

On the use of low-price guarantees to discourage price cutting

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Abstract

This paper formulates a novel test to assess whether, and to what extent, firms might be using low-price guarantees to discourage their rivals from cutting prices. The test is based on a comparison of paired observations of advertised prices that are set by competing firms at the same point in time on similar items, where one price is set by a firm that has a low-price guarantee and the other by a firm that does not have a low-price guarantee. Using data on retail tire prices, we find that the majority of paired observations involving firms that have *price-matching* guarantees are consistent with what one would expect if firms were using them to discourage price cutting, whereas the majority of paired observations involving firms that have *price-beating* guarantees are not. This suggests that price-matching and price-beating guarantees may be serving different purposes. The evidence also suggests that guarantees that apply to advertised prices only may be serving different purposes than guarantees that apply to both advertised and selling prices.

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1. Introduction

Retailers often advertise that they will not be undersold. Some firms promise to match any lower price offered by a competitor on the same item (price-matching guarantee), while others promise to beat any competitor's lower price on the same item by some percentage of the

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difference (price-beating guarantee). Examples of companies offering these guarantees include *Tire Kingdom*, *Staples*, *Circuit City*, *Tesco* and *Sears*, and the scope of the coverage ranges from tires and office products on the one hand to electronics, grocery items, and general merchandise on the other.

Although low-price guarantees are popular among retailers, and consumers may say they like them, it is not obvious that consumers are better off with low-price guarantees than they would be without them. On the one hand, if a firm promises to match or beat any lower price, and its rival has a lower price, consumers can ask that the lower price be matched or beaten. All else being equal, this makes consumers who are aware of the firm's low-price guarantee weakly better off.¹ On the other hand, to the extent that low-price guarantees alter firms' incentives and discourage price cutting, prices may be different in a world with low-price guarantees than in a world without them, and this could make consumers worse off. Prices may be higher in a world with low-price guarantees and hence consumers may be worse off.

In this paper we formulate a test to assess whether, and to what extent, firms might be using low-price guarantees to discourage their rivals from cutting prices. The test is based on a comparison of paired observations of advertised prices that are set by competing firms at the same point in time on similar items (same make and model number), where one price is set by a firm that has a low-price guarantee and the other by a firm that does not have a low-price guarantee. There are two possible outcomes. Either the firm that does not have a low-price guarantee has a higher advertised price than the firm with the low-price guarantee, or it has a weakly lower advertised price. In the latter case, we cannot rule out the possibility that the rival's low-price guarantee is inhibiting the firm from having an even lower price, and so we say that the observation is consistent with what one would expect if the firm with the low-price guarantee were using it to discourage price cutting. However, in the former case, when the firm that does not have a low-price guarantee has a higher price, the gain to the firm from decreasing its price by a small amount is unaffected by its rival's low-price guarantee all else being equal. In this case, we say that the observation is not consistent with what one would expect if low-price guarantees were being used to discourage price cutting (the rival's low-price guarantee is not keeping the firm's price higher than it would otherwise be).

Using data on tire prices that were advertised in Sunday newspapers, we pair price quotes on comparable items (same tire make and model number) in the same city on the same day, where one price quote comes from a firm that has a low-price guarantee and the other price quote comes from a firm that does not. If the truth is that there is no relationship between low-price guarantees and advertised prices, we would expect that, when prices in a paired observation differ, the firm with the guarantee would be equally likely to have the higher price as the firm without the guarantee. However, this hypothesis can be rejected at the 5% significance level for the sample of all low-price guarantees, the sample of price-matching guarantees only, and the sample of price-beating guarantees only. Surprisingly, given that there is a relationship between low-price guarantee and advertised prices in our sample, the evidence suggests that whether firms with low-price guarantees tend to have higher or lower prices than their competitors without low-price guarantees depends on the particular type of low-price guarantee being considered. We find that the majority of paired observations involving price-matching guarantees are consistent with what one would expect if they were being used to discourage price cutting, whereas the majority of paired observations involving price-beating guarantees are not.

Our results imply that in paired observations involving price-matching guarantees, the firms with the price-matching guarantees tend to have weakly higher advertised prices than the firms with

¹ Consumers are strictly better off if they buy from the firm and request that the rival's price be matched or beaten.

no guarantees, whereas in paired observations involving price-beating guarantees, the opposite is true. The firms with the price-beating guarantees tend to have strictly lower advertised prices than their rivals. These results are surprising because they suggest that price-matching and price-beating guarantees might be serving different purposes in practice. The results are also surprising because one might have thought that, if anything, price-beating guarantees would be more effective than price-matching guarantees at discouraging rivals from cutting prices, 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 our sample of paired observations in which the low-price guarantee applies to advertised prices only, the difference between price-matching and price-beating guarantees disappears. These results support the claims made in recent theoretical and empirical studies (Edlin, 1997; Kaplan, 2000; Arbatskaya et al., 2004) which suggest that the key distinction in determining whether low-price guarantees may be facilitating higher prices is in knowing whether the low-price guarantees apply to advertised prices only or whether they also apply to selling prices.

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 might be discouraging price cutting. Section 4 applies the test to paired observations of prices on similar items advertised by retailers on the same day in the same city and in the same newspaper. We focus on the differences between price-matching and price-beating guarantees, and between guarantees that apply to advertised prices only and guarantees that apply also to selling prices. Section 5 concludes.

2. Overview of related literature

Since our purpose is to assess the empirical relevance of the view that low-price guarantees are used to discourage price cutting, we focus on the strand of literature that was started by Hay (1982) and Salop (1986). In the simplest version of their 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 charges the monopoly price. Monopoly prices are supportable because neither firm has an incentive to undercut the other since each is committed to matching the lowest price.² 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 firms' products are homogeneous or differentiated (Logan and Lutter, 1989). Its robustness to hassle costs has been considered by Hviid and Shaffer (1999), and it has been applied to important issues relating to product variety (Zhang, 1995), free entry (Edlin and Emch, 1999), and entry deterrence (Arbatskaya, 2001).

More recently, a debate has arisen over whether price-beating guarantees are more or less effective than price-matching guarantees in discouraging price cutting when consumers are fully

² 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; Chen et al., 2001), and as a signal of low prices (Jain and Srivastava, 2000; Moorthy and Winter, 2004). We will discuss our results in the context of these other models in Section 4.

informed. Sargent (1993) argues that price-beating guarantees will be more effective because they have the potential to deliver more severe punishment. However, Corts (1995) and Hviid and Shaffer (1994) disagree. Corts posits a model with homogeneous firms and shows that the way to undercut a rival's price is, paradoxically, to adopt a price-beating guarantee and to advertise a *higher* price. The difference in posted prices then causes the firm's guarantee to be invoked, resulting in a lower effective price to consumers. Hviid and Shaffer allow for differentiated firms and also find that low-price guarantees do not discourage price cutting when price-beating guarantees are feasible. Thus, Corts (1995) and Hviid and Shaffer (1994) argue that Hay and Salop's insight is not robust.

Subsequent literature, however, has shown that the Corts and Hviid and Shaffer results implicitly assume that low-price guarantees apply to advertised prices only 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), Kaplan (2000), and Arbatskaya et al. (2004) argue, the ability of low-price guarantees (price-matching and price-beating) to support supracompetitive prices is restored if the guarantees apply to actual selling prices.

The empirical evidence on low-price guarantees is thin. One reason 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.³ They show that price-matching guarantees result in a greater conformity in prices and a slightly higher market-average prices for products included in the guarantee, relative to those not included in the guarantee. It is unknown to what extent these findings reflect the specific institutional features of the market they study.⁴

Arbatskaya et al. (1999) conduct a cross-sectional study (across multiple markets) to analyze the effects of low-price guarantees on the retail tire prices of a particular tire, P185/75R14. They find that while 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 that offer low-price guarantees does tend to raise the firm's advertised tire price. Their data consists of price quotes from all firms that advertised a price on tire P185/75R14 in a Sunday newspaper in certain select cities over a multi-week period, whether or not the firms offered a low-price guarantee and whether or not other firms in the same market did or did not advertise a price on the same tire. Thus, they are unable to compare relative prices on identical items between firms that have low-price guarantees and firms in the same market that do not, nor does their data allow them to distinguish between low-price guarantees that apply to advertised prices only and low-price guarantees that apply also to actual selling prices, which are key features of our analysis.

Arbatskaya et al. (2004) 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

³ 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.

⁴ 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 9000 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.

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. The results in this paper support the view that price-matching and price-beating guarantees may be serving different purposes, but we differ in that we have data on prices and thus can test for price differences between firms.

3. Theory

We begin with a well-known stylized fact. In many retail markets, one can find firms that have low-price guarantees and firms that do not. This is the case, for example, among U.S. firms selling tires. Economic theory has offered a variety of reasons to explain why these asymmetric outcomes may arise.⁵ What has gone unnoticed, however, is the following testable implication. In a comparison of prices on similar items between a firm that has a low-price guarantee and one that does not, the firm with the guarantee must have weakly higher prices if its guarantee is to discourage price cutting.

Suppose, for example, that one firm has a low-price guarantee but the other firm does not. Suppose also that the advertised prices of the two firms are \$60 and \$65. What can we conclude about the ability of the low-price guarantee to discourage price cutting? If the price of the firm that does not have a low-price guarantee is \$60 and its rival's price is \$65, then we cannot say for sure whether the firm that was pricing at \$60 would have preferred to price lower were it not for its rival's guarantee. It may be, for example, that the number of consumers who would stop buying from the firm and invoke the rival's guarantee is increasing in the difference between the two firms' prices. To illustrate an extreme case, suppose the hassle costs of asking the rival to match or beat the firm's price is \$5 for all consumers. Then no one would be willing to invoke the rival's guarantee when the price difference is only \$5 but they would be willing to invoke the rival's guarantee if the price difference were more than \$5. On the other hand, if the situation was reversed, then we can be sure that the firm is not being constrained in cutting its price. Indeed, if the price of the firm that does not have a low-price guarantee is \$65 and its rival's price is \$60, then the former would be able to cut its price by as much as \$5 before it would even have to worry about its rival's low-price guarantee being invoked. In this case, we can reject any hypothesis which asserts that the low-price guarantee is discouraging price cutting.

We can illustrate these points in Fig. 1, which depicts the best-response functions of firms that are competing simultaneously in prices. Let point N denote the Bertrand–Nash equilibrium. Then, 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'

⁵ Asymmetric outcomes in which only some firms have low-price guarantees arise in Logan and Lutter (1989), Corts (1997), Hviid and Shaffer (1999), Jain and Srivastava (2000), Chen et al. (2001) and Moorthy and Winter (2004).

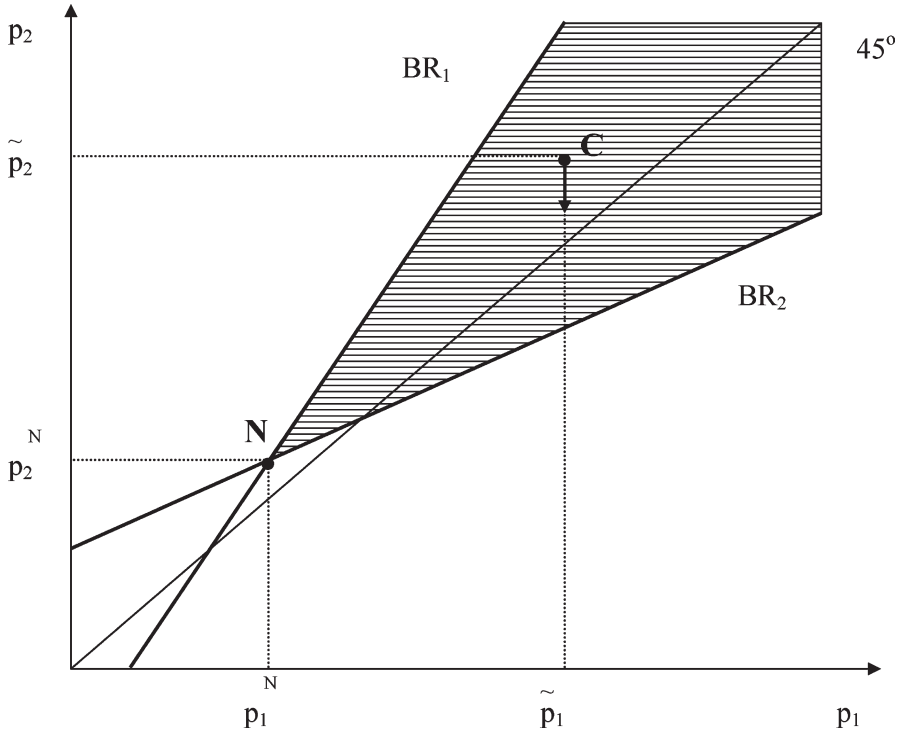


Fig. 1. Best-response functions of firms 1 and 2.

best-response functions and above the 45° 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 formalized in the next subsection for markets with an arbitrary number of firms. Our purpose is to provide a theoretical foundation for 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). In particular, we will propose the following test for pairwise facilitation: if a firm’s low-price guarantee is to discourage price cutting by its rival, then the firm must be advertising a weakly higher price.

3.1. Preliminaries

In order to formally define pairwise facilitation in an oligopolistic market, it is helpful to introduce some notation. Let $I = \{1, \dots, n\}$ denote the set of $n \geq 2$ firms in a market. For $i \in I$, let $p_i \in [0, \infty)$ denote firm i ’s advertised price, and let $g_i \in \{PM^a, PB^a, PM^s, PB^s, \emptyset\}$ denote its low-price guarantee policy, where PM^a means that firm i has adopted a price-matching guarantee that applies to its rivals’ advertised prices only, PB^a means that firm i has promised to beat a rival’s lower advertised price by some percentage of the difference, PM^s means that firm i has adopted a price-matching guarantee that applies to its rivals’ selling prices, PB^s means that firm i has

promised to beat a rival's lower selling price by some percentage of the difference, and \emptyset means that firm i has chosen not to have a guarantee.⁶ Denote as the 'low-price guarantee-price game', a game in which firms choose their advertised prices and low-price guarantee policies simultaneously.

Since our purpose is to examine whether low-price guarantees might be discouraging price cutting, we follow the Hay–Salop 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.⁷ Thus, each firm will have at most one selling price.⁸ When it exists, 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, $s_i = \min(p_1, \dots, p_n)$, and if firm i promises to beat any lower advertised price by λ times the difference, then $s_i = \min(p_1, \dots, p_n) - \lambda(p_i - \min(p_1, \dots, p_n))$.⁹ In each case, we have $s_i \leq p_i$. Writing the expression for s_i is more complicated when firm i 's low-price guarantee applies to its rivals' selling prices, and some restrictions must then be placed on λ to ensure that all selling prices converge in equilibrium, but given these restrictions, it can once again be shown that $s_i \leq p_i$.

The profit function of firm j depends on the selling prices of all firms:

$$\Pi_j(s_1, \dots, s_n) = \Pi_j(s_1(p, g), \dots, s_n(p, g)), \quad j \in I.$$

We assume that Π_j is twice continuously differentiable and concave. We also assume that selling prices are strategic complements, $\frac{\partial^2 \Pi_j(s_1, \dots, s_n)}{\partial s_i \partial s_j} \geq 0$, $i \neq j$, and that the set of profit-maximizing prices for firm j , for any vector of rival prices, p_{-j} , and low-price guarantees, g , is non-empty:

$$\text{BR}_j(p_{-j}, g) \equiv \arg \max_{p_j} \Pi_j(s_1(p, g), \dots, s_n(p, g)). \quad (1)$$

Finally, we assume that firm j 's best response is unique if it does not have a low-price guarantee. Given these assumptions, we can define pairwise facilitation as follows:

Definition. Consider an equilibrium (p^*, g^*) to the low-price guarantee-price game in which firm i has a low-price guarantee and firm j does not, $i, j \in I$. Let $g^{*i} = (g_1^*, \dots, g_i = \emptyset, \dots, g_n^*)$ for all $i \neq j$. Then, we say that firm i 's low-price guarantee *facilitates* firm j 's price in this equilibrium if

$$p_j^* \equiv \text{BR}_j(p_{-j}^*, g^*) > \text{BR}_j(p_{-j}^*, g^{*i}). \quad (2)$$

In other words, firm i 's low-price guarantee facilitates firm j 's price in an equilibrium (p^*, g^*) if in the absence of firm i 's guarantee firm j would want to lower its advertised price, holding all other advertised prices and low-price guarantees fixed. We refer to this situation as pairwise facilitation.

⁶ We restrict attention to the four types of low-price guarantees found in our data. For a more extensive characterization of the various types of low-price guarantees that one finds in practice, see Arbatskaya et al. (2004).

⁷ Hviid and Shaffer (1999) introduce a model in which the existence of hassle costs, even if they are arbitrarily small, can mitigate (and in some cases, eliminate) the ability of low-price guarantees to discourage price cutting.

⁸ With uninformed consumers and hassle costs, we would have to keep track of multiple selling prices for each firm.

⁹ For example, if firm i has a guarantee in which it promises to beat any lower price by 50%, then $\lambda = 0.5$.

3.2. Test for pairwise facilitation

We can now formulate our test for pairwise function based on observations of prices and low-price guarantees chosen by pairs of firms. Consider two competing firms selling a similar item, one with a low-price guarantee (firm i) and the other without (firm j). What should be true about the relationship between advertised prices p_i and p_j ? On the one hand, if there is no relationship between low-price guarantees and advertised prices, 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 discourage price cutting, then we would expect firm i 's guarantee to be facilitating firm j 's price, which by the following proposition, implies that firm i 's price must be weakly higher.

Proposition 1. *Consider an equilibrium (p^*, g^*) to the low-price guarantee-price game in which 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, $p_i^* \geq p_j^*$, $i \neq j \in I$.*

For Proof of Proposition 1, see Appendix A.

We can sketch the intuition for the Proof of Proposition 1 as follows. Suppose firm i 's low-price guarantee facilitates firm j 's price but firm j has the strictly higher advertised price in equilibrium, so that $p_j^* > p_i^*$. In this case, we would know that firm j does not have the lowest selling price in the market, and therefore that all other firms' selling prices are independent of firm j 's advertised price in the neighborhood of p_j^* . This is important because when it is combined with the observation that, for fixed advertised prices, the existence of firm i 's low-price guarantee can only (weakly) reduce all selling prices in the market and the assumption that selling prices are strategic complements, it follows that firm j would not choose to lower its advertised price in the absence of firm i 's adoption of a low-price guarantee. But this contradicts the supposition that firm i 's low-price guarantee facilitates firm j 's price.

Note that the condition in Proposition 1 is necessary but not sufficient for firm i 's low-price guarantee to facilitate firm j 's price. That is, it is possible that $p_i^* \geq p_j^*$ holds in equilibrium and yet at the same time firm i 's low-price guarantee does not facilitate firm j 's price. To see this most clearly, consider the case of two firms that produce a homogeneous product at a constant marginal cost c . Then, there exists an equilibrium in which firm i has a low-price guarantee and $p_j^* = p_i^* = c$, and yet, given p_i^* , firm j would have no incentive to change its price even in the absence of firm i 's low-price guarantee. 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. Thus, Proposition 1 and the test for pairwise facilitation that is based on it (see below) should be interpreted with some caution. When we say that the evidence is consistent with what one would expect if firm i were using its guarantee to discourage price cutting by firm j , we mean that we cannot rule it out.

We say that 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. We say that 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.

Our 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 of firms in the market, costs, or demand characteristics.¹⁰

This is an important point because in the environment that we consider—the retail tire market—firms are typically not homogeneous. There are reasons to believe that prices will differ across firms even in the absence of low-price guarantees and that consumers may have strong preferences over where to shop. Consider, for instance, two sellers: (a) *National Tire and Battery (NTB)*, a seller with a wide national network; and (b) *Barney's Tires*, a local single-store seller. Now consider an identical *Goodyear* tire being sold by both. Setting aside any strategic considerations, a priori it is difficult to say whether *NTB's* price will be higher or lower than *Barney's* price. On the one hand *NTB* is buying thousands of tires from *Goodyear* and they would potentially be in a position to obtain volume discounts from *Goodyear* which they could then pass onto consumers. On the other hand, *NTB* may offer more services at their stores, and it has a nationwide warranty for replacement and repair. Due to these additional aspects, *NTB's* price could well be higher. The net effect, of course, is an empirical matter. Moreover, due to *NTB's* additional services, the composite of the 'product plus services' will not in general be the same and so many consumers may not view these retailers as strong substitutes. Think of a sales representative who travels a lot. This person may well prefer to shop at *NTB* over *Barney's* because of the former's wide geographic (nationwide) service area.

While these observations are important and relate to the underlying cost and demand asymmetries that may be present in the industry, our analysis takes this as a starting point and asks whether the adoption of a low-price guarantee, by *NTB* or *Barney's*, might be facilitating the other's prices over and above what would exist in the absence of the guarantee, holding all other advertised prices and low-price guarantee choices constant. If it turns out that *Barney's*, for example, has both a low-price guarantee and lower prices than *NTB*, then the answer is no. *Barney's* low-price guarantee cannot be said to be discouraging *NTB* from price cutting. If, on the other hand, *Barney's* has higher prices than *NTB*, then we must be more cautious in our conclusion but we cannot rule out the possibility that price cutting on the part of *NTB* is being discouraged.

4. Evidence from retail tire prices

Our data comes from advertisements that were placed by automobile tire dealers 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 United States.¹¹ We chose to study the U.S. tire market because: (1) tire dealers advertise frequently in U.S. Sunday newspapers: 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 on different makes and models; (3) the model numbers on tires are standardized, allowing for 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 the characteristics of low-price guarantees affect the incidence of pairwise facilitation.

We collected information about tire prices from the ads placed by all tire dealers who advertised in our sample of Sunday newspapers, whether or not a low-price guarantee was offered

¹⁰ We have assumed that consumers can costlessly invoke low-price guarantees. If they must incur a hassle cost, $h > 0$, to obtain a refund, then $p_i^* > p_j^*$ must be satisfied if firm i 's low-price guarantee is to facilitate firm j 's price.

¹¹ To verify that the twenty-seven newspapers were representative of the top fifty U.S. Sunday newspapers, we applied the t -test for equal means to the 1996 circulation figures as reported in the *Wall Street Journal Almanac*.

by the advertising firm. We found a total of two-hundred and thirteen tire ads, of which ninety eight contained a low-price guarantee. In the event a firm advertised a low-price guarantee, we also gathered information about the actual wording of the guarantee, classifying it as either price-matching or price-beating.

Some examples of price-matching guarantees are “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.

Over 60% of the low-price guarantees in our sample are of the price-beating kind (60/98), and almost all of these promise to beat a rival’s lower price by some percentage of the difference in prices. In the above guarantee, *Just Tires* promises to beat any competitor’s lower price by 25% of the difference in prices. We also have low-price guarantees in which the price-beating percentages are 10% and 50%.

Edlin (1997), Kaplan (2000), and Arbatskaya et al. (2004) 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 a rival’s best deal, or selling price.

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

As mentioned above, in addition to setting the actual tire prices, retailers may have other charges associated with putting on new tires, and may charge for things like mounting, warranties, lifetime rotation, and balancing, making the composite of the ‘product plus services’ value difficult to ascertain. However, while this value may be relevant for consumers in determining where to shop, it is not typically needed for determining whether a firm’s low-price guarantee applies, because firms’ low-price guarantees typically apply only to the cost of the actual tires, as long as the price quote is legitimate and the tires are of the same make and model number. Thus, to ensure the applicability of a firm’s guarantee, we discarded price observations unless they came from competing firms advertising the same make and model number (e.g., *Goodyear* tires, P185/75R14) on the same date in the same city and newspaper. Formally, we define a ‘tire match’ observation to be 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 and in the same newspaper. We included all such pairs in the data.¹² When one firm in the tire-match offers a low-price guarantee and the

¹² The empirical tests that we employ assume that observations are independent random draws. This assumption may be violated because in some cases we collected multiple observations on prices for a pair of tire dealers and we included all possible tire matches when more than two tire dealers advertised the same tire in the same newspaper on the same date. We also implicitly assume that two tire dealers advertising in the same newspaper on the same date and in the same city are competitors when one of them has a low-price guarantee. This may be justified by the fact that the advertisements are in the same newspaper, and the guarantee itself links the two firms since then they must account for each other’s price.

other does not, we denoted the case as ‘No LPG–LPG.’ We have one-hundred and forty-three ‘No LPG–LPG’ tire matches in our data.

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 independent of advertised prices, then we would expect a firm with a strictly higher price in a No LPG–LPG tire match to be as likely to have a low-price guarantee as not. That is, we would expect the LPG firm to be as 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. This test has a number of advantages over 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.¹³

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 zero values for price differences (i.e., equal prices) are discarded and the sample size is redefined accordingly. 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 (no-LPG firm). A large test statistic suggests that an LPG firm is more likely to have a higher price than a no-LPG firm, while a small test statistic indicates that an LPG firm is more likely to have a lower price. For a sufficiently large or small signed rank statistic we can reject the two-sided null hypothesis H1.

The null hypothesis can be stated as follows: The probability of a positive (rather than negative) price difference between the prices of the LPG and no-LPG firms is 0.5:

$$H1: \pi \equiv \Pr(p_{LPG} - p_{no\ LPG} > 0 | p_{LPG} \neq p_{no\ LPG}) = 0.5.$$

Table 1, which reports the *p*-values for the test of the null hypothesis H1 against the alternatives H1a, H1b, and H1c, shows that the sign test allows us to reject the null hypothesis 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. The *p*-values for the first two populations are smaller than 5% and the *p*-value for the third population is smaller than 1%. Thus, we find that in all three populations, the probability of a positive price difference is not equal to the probability of a negative price difference.

Surprisingly, whether the LPG firm is more likely to have a higher or a lower price than the no-LPG firm depends on the type of low-price guarantee that it has. 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 opposite 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

¹³ See Hollander and Wolfe (1999) for further details on the Fisher sign test.

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**

* Denotes significance at a 5% level.

** Denotes significance at a 1% level.

hypothesis H1 in favor of the one-sided alternative H1c: $\pi < 0.5$ for the population of price-beating guarantees. The p -value for the Upper-Tail test is less than 5%. The p -value for the Lower-Tail test is less than 1%. Given that different one-sided alternatives are favored, these results suggest that price-matching and price-beating guarantees may be serving different purposes in practice.

4.2. Testing for pairwise facilitation

The Hay (1982) and Salop (1986) 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 suggests that this lack of distinction may not be innocuous with respect to the type of LPG, and recent claims by Edlin (1997), Kaplan (2000), and Arbatskaya et al. (2004) suggest that whether the guarantees apply to advertised or selling prices will also be important.

In this subsection, we apply the test of pairwise facilitation to our sample of tire matches. We say that an observation is consistent with pairwise facilitation (in the sense that we cannot rule it out) if the price of the LPG firm is weakly higher than the price of the no-LPG firm, and it is not consistent with pairwise facilitation if the price of the LPG firm is strictly lower than the price of the no-LPG firm. Table 2 presents the raw data with the ambiguously worded LPGs and LPGs that apply to rivals' selling prices lumped together in the category 'Not Advertised-Price LPG.' As we will show in Appendix B, 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% 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% 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% of the cases, whereas low-price guarantees that are not restricted to advertised prices are consistent with pairwise facilitation in 75% of the cases. In the last four rows, consistency with pairwise facilitation ranges from a low of 25% in the population of price-matching guarantees that apply to advertised prices to a high of 86.11% 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% of the cases. We formalize this as follows.

Hypothesis 2 (H2: pairwise facilitation). The pair of tire prices in a No LPG–LPG tire match are as likely to be consistent with pairwise facilitation as not.

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

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

$$H2: \tilde{\pi} \equiv \Pr(p_{LPG} - p_{no\ LPG} \geq 0) = 0.5.$$

Table 3, which reports the p -values for the test of the null hypothesis H2 against the alternatives H2a, H2b, and H2c, 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. More importantly, Table 3 shows that for the tire matches with price-matching guarantees, the LPG firm is more likely to have the weakly higher price, whereas the opposite is true for the 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 less than 1%. The p -value for the Lower-Tail test is less than 5%. Simply put: price-matching guarantees are consistent with pairwise facilitation in a majority of the cases whereas price-beating guarantees are not.

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	

* Denotes significance at a 5% level.

** Denotes significance at a 1% level.

The one-sided tests also provide confirming evidence for the importance of matching or beating advertised prices versus matching or beating selling prices in determining whether the majority of paired observations involving firms that have low-price guarantees are consistent with what one would expect if firms were using them to discourage price cutting. These tests reveal that for tire matches with LPGs that apply only to advertised prices, the LPG firm is less likely to have the weakly higher price, while the opposite 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 alternatives for both populations at the 1% level.

Overall, the empirical evidence supports the view that price-matching guarantees differ from price-beating guarantees in purpose; that observations with price-matching guarantees are more likely to be consistent with pairwise facilitation than observations with price-beating guarantees (indeed, the majority of observations with price-beating guarantees are not consistent with discouraging price cutting); that it matters whether low-price guarantees are based only on advertised prices or also on selling prices; and that observations with guarantees that are based only on advertised prices are less likely to be consistent with pairwise facilitation. Importantly, the data does not support the view that price-matching and price-beating guarantees are primarily being adopted to discourage price cutting. Most price-beating guarantees do not seem to be adopted to discourage price cutting, and even when we are unable to reject the hypothesis that the majority of observations with price-matching guarantees are consistent with discouraging price cutting, the observed low-price guarantee-price patterns could alternatively be explained by the use of low-price guarantees to implement effective price discrimination, not necessarily to facilitate higher prices (for models of low-price guarantees in which price-discrimination is the primary motive, see [Corts, 1997](#); [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. However, we can be confident that when pairwise facilitation is not supported in the data, the low-price guarantee cannot be said to be discouraging price cutting. One would then 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](#); [Moorthy and Winter, 2004](#)).

5. Conclusion

There are many approaches that one can use to assess whether, and to what extent, the use of low-price guarantees in practice is or is not consistent with firms using them to discourage price cutting. One approach is to compare the average prices of firms with low-price guarantees in a market to those of firms without low-price guarantees in the same market. However, this approach is problematic because it implicitly assumes that absolute price differences matter in facilitating higher prices, and moreover it 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 are adopted by firms that sell product lines with more higher end tires, then higher average prices at low-price guarantee firms cannot be fully attributed to the low-price guarantee policies. Nor is such a comparison valid if firms' product lines do not overlap. For example, most guarantees only apply to tires of the same make and model, which rules out the comparison of *Goodyear* tires and *Firestone* tires. Even if the product lines and proportions sold of each item are identical between firms, a comparison of the average prices of

firms with and without low-price guarantees may still be misleading if there are outliers in some of the prices, e.g., a firm may have a lower price on 99 of 100 products but if the price difference on the last product is sufficiently large, it may well have a higher average price.

A second approach is to compare the average price (across all markets) on a particular item set by firms with low-price guarantees to the average price (across all markets) on the same item set by firms with no low-price guarantees (e.g. Arbatskaya et al., 1999). Unfortunately, this approach is also problematic and its interpretation can be misleading. Suppose, for example, that for a particular product there are four firms with low-price guarantees and prices of 50, 40, 30, and 80, respectively, and three firms with no guarantees and prices of 51, 41, and 31. In this case the average price of the firms with low-price guarantees is clearly higher than the average price of the firms without guarantees. But, without more information, we would not be able to say anything about pairwise facilitation. Indeed, the data is consistent with the absence of any pairwise facilitation. Suppose the prices (50, 51) come from market 1, prices (40, 41) come from market 2, prices (30, 31) come from market 3, and the price 80 comes from market 4. Then the data is inconsistent with pairwise facilitation in markets 1, 2, and 3, and there is simply no basis for comparison in market 4.

Our approach avoids these criticisms by ensuring that the markets in which the firms compete are the same, making sure that the products to be compared are the same, and looking only at relative, not absolute, prices. To this end, we collected *paired observations* on prices for the same make and model automobile tires which were advertised by tire dealers in the same market at the same point in time in the same Sunday newspaper. We then checked whether, and to what extent, the necessary condition for pairwise facilitation was met. The intuition behind the test for *pairwise facilitation* is as follows: if firms are using low-price guarantees to discourage price cutting, then a firm with a guarantee should be advertising a weakly higher price than a firm without a guarantee.

We found that the empirical evidence supports the view that firms may be adopting price-matching guarantees for different reasons than price-beating guarantees. In our sample, observations with price-matching guarantees were more likely to be consistent with pairwise facilitation than observations with price-beating guarantees. Indeed, in the majority of cases, we found that observations involving price-beating guarantees were not consistent with firms using them to discourage price cutting. We also found that whether the guarantees are based on advertised prices or selling prices matters; observations with guarantees that are based on advertised prices are less likely to be consistent with pairwise facilitation. Importantly, the data does not support the view that the majority of price-matching and price-beating guarantees are primarily being adopted by firms to discourage price cutting.

Our empirical findings should be interpreted as suggesting that in many cases a firm's low-price guarantee cannot be said to be discouraging price cutting (the data violates our necessary condition). In other cases, however, our findings suggest only that the evidence is consistent with pairwise facilitation. In this sense the interpretation of our findings is not symmetric. In the cases where the evidence is consistent with pairwise facilitation, one would need to obtain further empirical evidence (for example, one could collect prices before and after low-price guarantees are adopted) before one could definitively assert that low-price guarantees were facilitating prices.

Lastly, our results suggest that the focus of the recent literature (Edlin, 1997; Kaplan, 2000; Arbatskaya et al., 2004) on the particulars of low-price guarantees is 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 prices only or also selling prices. It is our hope that future work will further the study of the interactions between these low-price guarantee features and their effects on market prices.

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Appendix A

Proposition 1. Consider an equilibrium (p^*, g^*) to the low-price guarantee-price game with n firms in which 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. Consider an equilibrium (p^*, g^*) in which firm i has a low-price guarantee and firm j does not. Using (1) and (2), firm i ’s low-price guarantee facilitates firm j ’s price if and only if

$$p_j^* \equiv \arg \max_{p_j} \Pi_j(s_1^*(p_j), \dots, s_n^*(p_j)) > \arg \max_{p_j} \Pi_j(s_1^i(p_j), \dots, s_n^i(p_j)), \tag{A.1}$$

where $s_k^*(p_j) \equiv s_k(p_1^*, \dots, p_j, \dots, p_n^*, g^*)$ and $s_k^i(p_j) \equiv s_k(p_1^*, \dots, p_j, \dots, p_n^*, g^{*i})$, $k \in I$ (recall that $g^{*i} = (g_1^*, \dots, g_i = \emptyset, \dots, g_n^*)$). Thus, we need to show that (A.1) implies $p_i^* \geq p_j^*$, $i \neq j \in I$.

Suppose to the contrary that firm i ’s low-price guarantee is facilitating firm j ’s price but in the equilibrium $p_j^* > p_i^*$. Let $s^* = (s_1^*(p_j^*), \dots, s_n^*(p_j^*))$ denote the vector of equilibrium selling prices. Then, since firm i has a low-price guarantee and firm j does not, it must be that $s_j^*(p_j^*) = p_j^* > p_i^* \geq s_i^*(p_j^*)$. It follows that for any $k \neq j$, $k \in I$, firm k ’s selling price is independent of firm j ’s advertised price, and hence also of firm j ’s selling price, in the neighborhood of p_j^* . To see this note that if firm k does not have a low-price guarantee then $s_k^*(p_j) = p_k^*$, 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 when firm j is pricing in the neighborhood of p_j^* . Moreover, this independence of firm k ’s selling price to firm j ’s advertised price around p_j^* holds even if firm i does not have a guarantee. Thus, we have that

$$\frac{\partial s_k^*(p_j)}{\partial p_j} \Big|_{p_j=p_i^*} = \frac{\partial s_k^{*i}(p_j)}{\partial p_j} \Big|_{p_j=p_i^*} = 0. \tag{A.2}$$

Using (A.2) and the definition of p_j^* , we can totally differentiate Π_j to obtain

$$\frac{d\Pi_j(s_1^*(p_j), \dots, s_n^*(p_j))}{dp_j} \Big|_{p_j=p_j^*} = \frac{\partial \Pi_j(s_1^*(p_j), \dots, s_n^*(p_j))}{\partial s_j} \Big|_{p_j=p_j^*} = 0. \tag{A.3}$$

Using (A.2), (A.3), and the definition of p_j^* , and noting that $s_k^{*i}(p_j^*) \geq s_k^*(p_j^*)$ for any $k \neq j$, $k \in I$ (because, for fixed advertised prices, the existence of firm i ’s low-price guarantee can only (weakly) reduce all selling prices in the market), we can totally differentiate Π_j to obtain

$$\frac{d\Pi_j(s_1^i(p_j), \dots, s_n^i(p_j))}{dp_j} \Big|_{p_j=p_j^*} = \frac{d\Pi_j(s_1^i(p_j), \dots, s_n^i(p_j))}{ds_j} \Big|_{p_j=p_j^*} \geq 0 \tag{A.4}$$

where the inequality follows because selling prices are assumed to be strategic complements.

Table A1

Incidence of pairwise facilitation

No LPG–LPG type	Consistency with pairwise collusion (%)	Number of tire matches
No LPG–selling-price LPG	100.00	24
No LPG–not selling-price LPG	41.18	119
No LPG–selling-price PM	100.00	7
No LPG–not selling-price PM	70.27	37
No LPG–selling-price PB	100.00	17
No LPG–not selling-price PB	28.05	82

It follows that, under the supposition that $p_j^* > p_i^*$, firm j would not choose to lower its advertised price in the absence of firm i 's adoption of a low-price guarantee. More formally, (A.4) implies that $\arg \max_{p_j} \Pi_j(s_1^{*i}(p_j), \dots, s_n^{*i}(p_j)) \geq p_j^*$, which contradicts (A.1). Hence, our supposition that $p_j^* > p_i^*$ cannot be true when firm i 's low-price guarantee is facilitating firm j 's price. \square

Appendix B

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 Selling-Price LPG.' It shows that in paired observations in which the firm's guarantee is based on selling prices, the firm with the guarantee has the weakly higher price in every case, whereas in paired observations in which the firm's guarantee is not based on selling prices, the firm with guarantee has the weakly higher price in only 41.18% of the cases. In the second set of rows, consistency with pairwise facilitation ranges from a low of 28.05% when the guarantee promises to beat only a rival's lower advertised price to a high of 100% in both populations of selling-price guarantees.

The difference between low-price guarantees that are based on selling prices and low-price guarantees that are not based on selling prices is striking and significant. Observations involving the former, whether they are of the price-matching or price-beating kind, are always consistent in our sample with pairwise facilitation, whereas the majority of the observations involving the latter are not. Table A2, which reports the p -values for the test of the null hypothesis H2 against the alternatives H2a, H2b, and H2c, confirms these findings with evidence from the sign test.

Table A2

Testing for pairwise facilitation

Low-price guarantee type	Alternative hypotheses		
	H2a: $\tilde{\pi} \neq 0.5$	H2b: $\tilde{\pi} > 0.5$	H2c: $\tilde{\pi} < 0.5$
Selling-price LPG	0.000**	0.000**	
Not selling-price LPG	0.066		0.033*
Selling-price PM	0.016*	0.008**	
Not selling-price PM	0.020*	0.010**	
Selling-price PB	0.000**	0.000**	
Not selling-price PB	0.000**		0.000**

* Denotes significance at a 5% level.

** Denotes significance at a 1% level.

References

- Arbatskaya, M., 2001. Can low-price guarantees deter entry. *International Journal of Industrial Organization* 19, 1387–1406.
- Arbatskaya, M., Hviid, M., Shaffer, G., 1999. Promises to match or beat the competition: evidence from retail tire prices. *Advances in Applied Microeconomics* 8, 123–138.
- Arbatskaya, M., Hviid, M., Shaffer, G., 2004. On the incidence and variety of low-price guarantees. *Journal of Law and Economics* 47, 307–332.
- Chen, Z., 1995. How low is a guaranteed-lowest-price? *Canadian Journal of Economics* 28, 683–701.
- Chen, Y., Narasimhan, C., 2001. Consumer heterogeneity and competitive price-matching guarantees. *Marketing Science* 20, 300–314.
- Corts, K., 1995. On the robustness of the argument that price-matching is anti-competitive. *Economics Letters* 47, 417–421.
- Corts, K., 1997. On the competitive effects of price-matching policies. *International Journal of Industrial Organization* 15, 283–299.
- Dixit, A., Nalebuff, B., 1991. *Thinking Strategically*. W.W. Norton & Company, Inc., New York, NY.
- Doyle, C., 1988. Different selling strategies in Bertrand Oligopoly. *Economics Letters* 28, 387–390.
- Edlin, A., 1997. Do guaranteed-low-price policies guarantee high prices, and can antitrust rise to the challenge? *Harvard Law Review* 111, 528–575.
- Edlin, A., Emch, E., 1999. The welfare losses from price-matching policies. *Journal of Industrial Economics* 47, 145–168.
- Hay, G., 1982. Oligopoly, shared monopoly, and antitrust law. *Cornell Law Review* 28, 439–481.
- Hess, J., Gerstner, E., 1991. Price-matching policies: an empirical case. *Managerial and Decision Economics* 12, 305–315.
- Hviid, M., Shaffer, G., 1994. Do low-Price Guarantees Facilitate Tacit Collusion, University of Michigan working paper, 94-02.
- Hviid, M., Shaffer, G., 1999. Hassle-costs: the Achilles heel of price-matching guarantees. *Journal of Economics and Management Strategy* 8, 489–521.
- Hollander, M., Wolfe, D., 1999. *Nonparametric Statistical Methods*, 2nd ed. John Wiley & Sons, New York.
- Jain, S., Srivastava, J., 2000. An experimental and theoretical analysis of price-matching refund policies. *Journal of Marketing Research* 37, 351–362.
- Kaplan, T., 2000. Effective price matching: a comment. *International Journal of Industrial Organization* 18, 1291–1294.
- Logan, J., Lutter, R., 1989. Guaranteed lowest prices: do they facilitate collusion. *Economics Letters* 31, 189–192.
- Moorthy, S., Winter, R., 2004. Price-Matching Guarantees, mimeo.
- Png, I.P.L., Hirshleifer, D., 1987. Price discrimination through offers to match price. *Journal of Business* 60, 365–383.
- Salop, S., 1986. Practices that (credibly) facilitate oligopoly coordination. In: Stiglitz, J., Mathewson, F. (Eds.), *New Developments in the Analysis of Market Structure*. The MIT Press, Cambridge, MA.
- Sargent, M., 1993. Economics upside-down: low-price guarantees as mechanisms for facilitating tacit collusion. *University of Pennsylvania Law Review* 141, 2055–2118.
- Zhang, J., 1995. Price-matching policy and the principle of minimum differentiation. *Journal of Industrial Economics* 43, 287–299.