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Corresponding Author: Dr. Praveen Kopalle, Ph.D

Corresponding Author's Institution: Dartmouth College

First Author: Praveen Kopalle, Ph.D

Order of Authors: Praveen Kopalle, Ph.D; Donald R Lehmann, Ph.D.

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The Truth Hurts: How Customers May Lose From Honest Advertising

Praveen K. Kopalle
Donald R. Lehmann*

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*Praveen Kopalle is professor of marketing at the Tuck School of Business at Dartmouth, Dartmouth College, 100 Tuck Hall, Hanover, NH 03755; phone: (603) 646-3612, fax: (603) 646-9297, e-mail: kopalle@dartmouth.edu; Don Lehmann is George E. Warren Professor of Business, Graduate School of Business, Columbia University, 507 Uris Hall, New York, NY 10027; phone: (212) 854-3465, fax: (212) 864-4857, e-mail: drl2@columbia.edu. The authors thank two anonymous reviewers and Special Issue Guest Editor of International Journal of Research in Marketing, Roland Rust for their constructive feedback on this paper. The authors also thank Peter Golder, Kinshuk Jerath, Oded Netzer, seminar series participants at Dartmouth College, University of Texas at Austin, Syracuse University, and attendees at University of Utah New Products and Service conference, Marketing Dynamics conference, and Marketing Science conference for their comments on earlier drafts of this manuscript, and Kartik Vittal, Saurabh Phansalkar, and Alison Pearson for their research assistance.
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ABSTRACT

This paper examines the impact of competition, brand equity, and the cost of overstating quality on optimal quality and quality claims of new products. We consider two firms simultaneously introducing a new product and making one-time decisions about its quality, price, and advertised quality. Using a two period model which allows for larger weight on future period sales, we find competition often leads firms to overstate quality unless they are constrained by high legal costs imposed by regulations or third-party legal action. More interesting, when competitors are constrained to be truthful in their advertising due to legal or other costs, optimal product quality can be lower and profits can be higher.

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1. INTRODUCTION

The pros and cons of competition (and capitalism) have been debated for centuries. While early debates centered on issues such as the appropriateness of charging interest (“usury”), more recent ones have involved issues such as the effect of large firms on small firms and consumers (hence the evolution of anti-trust laws). Much of the debate centers on the sense that, left to their own devices, firms will act in such a way as to damage both consumers and their competition unfairly. This paper highlights a different perspective, namely how controlling firm behavior by requiring truthful advertising may, paradoxically, harm some consumers and increase firm profits.

One area in which companies are tempted to behave “inappropriately” to gain competitive advantage is in advertising. Especially when product quality is hard to assess a priori and/or ambiguous after use (i.e., for credence and some experience goods), a firm has the apparent incentive to overstate quality. Indeed, misleading advertising is the reason for the existence of the Federal Trade Commission (FTC) in the U.S.A. The FTC serves partly as a policeman, imposing costs on firms who mislead the public.

Overstatement of the quality of new products is widespread. The Wall Street Journal (WSJ) has reported quality overstatement (deceptive advertising) in multiple industries including food (WSJ November 2003), toys (WSJ August 1996), finance (WSJ September 2007), retailing (WSJ July 2009), pharmaceuticals (WSJ June 2004), electronics (WSJ December 2004), and packaged goods (WSJ April 2009). Moreover, the Federal Trade Commission (FTC) examined 627 cases of deceptive advertising practices between 1995 and 2002, and found 626 of them were in violation of the law (http://www.ftc.gov/).

The core issues investigated here are the role of competition in overstating quality and the corresponding effect of discouraging quality overstatement on the products offered by firms.
Obviously regulations that discourage and punish quality overstatement will reduce overstatement, i.e. make advertising more truthful. However, the impact of these regulations on actual product quality, price, and profitability is less obvious. Here we examine why firms overstate quality and its consequences in the context of new product introduction.

There are two ways to approach this issue: empirically (i.e. examine what companies/managers do) and normatively (i.e. determine what companies should do to maximize profits). Here we focus on the second approach, i.e., the decisions that firms “should” make to maximize profits.

We focus on experience goods where product quality is revealed upon use, i.e. quality in use is observed at the end of the first period. While the model we use may be more generally applicable (e.g., to information goods), the type of product we have in mind is a repeat purchase good or service such as car tires or annual services (e.g., lawn care) with a fairly objective measure of quality (e.g., how long a product lasts or how promptly a service is performed).

We assume the cost of overstating quality increases as the degree of overstatement increases. This is consistent with results of cases decided by the FTC which show a positive relation between the seriousness of the distortion and the severity of the punishment. FTC data also indicate that firms with a larger number of competitors tend to make more substantial quality overstatements.

We extend prior work on optimal new product introduction strategy by a) considering competition, specifically a duopoly where two firms simultaneously introduce a new product (or an upgrade to an existing one), including the case where one firm has a stronger reputation (greater brand equity) than the other and by b) explicitly incorporating costs (which we call “legal costs”) which may be imposed by regulators (e.g., the FTC) or others (e.g., competitor

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1 Note that many of the categories where overstatement was identified in the various Wall Street Journal articles cited in the Introduction involved experience goods (Darby and Karni 1973) where products must be used in order for their quality to be observed.
lawsuits) on firms which overstate quality (i.e. advertise deceptively). We focus on new products because (a) that is when advertising is most influential and (b) once a claim is made, it is difficult for a firm to change it.

Several results emerge for a wide variety of, although not all, market conditions. First, competition encourages firms to overstate quality. More intriguing, while imposing a cost on overstating quality (beyond that naturally caused by the market via unsatisfied customers and negative word of mouth) leads to less overstatement (an obvious result), it also leads to firms producing a lower quality product. This later result was unanticipated and is somewhat counter-intuitive. Also, intuitively, imposing costs on overstating quality should lead to reduced profits. Interestingly the opposite result emerges; imposing a cost on overstating quality leads to greater firm profits.

The paper is organized as follows. The next section presents a brief literature review. We then describe the model and examine its consequences. We conclude with a discussion of implications, limitations, and directions for future research.

2. BACKGROUND

A large body of research has focused on new product introductions and diffusion (Biyalogorsky, Boulding, and Staelin 2006; Dahl and Moreau 2002; Peres, Muller, and Mahajan 2010; Rao and Humaira 2003; Shankar 1999; Urban and Hauser 1993). This work includes attempts to forecast sales (Bass 1969; Mahajan, Muller, and Bass 1990), identify determinants of success (Goldenberg, Lehmann, and Mazurski 2001; Henard and Szymanski 2001; Montoya – Weiss and Calantone 1994), and understand the process of customer adoption (Moreau, Lehmann, and Markman 2001; Rogers 2003). There has also been substantial research in the general area of optimal new product strategies. For example, Lehmann and Weinberg (2000) investigated the optimal time to move a new product into a different channel (specifically a movie from theaters to video rentals). In the research most closely related to this paper, Kopalle
and Lehmann (2006) examined optimal price, quality, and advertised quality for a monopoly firm introducing a new product.

Importantly, at least two forces influence the results of new product introductions beyond those typically considered in prior research. First, competition, although often ignored in normative models, clearly can impact optimal pricing and advertising decisions (Iyer, Soberman, and Villas-Boas 2005; Rao and Syam 2001; Thompson and Teng 1984). Second, misleading quality statements can lead to costs (beyond customer dis-satisfaction) being imposed by governmental agencies and other actors (e.g., consumer watchdog agencies), which we consider under the broad description of “legal costs”. Extant research implicitly assumes that overstatement of quality does not result in out-of-pocket costs for the firm (Crawford and Sobel 1982; Farrell and Gibbons 1989; Farrell and Rabin 1996; Gneezy 2005; Kopalle and Assunção 2000; Kopalle and Lehmann 2006); here, we relax this assumption.

There has been significant behavioral research on deceptive advertising. Boush, Friestad, and Wright (2009) indicate that deception is common in firm and consumer interactions and Richards (2010) provides a three step conceptual model of deceptiveness. Skurnik et al. (2005) show the “illusion of truth” effect where letting people know that a quality claim is false can actually make them recollect it as true. Overstated quality claims lead to higher levels of expectations relative to true information (Burke et al. 1988) while those in a positive mood are not only more likely to notice false information but also have positive feelings toward the brand (LaTour and LaTour 2009). True claims tend to be recalled more often than false claims (Nagar 2009). Recently, using functional magnetic resonance imaging data, Craig et al. (2012) observe significantly higher brain activity associated with quality claims that are moderately deceptive relative to
those that are either believable or highly deceptive. Thus, this body of literature suggests that quality claims by firms do impact consumer expectations.

On the normative side, prior work on deceptive advertising suggests that when customers are boundedly rational, companies will overstate quality (Nagler 1993). While prior research does not take customer expectations (and the ensuing satisfaction) into consideration, adaptive expectations seem to describe customer behavior better than rational expectations (Johnson, Anderson, and Fornell 1995). In this paper, we consider customer and firm dynamics, customer expectations and satisfaction with respect to quality, and legal costs of overstating quality.

We follow a micro-modeling approach (Chatterjee and Eliashberg 1990; Garber, Goldenberg, Libai, and Muller 2004), allowing customer heterogeneity regarding the quality they experience. Akin to Shi (2003), who linked pricing strategy to word of mouth (WOM), our two-period model considers WOM based on experience in a competitive market, including both positive (high quality) and negative (low quality) experiences (East, Hammond, and Lomax 2008).

We examine a duopoly where two firms make three decisions simultaneously: average product quality (which allows for experienced quality to be heterogeneous across customers), the advertised level of product quality (and by implication the level of over- or under-statement of quality relative to average/actual quality), and price. Overstating quality leads to higher sales in the first period but lower sales in the second period due to reduced customer satisfaction and negative word of mouth. On the other hand, more truthful claims result in lower sales in the first period but higher sales in the second period due to improved customer satisfaction. We find that competition may lead to overstatement of quality. We also show, paradoxically, that the imposition of legal costs (penalties) for overstating quality may lead to firms producing lower quality products.
3. MODEL

Consider two competitors (A and B, a duopoly) selling new products which are experience goods. Our model incorporates three aspects of quality\(^2\): 1) the average quality produced \((\mu)\), 2) the quality level advertised by the firm \((Ad)\), and 3) the quality expected by customers \((\hat{Q}\) both prior to and, appropriately revised, after experience with the product). We consider first and second period profits, with second period profit multiplied by a constant to account for both discounting and the long run (future period) consequences of decisions. Thus, the two period model allows for a larger weight on results in the second period to capture the impact of longer term sales.

In Period 1, firms make one-time decisions about average quality, advertised quality, and price \((P)\) and introduce the new product. Customers then form initial expectations based on a combination of public (independent) sources which have accurate (unbiased) information about a product’s average quality (e.g., via testing services such as Consumer Reports) and company-provided information (i.e., advertising) which may be misleading. Customers then decide (probabilistically) whether to buy based on these expectations and price.

In Period 2, customers who bought in Period 1 update their expectations based on prior expectations, individual experience, word of mouth, and satisfaction based on experienced quality and the gap between experienced and expected quality. While initial expectations are similar across potential customers, they become heterogeneous as customers have different experiences with the product once they purchase and use it. Customers who didn’t buy the product update their expectations based on prior expectations and word of mouth. Finally, customers decide (probabilistically) whether to buy in Period 2 based on their revised

\[^2\text{While quality can have multiple dimensions, here it stands for a single dimension (for example, how long a product lasts as a measure of performance) or overall value based on a linear combination of multiple dimensions.}\]
expectations, price, and satisfaction (if they bought in Period 1). Customer choice is modeled via a multinomial logit model which allows for non-purchase and hence makes primary demand a function of the firms’ decisions.

3.1 Customer Decisions in Period 1

Potential customers in period one form expectations of quality for the two new products \( j = 1, 2 \) as a combination of average quality produced, \( \mu_j \), which “leaks” into the market as an imperfect signal, and advertised quality, \( Ad_j \). That is, we assume there are sources which provide (on average) accurate information about the products’ average quality levels but customers do not know a priori whether they are perfectly accurate and therefore do not fully weight (“trust”) them. Specifically, the expected quality of product \( j \) in period 1 is:

\[
\hat{Q}_{1j} = a_1 Ad_j + a_2 \mu_j, \quad \text{where} \quad a_1 + a_2 = 1
\] (1)

Expected quality converts into purchase probability via a multinomial logit model which allows for a customer to buy either or neither (but not both) of the two new products. Thus the purchase probability of product \( j \) in period 1 is:

\[
P_{1j} = \frac{\exp\left(b_0 + b_1 \hat{Q}_{1j} + b_2 \text{Price}_j\right)}{1 + \sum_{k=1}^{2} \exp\left(b_0 + b_1 \hat{Q}_{1k} + b_2 \text{Price}_k\right)}
\] (2)

While this model assumes all customers have the same probability of buying in period 1, it produces variation in actual purchasing.

For customer \( i \) who buys product \( j \) in period 1, his/her satisfaction is a weighted combination of base satisfaction \( (d_0) \), experienced (observed) quality \( (Q_{1ij}) \), and the gap between experienced and expected quality (e.g., Boulding et al. 1993; Parasuraman, A., Zeithaml, and Berry 1994; Kőszegi and Rabin 2006; Yi 1990)\(^3\):

\(^3\)We use only a linear gap term here to enhance model tractability. Some authors (Anderson and Sullivan 1993; Mittal, Ross, and Baldasare 1998) have included a quadratic term, an extension we leave to future research.
Individuals’ experienced quality, $Q_{ij}$, is heterogeneous across customers, varying around its mean due to different usage patterns, evaluation standards, etc. We model it using a uniform distribution.

3.2 Customer Decisions in Period 2

Expectations in period 2 depend on whether or not individuals bought the product in the first period. For those that did buy it, their expectations are revised akin to adaptive expectations (Johnson, Anderson, Fornell 1995), i.e.,

$$\hat{Q}_{2ij} = c_1 \hat{Q}_{1ij} + c_2 Q_{ij} + (1 - c_1 - c_2)p_{ij} \int_{Q_{ij}}^{\mathcal{Q}} dQ_{ij}$$

Here the second term represents personally experienced quality and the third term represents feedback from the market (i.e., word of mouth from other purchasers). Expectations do not exactly equal experienced quality because a) quality may be hard to judge (i.e., we may not know exactly how many miles a car tire or light bulb lasted), b) a single data point is not sufficient to estimate the mean of a process with certainty, and c) customers are likely to recall how long they thought it would last as well as what other users say about it.

The third (final) term of (4) is a “social aggregation” mechanism (e.g., online reviews which aggregate user experience) which has more impact the more people buy $j$ in period 1 as captured by $p_{ij}$. The third term approaches $(1-c_1-c_2)$ times average quality as $p_{ij}$ approaches 1. Because a single experience does not perfectly reveal actual/average quality, following adaptive expectations (Johnson et al. 1995), customers still consider others’ experiences in anticipating what they will experience in the future if they buy the product again. (Alternative specifications
of period 2 expectations lead to similar results--see Appendix A.) Taking the expected value of
the third term, Equation (4) reduces to:

\[ \hat{Q}_{2ij} = c_1 \hat{Q}_{1ij} + c_2 Q_{1ij} + (1 - c_1 - c_2) p_{1j} \mu_j \]  

(5)

For those who didn’t buy, their expectations depend only on prior expectations and word of
mouth:

\[ \hat{Q}_{2ij\text{not buy}} = c_4 \hat{Q}_{1ij} + (1 - c_4) \int p_{1j} Q_{1j} dQ_{1j} = c_4 \hat{Q}_{1ij} + (1 - c_4) p_{1j} \mu_j \]  

(6)

Purchase probabilities for product \(j\) in the second period again follow a multinomial logit model,
conditional on what was bought in the first period. For those who bought product \(j\) in period 1,
the purchase probability becomes \((j, k = 1, 2, \text{and } k \neq j)\):

\[
\begin{align*}
  p_{2ij|j} &= \frac{\exp [b_0 + b_1 \hat{Q}_{2ij}] + b_2 \text{Price}_j + b_3 S_{1ij}] }{1 + \exp [b_0 + b_1 \hat{Q}_{2ij}] + b_2 \text{Price}_j + b_3 S_{1ij}] + \exp [b_0 + b_1 \hat{Q}_{2ik}] + b_2 \text{Price}_k ]}
\end{align*}
\]  

(7)

For those who bought neither in period 1,

\[
\begin{align*}
  p_{2ij\text{neither}} &= \frac{\exp [b_0 + b_1 \hat{Q}_{2ij}\text{neither} + b_2 \text{Price}_j] }{1 + \sum_{k=1} \exp [b_0 + b_1 \hat{Q}_{2ik}\text{neither} + b_2 \text{Price}_k]}
\end{align*}
\]  

(8)

The unconditional purchase probability of product \(j\) in period 2 for customer \(i\) is then

\[
\begin{align*}
  p_{2ij} &= p_{1j} p_{2ij|j} + p_{1k} p_{2ij|k} + p_{1\text{neither}} p_{2ij\text{neither}} \\
  &= p_{1j} p_{2ij|j} + p_{1k} p_{2ij|k} + (1 - p_{1j} - p_{1k}) p_{2ij\text{neither}}
\end{align*}
\]  

(9)

We assume experienced quality is uniformly distributed around the average quality, \(\mu\)
(Kopalle and Lehmann 2006). More specifically, we assume \(Q_{ij}\)’s are random draws from the
uniform distribution, \([\mu_j - L_j, \mu_j + L_j]\). (One could also assume experienced quality has a central
tendency, e.g., via the normal distribution, but this makes the model noticeably less tractable).

Period 2 share for product \(j\) \((\text{share}_{2j})\) is therefore:
3.3 Firm Decisions

While first period sales for an experience good are driven by customers’ initial quality expectations, long run sales are more dependent on product quality and customer satisfaction (Anderson and Sullivan 1993). Customer satisfaction is a function of the difference between experienced quality and prior expectations (Bolton and Drew 1991; Yi 1990). Thus, a firm has the option of either increasing initial sales via raising expectations by advertising higher quality levels or improving satisfaction and increasing repeat sales by lowering expectations via lowering advertised quality.

Firm $j$’s ($j=1,2$) objective is:

$$ \max \left[ K (\text{Price}_j - c)(\text{Share}_{1j} + m * \text{Share}_{2j}) - A \mu_j^2 - \text{Legal Cost of Overstating Quality}_j \right] $$

where,

- $K$ = scaling constant proportion to market size
- $m$ = multiplier for future periods
- $A$ = constant which converts the cost of quality into dollar units
- $c$ = variable cost

Parameter, $m$, captures future discounted profits as a multiple of second period profits and the relative value a firm puts on future sales⁴. (In the special case of $m = 0$, this reduces to a single period model.) Consistent with prior work (Rogerson, 1988; Schmalensee, 1978), we assume the (fixed) cost to produce quality rises as the square of the quality level. The term, $A \mu_j^2$, thus captures the fixed cost of producing different quality levels.

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⁴ As an example, if the average demand stabilizes in Periods 2 through $k$ (and then drops to zero), the average revenue per customer from Periods 2 through $k$ becomes:

$$ \sum_{i=2}^{k} \left( \frac{1}{1+r} \right)^{i-2} (P - v)i = \frac{1}{r(1+r)} \left[ 1 - \left( \frac{1}{1+r} \right)^{k-1} \right] (P - v)D_2, $$

where $v$ is variable cost and $r$ is the discount rate. Therefore $m$ would be:

$$ \frac{1}{r(1+r)} \left[ 1 - \left( \frac{1}{1+r} \right)^{k-1} \right]; \text{ note this can be greater than 1.}$$
Overstating advertising can have consequences beyond individual customer dissatisfaction and word of mouth. Customers, competitors, interest groups, and governmental entities (e.g., the FTC) can all get involved, producing undesirable publicity as well as legal actions which could result in costs to the company. We model this effect, which we call “legal costs”, as a concave function of the gap between advertised and average quality. There is, of course, no cost to understating quality. However, the probability that legal action is initiated, the likelihood it is successful, and the cost if it is successful all increase as the gap increases. At some point, legal costs will force bankruptcy and hence they have an upper limit ($K_1$). Thus,

$$\text{Legal Cost of Overstating Quality}_j = \begin{cases} K_1 e^{\frac{-K_2}{\text{Ad}_j - \mu_j}} & \text{if } \text{Ad}_j > \mu_j \\ 0 & \text{otherwise} \end{cases} \quad (12)$$

As $K_2$ decreases, legal costs increase.

4. ANALYSIS

Given the richness of its specification, a closed form solution is not available for our model. Therefore we utilized numerical methods. Specifically, we investigate how the optimal solution depends on different combinations of parameter values.

We use Kopalle and Lehmann’s (2006) study as a starting point for analysis. They examined optimal behavior for a monopolist introducing a new tire with how long a tire lasted (in miles) as the measure of quality.

We use their parameters ($d_0 = 3.4$, $d_1 = 0.26$, $d_2 = 2.0$, $b_0 = 0.5$, $b_1 = 0.2$, $b_2 = -0.25$, $a_1 = 0.5$) as a base case in Equations (9)-(11). We then vary them. For price elasticity we used a base value of -2.5 based on previous meta analyses (Bijmolt, van Heerde, and Pieters 2005; Sethuraman, Srinivasan, and Kim 1999; Tellis 1988). Without loss of generality, we set $b_3 = 1$. In period 1, we assume that customers weight advertised quality and

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5 Note that even if manufacturers provide a mileage guarantee, any refund is based on miles driven, limiting the value of a warranty. Further, when tires fail early, there is still inconvenience involved in unexpectedly (e.g., while on a trip) having to purchase new tires.
independent quality ratings equally, i.e., $a_1 = a_2 = .5$. Similarly, we assume customers who buy in period one equally weight prior expectations, experienced quality, and word of mouth in forming period 2 expectations, i.e., $c_1 = c_2 = 1/3$, and those who don’t buy, weight their prior expectations and word of mouth equally (i.e., $c_4 = .5$). To investigate the impact of legal costs, we set $K_1 = 100$ (i.e., the maximum penalty is approximately equal to the total annual profit level in our analysis) and $K_2 = 3$ or 1 to represent low and high legal costs respectively. We subsequently varied the parameters around these base values to check for the robustness of the results.

4.1 Special Case: No Legal Costs

To get an initial sense for the results, we examined the special case where mean quality was set at a useful life of fifty thousand miles and price was set at $50 for both firms. We then determined optimal advertised quality numerically using increments of 2,500 miles, assuming no legal costs. Table 1 shows a subset of the results.

<table>
<thead>
<tr>
<th>Firm 1’s Advertised Quality (’000)</th>
<th>50.0</th>
<th>60.0</th>
<th>70.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Firm 2’s Advertised Quality (’000)</strong></td>
<td>79.2 (Firm 1)</td>
<td>76.1</td>
<td>75.1</td>
</tr>
<tr>
<td><strong>50.0</strong></td>
<td>79.2 (Firm 2)</td>
<td>81.8</td>
<td>80.0</td>
</tr>
<tr>
<td><strong>60.0</strong></td>
<td>81.8</td>
<td>78.7</td>
<td>77.8</td>
</tr>
<tr>
<td><strong>70.0</strong></td>
<td>80.0</td>
<td>77.0</td>
<td>76.1</td>
</tr>
</tbody>
</table>

In the absence of collusion, the Nash equilibrium is for both firms to advertise at 60 thousand miles. Notice this involves overstating quality, which presumably irritates and potentially harms consumers and leads to lower profits than the cooperative solution of both firms advertising at 50
thousand miles. In other words, competition results in a prisoner’s dilemma type situation which potentially harms both consumers (who are deceived) and manufacturers (who obtain lower profits).

For the base case where average quality, advertised quality, and price are all at the discretion of the firm and there are no legal costs, the equilibrium strategy is an average quality of 50.0 (thousand miles), advertised quality of 60.0 thousand miles (i.e. overstated), and price of $60. The intuition for this is: (a) it is cheaper to raise promised than average product quality, (b) first period sales are not affected if quality fails to match a promise, and (c) higher average quality increases sales more in the second period than in the first period whereas costs are incurred up front. The market shares of each firm in periods 1 and 2 are 34.42% and 42.02% respectively.

4.2 Impact of Competition and Legal Costs

In order to highlight the impact of competition and legal costs on average quality, advertised quality, and price, we examined three additional scenarios: (1) low legal costs \(K_2=3\) and competition, (2) high legal costs \(K_2=1\) and competition, (3) low legal costs \(K_2=3\) and a monopolist offering two products. (A fourth scenario where the competitors agree to be truthful in advertising, i.e., only compete on price and average quality, leads to the same result as high legal costs, suggesting “honest” competition is a substitute for legal costs/regulation). While the exact results depend on the particular parameters used, Table 2 provides the results for the base set of parameters.
As expected, higher potential legal costs lead to a smaller (and eventually no) gap between advertised and average quality. More interesting, it appears that greater legal costs may lead to the production of lower quality goods and, partly as a consequence of this, greater manufacturer profits as it eliminates the prisoner’s dilemma type situation seen in Table 1. In effect, legal pressure designed to help customers by forcing honest disclosure of quality may produce a reason (incentive) for competitors to implicitly cooperate by competing less strongly on quality.

Unsurprisingly, the monopolist generates the greatest profits by having both lower quality, i.e., 35 thousand miles, and a higher price ($85). The next highest profits occur when competitors are truthful due to sufficiently high legal costs (or based on mutual agreement/collusion). Unconstrained competitors thus might, somewhat surprisingly, welcome some regulation.

The result that overstatement of quality leads to higher quality, and that regulations against overstatement lead to lower quality, may seem counter-intuitive. The reason for this result is as follows. When legal costs are low, firms overstate quality to increase sales in the first period. To mitigate the impact of the resulting lower satisfaction in the second period, average quality is increased. However, when legal costs are high, firms no longer provide the higher
quality because (i) they no longer overstate quality and (ii) providing higher quality is costly. For example, if both firms provide a higher quality of 47.5 thousand miles and advertise it as such when legal costs are high, their equilibrium profitability goes down from 103.3 to 100.4. In essence, increasing average quality leads to higher second period sales and lower legal costs but also to higher production costs, while increasing advertised quality leads to higher first period sales but also higher legal costs. Net-net this leads firms that face high legal costs to lower advertised quality and consequently average quality as well.

In summary, two main results hold here:

1. **Result 1**: When the cost of overstating quality is low, it is optimal for both firms to overstate quality, i.e., in equilibrium, advertised quality ($Ad^*$) is greater than product quality ($\mu^*$). Put differently, competition leads to overstating quality.

2. **Result 2**: When the cost of overstating quality is high enough such that advertised quality equals product quality, equilibrium product quality is lower than in the case where the cost of overstating quality is low. In other words, imposing legal costs on quality overstatement leads to firms supplying lower quality goods.

### 4.3 Generalizability of the Results

In order to see how generalizable the results are, we did two things. First, we developed and solved a simpler, analytical model of duopoly and arrived at a closed form expressions for the optimal firm behavior. The propositions based on the analytical model are consistent with the results based on numerical methods reported in this paper (see Appendix B).

Second, we explored a range of values for each parameter. Specifically, we first conducted sensitivity analyses on the key parameters one at a time by varying them by at least +/- 60%. The results (Appendix C) lead to several fairly obvious conclusions and a few interesting ones.
Average quality, advertised quality, and price depend most on quality and price sensitivity. In our parameter range, variation in the influence of word of mouth has a relatively small effect on optimal quality, advertised quality, and price. Since the product is an experience good, post-hoc this makes sense. Most of the other model parameters also have minimal impact on the optimal decisions.

Interestingly, when quality sensitivity is low (which reduces the benefit of overstating quality), it is optimal to understate quality. Further, the incentive to overstate quality is lowest when a) the base level of satisfaction with the product is low and b) the importance of experienced quality per se is high in forming satisfaction judgments. Some other (fairly obvious) results are:

- When the base level of satisfaction is larger, the overstatement of quality is greater.
- Greater sensitivity of satisfaction to quality disconfirmation increases optimal average and advertised quality levels.
- Higher sensitivity of satisfaction to quality leads to lower overstatement of quality, while both average and advertised quality increase substantially.
- The more quality (price) matters to customers, the higher (lower) the optimal quality and the higher (lower) the optimal price.
- The more emphasis a firm places on sales from future periods (via the multiplier, \( m \)), the higher will be both the average quality and price (justified by the higher quality), while the degree of overstatement of quality decreases and eventually disappears.

One other interesting case is where quality is perfectly revealed with use, i.e., if \( c_2=1 \) (a pure experience good). Importantly, this produces the same result as the base case; overstating quality is still optimal.
Another interesting case occurs when customers are very sensitive to quality ($b_1=0.7$) and place little weight on advertised quality ($a_1=0.2$). This scenario produces higher actual quality (100) and advertised (110) quality as well as a higher price (80). However, it again suggests that overstating quality is optimal.

To summarize, for a broad range of parameter values, two principle results hold: competition leads to quality overstatement and imposing a cost on overstatement leads to firms producing a lower quality product (see Appendix C). However, three cases favor understating quality. When the base level of satisfaction is very low, it is optimal to advertise a quality level of 40,000 miles and produce actual quality of 45,000 miles. In addition, if consumers are largely insensitive to quality, it is optimal to produce low quality tires (15,000 miles) and promise even less (5,000 miles). In this case, having low quality causes little harm while understating quality provides a benefit. (This is driven by the implicit assumption that understatement has the same magnitude of effect on satisfaction as overstatement.) Finally, if consumers are highly sensitive to disconfirmation (and are “happy” when actual miles exceed their expectations), it makes sense to slightly understate quality (45,000 vs. actual quality of 47,500).

### 4.4 The Impact of Brand Equity (Asymmetric Competition)

So far the results have been based on the assumption of symmetric competition. In many markets, however, one firm is stronger/better known and regarded than the other(s). More specifically, one firm may have higher brand equity than its competition (which could be either another known brand or a more generic competitor).

There are several expected consequences of having greater brand equity. Most obvious, it should lead to higher sales and/or higher prices for the higher equity firm, resulting in greater
profits. Indeed, we find the higher equity firm in general should produce a higher quality product, sell it at a higher price, and be more profitable.

Brand equity has often been included as a constant in logit choice models (Kamakura and Russell 1993; Sriram, Balachander, and Kalwani 2007). We follow in that tradition by introducing an additional constant term (brand equity), $b_4$ to the utility in Equations (2), (7) and (8), equal to 0.25 for the higher equity firm and -0.25 for the low equity firm.\(^6\)

Table 3 reports results for the two firms when firm A has higher equity ($b_4=0.25$). As expected, Firm A earns higher profits, produces a higher quality product and charges a higher price. More interesting, both firms still have an incentive to overstate quality with one exception. In a market where consumers place little weight on quality, both firms have incentive to understate quality. Also interestingly, in some cases the high equity firm still has the incentive to overstate quality when legal costs are high whereas their lower equity competitor does not.

---

\(^6\) The impact of a gap between realized and expected quality could occur either directly through an impact on brand equity or indirectly through its impact on satisfaction. If we include direct impact on brand equity as $K_g(Q - \bar{Q})$, the total effect would be $K_g(Q - \bar{Q}) + b'_4d'_3(Q - \bar{Q})$. Here, we implicitly set $K_g=0$ so the entire effect of quality overstatement is driven by satisfaction (i.e., our $b'_3d'_3 = K_g + b'_3d'_2$).
TABLE 3
Impact of Brand Equity
(Firm A’s intercept, $b_4 = .25$, Firm B’s intercept $b_4 = -.25$)

<table>
<thead>
<tr>
<th></th>
<th>Base Case</th>
<th>Low Price Sensitivity ($b_2 = -.15$)</th>
<th>High Price Sensitivity ($b_2 = -.35$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firm A</td>
<td>Firm B</td>
<td>Firm A</td>
</tr>
<tr>
<td>Profit</td>
<td>141.2</td>
<td>68.4</td>
<td>265.15</td>
</tr>
<tr>
<td>Adv. Quality</td>
<td>6.5</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Mean Quality</td>
<td>6</td>
<td>3.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Price</td>
<td>7</td>
<td>5</td>
<td>11.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Low Quality Sensitivity ($b_1=.1$)</th>
<th>High Quality Sensitivity ($b_1=.3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firm A</td>
<td>Firm B</td>
</tr>
<tr>
<td>Profit</td>
<td>132.06</td>
<td>81.58</td>
</tr>
<tr>
<td>Adv. Quality</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Mean Quality</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Price</td>
<td>6</td>
<td>5.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Low Weight on Advertising ($a_1=.25$)</th>
<th>High Weight on Advertising ($a_1=.75$)</th>
<th>High Legal Costs ($K_1=1$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firm A</td>
<td>Firm B</td>
<td>Firm A</td>
</tr>
<tr>
<td>Profit</td>
<td>149.2</td>
<td>68.51</td>
<td>141.3</td>
</tr>
<tr>
<td>Adv. Quality</td>
<td>6.5</td>
<td>4</td>
<td>6.5</td>
</tr>
<tr>
<td>Mean Quality</td>
<td>6</td>
<td>3.5</td>
<td>6</td>
</tr>
<tr>
<td>Price</td>
<td>7</td>
<td>5.5</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Low Multiplier ($m=2$)</th>
<th>High Multiplier ($m=8$)</th>
<th>High Max. Penalty ($K_1=200$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firm A</td>
<td>Firm B</td>
<td>Firm A</td>
</tr>
<tr>
<td>Profit</td>
<td>63.21</td>
<td>36.37</td>
<td>258.1</td>
</tr>
<tr>
<td>Adv. Quality</td>
<td>3</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Mean Quality</td>
<td>2.5</td>
<td>1.5</td>
<td>11</td>
</tr>
<tr>
<td>Price</td>
<td>6</td>
<td>5</td>
<td>9</td>
</tr>
</tbody>
</table>

6. DISCUSSION
This paper examined optimal strategy for product quality, advertised quality, and price when two firms simultaneously introduce a new or upgraded product in a market where there are (legal) costs to overstating quality. Results were obtained via numerical analyses of a model which accounts for the effect of actual quality on expectations, a direct effect of experienced...
quality on satisfaction, heterogeneity in experienced quality, market expansion across periods, and a non-linear cost of overstating quality as well as differences in brand equity. These results were consistent with those based on a simpler, analytical model.

Our analysis produced two important and interesting results. First, in the absence of legal costs or when legal costs are low, it is generally optimal for both competitors to overstate quality in their advertising, even though the firms would be better off if both advertised product quality accurately. Absent collusion, however, competing firms are individually better off overstating quality, leading to customer dissatisfaction. In effect, providing competitors another basis of competition (advertising claims) leads them to “compete” by upping their claims. Interestingly, data from the FTC suggests that overstatement appears to be higher when there is more competition.7

The second key finding has to do with the regulation of advertising claims. Punishing advertising which overstates quality achieves its basic objective of making advertising more truthful. In effect, regulating advertising shifts the focus of competition to quality and price. An unintended consequence is that, while this has no effect on price, it reduces optimal quality. From a consumer welfare perspective, therefore, legal costs are justified only if the increased

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7 Using 627 cases on deceptive advertising decided by the Federal Trade Commission (FTC) between August 1996 and December 2002, we recorded the severity of the infraction (a proxy for overstatement) based on the four-level classification used by the FTC: (1) Misrepresentation, e.g., a company promises customers awards if they purchased their product, but then provides awards worth significantly less than represented, (2) Unsubstantiated claim, e.g., advertising a dietary supplement as a cellulite treatment without substantiating the claim, (3) False claim, e.g., a company claims it has evidence establishing a product’s efficacy but no such evidence exists, and (4) Scam, fraudulent activity that is intentionally devised to cheat customers. Similarly, four levels of penalties (a proxy for legal costs) are assessed, with each subsequent penalty including the penalties of the less severe levels: (i) warning, (ii) fine, (iii) requirement to substantiate future claims, and (iv) being banned from operating similar businesses. Unsurprisingly, the more severe the infraction, the more severe the penalty, with a chi-square value of 91.46, significant at \( p < .001 \). Almost 75% of the 627 companies were unknown firms. Of the remaining companies, found using Hoovers Pro Online (http://premium.hoovers.com/subscribe), we determined the number of competitors for 96 companies. We then correlated the degree of overstatement as measured by the four level FTC scale described earlier with the number of competitors. As the model suggests, there is a significant positive relation between the level of competition and overstatement of quality \( (r = .28, p < .01) \), again suggesting that quality overstatement is more likely under heightened competition.
truthfulness sufficiently decreases whatever costs (psychological or real) there are to being deceived in order to adequately offset the negative effect of the reduction in product quality.

### 6.1 Implications

**TABLE 4**

Cost to Consumer Under A Specific Set of Parameters

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unconstrained Competition</th>
<th>Monopolist Offering Two Products ($K_2=3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Legal Costs</td>
<td>High Legal Costs ($K_2=1$)</td>
</tr>
<tr>
<td>Cost Per Tire to Drive 100,000 Miles</td>
<td>$120</td>
<td>$133.33</td>
</tr>
<tr>
<td>Consumer Dissatisfaction Due to False Expectations</td>
<td>$X$</td>
<td>0</td>
</tr>
<tr>
<td>Total Per Tire Cost to Consumer</td>
<td>$120 + X</td>
<td>$133.33</td>
</tr>
</tbody>
</table>

Unconstrained competition may lead to higher quality products (at the same price) than markets where advertisers are truthful or are subject to significant potential legal costs. In essence, there is a tradeoff between accurate advertising and average quality. We highlight this via example by assessing consumer welfare under different scenarios by calculating the per tire cost of driving 100,000 miles (see Table 4) as well as $X$, the cost of being deceived. This cost could arise as a result of the direct costs of an emergency repair, inconvenience due to a disrupted schedule, or because of a negative psychological reaction to being deceived.

The example uses optimal quality, advertised quality, and price from our base condition (Table 2). As Table 3 shows, competition is beneficial compared to a monopoly regardless of the level of the legal costs of overstating quality, as expected. However, the actual per tire cost increases as legal costs increase. This means there is a tradeoff between out of pocket purchase costs and the costs (real and psychological) of operating on inaccurate information concerning quality (durability). If the latter is greater than $13.33 in this case, then consumers are better off.
if no legal costs to enforce truthful advertising are in place.

Obviously the costs to the consumer will depend on the specific parameters. Nonetheless, the general principle will hold: there is a tradeoff between the benefit of not being deceived when advertising is truthful and the lower quality which is (optimally) offered versus when quality overstatement is allowed. Combined with the earlier result which suggests that companies may benefit for the imposition of legal costs to deter inaccurate advertising claims, this suggests paradoxically that consumers should oppose the imposition of legal costs while companies should welcome them. Given this, self-regulation makes economic sense; hence, participation in the National Advertising Review Board appears to be in firms’ self interest.

6.2 Limitations and Extensions

Like any analytical study, the results are only as good as its assumptions. Here we assumed a quadratic cost function for fixed costs and simultaneous (Bertrand) competition. We also assume a uniform distribution of experienced quality. Clearly this limits the generalizability of the results. Useful extensions could involve allowing for variable costs to be a function of quality, a category leader (first mover) cost reduction due to experience over time (or volume), and non-constant pricing over time. While we did explore a simpler model with a linear demand function analytically and found similar results, clearly more work needs to be done to establish how general the results are.

Regardless, the results suggest an interesting direction for future research – trying to quantify X, the cost of being misled, and understand the psychological process behind it. They also suggest examining whether mechanisms which allow or force competitors to be truthful also improve consumer welfare and/or firm profits.
Other aspects of the model suggest a number of promising areas for extensions. These include (i) making expectations a non-linear (e.g., quadratic) function of advertising, thus taking into consideration that at some point consumers will tend to disregard advertising claims (ii) examining cases where competition and legal costs produce lower quality, which then leads to more frequent replacement (hence purchasing), related to the notion of planned obsolescence, (iii) including the signaling effect of price on expected quality, at least in the first period, (iv) allowing for asymmetric impacts of positive and negative word of mouth (Mahajan, Muller, and Kerin 1984) as well as the gap between advertised and expected quality, (v) incorporating local network effects, i.e., assuming customers in a “neighborhood” have most or all of the word of mouth influence, and (vi) incorporating inertia/state dependence in future choice.

Finally, the preceding discussion treated legal costs as exogenous, i.e., caused by a third party such as the FTC. Legal costs could also arise if competitors detect overstatement and challenge it by advertising (making customers aware of the overstatement directly), by complaining to a third party such as the FTC, or by direct legal action. The countervailing force to taking such actions would be the likely retaliation against them, given their own incentive to overstate the quality of their product. Depending on the payoffs, a collusion to overstate could emerge as the equilibrium (optimal) strategy. Future research can investigate when costs from overstating quality come more from competition or from a third party (possibly driven in part by customer complaints).

In summary, this paper has examined the impact of competition and the cost of overstating quality in advertising on new product introduction strategy. We believe work like this, which extends normative work to more complex and relevant situations, has great potential for contributing to knowledge. We hope this paper will encourage work in this direction.
REFERENCES


APPENDIX A

Alternative Specifications for Second Period Expectations

Those who bought in the first period have three reference points for forming updated expectation: their prior expectations, their experience, and word of mouth (WOM). Based on these, there are several possible combination rules. For example, one could produce a weighted average of the three, \( C_1 \hat{Q}_{1j} + C_2 Q_{1j} + C_3 \mu_j \), where \( C_1 + C_2 + C_3 = 1 \). This rule essentially assumes that the impact of WOM is the same regardless of whether one person or the entire population bought in period 1. While the Internet (i.e. blogs, tweets, evaluations) certainly makes a single person’s voice more powerful (especially given individual’s tendency not to factor in sample size), this may give too much weight to limited WOM.

An alternative approach is to adjust the impact of WOM based on the proportion of people who have already bought the product, i.e. have expectation equal to \( C_1 \hat{Q}_{1j} + C_2 Q_{1j} + C_3 p_j \mu_j \). In effect this approach, which we focus on here, assumes individuals are cautious in their revised expectations pending “social approval/proof”. As an example, if \( C_1 = C_2 = C_3 \), and \( \hat{Q}_{1j} = Q_{1j} = \mu_j = K \), then individuals will expect quality between 67% and 100% of \( K \). In our particular case where sales in the first period tend to be about 40%, this leads to an expectation of about 0.8\( K \). The effect of this in the model is to lower the value of the product in both the numerator and denominator of the equation. Directionally this will slightly decrease second period sales, producing a “conservative” result.

A third approach is to re-allocate the potential weight on the third term (\( C_3 \)) when \( p_j \) is less than one to the other two weights. For \( C_1 + C_2 + p_j C_3 \) to equal 1, the reweighting is:

\[
\frac{1-p_j}{c_1+c_2} C_2 \frac{1-p_j}{c_1+c_2} C_3, \text{ and } p_j C_3.
\]

In the previous numerical example, this produces \( \hat{Q}_{2j} = K \). While we also explore this approach briefly, it implies fairly sophisticated thinking on the part of consumers. Specifically, before adopting, a consumer would adjust their weights each period. We suspect they are unlikely to do so.

Below are the results for our base case with the above three weighting mechanism. Directionally, the results are similar across all three cases studied. (In our chosen model, second period expectations slightly lower, leading to somewhat lower levels of price, quality, and advertised quality, which produce slightly lower levels of sales and profits.)

### Results with Alternative Specifications

<table>
<thead>
<tr>
<th>Alternative Weightings for Period 2 Expectations</th>
<th>Profit</th>
<th>Advertised Quality</th>
<th>Average Quality</th>
<th>Price</th>
<th>Period 1 Share</th>
<th>Period 2 Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_1 \hat{Q}<em>{1j} + C_2 Q</em>{1j} + C_3 \mu_j, \newline \small{C_1+C_2+C_3=1} )</td>
<td>103.23</td>
<td>57.5</td>
<td>52.5</td>
<td>65</td>
<td>33.67</td>
<td>43.67</td>
</tr>
<tr>
<td>( C_1 \hat{Q}<em>{1j} + C_2 Q</em>{1j} + C_3 p_j \mu_j, \newline \small{C_1+C_2+C_3=1} )</td>
<td>100.18</td>
<td>52.5</td>
<td>47.5</td>
<td>60</td>
<td>33.33</td>
<td>41.85</td>
</tr>
<tr>
<td>( C_1 \hat{Q}<em>{1j} + C_2 Q</em>{1j} + C_3 p_j \mu_j, \newline \small{C_1+C_2+p_j C_3=1} )</td>
<td>103.05</td>
<td>57.5</td>
<td>52.5</td>
<td>65</td>
<td>33.67</td>
<td>43.67</td>
</tr>
</tbody>
</table>
APPENDIX B: SIMPLE ANALYTICAL MODEL

In period 1, the model assumes customer expectations for a product’s quality ($\hat{Q}_{1A}, \hat{Q}_{1B}$) are a percent of the advertised quality level ($Ad_A, Ad_B$).

$$\hat{Q}_{1A} = \alpha Ad_A, \quad \hat{Q}_{1B} = \alpha Ad_B \quad (B.1)$$

Note this can account for trusting customers ($\alpha = 1$) as well as customers who discount advertised quality ($\alpha < 1$). We assume the probability of purchase in the first period ($D_1$) follows a linear probability model (Ben-Akiva and Lerman 1994, p. 67) which has a base level plus the effects of the differences in expected quality and price between the two products:

$$D_{1A} = b_0 + b_1 (\hat{Q}_{1A} - \hat{Q}_{1B}) + b_2 (P_B - P_A) \quad (B.2)$$

$$D_{1B} = b_0 + b_1 (\hat{Q}_{1B} - \hat{Q}_{1A}) + b_2 (P_A - P_B), \quad 0 < b_0 < .5, 0 < b_1, b_2 < 1$$

For those that buy in the first period, their satisfaction is determined by the gap between the experienced quality ($\mu_A$ or $\mu_B$) and expected quality ($Y_i$ 1990), i.e.,

$$S_A = d_0 + d_1 (\mu_A - \hat{Q}_{1A}), \quad S_B = d_0 + d_1 (\mu_B - \hat{Q}_{1B}), \quad 0 < d_0, d_1 < 1 \quad (B.3)$$

Those who bought in the first period update their expectations to a combination of prior expectations and experienced quality ($\mu_A, \mu_B$), i.e., they have adaptive expectations (Johnson, Anderson, Fornell 1995).

$$\hat{Q}_{2A} = \alpha \hat{Q}_{1A} + (1 - \alpha) \mu_A, \quad \hat{Q}_{2B} = \alpha \hat{Q}_{1B} + (1 - \alpha) \mu_B \quad (B.4)$$

Their probability of purchase in period 2 then depends on both relative quality and satisfaction, i.e., demand depends not just on updated expectations but also on the (“emotional”) carryover of being satisfied (or not) in the previous period (e.g., customers can “hold a grudge”). Therefore,

$$D_{2A|buy} = b_o + b_1 (\hat{Q}_{2A} - \hat{Q}_{2B}) + b_2 (P_B - P_A) + S_A \quad (B.5)$$

$$D_{2B|buy} = b_o + b_1 (\hat{Q}_{2B} - \hat{Q}_{2A}) + b_2 (P_A - P_B) + S_B$$

Where $S_A$ and $S_B$ are given by Equation (A.3).

For those that did not buy in period 1, we assume their purchase probability does not change. Thus, the unconditional purchase probability in period 2 is given by:

$$\begin{cases} D_{2A} = D_{1A} \cdot D_{2A|buy} + (1 - D_{1A}) \cdot D_{2A|no-buy} \\ D_{2B} = D_{1B} \cdot D_{2B|buy} + (1 - D_{1B}) \cdot D_{2B|no-buy} \end{cases} \quad (B.6)$$

An essential part of the model is that firms incur additional cost if they overstate quality. The profit function facing the firms across the two periods is thus:

$$\pi_A = \begin{cases} KP_A (D_{1A} + m \cdot D_{2A}) - \frac{\mu_A^2}{2} - \text{Cost of Overstating Quality}_A, & \text{if } Ad_A > \mu_A \\ KP_A (D_{1A} + m \cdot D_{2A}) - \frac{\mu_A^2}{2}, & \text{if } Ad_A \leq \mu_A \end{cases} \quad (B.7)$$
To examine the impact of competition and the cost of overstating quality, we contrast three cases and derive propositions:

1. A duopoly where the cost of overstating quality is low and linear in overstatement
2. A duopoly where the cost of overstating quality is high ($\infty$)
3. A monopolist managing both products $A$ and $B$ when cost of overstating quality is low

**Proposition B.1:** When the cost of overstating quality is low, the Nash equilibrium strategy for both firms is to overstate quality, i.e., in equilibrium, advertised quality ($Ad^*$) is greater than product quality ($\mu^*$). Put differently, competition leads to overstatement of quality.

**Proof:**

Let cost of overstatement of quality = $Ad - \mu$. Profit for firms $A$ and $B$ is given by:

$$\pi_A = KP_A (D_{1A} + m \cdot D_{2A}) - (AD_A - \mu_A) - \frac{\mu_A^2}{2}$$
$$\pi_B = KP_B (D_{2B} + m \cdot D_{2B}) - (AD_B - \mu_B) - \frac{\mu_B^2}{2}$$

Taking the first order conditions, we get,

$$\frac{\partial \pi_A}{\partial Ad_A} = -1 + \alpha KP_A \left[ -d_1 m (b_0 + b_2 (P_B - P_A)) + b_1 \left( 1 + d_0 m + a m (1 + d_1 (-2AD_A + AD_B)) + d_1 \mu_A \right) \right] = 0 \quad (B.9)$$

$$\frac{\partial \pi_A}{\partial \mu_A} = 1 + m KP_A \left[ d_1 (b_0 + b_2 (P_B - P_A)) + b_1 (1 - \alpha - \alpha d_1 AD_B + \alpha d_1 AD_A) \right] - \mu_A = 0 \quad (B.10)$$

$$\frac{\partial \pi_B}{\partial Ad_B} = \frac{-1 + \alpha KP_B \left[ -d_1 m (b_0 + b_2 (P_A - P_B)) + b_1 \left( 1 + d_0 m + a m (1 + d_1 AD_A - 2d_1 AD_B) + d_1 \mu_B \right) \right] = 0 \quad (B.11)$$

$$\frac{\partial \pi_B}{\partial \mu_B} = 1 + m KP_B \left[ d_1 (b_0 + b_2 (P_A - P_B)) + b_1 (1 - \alpha - \alpha d_1 AD_A + \alpha d_1 AD_B) \right] - \mu_B = 0 \quad (B.13)$$

To arrive at $\frac{\partial \pi_A}{\partial P_A}$, in Equation (B.11), replace $AD_A$ with $AD_B$, $P_A$ with $P_B$ and $\mu_A$ with $\mu_B$

By symmetry, in equilibrium (denoted by $^*$), $AD_A^* = AD_B^* = AD^*$, $\mu_A^* = \mu_B^*$, $P_A^* = P_B^* = P^*$

Upon substitution in equation B.9 and simplifying, we get,
\[Ad^* - \mu^* = \mu^* \left[ \frac{1 - \alpha}{\alpha} \right] - \frac{1}{\alpha^2 K m P^* b_1 d_1} + \frac{b_1 + d_0 m b_1 + \alpha m b_1 - b_0 m d_1}{\alpha m d_1 b_1}, \text{ But, } b_1 = d_1 + \Delta \Rightarrow \]

\[Ad^* - \mu^* = \mu^* \left[ \frac{1 - \alpha}{\alpha} \right] - \frac{1}{\alpha^2 K m P^* b_1 d_1} + \frac{b_1 + m[(\alpha(d_1 + \Delta) + b_1 d_0 - b_0 d_1]}{\alpha m d_1 b_1} \]

\[= \mu^* \left[ \frac{1 - \alpha}{\alpha} \right] - \frac{1}{\alpha^2 K m P^* b_1 d_1} + \frac{b_1 + m[(d_1(\alpha - b_0) + \alpha \Delta + b_1 d_0)]}{\alpha m d_1 b_1} \]

Note that \(b_0 \leq 0.5\). Hence, a sufficient condition for the above term to be positive is large market size (as \(K\) is proportion to the market size) and \(\alpha > 0.5\). This implies, both firms overstate quality in equilibrium. \textbf{Q.E.D.}

\textbf{Note:} Second order conditions are fulfilled, i.e., \(\frac{\partial^2 \pi_A}{\partial d_A d_A} = -2\alpha^2 m K P^* < 0\) and \(\frac{\partial^2 \pi_B}{\partial d_B d_B} = -2\alpha^2 m K P^* < 0\). Furthermore, since the above equilibrium \(AD^*, \mu^*, \text{ and } P^*\) levels are arrived at unconditionally, i.e., without the constraint \(AD^* > \mu^*, \text{ non-overstatement, that is, } AD^* = \mu^*\) will be a suboptimal strategy for either firm.

\textbf{Optimal Quality, } \mu^*

To arrive at optimal quality, \(\mu^*\), substituting the symmetry conditions in Equation B.10, and simplifying, we get,

\[1 + b_0 d_1 m K P^* + b_1 [1 - \alpha] m \cdot K P^* - \mu^* = 0 \]

\[\Rightarrow \mu^* = 1 + b_0 d_1 m K P^* + b_1 (1 - \alpha) m K P^* = 1 + K m P^* [b_0 d_1 + b_1 (1 - \alpha)]. \]

Note: The second order conditions are fulfilled, i.e., \(\frac{\partial^2 \pi_A}{\partial \mu_A \mu_A} = -1 < 0, \frac{\partial^2 \pi_B}{\partial \mu_B \mu_B} = -1 < 0\)

\textbf{Optimal Price, } P^*

To arrive at optimal price, \(P^*\), substituting the symmetry conditions in Equation B.11, and simplifying, we get,

\[K[1 + m (1 + d_0 - \alpha d_1 A D^* + d_1 \mu^*)][b_0 - b_2 P] = 0 \Rightarrow P^* = \frac{b_0}{b_2}. \]

Note: The second order conditions are fulfilled, i.e., \(\frac{\partial^2 \pi_A}{\partial P_A P_A} = \frac{\partial^2 \pi_B}{\partial P_B P_B} = -1 < 0\)

\textbf{Proposition B.2:} When the cost of overstating quality is high enough such that advertised quality equals product quality, the equilibrium product quality is lower than in the case where the cost of overstating quality is low. In other words, imposing legal costs on quality overstatement leads to firms supplying lower quality goods.

\textbf{Proof:}
When the cost of overstatement is high (say, ∞D), following the firms’ profit functions in Equations B.7 and B.8, we find that firms will not overstate, i.e., $Ad_A = \mu_A$ and $AD_B = \mu_B$. Thus, the respective profit functions reduce to:

$$
\pi_B = KP_B(D_{1B} + m \cdot D_{2B}) - \frac{\mu_B^2}{2}, \quad \pi_A = KP_A(D_{1A} + m \cdot D_{2A}) - \frac{\mu_A^2}{2}
$$

**Optimal Price, $P^*$**

Taking the first order conditions with respect to price, i.e., $\frac{\partial \pi_A}{\partial P_A}$ and $\frac{\partial \pi_B}{\partial P_B}$, substituting the symmetry conditions in equilibrium, i.e., $Ad_A^* = Ad_B^* = Ad^*, \mu_A^* = \mu_B^* = \mu^*$, and $P_A^* = P_B^* = P^*$, and simplifying, we get,

$$K[1 + \alpha(1 + (1 + d_0 - \alpha d_1 \mu^* + d_1 \mu^*))][b_0 - b_2 P] = 0 \Rightarrow P^* = \frac{b_0}{b_2}.$$

The above $P^*$ is equal to the optimal price in a duopoly where cost of overstating quality is low.

Note: The second order conditions are fulfilled, i.e., $\frac{\partial^2 \pi_A}{\partial P_A^2} = \frac{\partial^2 \pi_B}{\partial P_B^2} < 0$.

**Optimal Quality, $\mu^*$**

Now, taking the first order conditions with respect to quality, we get,

$$
\frac{\partial \pi_A}{\partial \mu_A} = mKP_A[b_1(1 + \alpha(-1 + d_1 Ad_A - d_1 Ad_B))] + d_1(1 + b_2(-P_A + P_B))] - \mu_A = 0
$$

$$
\frac{\partial \pi_B}{\partial \mu_B} = mKP_B[b_1(1 + \alpha(-1 + d_1 Ad_B - d_1 Ad_A))] + d_1(1 + b_2(-P_B + P_A))] - \mu_B = 0
$$

By symmetry, in equilibrium, $Ad_A^* = Ad_B^* = Ad^*, \mu_A^* = \mu_B^* = \mu^*$, and $P_A^* = P_B^* = P^*$.

Substituting this in the above equations, we get,

$$
\mu^* = Kmp^*(b_0 d_1 + b_1(1-\alpha)) < 1 + Kmp^* [b_0 d_1 + b_1(1-\alpha)], \quad \text{the equilibrium quality in case B.1, when cost of overstating quality is low. This is because of the optimal } P^* \text{ when cost of overstating quality is the same as in the case when the cost of overstating quality is low.} \quad \text{Q.E.D.}
$$

Note: The second order conditions are fulfilled, i.e., $\frac{d^2 \pi_A}{d \mu_A^2} = -1 < 0 \text{ and } \frac{d^2 \pi_B}{d \mu_B^2} = -1 < 0$.

**Proposition B.3:** It is not optimal for the monopolist managing both products to overstate quality even when the cost of overstating quality is low, i.e., $Ad_A^* = \mu_A^* = Ad_B^* = \mu_B^*$.

**Proof:**

Total profit $= \pi_{Total} = KP_A(D_{1A} + mD_{1A}) - (AD_A - \mu_A) - \frac{\mu_A^2}{2} +$
\[ KP_B(D_{1B} + m \cdot D_{1B}) - (AD_B - \mu_B) - \frac{\mu_B^2}{2} \]

By symmetry, at optimum, \( AD_A^* = AD_B^* = AD^* \), \( \mu_A^* = \mu_B^* = \mu^* \), and \( P_A^* = P_B^* = P^* \), where * denotes the corresponding optimal level.

Upon substitution,

\[ \pi_{\text{Total}} = -2AD^* + 2\mu^* - (\mu^*)^2 + 2b_0KP^*[1 + m(1 + d_0 - \alpha d_1 AD^* + d_1 \mu^*)] \]

CASE 1: Monopolist does not overstate quality, i.e., \( AD = \mu = \mu^* \),

\[ \pi_{\text{Total, Case 1}} = -(\mu^*)^2 + 2b_0KP^*[1 + m(1 + d_0 - \alpha d_1 \mu^* + d_1 \mu^*)] \]

\[ = -(\mu^*)^2 + 2b_0KP^*[1 + m(1 + d_0)] + 2b_0Kmd_1 \mu^*(1 - \alpha) \]

CASE 2: Monopolist overstates quality, i.e., \( AD = \mu^* + \epsilon, \epsilon > 0 \)

\[ \pi_{\text{Total, Case 2}} = -2(\mu^* + \epsilon) + 2\mu^* - (\mu^*)^2 + 2b_0KP^*[1 + m(1 + d_0 - \alpha d_1 (\mu^* + \epsilon) + d_1 \mu^*)] \]

\[ = -2\epsilon - (\mu^*)^2 + 2b_0KP^*[1 + m(1 + d_0 - \alpha d_1 \mu^* + d_1 \mu^*)] - 2b_0KP^* m\epsilon \]

\[ = \pi_{\text{Total, Case 1}} - 2\epsilon[1 + b_0KP^* m\epsilon] < \pi_{\text{Total, Case 1}} \]

\[ \Rightarrow \] **Monopolist Doesn’t Overstate Quality.** Q.E.D.

**Appendix B1: Foresighted Customers (equilibrium results when \( \alpha < 1 \) when cost of overstatement is low and \( \alpha = 1 \) when cost of overstatement is high)**

What happens when consumers correctly anticipate firm behavior with respect to overstatement. We consider two cases. (1) Consumers who accept advertised quality (i.e., \( \alpha = 1 \) in Equation (B.1)) when the cost of overstating quality is high (because they know that firms do not have an incentive to overstate quality when the cost of overstatement to the firm is high), and (2) Consumers who discount advertising claims (\( \alpha < 1 \)) when the cost of overstating quality is low (because they know firms have an incentive to overstate quality and therefore will discount their claims).

As shown in Proposition B.1, when \( \alpha < 1 \) and cost of overstating quality is low, both firms in a duopoly will overstate quality. The question is whether the optimal quality would be lower when \( \alpha = 1 \) than when \( \alpha < 1 \). When the cost of overstating quality is low, the optimal level of quality (derived in Appendix B) is given by:
By contrast, when the cost of overstating quality is high, optimal quality is \( KmP^* (b_0 d_1) \). In both cases, \( P^* \approx \frac{b_0}{b_2} \). The difference in optimal quality is thus \( 1 + KmP^* (b_1 (1 - \alpha)) \). Since \( b_1 > 0, \alpha < 1 \), and \( K, m, P^* > 0 \), optimal quality is higher when the cost of overstating is low.

**B1.1. Duopoly where cost of overstating quality is low (and linear in overstatement)**

Since \( \alpha < 1 \), the results in this case are the same as in Appendix B.

**B1.2. Duopoly where cost of overstating quality high (\( \infty \))**

When the cost of overstatement is high (say, \( \infty \)), based on firms’ profit functions in Equations B.7 and B.8, we find that firms will not overstate, i.e., \( Ad_A = \mu_A \) and \( AD_B = \mu_B \). Since the customers know that firms will not overstate quality, they believe the advertised quality claim, i.e., \( \alpha = 1 \) (see Equations 1 and 4). The respective profit functions reduce to:

\[
\pi_B = KP_B(D_{1B} + m \cdot D_{2B}) - \frac{\mu_B^2}{2}, \quad \pi_A = KP_A(D_{1A} + m \cdot D_{2A}) - \frac{\mu_A^2}{2}
\]

**Optimal Price, \( P^* \)**

Taking the first order conditions with respect to price, i.e., \( \frac{\partial \pi_A}{\partial P_A} \) and \( \frac{\partial \pi_B}{\partial P_B} \), substituting the symmetry conditions in equilibrium, i.e., \( Ad_A^* = Ad_B^* = Ad^*, \mu_A^* = \mu_B^* = \mu^* \), and \( P_A^* = P_B^* = P^* \), and simplifying, we get,

\[
K[1 + m(1 + d_0)][b_0 - b_2 P] = 0 \Rightarrow P^* = \frac{b_0}{b_2}.
\]

Note that the above \( P^* \) is equal to the optimal price in a duopoly where cost of overstating quality is low (Appendix B.1)

Note: The second order conditions are fulfilled, i.e., \( \frac{\partial^2 \pi_A}{\partial P_A^2} = \frac{\partial^2 \pi_B}{\partial P_B^2} < 0 \)

**Optimal Quality, \( \mu^* \)**

Now, taking the first order conditions with respect to quality, we get,

\[
\frac{\partial \pi_A}{\partial \mu_A} = mKP_A [b_1 (\alpha (Ad_A - d_1 Ad_B)) + d_1 (b_0 + b_2 (-P_A + P_B))] - \mu_A = \emptyset
\]

\[
\frac{\partial \pi_B}{\partial \mu_B} = mKP_B [b_1 (\alpha (Ad_B - d_1 Ad_A)) + d_1 (b_0 + b_2 (-P_B + P_A))] - \mu_B = \emptyset
\]

By symmetry, in equilibrium, \( Ad_A^* = Ad_B^* = Ad^*, \mu_A^* = \mu_B^* = \mu^* \), and \( P_A^* = P_B^* = P^* \).

Substituting this in one of the above equations, we get,

\[
\mu^* = KmP^*(b_0 d_1) < 1 + KmP^* [b_0 d_1 + b_1 (1 - \alpha)], \quad \text{the equilibrium quality in}
\]
case B.1, when cost of overstating quality is low. This happens because the optimal $P^*$ when cost of overstating quality is the same as in the case when the cost of overstating quality is low.

**Note:** The second order conditions are fulfilled, i.e., $\frac{d^2\pi_A}{d\mu_A^2} = -1 < 0$ and $\frac{d^2\pi_B}{d\mu_B^2} = -1 < 0$

**B1.3. Monopolist Managing Two Products, A and B**

**CASE 1:** Consumers know the cost of overstating quality is high so the monopolist does not overstate quality ($AD = \mu$), and therefore $\alpha = 1$. Here, the total profit is given by:

$$\pi_{\text{No overstatement}} = - (\mu)^2 + 2b_0KP[1 + m(1 + d_0)]$$

**CASE 2:** Consumers know cost of overstating quality is low and thus that the monopolist might overstate quality; therefore $\alpha < 1$

If the monopolist overstates quality, then $AD = \mu + \epsilon$, $\epsilon > 0$. The total profit (for any level of $Ad, \mu, and \epsilon$) is given by:

$$\pi_{\text{overstatement}} = -2(\mu + \epsilon) + 2\mu - (\mu)^2 + 2b_0KP[1 + m(1 + d_0 - \alpha d_1(\mu + \epsilon) + d_1\mu)]$$

$$= -2\epsilon - (\mu)^2 + 2b_0KP[1 + m(1 + d_0 - \alpha d_1\mu + d_1\mu)] - 2b_0KPm\alpha\epsilon$$

But, the total profitability if there is no overstatement, i.e., $\epsilon = 0$, is given by:

$$\pi_{\text{No overstatement}} = -(\mu)^2 + 2b_0KP[1 + m(1 + d_0 - \alpha d_1\mu + d_1\mu)]$$

The difference in profit if the firm overstates quality is thus $-2\epsilon - 2b_0KPm\alpha\epsilon$. Because $\epsilon, b_0, K, P, m, and \alpha$ are all positive, overstating quality reduces profit. Thus, for all values of $P, \mu, and \epsilon$, $\pi_{\text{No overstatement}} < \pi_{\text{overstatement}}$.

**Hence, the monopolist does not overstate quality when $\alpha = 1$ or $\alpha < 1$. Q.E.D.**

**Note:** In Case 2, when consumers learn there is no overstatement, $\alpha$ will equal 1, and the corresponding profit function, $\pi_{\text{No overstatement}}$ will be the same as in Case 1.
Appendix C: Sensitivity Analysis

<table>
<thead>
<tr>
<th>Parameter and Value</th>
<th>Average Quality ('000)</th>
<th>Advertised Quality ('000)</th>
<th>Price ($)</th>
<th>Expected Profit</th>
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