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**Conference Paper**

## Anchoring, Reference Prices, and List Price Collusion

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2019: 30 Jahre Mauerfall - Demokratie und Marktwirtschaft - Session: Industrial Organisation IV, No. E26-V1

**Provided in Cooperation with:**

Verein für Socialpolitik / German Economic Association

*Suggested Citation:* Paha, Johannes (2019) : Anchoring, Reference Prices, and List Price Collusion, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2019: 30 Jahre Mauerfall - Demokratie und Marktwirtschaft - Session: Industrial Organisation IV, No. E26-V1, ZBW - Leibniz-Informationszentrum Wirtschaft, Kiel, Hamburg

This Version is available at:

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## Anchoring, Reference Prices, and List Price Collusion

**Abstract:** The firms in this model set non-binding list prices before competing for buyers by non-cooperatively granting discounts. Each firm has an incentive to set a high list price if, for example, the customers anchor their willingness-to-pay on the list price. However, list price competition occurs if customers are loss-averse with respect to firms charging above-average list prices. The firms may thus find agreements on higher list prices profitable, even if they continue granting discounts non-cooperatively. Most importantly, for being an equilibrium of the game, such agreements do not require a dynamic game or mutual monitoring of the list prices.

**Keywords:** Anchoring, behavioral industrial organization, collusion, list price, loss aversion, reference price

**JEL Classification:** D90, D91, K21, L21, L41, M30

### Highlights:

- List price collusion is ineffective with rational buyers and perfect information.
- Using list prices and discounts raises profits because of anchoring effects.
- Loss aversion relative to reference prices causes list price competition.
- List price collusion is an equilibrium of the stage game even without monitoring.

*January 11, 2019*

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# 1 Introduction

The European Commission imposed its hitherto largest fine (3.8bn EUR) on a cartel among six producers of trucks who had agreed on raising and harmonizing list prices without, however, fixing transaction prices (list prices minus a discount). List price collusion is not a niche phenomenon because, for example, Hay and Kelley (1974) attributed the label ‘list price fixing’ to 31 of the 65 cases analyzed for their study. More recent cases have been reviewed by Boshoff and Paha (2017).

These cases suggest that firms resort to list price collusion even if (i) list prices are non-binding when it comes to setting transaction prices, (ii) no customer actually purchases the good at the list price, and (iii) there are no additional agreements on the admissible level of discounts. Under such circumstances, economic theory typically suggests that transaction prices in case of list price collusion are the same as in competition. Harrington and Ye (2017) provide one exception by allowing for asymmetric information about production costs between sellers and buyers.

Courts have frequently rationalized the effectiveness of list price collusion by a behavioral effect, i.e., anchoring as has been established, for example, by Northcraft and Neale (1987), Ritov (1996), or Beggs and Graddy (2009). In courts’ view, higher list prices translate into higher transaction prices by serving as a starting point for negotiations between the sellers and the buyers. This reasoning explains why firms have a unilateral incentive to distinguish between regular prices (list prices) and sales prices (transaction prices). Yet, in light of the prevalence of this practice in markets not having been convicted of collusion, the presence of merely the anchoring effect must not be expected to explain fully why the firms would want to resort to collusion – as opposed to competitive conduct – for exploiting the anchoring effect.

This article suggests that despite the anchoring effect the firms compete in list prices if buyers compare list prices to a reference price (e.g., the mean or the minimum of all firms’ list prices in the relevant market; Rajendran and Tellis (1994)). If buyers are loss averse (Tversky and Kahneman, 1991), they have a lower willingness to pay for the product of firms with a list price above the reference price. Alternatively, competition in list prices can also be motivated by non-behavioral effects such as asymmetric information about product quality (Armstrong and Chen, 2017) or by brand prominence in markets with search frictions (Armstrong et al., 2009).

The firms may then use list price collusion to overcome the competition

caused by reference price effects and loss aversion (or by price-related brand prominence), with these agreements being effective because of the anchoring effect. Interestingly and unlike most models of collusion, the article shows why the firms need not necessarily enforce the agreements on list prices by monitoring and potentially sanctioning each other's pricing behavior. In other words, agreements on list prices can be equilibria of the stage game and do not require a dynamic game structure for being stable.

Section 2 presents the model, with anchoring and reference points being addressed in Sections 3 and 4. The equilibria of the game are presented in Section 5 before concluding in Section 6.

## 2 The Model

Consider an industry with  $n \geq 2$  symmetric firms indexed by  $i \in \{2, 3, \dots, n\}$ . The timing of the game is as follows: In stage 1, each firm decides about a list price in the interval  $l_i \in [l_{min}, l_{max}]$ . In stage 2, each firm decides individually about the transaction price  $p_i$  that the customers actually pay. Afterwards, the game returns to stage 1, and the alternating sequence of stages 1 and 2 is infinitely repeated.

The profit of firm  $i$  in the stage 2 equilibrium is assumed to be a function  $\pi_i^*(z_i)$  of the parameter  $z_i \geq 1$  that is presented in the next paragraph. It will prove convenient to model  $z_i$  as a scaling factor as is shown in (1).<sup>2</sup>

$$\pi_i^*(z_i) = z_i \pi_i^*(z_i = 1) \quad (1)$$

Although the list price  $l_i$  is assumed to be non-binding, i.e., it does not constrain the firms when it comes to setting the transaction price  $p_i$ , the choice of  $l_i$  may affect the profit of firm  $i$ , for example, by causing an anchoring effect and/or a reference point effect. Both effects are captured by  $z_i$  that thus is a function of the list price  $l_i$  chosen by firm  $i$  and the vector of list prices  $\mathbf{l}_{-i}$  chosen by the other firms, as is shown in equation (2) and explained in Sections 3 and 4.

$$z_i(l_i, \mathbf{l}_{-i}) = \begin{cases} \zeta_1 l_i - \zeta_3(l_i - R) & \text{if } l_i > R \\ \zeta_1 l_i + \zeta_2(R - l_i) & \text{if } l_i \leq R \end{cases} \quad (2)$$

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<sup>2</sup>The appendix shows that condition (1) applies in a Bertrand-model with differentiated goods if the scaling factor rotates a linear demand curve in its intercept with the abscissa, i.e., it raises or lowers customers' willingness to pay while leaving market size constant. The model, however, is not restricted to this interpretation of  $z_i$ .

The customers compare the list price to a reference price  $R$  as is defined in Section 4. Given  $z_i = z_i(l_i, \mathbf{l}_{-i})$ , the notations  $\pi_i^*(z_i) = \pi_i^*(l_i, \mathbf{l}_{-i})$  will be used interchangeably.

### 3 Anchoring

The literature cited in this section suggests that it may be profitable for the firms to set a non-binding list price  $l_i$  above the transaction price  $p_i$  even if none of the buyers actually buys the product at  $l_i$ . This is the case, first, under the assumptions of Harrington and Ye (2017) who assume that the buyers have incomplete information about firms' production costs and infer from high list prices that the product is produced at high costs, which induces them to bargain less aggressively. Second, Armstrong and Chen (2017) assume that the buyers have incomplete information about the quality of the product and infer from high list prices that the product is of a high quality, which induces the customers to raise their willingness to pay. Third, customers' willingness to pay may also be raised because of anchoring effects.

Kahneman (1992, p. 308) defines anchoring as "cases in which a stimulus or a message that is clearly designated as irrelevant and uninformative nevertheless increases the normality of a possible outcome." In the absence of information asymmetries, the list price  $l_i$  might serve as such a stimulus. Yet, even professional real estate agents overestimate the fair price of a house after having been exposed to an excessive list price as has been shown by Northcraft and Neale (1987). Ritov (1996) found that initial offers in bilateral negotiations serve as anchors, i.e., in her bargaining experiment a seller and a buyer typically settle on a higher price if the seller starts the negotiation with a higher initial price. Beggs and Graddy (2009) show empirically for a dataset on art auctions that paintings, which were sold at higher prices in the past, are typically also sold at higher prices in the present, even if one controls for their observable characteristics. The marketing literature provides evidence of firms using the distinction between external reference prices (suggested, list, or regular prices) and actual prices (transaction prices) for raising their profits (Mayhew and Winer, 1992).

Therefore, in the present model, the list price  $l_i$  serves as an anchor whose effect is captured by  $\zeta_1 l_i$  in (2). Customers' willingness to pay and the profit  $\pi_i^*$  thus rise in  $l_i$ . The model assumes  $l_{min} = p_i^*(z_i = 1)$ , where  $p_i^*(z_i = 1)$  denotes the equilibrium price of an alternative game consisting entirely of

stage 2, where the firms do not use list prices and where  $z_i = 1$  shall apply. The model also assumes  $\zeta_1 = 1/l_{min}$ . Therefore, if all firms set  $l_i = l_{min} \forall i$  so that  $R = l_{min}$ ,  $|l_i - R| = 0$  and  $z_i = \zeta_1 l_{min} = 1$ , the present game collapses into the alternative game without list prices.

The assumption of an upper bound  $l_{max}$  is motivated by the results of Kopalle and Lindsey-Mullikin (2003) who empirically find an inverse u-shaped relationship between the anchor price and the transaction price. This suggests that everything else equal  $\pi_i^*$  rises with higher values of the list price as long as  $l_i \leq l_{max}$  and falls thereafter. Explicitly modeling these non-linearities instead of assuming an upper bound  $l_{max}$  would merely have reduced the tractability of the model without, however, changing its main interpretation.

## 4 Reference Points and Loss Aversion

Besides anchoring, buyers are assumed to compare  $l_i$  to a reference price  $R$ . A reference price “separates [a] domain into regions of desirable outcomes (gains) and undesirable ones (losses)” (Kahneman, 1992, p. 296), and buyers often are averse to losses (Kalyanaram and Winer, 1995). Putler (1992) provides a seminal model for studying loss aversion, and equation (2) is inspired by his specification: If  $R < l_i$ ,  $z_i$  falls by  $\zeta_3(l_i - R)$  because  $l_i$  is perceived as a loss relative to  $R$ . If  $R \geq l_i$ ,  $z_i$  rises by  $\zeta_2(R - l_i)$  because  $l_i$  is perceived as a gain. To model loss aversion, I assume  $\zeta_3 > \zeta_2$  so that a greater weight is attached to losses than to gains.<sup>3</sup>

The literature on reference price formation (for example, Monroe, 1973; Rajendran and Tellis, 1994; Mazumdar et al., 2005) suggests that customers form their reference price  $R$  based on the prices charged for the same good in the past (intrabrand, temporal comparisons) and on the prices charged contemporaneously for products in the same category (interbrand, contextual comparisons).<sup>4</sup> Because list price competition relies on strategic interaction

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<sup>3</sup>Other literature has studied a somewhat different setting where a buyer uses the list price  $l_i$  as the reference price that he/she compares to the transaction price  $p_i$  (Greenleaf, 1995; Kopalle et al., 1996; Heidhues and Köszegi, 2008; Spiegler, 2012; Heidhues and Köszegi, 2014; Ahrens et al., 2017).

<sup>4</sup>While most of the related literature has established these effects for consumer goods industries, Bruno et al. (2012) provide empirical evidence for the existence of reference points and loss aversion also in business-to-business markets. Monroe et al. (2015) review further literature supporting this point.

among the firms, the present paper focuses on interbrand price comparisons. This is the case, for example, if the good is a durable and purchased only infrequently, so that a new set of customers enters the industry in every period, who thus cannot recall past prices.

Rajendran and Tellis (1994) find empirical support for mainly two types of reference prices based on interbrand comparisons, both of which are explored in Section 5. Equation (3) adopts the notion that the reference price is established as the average list price of different brands.

$$R_{avg} = \frac{1}{n} \left( l_i + \sum l_{-i} \right) \quad (3)$$

Equation (4) assumes that buyers use the lowest value in the set of all firms' list prices.

$$R_{min} = \min\{l_i, \mathbf{l}_{-i}\} \quad (4)$$

The features of the present model are reminiscent of Armstrong et al. (2009, p. 221) who in their model with search frictions find that a “prominent firm earns more than a non-prominent firm”. This is because they assume customers to visit a prominent firm first, and the customers incur a search cost if looking for a better match at other suppliers. The present model assumes a positive impact on the profit of firms setting  $l_i \leq R$ . Therefore, if brand prominence derives from list prices being low, the specification of  $z_i$  in (2) is consistent with the non-behavioral model of (Armstrong and Zhou, 2011), i.e., search frictions and brand prominence would produce similar effects on profits as orientation on reference points and loss aversion. Indeed, they (*ibid.*, p. F369) suggest that low prices may be a “route to prominence”, though this suggestion refers to transaction prices because their model does not distinguish between list prices and transaction prices.

## 5 Equilibria

Let  $l_i$  denote the list price of firm  $i$  if  $l_i > R(l_i, \mathbf{l}_{-i})$ , whereas  $l'_i$  denotes the list price if  $l'_i \leq R(l'_i, \mathbf{l}_{-i})$ . Equation (5) shows the average list price  $R_{avg,-i}$  of the firms other than  $i$ .

$$R_{avg,-i} = \frac{\sum l_{-i}}{n-1} \quad (5)$$

It is straightforward to show that  $l_i > R(l_i, \mathbf{l}_{-i})$  can also be expressed as  $l_i > R_{avg,-i}$ , and  $l'_i \leq R(l'_i, \mathbf{l}_{-i})$  as  $l'_i \leq R_{avg,-i}$ .

Proposition 1 characterizes the equilibria of the game in the list price setting stage if the customers determine the reference price as the mean of all firms' list prices ( $R_{avg}$ ). The proposition suggests that all firms find it individually rational to set  $l_{max}$  if anchoring the customers on  $l_{max}$  raises their willingness to pay sufficiently strongly. All firms set  $l_{min}$  if the effect of anchoring is weak relative to customers' preference for gains. For intermediate values of the anchoring parameter  $\zeta_1$ , i.e., the anchoring effect is stronger than customers' preference for gains but not strong enough to offset their loss aversion, any symmetric profile of list prices in the interval  $[l_{min}, l_{max}]$  can be an equilibrium of the stage game.

**Proposition 1.** *Given  $R = R_{avg}$ , the stage game equilibrium is characterized by  $l_i = l_{max} \forall i$  if inequality (6) applies.*

$$\zeta_3 \left(1 - \frac{1}{n}\right) < \zeta_1 \quad (6)$$

*If inequality (7) applies, the stage game equilibrium is characterized by  $l'_i = l_{min} \forall i$ .*

$$\zeta_1 \leq \zeta_2 \left(1 - \frac{1}{n}\right) \quad (7)$$

*If (8) applies, any symmetric profile of list prices satisfying  $l'_i = R_{avg,-i} \forall i$  and  $l'_i \in [l_{min}, l_{max}]$  constitutes an equilibrium of the game.*

$$\zeta_2 \left(1 - \frac{1}{n}\right) < \zeta_1 \leq \zeta_3 \left(1 - \frac{1}{n}\right) \quad (8)$$

*Proof.* The definition of  $z_i$  in (2) causes a discontinuity in  $\partial \pi_i^*(l_i, \mathbf{l}_{-i}) / \partial l_i$  as is shown in (9).

$$\frac{\partial \pi_i^*(l_i, \mathbf{l}_{-i})}{\partial l_i} = \begin{cases} \zeta_1 - \zeta_3(1 - 1/n) & \text{if } l_i > R_{avg,-i} \\ \zeta_1 + \zeta_2(1/n - 1) & \text{if } l_i \leq R_{avg,-i} \end{cases} \quad (9)$$

Setting  $l'_i = R_{avg,-i}$  and  $l_i = l'_i + \epsilon$  with  $\epsilon \rightarrow 0$ , one finds  $\pi_i^*(l_i, \mathbf{l}_{-i}) > \pi_i^*(l'_i, \mathbf{l}_{-i})$  if inequality (6) is satisfied. Equation (9) shows that in this case  $\partial \pi_i^* / \partial l_i > 0$  applies so that firm  $i$  would set  $l_i = l_{max}$ . For symmetric firms, one thus finds  $l_i = l_{max} \forall i$  in equilibrium.

If inequality (6) is violated one finds  $\pi_i^*(l_i, \mathbf{l}_{-i}) \leq \pi_i^*(l'_i, \mathbf{l}_{-i})$  so that firm  $i$  would ideally set a list price  $l'_i \leq R_{avg,-i}$ . Here, two cases may emerge.



The first case applies if inequality (7) is satisfied. In this case, equation (9) implies  $\partial\pi_i^*/\partial l'_i \leq 0$  so that firm  $i$  would set  $l'_i = l_{min}$ . For symmetric firms, one finds  $l'_i = l_{min} \forall i$  in equilibrium.

The second case emerges if (8) applies, so that one finds  $\pi_i^*(l_i, \mathbf{l}_{-i}) \leq \pi_i^*(l'_i, \mathbf{l}_{-i})$  but  $\partial\pi_i^*/\partial l'_i > 0$ . In this case, firm  $i$  would set  $l'_i = R_{avg,-i}$ . For symmetric firms, any profile of list prices in the interval  $[l_{min}, l_{max}]$  satisfying  $l'_i = R_{avg,-i} \forall i$  constitutes an equilibrium of the game.  $\square$

Proposition 2 establishes the equilibria of the game if the reference price is determined by the customers as the minimum of all firms' list prices ( $R = R_{min}$ ) rather than being the average of all firms' list prices. The proposition suggests that all firms set  $l_{max}$  if the anchoring effect is strong relative to loss aversion. Otherwise, any symmetric list price chosen from the interval  $[l_{min}, l_{max}]$  may constitute an equilibrium of the game.

**Proposition 2.** *Given  $R = R_{min}$ , the stage game equilibrium is characterized by  $l_i = l_{max} \forall i$  if inequality (10) applies.*

$$\zeta_3 < \zeta_1 \quad (10)$$

If (10) is violated, any symmetric profile of list prices satisfying  $l'_i = R_{min} \forall i$  and  $R_{min} \in [l_{min}, l_{max}]$  constitutes an equilibrium of the game.

*Proof.* Given  $R = R_{min}$ , firm  $i$  can either set  $l_i > R_{min}$  or  $l'_i = R_{min}$ , and the first derivative of the profit function may be written as in (11).

$$\frac{\partial\pi_i^*(l_i, \mathbf{l}_{-i})}{\partial l_i} = \begin{cases} \zeta_1 - \zeta_3 & \text{if } l_i > R_{min} \\ \zeta_1 & \text{if } l_i = R_{min} \end{cases} \quad (11)$$

Inequality (10) follows from  $\pi_i^*(l_i, \mathbf{l}_{-i}) > \pi_i^*(l'_i, \mathbf{l}_{-i})$ . Combining (10) and (11) implies  $\partial\pi_i^*/\partial l_i > 0$ , which causes  $l_i = l_{max} \forall i$ .

If inequality (10) is violated, one finds  $\pi_i^*(l_i, \mathbf{l}_{-i}) \leq \pi_i^*(l'_i, \mathbf{l}_{-i})$  in combination with  $\partial\pi_i^*/\partial l_i > 0$ . Hence, firm  $i$  would want to match the lowest list price charged by any of the other firms ( $l'_i = \min\{\mathbf{l}_{-i}\}$ ). Because this incentive is the same for all firms, they would all set  $l'_i = R_{min} \forall i$  with  $R_{min} \in [l_{min}, l_{max}]$ .  $\square$

Turning to list price collusion, Propositions 1 and 2 have one obvious and one other, potentially more intricate implication. In the case with  $R = R_{avg}$  and  $\zeta_1 \leq \zeta_2(1 - 1/n)$ , the firms set  $l'_i = l_{min} \forall i$  in the stage game

because setting a below-average list price is a best response for each firm although setting  $l_i = l_{max} \forall i$  would actually create a Pareto improvement ( $\pi_i^*(l_{min}, l_{min}) < \pi_i^*(l_{max}, l_{max})$ ), which turns the game into a prisoners' dilemma. Using standard folk theorems and denoting firms' discount factor by  $\delta$ , it is straightforward to show that setting  $l_i = l_{max} \forall i$  constitutes an equilibrium of the dynamic game if the firms monitor each other's list prices and punish deviations, for example, by the eternal reversion to low list prices. List price collusion constitutes a stable outcome under the established condition on firms' discount factor (12).

$$\begin{aligned} \frac{\pi_i^*(l_{max}, l_{max})}{1-\delta} &\geq \pi_i^*(l_{min}, l_{max}) + \frac{\delta \pi_i^*(l_{min}, l_{min})}{1-\delta} \\ \delta &\geq \frac{\pi_i^*(l_{min}, l_{max}) - \pi_i^*(l_{max}, l_{max})}{\pi_i^*(l_{min}, l_{max}) - \pi_i^*(l_{min}, l_{min})} \end{aligned} \quad (12)$$

An interesting result relates to those equilibria where all firms set the same list price  $l_i = l \forall i$  in the interval  $l \in [l_{min}, l_{max}]$ . The stage game, thus, has multiple equilibria, and the firms have to coordinate on one of them. From their point of view, they do best by coordinating on  $l = l_{max}$ . Because this is an equilibrium of the stage game, the firms do not need to take further measures (in particular, monitoring prices and punishing deviations) for ensuring that everyone adheres to the agreed-upon list prices. This may help to explain those cases where firms got together for agreeing on list prices without, however, implementing mechanisms for monitoring and sanctioning deviations. Such mechanisms are unnecessary because the game does not constitute a prisoners' dilemma so that there is no incentive for any of the firms to deviate from the agreed-upon list price.

## 6 Conclusion

This article suggests a theory explaining that anchoring (or alternatively asymmetric information about product quality or production costs) may make list price collusion profitable even if list prices are non-binding, no customer actually purchases the good at the list price, and the sellers have not made any additional agreements on list prices. The sellers find list price collusion profitable only if there is list price competition otherwise. The article shows that this is the case if buyers compare the list prices of different sellers to an endogenous reference price and if they are averse to list prices above this reference price. A similar constellation occurs if setting a low list

price makes a brand more prominent while customers incur search costs for identifying the product matching their needs best.

The model gives rise to collusive equilibria in an infinitely repeated game when the firms agree on raising list prices, and they also monitor the prices being set by the other firms for sanctioning deviations from the agreed-upon prices. Additionally, the model points out instances where agreements on list prices are equilibria of the stage game, which makes additional provisions on monitoring and sanctioning unnecessary. This may shed light on cartel cases where monitoring and sanctioning schemes were apparently missing.

## Appendices

This appendix shows that equation (1) ( $\pi_i^*(z_i) = z_i \pi_i^*(1)$ ) is satisfied in a Bertrand-model with inverse demand for a differentiated good given by  $p_i = z_i(a - bq_i - b\theta \sum q_{-i})$  and  $\theta \in [0; 1]$ . Changes in  $z_i$  rotate the residual demand curve in its intercept with the abscissa. The demand parameter  $z_i$  is thus assumed to raise customers' willingness to pay by increasing the slope of the residual demand curve without, however, affecting market size. Inverting the system of demand curves yields demand as is shown in (13).

$$q_i = \frac{az_i(1 - \theta) - [1 + (n - 2)\theta]p_i + \theta \sum p_{-i}}{z_i b[1 + (n - 2)\theta] - (n - 1)\theta^2} \quad (13)$$

Maximizing the profit function  $\pi_i$  with regard to  $p_i$  while abstracting from production costs yields the equilibrium price and profit as are shown in (14) and (15).

$$p_i^*(z_i) = z_i \cdot \frac{a(1 - \theta)}{2 + (n - 3)\theta} \quad (14)$$

$$\pi_i^*(z_i) = z_i \cdot \frac{[a(1 - \theta)]^2[1 + (n - 2)\theta]}{[2 + (n - 3)\theta]^2 b[1 + (n - 2)\theta - (n - 1)\theta^2]} \quad (15)$$

Equation (15) proves the property  $\pi_i^*(z_i) = z_i \pi_i^*(1)$ .

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**Acknowledgments:** I would like to thank Willem Boshoff with whom I did further research on list price collusion that inspired me to this article. I also gratefully acknowledge the hospitality of Stellenbosch University where part of this research was conducted. Further valuable comments were received from Thomas Fagart.