in a majority of the cases; price-beating guarantees are not.

[17] Table 3 reports the p-values for the test of the null hypothesis H2 against alternatives H2a, H2b, and H2c. A single asterisk denotes significance at the 5 percent level; a double asterisk denotes significance at the 1 percent level.

The one-sided tests also provide confirming evidence for the importance of advertised prices versus selling prices in determining whether low-price guarantees can facilitate high prices. These tests reveal that for tire-matches with LPGs that apply to advertised prices, the LPG firm is less likely to have the weakly higher price, while the reverse is true for tire-matches with LPGs that are not restricted to advertised prices. In particular, the sign test allows us to reject the null hypothesis H2 in favor of the respective one-sided alternative for both populations at the 1 percent level.

Overall, the empirical evidence supports the view that price-matching guarantees differ from price-beating guarantees in purpose; that price-matching guarantees are more likely to be consistent with discouraging price-cutting than price-beating guarantees; that it matters whether low-price guarantees are based on advertised prices or not; and that those guarantees that are based on advertised prices are less likely to be adopted to discourage price-cutting. Importantly, the data do not support the view that all price-matching and price-beating guarantees are adopted to discourage price-cutting. Even when we are unable to reject the hypothesis that the majority of LPGs are consistent with pairwise facilitation, the observed low-price guarantee-price patterns could alternatively be explained by the use of low-price guarantees as a means of price discrimination, not facilitation (for models of low-price guarantees in which price-discrimination is the motive, see Corts, 1997; and Chen et al, 2001). As both of these rationales for low-price guarantee adoption imply higher advertised prices for the firm with the low-price guarantee, the empirical assessment of prices consistent with pairwise facilitation does not allow us to discriminate between the two theories. We can, however, be confident that when pairwise-facilitation is not supported, the low-price guarantee cannot be said to be discouraging the rival from cutting price. One would have to appeal to the literature that considers the use of low-price guarantees as a way to signal low prices to explain these observations (see Jain and Srivastava, 2000; and Moorthy and Winter, 2002).

5 Conclusion

There are many approaches one could use to obtain evidence on whether the use of low-price guarantees in practice is consistent with firms using them to discourage price-cutting. The simplest approach is to construct a test based on equality in advertised prices. However, such a test is flawed because unequal advertised prices are the norm and, as we have seen, low-price guarantees can discourage a firm's rival from cutting prices even if advertised prices are not identical.

Another approach is to compare the average prices of firms with low-price guarantee to those of firms without low-price guarantees. However, this approach is prone to selection bias, which may arise due to an association between low-price guarantee adoption and unobserved product heterogeneities. For example, if low-price guarantees tend to be adopted by firms selling a better quality product (due to locational advantage, in-store service, etc.), then higher prices at low-price guarantee firms cannot be fully attributed to the low-price guarantee policies. Even if there were no selection bias, the comparison of average prices of firms with and without low-price guarantees does not address the question of whether low-price guarantees might be facilitating prices. This is because facilitation is achieved only through the effect low-price guarantees have on rivals' prices.

Our approach to testing for pairwise facilitation avoids these criticisms. We collected *paired observations* on prices for identical automobile tires advertised by tire dealers in U.S. Sunday newspapers. Using the data, we check whether the necessary condition is met for a firm's low-price guarantee to be facilitating its rival's price. The intuition behind the test for *pairwise facilitation* is as follows. If low-price guarantees are facilitating practices, they should restrain rivals from cutting their prices. This can only occur when an LPG firm advertises a weakly higher price than its rival.

Our empirical findings should be interpreted as suggesting that in many cases a firm's low-price guarantee cannot be said to be facilitating the prices of its rivals. However, in the other cases, the findings cannot be interpreted as finding evidence for the facilitation of prices. We can only

say that in these other cases the evidence is consistent with this interpretation. In this sense, the interpretation of our findings is not symmetric—actual before-and-after prices would be needed before one can assert that the low-price guarantees have indeed facilitated tacit collusion.

Lastly, our results suggest that the focus of recent literature (Edlin, 1997; Arbatskaya et al, 1999b; Kaplan, 2000) on the particulars of low-price guarantees is well-justified. We have found that it matters whether the low-price guarantee is price-matching or price-beating, and whether it is based on advertised or selling prices. It is our hope that future work would further the study of the interactions between these low-price guarantee features and their effect on market prices.

Appendix

Table A1. Incidence of Pairwise Facilitation.

No LPG - LPG Type	Consistency with Pairwise Collusion	Number of Tire Matches
No LPG - Best-Deal LPG	100.00%	24
No LPG - Not Best-Deal LPG	41.18%	119
No LPG - Best-Deal **PM**	100.00%	7
No LPG - Not Best-Deal **PM**	70.27%	37
No LPG - Best-Deal **PB**	100.00%	17
No LPG - Not Best-Deal **PB**	28.05%	82

Table A2. Testing for Pairwise Facilitation.[18]

Low-Price Guarantee Type	Alternative Hypotheses		
	H2a: $\tilde{\pi} \neq 0.5$	H2b: $\tilde{\pi} > 0.5$	H2c: $\tilde{\pi} < 0.5$
Best-Deal LPG	0.000**	0.000**	
Not Best-Deal LPG	0.066		0.033*
Best-Deal **PM**	0.016*	0.008**	
Not Best-Deal **PM**	0.020*	0.010**	
Best-Deal **PB**	0.000**	0.000**	
Not Best-Deal **PB**	0.000**		0.000**

Table A1 presents the raw data with the ambiguously worded LPGs and LPGs that apply only to a rival's advertised price lumped together in the category 'Not Best-Deal LPG.' It shows that a firm with a best-deal guarantee has the weakly higher price in *every* case in which it is compared with a firm that does not have an LPG, whereas a firm that does not have a best-deal guarantee has the weakly higher price in only 41.18 percent of the cases. In the second set of rows, consistency with pairwise facilitation ranges from a low of 28.05 percent in the population of not best-deal price-beating guarantees to a high of 100 percent in both populations of best-deal guarantees.

The difference between best-deal and not best-deal low-price guarantees is striking and significant. Best-deal low-price guarantees, whether price-matching or price-beating, are always consistent with pairwise facilitation. Table A2 confirms this with evidence from the sign test.

[18] Table A2 reports the p-values for the test of the null hypothesis H2 against alternatives H2a, H2b, and H2c. A single asterisk denotes significance at the 5 percent level; a double asterisk denotes significance at the 1 percent level.

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