

# With a Little Help from my Enemy: Comparative Advertising as a Signal of Quality\*

Francesca Barigozzi<sup>†</sup>  
University of Bologna

Paolo G. Garella<sup>‡</sup>  
University of Milano

Martin Peitz<sup>§</sup>  
International University in Germany

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## Abstract

We extend the theory of advertising as a quality signal, using a model where an entrant can choose to advertise by comparing its product to that of an established incumbent, or by generic ads. Comparative advertising, comparing quality of one's own product to that of a rival's, empowers the latter to file for court intervention if it believes the ads to be false or misleading. Here, the firm launching the ad, the named rival, and the court play a role in the process of information disclosure. We show that if not only the entrant but also the incumbent is better informed than consumers, comparative advertising signals quality at lower cost than generic, irrespective of whether or not consumers observe the incumbent's action. However, significant differences arise in the two cases, concerning the role of damages imposed by courts and the process of belief revision by consumers.

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<sup>†</sup>Dipartimento di Scienze Economiche, Strada Maggiore 45, 40125, Bologna (Italy). E-mail: barigozz@spbo.unibo.it

<sup>‡</sup>Corresponding author. Dipartimento di Scienze Economiche, Aziendali e Statistiche, via Conservatorio 7, 20122 Milano (Italy). E-mail: paolo.garella@unimi.it. The author gratefully acknowledges support from University of Crete (contract n. MTKD-CT-014288) *Marie Curie Transfer of Knowledge-EU's 6th F.P.*

<sup>§</sup>International University in Germany, 76646 Bruchsal (Germany). E-mail: Martin.Peitz@i-u.de

## 1. Introduction

This paper analyzes comparative advertising as a signal of product quality. Economic theory supports the view that advertising can be informative also in an indirect way, irrespective of content. A well known explanation of advertising as a rational phenomenon is based on the idea that high advertising expenditures work as a device to signal high quality of a brand (Nelson, 1974, Kihlstrom and Riordan, 1984, Milgrom and Roberts, 1986). The signaling motive, as advanced by Nelson, filled a gap in the understanding of a controversial economic phenomenon, namely the apparently wasteful advertising campaigns. The argument, intended to apply to *generic* advertising, implies that the expenditure and not the content of an ad is what really matters. While advertising as “money burning” has been analyzed, with few exceptions, in a monopoly context, comparative advertising is essentially an oligopoly phenomenon. We find that comparative claims differ from generic ones as they open up different strategic opportunities for rivals.

We consider a duopoly situation in which the incumbent sells a product of known quality, while the entrant’s quality is yet unknown to consumers. The entrant may use dissipative advertising as a signal of quality. A low quality entrant would like to be perceived to be of high quality. By contrast, a high quality entrant does not want to be confused with a low quality entrant. To signal quality, the entrant can choose among generic or comparative advertising (or choose not to advertise at all). If advertising is comparative, the entrant says explicitly that its quality is not lower than the incumbent’s. While the choice of comparative advertising empowers the rival with the right to go to court, generic does not. Hence, if the entrant uses comparative instead of generic ads it *chooses* to give the incumbent the option to go to court. Therefore, consumers can infer that the entrant must think to have a strong case. While this general statement can easily be understood, it is less clear in which environment comparative advertising survives and how consumers form beliefs. In particular, how do consumers interpret the entrant’s choice of the type of advertising? What is the role of a possible reaction by the incumbent, if consumers cannot observe it? What are the consequences of enabling consumers to observe the action of the incumbent and the court proceedings before they purchase? Is this essential to prevent the use of false claims? Is the threat of paying damages or the threat of simply being discovered before consumers purchase that discourages false claims? And, finally, is comparative advertising more or less costly than generic, and why?

To answer these questions we analyze two channels through which consumer beliefs and the entrant’s incentives can be affected by the incumbent’s reaction. First, if the incumbent sues, the court may impose damages. Second, in case of an early reaction by the incumbent and fast court proceedings the court ruling becomes publicly known before consumers have made their purchasing decision. We show that each of the two channels can make comparative advertising the preferred advertising choice, that is, comparative advertising often involves a lower signaling cost for a high-quality product.

Consistent with our findings, comparative advertising, in which the advertised brand is compared with

one or more competing brands, has become increasingly popular in recent years.<sup>1</sup> Relevant sectors are food, retail, and motoring, which all rely heavily on aggressive marketing strategies.<sup>2</sup> This trend contrasts with previous patterns. For instance, in the United States, although no ban prevailed, advertisers were reluctant to compare brands, due to concerns about possible misidentification of the sponsoring brand and fear of consumers' mistrust. They also feared long-term consequences of comparative advertising to be detrimental to all advertising (Wilkie and Farris, 1975; Prasad, 1976). In spite of some researchers in marketing being still cautious about the general effectiveness of comparative advertising (see e.g. Shimp, 1990; Pechmann and Ratneshwar, 1991; Jain *et al.*, 1998; Barone and Miniard, 1999), the marketing literature generally agrees that if a brand has a small market share, or is unfamiliar to buyers, it can enhance the relevance of an ad by naming a leading brand, which is regularly purchased or is familiar to consumers (e.g. Shimp and Dyer, 1978; Muehling *et al.*, 1990; Pechmann and Stewart, 1990; Gnepa, 1993). This belief is shared by practitioners. For example, according to Mitsubishi's marketing manager the company used comparative advertising when entering the European market, "to guide the consumer by making associations with top brand names" (Alison Coleman in *Director*; London, June 2000).

It seems a distinctive feature of comparative advertising that a firm using it risks costly litigation, especially by competitors that are explicitly named. Indeed, in many countries the law raises barriers against unfair use of comparative advertising.<sup>3</sup> Moreover, costly litigation may be followed by significant damages. Damages include "lost" profits, corrective advertising expenses, and punitive damages. In a number of cases in the US punitive damages have been significant. In 1986 U-Haul International claimed the comparative advertising campaign by Jartran "do-it-yourself" moving company was false and in violation of Lanham Act: the court agreed and awarded \$40 million in damages, half of which were punitive.<sup>4</sup> Another possible outcome is that a court forces a comparative advertising campaign to be simply ceased; since at least part of the cost of this campaign is sunk, this is still costly for the advertising firm.<sup>5</sup> By contrast, for the advertising firm, the danger to be legally prosecuted is much lower

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<sup>1</sup>For the US, Muehling *et al.* (1990) note that around 40 percent of all advertising is comparative. Pechmann and Stewart (1990) on different data find a percentage as high as 80 percent.

<sup>2</sup>As an example, a 1999 General Motors Corp. ad claimed the Cadillac Seville STS to outperform BMW 540 in a slalom race. Other well-known examples involve: Pepsi and Coke, Burger King and McDonald's, and Avis and Hertz (see David Teather in *Marketing*; London; May 11, 2000). In all these cases the "underdog" (in our terminology, the entrant) ran the comparative advertising campaign.

<sup>3</sup>In the US., federal advertising legislation is found in two major laws: the Federal Trade Commission Act and the Trademark (Lanham) Act (prohibiting false designations of origin and false or misleading descriptions of facts).

<sup>4</sup>Notice that it is generally difficult to prove that consumers are really misled by an ad. This problem was solved by the court ruling that when a marketer spends "substantial funds" in an advertising campaign, the court will presume that consumers were misled if the ad is determined to be false. In another case, in 2000 a federal judge ruled that *Papa John's* must pay over \$468,000 in damages to *Pizza Hut* and desist from using its tag line "Better ingredients. Better pizza." The ruling was in favor of *Pizza Hut*, as the ingredient comparison was "misleading". In fact the claim cannot be scientifically substantiated nor taste tests exist that prove a statistically significant preference for *Papa John's* product.

<sup>5</sup>R. Freeman and E. Nemiroff from Collier Shannon Scott, a law firm, note that "comparative advertising can be a very effective marketing tool, but with it comes the risk of challenges by competitors, state attorneys general, and even

when using generic advertising.<sup>6</sup>

Comparative advertising as a means to transmit information to consumers has been emphasized by antitrust authorities. The relatively sudden increase, during the 1970s and 1980's, in the use of explicit comparisons in advertising in the US, was in part a result of a Federal Trade Commission appraisal of such a practice as a means of improving competition (see the FTC statement from 1979, available at <http://www.ftc.gov>),<sup>7</sup> arguing that direct comparison ads would encourage consumers to make more informed purchasing decisions—moreover, comparison ads would ease the consumer's task of evaluating the performance of particular brands against other brands.<sup>8</sup> Our paper provides a formal analysis of this alleged information role.

*Model and results.* We analyze two versions of a simple Bayesian game. In both versions of the model we assume that the two firms observe the same imperfect signal about the entrant's quality that can take only two values: "good" or "bad". Firms compete in an imperfectly competitive market and the entrant, through the use of advertising, tries to convince consumers that its product is of high quality. We analyze in which way the entrant's strategy and the incumbent's reactions depend on the signal precision. The two versions of the model differ with respect to the consumers' information acquisition. In *model A*, (analyzed in section 3), consumers observe what type of advertising has been chosen and how much is spent on it, but they *do not* observe the incumbent's action and the court's verdict. In *model B*, (analyzed in section 4), consumers also observe the incumbent's action and the court's verdict; consumers then can make their purchasing decision depending on the court's verdict, knowing that the court's ruling may be wrong.

Model A fits reality when consumers are not perfectly aware of the firms' legal actions; for instance

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the FTC. [...] Accordingly, before embarking on a comparative advertising campaign, ask if a skeptical judge would find your substantiation to be adequate. Unless spending large amounts of money and company time on legal challenges is part of your strategic plan, make sure the answer to that question is 'Yes'." (in: *We're Number 1: A Guide to Comparative Advertising*, March 30, 2001).

<sup>6</sup>An example that shows in which sense a comparative ads makes the advertiser more vulnerable, is what the US law defines as "puffery". An ad can be considered a puffery as long as "the customer believes the commercial statement is so vague, ridiculous or opinionated that it could not possibly be taken serious" (for a clear explanation see Jim Edwards in *Brandweek*, New York, May 2001). Puffery is accepted in generic advertising but it becomes illegal whenever it tags a competitor, exactly as in the case of Papa John's ad "Better ingredients better pizza".

<sup>7</sup>For instance, Townley has reported that comparative television advertising increased from 10 percent in 1977 to almost 25 percent in 1982 of all television advertising (Rod Townley, *No Hitting Below the (Money) Belt*, TV Guide, August 7, 1982, pages 18-20).

<sup>8</sup>The European Union first addressed the issue of comparative advertising in the late 1970s; however, practice was markedly different among member states and laws on comparative advertising were harmonized only in April 2000. According to current European legislation comparative advertising is allowed only if it is not misleading, compares like with like, does not create confusion, discredit or take unfair advantage of a rival's trademark or present goods as imitations of those bearing a protected trade name. See Directive 97/55/EC of European Parliament and of the Council of 6 October 1997 amending Directive 84/450/EEC concerning misleading advertising so as to include comparative advertising. For a general discussion of comparative advertising from an antitrust perspective see Barigozzi and Peitz (2004).

because these are not broadly discussed by the media or because purchasing decisions are made before any legal action is taken. In model A the entrant’s choice about the type of advertising is the key element for the signaling mechanism. Model B applies where consumers not only observe the incumbent’s reaction but also the court’s verdict. There, if the incumbent sues the entrant, consumers can update their beliefs on quality after the court’s ruling. This updating represents a second channel through which the presence of comparisons modifies the signaling mechanism. In this case the court’s precision is particularly important.

In model A we show that the choice of comparative advertising can signal quality and be more efficient (less costly) than generic advertising even though consumers are not informed about the incumbent’s actual strategy choice and the court’s verdict. In model B we show that comparative advertising not only can be less costly than generic advertising, but it can also be more informative, thanks to the revelation of the court’s (imprecise) findings to the public. Moreover, in this case because of its higher signaling potential comparative advertising can be compatible with a damage level equal to zero, that is, the second channel can sustain comparative advertising on its own. This fits some real world cases in which courts rule that an advertising be stopped, without imposing damages (because hardly any profits were lost and no corrective measures have to be taken).

In both models, two types of separating equilibria with comparative advertising can arise. The first, “contested advertising”, arises if the signal precision is low. Then, the incumbent files for damages also when it receives the good signal about the entrant’s quality. Damage payments can result along the equilibrium path. The second type, “uncontested advertising”, arises if the signal precision is high. It is characterized by the incumbent suing the entrant only after observing a bad signal (which is off the equilibrium path). The incumbent, here, does not react in case of a good signal. Consequently, damages are not paid along the equilibrium path.

The results in both versions of the model, and for both types of comparative advertising equilibria, point that comparative can be a more powerful signal than generic advertising. Indeed, the minimum amount of “money burning” necessary to separate under comparative advertising is lower than the corresponding amount under generic advertising, provided that the incumbent has an incentive to react to false claims. When the uncontested advertising equilibrium arises, the incumbent’s right to file for damages reduces the cost of advertising for the entrant, even though this right is not exercised along the equilibrium path.

In Model A, provided the incumbent’s legal costs are lower than the damages it may be awarded, both generic and comparison ads can arise at equilibrium. However, comparative advertising, which is less costly than generic, is easily singled out as the preferred type of advertising if the signal precision is high. Instead, if the signal precision is low, the incumbent files and damages may follow. Then, comparative advertising is still less costly, but is preferred to generic only if damages are not too high. Note, furthermore, that comparative advertising can be used as a signal in situations in which generic cannot be supported in equilibrium — for instance, when high quality entails higher production costs

than low quality. In that case, indeed, it can be shown in our model that there do not exist equilibria with generic advertising.

*Related literature.* To our knowledge the economics literature has neglected the analysis of comparative advertising as a signal about quality. Shy (1992) and (1995, chap. 11) assumes that comparative advertising is directly informative. He focuses on the matching of heterogeneous consumers with differentiated brands, where the brand producing firms dynamically compete on market shares. In his model the two firms can use either non-comparative or comparative advertising. In Shy's terms, a non-comparative advertising is 'persuasive' since it is aimed to attract new users. In contrast a comparative advertising is 'informative' and is targeted to experienced users: it is used to inform those consumers who have already purchased the product before. By assumption, informative advertising cannot be misleading. By contrast, Aluf and Shy (2001) postulate that (negative) comparative advertising is persuasive and decreases the willingness-to-pay for the competitor's product. In a similar vein, Shaffer and Zettelmeyer (2002) analyze the effects of a firm's advertising campaign on its retailer's profits. They postulate persuasive comparative advertising, leading to an increase of consumer valuations of the advertised product and a decrease for the compared product. Our paper differs by taking the view that comparative advertising is indirectly informative.

In the literature on indirectly informative advertising, the paper that is closest to ours is Matthews and Fertig (1990). In their model an incumbent and an entrant can use dissipative generic advertising to signal the entrant's quality. Similar to our model, their model allows for a reaction by the incumbent to the entrant's advertising decision. However, their model is markedly different from our: in particular, the incumbent's reaction is in the form of a counteradvertising campaign and, more importantly, the incumbent's strategy space is not affected by the entrant's advertising decision. In the conclusion, we refer to additional papers that consider advertising signals in an oligopoly context.<sup>9</sup>

At a more general level our paper lies at the intersection of two strands of literature on advertising (for a comprehensive survey see Bagwell, 2005). One strand considers directly informative advertising, that is, advertising with true content information — see in particular Anderson and Renault (2005) and Meurer and Stahl (1994). In this literature, content claims are always truthful so that the question of the credibility of these claims does not arise. Another strand, which we have mentioned above, considers indirectly informative advertising, that is, advertising may be used as a signal of product quality. In this literature, no content claims are made. In our set-up a firm makes content claims if it uses comparative advertising but these claims are not necessarily truthful.

The plan of the paper is as follows: in section 2 we present the model. In section 3 we analyze in detail model A. In section 4 we analyze model B. Section 5 concludes. Several appendices complement

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<sup>9</sup>The present paper is also loosely related to the literature on generic advertising and market entry (Bagwell and Ramey, 1988, 1990, and Linnemer, 1998). In these models the advertising strategy is undertaken by the incumbent to deter entry, whereas in our model is taken by an entrant to improve its position in the market.

the analysis of the main text.

## 2. The model

We consider a market where an established firm, the incumbent  $I$ , sells a product of known quality and a new firm, entrant  $E$ , has entered with a product of quality-index  $q_E$ , a nonnegative real number. By “quality” we mean a vertical product characteristic that gives rise to an unanimous ranking among consumers (see e.g. Mussa and Rosen, 1978, and Gabszewicz and Thisse, 1979). The duopoly we have in mind is one where the two products have two characteristics, a horizontal one — which is exogenously given, is common knowledge, and in which products differ—and a vertical one. Therefore the unanimous ranking only applies to the vertical characteristic and not to the goods. We provide an example in Appendix 6.1. This is similar to the quality-augmented Salop model by Economides (1989). Another example is provided by Häckner (2000), who extends the Singh and Vives (1984) linear-demand duopoly model to incorporate a vertical dimension.<sup>10</sup> More examples are presented and discussed in Garella and Peitz (2000). The two firms and a population of consumers play a multistage game with a sequence of moves that shall be explained in the following, after some preliminary description of the environment.

*Expected qualities.* We make the non-restrictive assumption that the incumbent ( $I$ ) is known to be of high quality. The entrant ( $E$ ) produces a good of quality which can be either high ( $q = H$ ) or low ( $q = L$ ), where  $H$  and  $L$  are non-negative numbers and  $H > L$ . We assume that it is common knowledge that the entrant’s quality results from a random mechanism and it is high,  $H$ , with probability  $\alpha_0$  or low,  $L$ , with probability  $1 - \alpha_0$ . Hence, the *ex ante* expected average quality of the entrant,  $M_0$ , is

$$M_0 \equiv \alpha_0 H + (1 - \alpha_0)L. \tag{2.1}$$

Both the incumbent and the entrant observe at no cost a signal  $s_i \in \{s_L, s_M\}$  and update their priors on the entrant’s quality (an analysis of the case with imperfect correlation of signals is relegated to Appendix 6.4). If the observed signal is  $s_L$  (i.e. the state of nature is  $s_L$ ) both firms exactly know that the entrant’s quality is low. Whereas, if the observed signal is  $s_M$ , (state of nature  $s_M$ ) both firms know that the entrant’s quality is high with probability  $\alpha_1$  and low with probability  $1 - \alpha_1$ ; where  $\alpha_1$  and  $1 - \alpha_1$  represent updated beliefs. This is a simple way to introduce imperfect knowledge on the side of the firms.<sup>11</sup>

Accordingly, let  $\lambda \in [0, 1]$ , be the exogenous probability that the signal  $s_M$  is observed when the type is low:  $\lambda = \text{prob}(s_M | L)$ . One can think of  $\lambda$  as the probability that a low quality product remains

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<sup>10</sup>Daughety and Reinganum (2005) use a similar framework for an arbitrary number of firms to address asymmetric information about quality. See also our conclusion section.

<sup>11</sup>Testing a product allows a firm to find out that it is of low quality if the test is not successful. However, even after a series of successful tests there remains a doubt whether the product is indeed of high quality.

undetected after testing. By applying Bayes' rule we find:

$$\text{prob}(H | s_M) \equiv \alpha_1 = \frac{\alpha_0}{\alpha_0 + \lambda(1 - \alpha_0)} \geq \alpha_0$$

and  $1 - \alpha_1 \leq 1 - \alpha_0$ . Notice that, for  $\lambda = 0$ , both firms perfectly infer the type from the signal; while, for  $\lambda = 1$ , there is no updating and the signal is useless. In other words,  $1 - \lambda$  measures the precision of the signal. After observing the signal  $s_M$ , the expected average quality is revised to  $M_1$ , where

$$M_1 \equiv \alpha_1 H + (1 - \alpha_1) L. \quad (2.2)$$

Consumers do not observe the signal, i.e. they do not have direct access to the firms' information. Hence, at this point, their *priors* remain  $\alpha_0$  and  $1 - \alpha_0$ .<sup>12</sup>

*Reduced profit functions.* We denote  $\Pi_E(q^e, q)$  the gross profit of an entrant with true quality  $q$  that is perceived by consumers as quality  $q^e$ . For instance,  $\Pi_E(q^e, L)$  with  $q^e > L$  is the gross profit of a low quality entrant whose quality is wrongly perceived to be  $q^e$ . The quality of the product affects production costs. We will consider both the case where production costs are increasing and the case where they are decreasing in quality. We denote  $\Pi_I(q^e)$  the gross profit of the incumbent, dependent on the entrant's perceived quality.

We assume that the entrant's sales and profits are increasing, while the incumbent ones are decreasing in the *perceived* quality of the entrant  $q^e$ . Thus, the following inequalities are assumed:

- A.1  $\Pi_E(q^e, q) > \Pi_E(q^{e'}, q)$  if  $q^e > q^{e'}$
- A.2  $\Pi_I(q^e) < \Pi_I(q^{e'})$  if  $q^e > q^{e'}$

Assumptions (A.1) and (A.2) are standard properties of many oligopoly models where products have some degree of both, horizontal and vertical differentiation (see above).

*Advertising.* We follow the literature started by Nelson (1974) and assume that advertising has no direct impact on utility or demand. Its only possible influence is, indirectly, through consumers' perception of quality. The type of advertising and its cost are publicly observable. We assume that advertising is not needed to inform consumers of the marketed products' existence; therefore, if consumers were fully informed concerning the entrant's quality, the entrant would not advertise at all.

After observing the signal  $s_i$ , the entrant chooses the type of advertising action between comparative,  $c$ , generic,  $g$ , or no advertising,  $n$ . Comparative advertising by the entrant contains the claim to offer the same quality as the incumbent. After choosing  $n$  the entrant has no cost and no further option to claim

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<sup>12</sup>The assumption that an entrant's quality may not be known to consumers is not new (Farrell, 1986) and seems natural for many markets. The assumption that the incumbent has access to the same information about the competitor's quality as the entrant itself, while consumers have not, is certainly a good approximation for a wide range of cases. It essentially means that the entrant cannot hide information about product quality from its competitor or that both firms use the same detection technology to form an opinion about the entrant's product quality.

a high quality. After choosing  $c$  or  $g$  the entrant decides the level of advertising expenditure, denoted respectively  $A_c$  or  $A_g$ . We impose that having chosen  $c$ , or  $g$ , advertising expenditures must exceed a nonnegative threshold,  $A_j \geq \underline{A} \geq 0$ ,  $j = g, c$ , where  $\underline{A} \geq 0$  is interpreted as a diffusion cost of advertising which is necessary to reach consumers. Therefore the difference  $A_j - \underline{A}$  is the dissipative advertising.

*Lawsuits threats.* The incumbent's action space depends upon the entrant's strategy choice: in the case of comparative advertising, the incumbent's action space is the set  $\{\ell, a\}$ , where  $\ell$  denotes the decision to dispute the entrant's quality claim and file for a lawsuit, while no action (accommodate the quality claim) is denoted as  $a$ . If the entrant chooses  $g$ , or  $n$ , the incumbent cannot file and its action space is trivially  $\{a\}$ .

We assume that action  $a$  has no cost attached, while choosing  $\ell$ , the incumbent pays legal costs  $C$ . Choice of  $\ell$  triggers automatically court intervention. If the court finds the entrant's quality to be low, the incumbent also obtains pecuniary payment of damages,  $D \geq 0$ . No payments are made by the entrant if the court finds the entrant's product to be of high quality.<sup>13</sup>

*Pricing.* The focus of this paper is on the signaling role of different advertising strategies. We have decided to separate the issue of advertising as a signal from the more complicated joint signaling via price and advertising. For this reason we assume that price cannot be used as a signal of product quality. This is the case if firms do not have control over price (as in our model in Appendix 6.1) or if (boundedly rational) consumers ignore the signaling role prices may play. In the conclusion section, we give examples of industries in which firms take price as given and provide some comments on the robustness of our results when price signaling in oligopoly is taken into account.

*Sequence of moves.* The sequence of moves can be summarized as follows. Throughout, all variables are observed by the firms, except the initial true quality of the entrant.

Stage 1. Nature chooses the type of the entrant ( $H$  or  $L$ ). Firms receive a signal  $s_i \in \{s_L, s_M\}$  about the entrant's product quality.

Stage 2. At stage 2a, for  $s_i \in \{s_M, s_L\}$ , the entrant chooses action  $j \in \mathcal{J} = \{c, g, n\}$ , the type of advertising. At stage 2.b he chooses<sup>14</sup> the level of advertising expenditure of type  $j$ ,  $A_j \in \mathcal{A}(j)$  with  $\mathcal{A}(j) = \{A_j \in \mathbb{R}_+ : A_j \geq \underline{A}\}$ , for  $j = c, g$ , and  $\mathcal{A}(n) = \{0\}$ . The action choice results in a vector denoted  $z_E = (j, A_j)$ , which is observed by all players.

Stage 3: for  $s \in \{s_M, s_L\}$ , if  $c$  has been chosen at stage 2, the incumbent chooses  $z_I \in \{\ell, a\}$ , where choice of  $\ell$  implies cost  $C$ . If the incumbent chooses  $\ell$  the court is to intervene. The court rules whether or not the advertising is false. The court verdict can be represented by  $v = 0, 1$  according

<sup>13</sup>Note that the special case  $D = C$  is equivalent to the situation in which the losing party has to pay all the legal costs.

<sup>14</sup>It is convenient, for expository purposes, and without loss of generality, to think of the expenditures in different types of advertising as different objects, although they both consist of money layouts, so that money spent is "labeled"  $c$  or  $g$ .

to whether it rules against or in favor of the entrant. If  $v = 0$  the court automatically awards damages  $D \geq 0$  to the plaintiff.

Stage 4: Consumers make purchasing decisions based on their updated beliefs about quality.

*Consumers' information.* In model A consumers update beliefs having observed only  $z_E$ , in model B they observe  $(z_E, z_I)$  if  $z_I = a$  and  $(z_E, z_I, v)$  if  $z_I = \ell$ . The consumers' belief system can be represented by a function, denoted  $b(\cdot)$ , that assigns a probability to state  $s_M$ , having as arguments the relevant variables observed among  $z_E, z_I, v$ , according to what has been observed. However, a more handy representation of consumers' beliefs for our purposes is obtained by use of  $q^e$ , the expected quality.

The values of the parameters  $D, C, \lambda, H$ , and  $L$ , are common knowledge.

*Equilibrium.* We shall use the solution concept of weak Perfect Bayesian Equilibrium. An equilibrium of the game is defined as a strategy profile and a belief system, such that each player's strategy is sequentially rational, and consumers' beliefs are updated according to Bayes' rule whenever this is possible. An equilibrium is said to be separating when consumers' beliefs assign probability 1 to the true state (which is the signal received by the firms) and 0 to the other. In particular, we are interested in separating equilibria where no advertising ( $n$ ) is used when the signal is  $s_L$ , while advertising ( $c$  or  $g$ ) is chosen when the signal is  $s_M$ .<sup>15</sup>

### 3. Belief revision based upon the type of advertising (model A)

In this section we explore model A where consumers only observe the entrant's advertising decision, update their priors on the entrant's quality, and make their purchasing decision. They do not observe the firms' legal dispute.

**Definition 1.** *We distinguish three types of separating equilibria. In all these equilibria the entrant chooses no advertising,  $n$ , if the signal is  $s_L$ :*

1. *Contested comparative advertising equilibria. The entrant chooses comparative advertising,  $c$ , only when the signal is  $s_M$ ; the incumbent files for a lawsuits whenever the entrant uses  $c$ ;*
2. *Uncontested comparative advertising equilibria. The entrant chooses comparative advertising,  $c$ , only when the signal is  $s_M$ ; the incumbent files only if  $c$  is used in state  $s_L$ ;*

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<sup>15</sup>Let  $I(j)$  be an indicator function that takes values  $I(c) = I(g) = 1$  and  $I(n) = 0$ , and let  $\mathcal{S}(j) = \{(j, A_j I(j))\}$ , where  $j \in \mathcal{J}$ ,  $A_j \in \mathcal{A}(j)\}$ , then action  $z_E = (j, A_j)$  is an element of the set  $\mathcal{S}(j)$ , and  $\mathcal{Z}_E = \mathcal{S}(c) \cup \mathcal{S}(g) \cup \mathcal{S}(n)$  is the action space for the entrant. A pure strategy vector for the entrant is a vector assigning an element of  $\mathcal{Z}_E$  to any state  $s$ .

The action space for the incumbent is  $\mathcal{Z}_I(j)$ , with  $\mathcal{Z}_I(n) = \mathcal{Z}_I(g) = \{a\}$ , and  $\mathcal{Z}_I(c) = \{a, \ell\}$ . A pure strategy for the incumbent is a vector assigning to each pair  $(s, z_E)$ , an element of  $\mathcal{Z}_I(j)$ , where  $j$  is the first element of  $z_E$ .

3. *Generic advertising equilibria.* Here the entrant uses generic advertising,  $g$ , when the signal is  $s_M$ .

Notice that in both types of comparative advertising equilibria the incumbent claims damages if comparative advertising was used in state  $s_L$ : such reaction represents the incumbent's strategy off the equilibrium path. What distinguishes these two types of equilibria is the incumbent's reaction in state  $s_M$ . Uncontested comparative advertising equilibria are particularly interesting because the incumbent does not file for a lawsuit along the equilibrium path; that is, in equilibrium the incumbent never becomes active and it is the threat to become active which disciplines the entrant. While in both types of equilibria it is essential that the incumbent's option to react be there, only uncontested comparative advertising equilibria have the property that the incumbent chooses a different action ( $\ell$  or  $a$ ) according to the type of information he has received, making active use of information. By contrast, at a contested equilibrium the incumbent's action, although based upon his updated beliefs, is the same after either one or the other type of signal received.

At a separating equilibrium, if the entrant undertakes an advertising campaign, consumers learn that the signal  $s_M$  was observed, they update their beliefs and form expectations about quality  $M_1$  as defined by (2.2). Both with comparative and generic advertising, in state  $s_M$  the entrant gets profits  $\Pi_E(M_1, H)$  with probability  $\alpha_1$  and  $\Pi_E(M_1, L)$  with probability  $1 - \alpha_1$ , gross of advertising expenditures (and of damages in a contested comparative advertising equilibrium). Let

$$\bar{\Pi}_E(q^e) \equiv \alpha_1 \Pi_E(q^e, H) + (1 - \alpha_1) \Pi_E(q^e, L)$$

denote the expected profit under expected quality  $q^e$ . For instance, it may be  $q^e = M_1$  (in this case  $\bar{\Pi}_E(M_1)$  represents gross expected profits).

*Generic advertising equilibria.* We first consider generic advertising equilibria. Since  $n$  is used only when the state is  $s_L$ , the separating constraint for an entrant who observes the signal  $s_M$  is:

$$\bar{\Pi}_E(M_1) - A_g \geq \bar{\Pi}_E(L). \quad (3.1)$$

The inequality ensures that, when the signal is  $s_M$ , the entrant has an incentive to reveal the state of nature  $s_M$  at a cost  $A_g$ . The separating constraint for an entrant who observes the signal  $s_L$  is:

$$\Pi_E(L, L) \geq \Pi_E(M_1, L) - A_g. \quad (3.2)$$

Putting together (3.1) and (3.2), the condition for the existence of a separating PBE with generic advertising expenditure, that is an equilibrium of type 1, is:

$$\Pi_E(M_1, L) - \Pi_E(L, L) \leq A_g \leq \bar{\Pi}_E(M_1) - \bar{\Pi}_E(L). \quad (3.3)$$

The set of  $A_g$  that satisfies this condition is non-empty if and only if

$$\Pi_E(M_1, L) - \Pi_E(L, L) \leq \Pi_E(M_1, H) - \Pi_E(L, H). \quad (3.4)$$

Here the left-hand side represents the gain for the low type from mimicking the high type with expected quality  $M_1$ , and the right-hand side is the gain for the true high type by revealing information  $M_1$  rather than accepting to be believed as a low type. Inequality (3.4) is satisfied if the entrant's profit function is supermodular in  $q^e$  and  $q$ . With  $\Pi_E$  differentiable in  $q^e$  we have the following sufficient condition:

$$\text{C.1} \quad \frac{\partial \Pi_E(q_E^e, H)}{\partial q_E^e} \geq \frac{\partial \Pi_E(q_E^e, L)}{\partial q_E^e}$$

Condition C.1 says that profit changes due to changes in the expected quality are non-decreasing in the true quality of the entrant's product.<sup>16</sup> This condition limits the scope for generic advertising. In the example in Appendix 6.1, condition C.1 is met if  $dc_E(q_E)/dq_E \leq 0$ . This means that unit costs are non-increasing in quality.<sup>17</sup> Hence, in this adverse selection world higher, correctly perceived quality is good news for two reasons: the consumers' willingness to pay is higher and production costs are lower. In terms of the R&D vocabulary, a higher consumer willingness to pay due to higher quality stems from product innovation. Lower costs because of higher quality stem from process innovation. Hence, in the present example condition C.1 holds if process and product innovations go hand-in-hand. If, on the contrary, the entrant's unit costs are increasing in quality, then C.1 is never satisfied and no separating equilibrium with *generic* advertising can exist. Notice also that condition C.1 holds with equality if product quality only affects fixed costs or does not affect costs at all.

*Comparative advertising equilibria.* We are interested in equilibria where no player uses dominated strategies. Therefore we eliminate from our analysis those equilibria with generic advertising, where the incumbent, given  $C < D$ , never files after play of  $c$  by the rival, namely where  $z_I(s_L) = z_I(s_M) = a$ . In these separating equilibria, consumers' beliefs that the state is  $s_M$  must be zero, namely  $b(z_E) = 0$  if  $z_E = (c, A)$ . Comparative advertising cannot arise, but clearly, if  $C < D$  and the signal  $s_L$  has been observed,  $a$  is strictly dominated by  $\ell$  as a reply by the incumbent to  $c$ . We can state the following more general Lemma.

**Lemma 1.** *At all PBE of the game, if  $D > C$ , in state  $s_L$ , the incumbent's strategy in response to the use of comparative advertising is  $\ell$ .*

*Contested comparative advertising equilibria.* Recall that a contested comparative advertising equilibrium has the property that the entrant chooses  $c$  if the signal is  $s_M$  and the incumbent chooses  $\ell$ . The incumbent's gross expected profit by playing  $\ell$  after a comparative claim in state  $s_M$  is  $\Pi_I(M_1)$ . If the

<sup>16</sup>When C.1 is verified the so-called "single crossing condition" is automatically verified.

<sup>17</sup>In many markets mandatory warranties exist. Then a low quality can be interpreted as a high probability of a defective items, which breaks down within the period the warranty is valid. This translates into higher costs.

signal  $s_M$  has been observed, the incumbent files for damages when observing a comparative ad if the following condition is verified:

$$\Pi_I(M_1) - C + (1 - \alpha_1) D \geq \Pi_I(M_1) \quad (3.5)$$

which can be rewritten as:

$$\alpha_1 \leq \hat{\alpha} \equiv (D - C)/D \quad (3.6)$$

that is, the incumbent always chooses  $\ell$  when the probability that the entrant is a high quality producer is low enough: substituting for  $\alpha_1$  the above condition says that the precision of the signal,  $1 - \lambda$ , has to be low enough,  $\lambda \geq [C/(D - C)][\alpha_0/(1 - \alpha_0)]$ . While, if  $\alpha_1 > \hat{\alpha}$ , the incumbent does not file in state  $s_M$ . Therefore, contested comparative advertising equilibria exist only for low values of the revised probability that the entrant is of high type (low values of  $\alpha_1$  come from high values of  $\lambda$ , i.e. low signal precision).

If the signal  $s_L$  has been observed, the incumbent chooses  $\ell$  when observing a comparative ad if:

$$\Pi_I(M_1, L) - C + D \geq \Pi_I(M_1, L) \quad (3.7)$$

that is if damages  $D$  is higher than legal costs  $C$ . If  $D < C$  instead, the content in advertising cannot play a signaling role because the incumbent never files for damages and advertising with a comparative claim is *de facto* equivalent to generic advertising.

**Lemma 2.** *A contested comparative advertising equilibrium entails a level of expenditure  $A_c$  such that:*

$$\Pi_E(M_1, L) - \Pi_E(L, L) - D \leq A_c \leq \bar{\Pi}_E(M_1) - \bar{\Pi}_E(L) - (1 - \alpha_1)D. \quad (3.8)$$

**Proof.** Suppose the state is  $s_L$ . The incumbent always files for damages if comparative advertising is used in state  $s_L$ ; the entrant in that case has to pay  $D$ . Following the same reasoning which led to inequality (3.2) we find that the gain from mimicking is  $\Pi_E(M_1, L) - \Pi_E(L, L) - D$ . This is the term that appears as the lower bound in (3.8). Suppose now the state is  $s_M$ . Given that  $\alpha_1 \leq \hat{\alpha}$ , the incumbent chooses  $\ell$  in state  $s_M$  and damages  $D$  must be paid only if quality turns out to be low, that is with (revised) probability  $1 - \alpha_1$ . Following the same reasoning which led to inequality (3.1) we find that the gain for the high type by revealing its information rather than accepting to be believed as a low type is:  $\bar{\Pi}_E(M_1) - \bar{\Pi}_E(L) - (1 - \alpha_1)D$ . This is the term that appears as the upper bound in (3.8). ■

As a special case, if the damages are large enough, the lower bound for  $A_c$  can be zero. More generally, a claim that the state is  $s_M$  can be supported without a proper signaling cost if the lower bound in (3.8) is less than  $\underline{A}$ . In this case the entrant does not incur any dissipative advertising costs to make the signal credible. It is as if the entrant was telling consumers: *Because my rival can inflict a loss upon me if I lie, you must mostly believe my words that my product is of comparable quality.*<sup>18</sup> With generic advertising,

<sup>18</sup>Note that in a situation in which comparative advertising transmits information without a cost so that  $A_c = \underline{A} = 0$ , the firm would not use *price* as a signal of product quality because a price distortion is costly for the firm. Note also that in such a situation one can see a model with *directly* informative comparative advertising as a short-cut of our model because the advertising firm does not incur any signaling cost.

by contrast, the lower bound of advertising expenditure is always positive (see (3.3)).

*Uncontested comparative advertising equilibria.* Recall that an uncontested comparative advertising equilibrium has the property that the entrant only uses comparative advertising if the signal is  $s_M$  and the incumbent only goes to court as a response to comparative advertising if the signal is  $s_L$ , (that is, off the equilibrium path). The incumbent chooses  $a$  if he observes  $s_M$  if  $\alpha_1$  exceeds the critical value  $\hat{\alpha} \equiv (D - C)/D$ .

**Lemma 3.** *An uncontested comparative advertising equilibrium entails a level of expenditure,  $A_c$ , such that:*

$$\Pi_E(M_1, L) - \Pi_E(L, L) - D \leq A_c \leq \bar{\Pi}_E(M_1) - \bar{\Pi}_E(L) \quad (3.9)$$

**Proof.** The proof is quite obvious. The lower bound for  $A_c$  only depends on the behavior of players in state  $s_L$ , which is identical in both types of comparative advertising equilibria. The upper bound gives the entrant's gain from revealing signal  $s_M$  when no lawsuit follows. ■

*Existence of separating equilibria with advertising.*

We can now put our findings together. If condition C.1 holds we obtain the following result:

**Proposition 1.** *Suppose condition C.1 holds.*

(a) *There exist PBE with generic advertising. There is no advertising in state  $s_L$ , and  $A_g \geq A_g^*$  in state  $s_M$ .*

(b) *If  $D > C$  and  $\alpha_1 \leq \hat{\alpha}$ , there exist PBE with contested comparative advertising, i.e., there is no advertising in state  $s_L$ , and  $A_c \geq A_c^*$  in state  $s_M$ , and the incumbent claims for damages if comparative advertising is used.*

(c) *If  $D > C$  and  $\alpha_1 > \hat{\alpha}$ , there exist PBE with uncontested comparative advertising, i.e., there is no advertising in state  $s_L$ ,  $A_c \geq A_c^*$  in state  $s_M$ , and the incumbent would claim for damages only if comparative advertising were used in state  $s_L$ .*

Proof. (i) Under C.1 the interval for  $A_g$  defined by (3.3) is not empty. This provides satisfaction of the separating conditions for the entrant that has played  $g$ , for all levels of  $D$  and  $\alpha$  and proves (c). (ii) Furthermore, it can be shown that if the interval defined by (3.3) is not empty then the intervals for  $A_c$  defined by (3.8) and (3.9), are also not empty. This provides satisfaction of the separating conditions for the entrant that has played  $c$ , for all levels of  $D$  and  $\alpha$ . (iii) The separating condition for the incumbent at a contested equilibrium is satisfied if  $\alpha_1 \leq \hat{\alpha}_1$ , and  $D > C$ , which, together with (ii) proves (b). The proof of (c) uses a similar argument. ■

Figure 1 illustrates Proposition 1 in the  $(D, \alpha_1)$  space.

Note that the two types of comparative advertising equilibria are mutually exclusive. When condition C.1 holds, generic and comparative advertising can be supported at equilibrium. Clearly, we want to

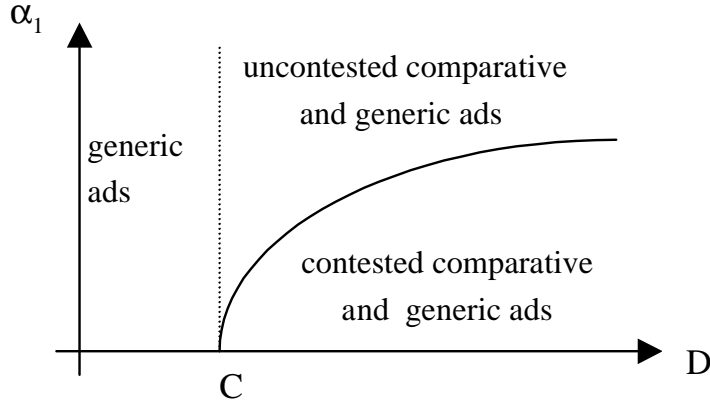


Figure 3.1: Types of equilibria in the  $(D, \alpha_1)$ -space.

select between comparative and generic advertising to make predictions on the type of advertising that emerges in equilibrium. A key observation is stated as the following proposition.

**Proposition 2.** *Comparative advertising can signal product quality at a lower cost than generic.*

*Proof.* This is seen by comparing the lower bounds in inequalities (3.3), (3.8), and (3.9) and setting  $\underline{A}$  sufficiently small ■

Recall, finally, that if C.1 does *not* hold, there is no signaling role for generic advertising. This means that if condition C.1 does not hold, only separating equilibria with comparative advertising may exist. Such separating equilibria exist only if  $D > C$  and imply the use of comparative advertising. If  $\alpha_1 \leq \hat{\alpha}$ , separating equilibria can only be of the contested type and they exist if inequality (3.8) above is verified. If  $\alpha_1 > \hat{\alpha}$ , separating equilibria can only be of the uncontested type and they exist if inequality (3.9) above is verified. If comparative advertising equilibria exist whereas generic advertising equilibria do not, the prohibition of comparative advertising leads to less informed consumers.

#### *Equilibrium selection*

We select among separating equilibria by making use of the *intuitive criterion* (see Cho and Kreps, 1987). First, note that, for  $D > C$ , there exist separating equilibria where the choice of the advertising type is determined by beliefs. These are equilibria where beliefs are such that comparative ads are not believed and generic ads are (or the contrary). However both of these types of equilibria can be eliminated by making use of the intuitive criterion. Suppose indeed that beliefs are such that generic ads is believed but comparative ads are not (the belief function is such that  $b(z_E = (c, A_c)) = 0$  but  $b(z_E = (g, A_g)) = 1$  for  $A_g \geq A_g^*$ ); then, recalling that by Lemma 1, a deviation to  $c$  in state  $s_L$  triggers the strategy  $\ell$  by the

incumbent, a deviation to  $c$  and a level of expenditure higher than the threshold level  $A_c$ , cannot come from an entrant that observed  $s_L$ , since this type of entrant would still prefer strategy  $n$  and  $A = 0$ . A similar reasoning eliminates the separating equilibria where generic advertising is not believed.

Hence, the only separating equilibria that resist the intuitive criterion are those where both kinds of advertising can separate, provided the amount spent satisfies the separating constraints. At these equilibria, the belief function  $b(\cdot)$  is such that  $b(z_E) = 1$  if  $z_E$  is such that  $j \in \{g, c\}$  and  $A_j \geq A_j^*$  for  $j = g, c$ . Then, the argument by which generic advertising equilibria can be eliminated when  $D$  is larger than  $C$  is that, by using subgame perfection, along these remaining equilibria, the entrant will choose the most profitable strategy. To be more precise, uncontested comparative advertising equilibria always prevail over generic advertising equilibria. Contested comparative advertising equilibria prevail over generic advertising equilibria if a condition on the level of damage is verified. The reason is that damages affect the expected payoff of the entrant. In the least-cost equilibrium with contested comparative advertising the entrant's expected profits are:

$$\pi_c \equiv \alpha_1 \Pi_E(M_1, H) + (1 - \alpha_1)(\Pi_E(M_1, L) - D) - A_c^*.$$

These profits have to be compared to expected profits in the least-cost equilibrium with generic advertising,  $\pi_g \equiv \alpha_1 \Pi_E(M_1, H) + (1 - \alpha_1)\Pi_E(M_1, L) - A_g^*$ . The difference between these two terms is positive if  $D < (A_g^* - A_c^*)/(1 - \alpha_1)$ , or

$$\alpha_1 > (D + A_c^* - A_g^*)/D. \quad (3.10)$$

To summarize, the application of the intuitive criterion singles out the separating equilibria with comparative advertising if these are of the uncontested type, that is, when  $D > C$  and  $\alpha_1 > \hat{\alpha}_1$  hold. If separating equilibria with comparative advertising are of the contested type, that is, when  $D > C$  and  $\alpha_1 \leq \hat{\alpha}_1$ , then the application of the intuitive criterion singles out the comparative advertising equilibria only if  $\alpha_1 > (D + A_c^* - A_g^*)/D$  holds.<sup>19</sup>

#### 4. Belief revision after the legal outcome (model B)

We assume in this section that consumers observe the incumbent's action and the court's verdict (model B). The classification of equilibria introduced above carries over to model B. The incumbent's strategy choice here must be an explicit argument in the consumers' belief revision function, while the court verdict is an argument in case the court is called to intervene. Furthermore, at a contested comparative advertising equilibrium, the incumbent always chooses  $\ell$ , and the action of the incumbent leads to more information being diffused only because the court intervenes. By contrast, at an uncontested comparative

<sup>19</sup>With respect to pooling equilibria, we note that the best equilibrium for the entrant is not to advertise and to be believed to be of average quality  $M_0$ . In this case expected profits of a firm that has received the signal  $s_M$  are  $\bar{\Pi}(M_0)$ . Again, for  $A_j^*$  sufficiently small one can use the intuitive criterion to select the separating equilibrium.

advertising equilibrium (where the court shall not intervene), the observation that the incumbent plays  $a$  rather than  $\ell$  confirms that the entrant has not tried to cheat consumers. If the incumbent had chosen  $\ell$ , that would reveal a deviation from the equilibrium path by the entrant. Note that inferences such as these cannot be made in model A. With respect to the court's verdict we assume that the court does not take into account the signal received by the firms, since they both have incentives to manipulate their reports. The court collects (incomplete) evidence on which to base a verdict and firms cannot take any action after the verdict. It is common knowledge that the court can make mistakes due to imperfect evidence gathering. In the main text we focus on uncontested comparative advertising. A large part of the analysis is, however, relegated to Appendix 6.2. Appendix 6.3 complements the analysis by considering equilibria with contested comparative advertising. Appendix 6.4 finally considers a different setting in which the two firms' signals are uncorrelated. It turns out that the analysis formally replicates the analysis in this section.

Introducing the court's imprecise verification adds an additional dimension to the problem. We assume that with probability  $1 - \mu$  the court does not discover a false claim, i.e. a claim coming from type- $L$  in either state  $s_L$  or  $s_M$ . A claim from an entrant of underlying quality  $H$  is never falsified by the court. In short, the court does not always uncover verifiable evidence against a low quality entrant, while it accepts verifiable evidence. Therefore, by assumption the entrant does not pay damages if its true, yet unknown, quality is high.<sup>20</sup>

Consumers know that with probability  $1 - \mu$  a low quality entrant is not unmasked by the court. As a consequence, when observing a verdict in favor of the entrant, consumers update their beliefs on the entrant's quality taking the possible mistake by the court into account.

Again, at a separating equilibrium, comparative advertising is chosen only if the signal received is  $s_M$  and not  $s_L$ . We call  $\alpha_2$  the updated probability to face a high quality entrant when the court's verdict, denoted  $\hat{q}$ , claims that quality is high:<sup>21</sup>

$$\alpha_2 = \text{prob}(q = H | \hat{q} = H) = \alpha_1 / [1 - \mu(1 - \alpha_1)].$$

Obviously  $\alpha_2 \geq \alpha_1$ . Correspondingly,  $1 - \alpha_2 = \text{prob}(q = L | \hat{q} = H)$  is such that  $1 - \alpha_2 \leq 1 - \alpha_1$ . Accordingly, uncertainty about quality is reduced if the court is called to act after the firms have received signal  $s_M$ . This contrasts with the case in which the court is called to intervene when the entrant cheats (out-of-equilibrium) in state  $s_L$ : in that case the court can wrongly rule in favor of the entrant. The latter pays damages with a probability less than 1 which is increasing in the court's precision.

At a separating equilibrium, in which the entrant signals  $s_M$  with a positive amount of comparative

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<sup>20</sup>This is in line with the information received by the firms. Firms and the court recognize certain failures. One could also analyze the model under the assumption that the court can take as wrong a true claim. Our main results remain valid under this different assumption. Important is that the court's action reveals additional information.

<sup>21</sup>Indeed  $\text{prob}(\hat{q} = L | s_M) = \mu \text{prob}(L | s_M) = \mu(1 - \alpha_1)$  and  $\text{prob}(\hat{q} = H | s_M) = 1 - \text{prob}(\hat{q} = L | s_M) = 1 - \mu(1 - \alpha_1)$ .

advertising and the incumbent reacts by suing, consumers revised beliefs on quality are

$$M_2 = \alpha_2 H + (1 - \alpha_2)L > M_1.$$

It is important to recall at every stage that  $M_2$  is the up-dated quality when consumers observe comparative advertising *only if* followed by a verdict (namely only in contested comparative advertising equilibria). The analysis of generic advertising is unchanged with respect to model A.

Let us consider uncontested comparative advertising equilibria. Here, the incumbent uses different strategies against comparison ads in state  $s_M$  (no-reaction  $a$ ) and  $s_L$  (reaction  $l$ ) and therefore consumers rely upon both firms' actions in their interpretation of comparison advertising as a signal. By contrast, in contested comparative advertising equilibria, the incumbent uses the same strategy (reaction  $l$ ) against comparison ads whether the signal is  $s_M$  or  $s_L$  to the effect that consumer beliefs do not depend upon the incumbent's strategy.

We proceed to a summary of the main features of uncontested equilibria in the scenario of model B (for details and formal results see Appendix 6.2). At an uncontested comparative advertising equilibrium, the incumbent does not file for damages in state  $s_M$  and it does in state  $s_L$ . There are three reasons why a lack of precision of the court may imply that an uncontested comparative advertising equilibrium may not exist. (i) If  $\mu$  is low, the incumbent does not file even when the signal is  $s_L$ , because the chances of winning the case are too thin. This leads to calculation of a threshold value for  $\mu$ , denoted  $\mu_I$ , below which the incumbent never files. (ii) If  $\mu$  is higher than a threshold value,  $\mu_I(\alpha_1)$ , the incumbent files also in state  $s_M$ , leading to equilibria of contested type if comparative ads are used. However, the interval  $[\mu_I, \mu_I(\alpha_1)]$  can be shown to be always non-empty, so that there always are values of  $\mu$  for which the incumbents' strategies are "the right ones" for an uncontested equilibrium. (iii) If  $\mu$  is lower than some threshold value, then the entrant of the low type (where  $s_L$  is the relevant state) has an incentive to mimic an entrant of the high type (where  $s_M$  is the relevant state). Due to reasons (i) and (iii), a low court precision may destroy the comparative advertising as a signal and force the entrant to use generic advertising, or not to advertise at all.

The minimal amount of comparative advertising needed to separate in an uncontested equilibrium can be shown to be equal to (see Appendix 6.2)

$$A_c^{**} = (1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)] - \mu D$$

As in the analysis in section 3, here too the minimum amount of expenditure necessary to separate in the case of generic advertising is  $A_g^* = \Pi_E(M_1, L) - \Pi_E(L, L) > 0$ .

Comparing  $A_g^*$  and  $A_c^{**}$  it is clear that comparative advertising (in the payoff-dominant PBE with comparative advertising) is less costly than generic advertising, provided that  $0 \leq A_c^{**}$  and that  $\mu$  is sufficiently high.

Note that in model A of section 3, comparative advertising can be less costly than generic only if  $D > 0$ . In the present model  $A_c^{**} < A_g^*$  if

$$(1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)] - \mu D < \Pi_E(M_1, L) - \Pi_E(L, L). \quad (4.1)$$

Two effects arise in this model: the first is the “double upgrading” effect by which, in the term on the left of the inequality (4.1),  $M_2$  appears in place of  $M_1$ . This increases the mimicking gain for the entrant in state  $s_L$  and raises the cost of comparative advertising. The second effect is due to the presence of the court, that can unmask a false claim, and is reflected in the term  $\mu$ . If  $\mu$  increases the cost of comparative advertising decreases. If this effect is strong enough comparative advertising may cost less than generic even if  $D = 0$ . When  $D = 0$  the minimum amount of advertising in an uncontested equilibrium is

$$A_{c0}^{**} \equiv (1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)].$$

Then, with no damages, the inequality  $A_{c0}^{**} < A_g^*$  obtains if  $\mu$  is large enough, namely  $\mu > [\Pi_E(M_2, L) - \Pi_E(M_1, L)] / [\Pi_E(M_2, L) - \Pi_E(L, L)]$ . The latter inequality is necessarily satisfied if the court does not make mistakes, i.e.  $\mu = 1$ . In this case quality revelation by the court is sufficient for comparative advertising to be the preferred type of advertising for the entrant. This illustrates the role of the observability of the court’s verdict and clarifies the difference between models B and A.

As a final comment, note that an increase in  $\mu$  can lead to a contested instead of an uncontested comparative advertising equilibrium. Therefore, other things equal, an increase in the court’s precision can lead to a higher number of lawsuits.

## 5. Conclusion

We have shown in this paper that comparative advertising has a different signaling potential than generic advertising. In particular, comparison ads may trigger a reaction (possibly only off the equilibrium path) by the firm that is the target of the comparison. The strategy space of the incumbent is a function of the entrant’s choice about the type of advertising. This may be especially useful for firms wishing to enter a market in which an incumbent with a renown brand already operates.

To summarize, *if the entrant uses comparative instead of generic ads it chooses to give the incumbent the option to appeal to court. Therefore, consumers can infer that the entrant must think to have a strong case.* This logic appears to be consistent with the practitioners’s point of view on the use of comparative advertising: on the web site of the advertising agency Kaye&Company (<http://www.kayeco.com>, consulted May 2001) the use of comparative advertising is encouraged because it increases credibility for the advertised product: “Side-by-side or ‘A-B’ comparisons can provide prospective customers with compelling reasons to buy from you. They can also help build credibility for your product. Subconsciously, the prospective customer says: -Who would risk making a direct comparison if they didn’t have something truly superior?-”.

The main "policy" conclusions of the paper are the following. First, in an oligopoly situation, when firms have private information, this information can be revealed to consumers through the use of advertising. However, if comparison advertising is banned, a channel is shut that allowed information possessed by rivals of advertising firms to play a role. Only the information possessed by the advertising firm can be then revealed, through generic ads, and likely at a higher cost. Even if generic advertising is viable, the entrant's profits often improve under comparative advertising. This is indeed necessarily the case if, in equilibrium, comparative advertising is not contested by the incumbent. Thus the use of comparative advertising can lower the entry costs that are due to asymmetric information and therefore facilitate entry. In this sense the FTC's view that promoting comparative advertising would promote competition is validated by our results.

Second, concerning welfare, if information is revealed via generic advertising, it often comes at a higher social cost since it involves higher, socially wasteful advertising expenditures than under comparative advertising. To be precise, compared to generic advertising, uncontested comparative advertising is unambiguously welfare improving since it reduces the amount of advertising that is needed to signal high quality. The case of contested comparative advertising is less clear-cut because here the social loss from higher advertising expenditures under generic advertising has to be compared to the social costs of using the court system under contested comparative advertising. However, the court's action may lead to additional information disclosure.

Third, it is useful to have a judicial practice that clearly defines what are the contestable claims (e.g. verifiable content) so that incumbents can use the law properly in order to react to comparison claims and the courts make few mistakes. If incumbents feel secure that a false or misleading claim is appropriately sanctioned, they will indeed go to court. Consumers benefit twice from a high precision of the courts ( $\mu$  high) when enforcing the laws on misleading advertising: first, as is obvious, they are directly better off because the message they receive from the courts is more accurate. Second, as our model shows for uncontested comparative advertising, society benefits indirectly from high precision, because this enables entrants to use a cheaper signal (an increase in the parameter  $\mu$  reduces the minimum level of advertising expenditures necessary to signal quality). However, judicial practice should depend on the way in which consumers interpret content claims in comparative advertising. In countries where consumers are not used to an unprotected environment and to aggressive marketing, they may view informal and vague comparison claims, that are not contestable by rivals, as genuinely comparative claims. Then, an active role by courts and antitrust authorities may be required. This may explain the more reluctant approach in continental Europe towards comparative advertising compared to e.g. the UK and the US (see Barigozzi and Peitz, 2004).

Fourth, as the model shows, even if the incumbent knows that consumers cannot timely observe its actions, as in our model A of section 3 above, the incumbent may go to court upon observing a false or misleading claim. In this case an appropriate level of damage payment is necessary to support the

signaling mechanism. If, on the contrary, a large share of consumers make their purchasing decision after observing the court decision (and the court precision is high), damage payments may not be needed.<sup>22</sup> Hence, the level of damage payment should critically depend on the extent to which the incumbent has been hurt by false or misleading claims. However, if the courts' work is not that reliable ( $\mu$  is low) damages are needed to avoid false claims, as a substitute for court precision. Recall, however, that if damages are too high, and the level of the signal precision to firms is low, then the entrant may not venture into comparison ads that would be contested. Rather, the entrant may use generic advertising in that case.

Our results were derived under the assumption that both firms have access to the same noisy information. Our model can be extended to allow for imperfect correlation between the signals received by the two firms (as is done in Appendix 6.4). In this extension the role of the observability of the actions taken by the incumbent is further emphasized. In this setting, firms may have different beliefs about the true quality of the entrant. When the incumbent *does not react* to a comparison advertisement it behaves as a watchdog that does not bark and it reveals that it too, and not only the entrant, has received a good signal.

Our results suggest that the incumbent may gain from committing not to sue the entrant in order to increase the signaling costs, as part of an entry deterring strategy. While this is suggestive, we think that this commitment is difficult to be gained. Indeed, the incumbent would need to commit not to learn anything about the entrant's quality. This is difficult to maintain, especially in view of the fact that for such a commitment to be effective, any investigations on behalf of the incumbent must be observable to consumers.

One issue, we have deliberately put aside, is price signaling in oligopoly. This issue is a complex one and only a small body of literature exists on the topic. In a recent paper, Daughety and Reinganum (2005) analyze price signaling with no advertising in oligopoly with an arbitrary number of firms. Fluet and Garella (2002) and Hertzendorf and Overgaard (2001) analyze price and advertising in a vertically differentiated duopoly, and show that advertising is actually used in separating equilibria, in contrast to what would happen under monopoly. Barigozzi, Garella, and Peitz (2005) reconsider the same issue in a duopoly where the incumbent's quality is known, which closely resembles the present context, to get similar conclusions. This suggests that the key mechanism according to which the entrant prefers comparative advertising over generic advertising is robust to the possibility of price signaling (since advertising is used as part of the strategy to signal product quality). While we do believe that a detailed analysis along these lines is worthwhile, we decided to concentrate in this paper on the basic mechanism behind the role of comparative advertising as a signal.

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<sup>22</sup>In a sense, our model B can be seen as an extreme version of a repeat purchase model, with the difference that consumers do not learn from previous experience but from the court ruling (which is conditional upon the incumbent's reaction whereas standard consumer learning is not). Hence, the incumbent's reaction (together with the court ruling) can be seen as a substitute for consumer learning.

There are several industries to which our analysis can be directly applied because price signaling is not a possibility. A first group of examples are industries in which prices are regulated. For example, in Europe the state fixes the price for many services by professionals (however, certain advertising practices such as comparative advertising are often banned for these services). A second group of examples are industries in which prices are set upstream and resale-price-maintenance is practiced. Then the downstream firm, or retailer, cannot influence price but it can advertise its relative advantages (e.g. biggest selection or fastest delivery in town). A third group of examples concerns industries in which the audience targeted by advertising only indirectly generates revenues. For instance, commercial free-to-air broadcasters compete for viewers or listeners, but do not charge them, and firms that advertise on the programs are willing to pay more for larger audiences. In this example, broadcasters may air comparison claims for their programs.<sup>23</sup>

## 6. Appendix

### 6.1. Example of differentiated product duopoly

Assume that the incumbent is a firm located at point 0 and the entrant at point 1 on the Hotelling line. Consumers are uniformly distributed on  $[0, 1]$  and have unit mass. Further, assume that each consumer buys one unit at most of the indivisible, differentiated good. Consumer transportation costs are linear, and the unit transport cost parameter is  $t$ . A consumer located at point  $x$  in  $[0, 1]$  obtains utility  $u_I^x = r + \theta H - tx - p$  if she purchases the good from the incumbent at price  $p$ . The sum  $r + \theta H$  is the maximum reservation price (surplus), when  $x = 0$  for the high quality good produced by the incumbent. Similarly, the expected utility from buying at a price  $p$  from the entrant is  $u_E^x = r + \theta q_E^e - t(1 - x) - p$ , where  $q_E^e$  is the expected surplus obtained from purchase from the entrant given beliefs on quality. Firms do not set prices to consumers; however, they obtain a fixed benefit  $p$  per consumer. Suppose that  $r$  is sufficiently high so that the whole market is covered in equilibrium. After entry, and having observed the fixed benefit  $p$ , consumer  $\tilde{x}$  is indifferent between buying from the incumbent or the entrant, and

$$\tilde{x} = \frac{t + \theta(H - q_E^e)}{2t}.$$

Note that  $\theta(H - q_E^e)$  is the additional surplus of the incumbent's product due to the perceived quality difference. Let the cost function be  $c_j q_j x$ , for  $j = E, I$  where  $q_j$  is the true quality. Suppose that costs are known by the firms. Then the solution for the incumbent profits,  $\pi_I$ , and for the entrant's,  $\pi_E$  gives

$$\begin{aligned} \pi_I(q_E^e) &= (p - c_I H) \frac{t + \theta(H - q_E^e)}{2t}, \\ \pi_E(q_E^e, q_E) &= (p - c_E q_E) \left[ 1 - \frac{t + \theta(H - q_E^e)}{2t} \right]. \end{aligned}$$

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<sup>23</sup>Instances of comparative advertising by broadcasters are reported in "Why Media Owners Use Comparative Advertising", Campaign, 27 February 1998, p. 20.

It is easy to check that A.1 and A.2 are met. Note in particular that the incumbent's profits is independent of the entrant's true quality and only depends on the consumers' beliefs with respect to this quality.

## 6.2. Analysis of uncontested equilibria when consumers observe the incumbent's action

**Lemma 4.** (a) *The incumbent goes to court after receiving signal  $s_L$  if*

$$\mu \geq \mu_{I_1} \equiv \frac{\Pi_I(M_1) - \Pi_I(M_2) + C}{\Pi_I(L) - \Pi_I(M_2) + D}. \quad (6.1)$$

(b) *The incumbent does not go to court after receiving signal  $s_M$  if*

$$\mu \leq \mu_{I_2}(\alpha_1) \equiv \mu_{I_1} + \left( \frac{\alpha_1}{1 - \alpha_1} \right) \frac{\Pi_I(M_1) - \Pi_I(M_2) + C}{\Pi_I(L) - \Pi_I(M_2) + D}. \quad (6.2)$$

**Proof.** (a) Note that the beliefs are such that if the incumbent *does not* sue the entrant after comparison ads, the entrant is believed to be of quality  $M_1$ . This corresponds to what was established in model A where there is no further updating after observing the advertising policy. The incumbent benefits from winning the case because it receives damages and it enjoys a stronger position in the market in case the court unmasks a low quality entrant. However, the incumbent obtains a decrease in profits if the court's verdict is favorable to the entrant. In fact, in that case, consumers up-dated beliefs are  $M_2$  instead of  $M_1$ . The condition for the incumbent to react to comparative advertising in state  $s_L$  is:

$$\mu [\Pi_I(L) + D] + (1 - \mu)\Pi_I(M_2) - C \geq \Pi_I(M_1) \quad (6.3)$$

which is equivalent to  $\mu \geq \mu_{I_1}$  in the lemma.

(b) Consider now state  $s_M$ . Formally the constraint for the incumbent *not* to react to comparative advertising in state  $s_M$  reads:

$$\Pi_I(M_1) \geq \alpha_1 \Pi_I(M_2) + (1 - \alpha_1) [\mu (\Pi_I(L) + D) + (1 - \mu)\Pi_I(M_2)] - C \quad (6.4)$$

Condition (6.4) reduces to  $\mu \leq \mu_{I_2}(\alpha_1)$ . ■

Note that  $\mu_{I_1} > 0$ , so that if the court's precision is too low ( $\mu < \mu_{I_1}$ ) the incumbent's reaction in state  $s_L$  cannot be supported. Note also that  $\mu_{I_1} < 1$  is implied by  $D > C$ . In words, if damages paid at least cover legal costs the incumbent reacts in state  $s_L$  if the court's precision is sufficiently high ( $\mu > \mu_{I_1}$ ). As an implication, if  $\mu = 1$ ,  $D > C$  is a sufficient condition for (6.3) to be verified.

Note also that, if damages exceed legal costs one can always find values for  $\alpha_1$  such that the critical  $\mu_{I_2}(\alpha_1)$  is between 0 and 1 (observe that  $\mu_{I_2}(0) = \mu_{I_1}$  and that  $\mu_{I_2}(\alpha_1) > \mu_{I_1}$  for  $\alpha_1 > 0$ ).

As it is also true for model A, the separating constraint for an entrant that receives signal  $s_L$  is identical in both types of comparative advertising equilibria:<sup>24</sup>  $\Pi_E(L, L) \geq \mu [\Pi_E(L, L) - D] + (1 -$

<sup>24</sup>Without the assumption that the court can make mistakes, that is when  $\mu = 1$ , the separation constraint for a low type would be:  $\Pi_E(L, L) \geq \Pi_E(L, L) - D - A_c$ . The constraint reads  $A_c \geq -D$ , so that it does not give any restriction on the amount of comparative advertising required.

$\mu)\Pi_E(M_2, L) - A_c$ . As it appears, in the constraint, a mimicking strategy gets  $\Pi_E(L, L)$  if the court uncovers the truth and  $\Pi_E(M_2, L)$  if it does not. This can be rewritten as

$$A_c \geq (1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)] - \mu D \quad (6.5)$$

so that, setting  $\underline{A} = 0$ , the minimum amount of advertising expenditure  $A_c^{**}$  necessary to separate is:

$$A_c^{**} \equiv \max\{0, (1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)] - \mu D\} \quad (6.6)$$

Such a minimum value is the same as for a contested and an uncontested equilibrium.

**Lemma 5.** *Consider separating PBE with uncontested comparative advertising. The interval of admissible comparative advertising expenditures is non-empty if the following inequality holds:*

$$(1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)] - \mu D \leq \bar{\Pi}_E(M_1) - \bar{\Pi}_E(L) \quad (6.7)$$

**Proof.** If the entrant, after receiving the signal  $s_M$ , uses comparative advertising it is sued by the incumbent and its expected profit is  $\alpha_1 \Pi_E(M_1, H) + (1 - \alpha_1) \Pi_E(M_1, L) - A_c$ . No advertising yields  $\alpha_1 \Pi_E(L, H) + (1 - \alpha_1) \Pi_E(L, L)$ . Therefore the separating constraint can be rewritten as

$$A_c \leq \bar{\Pi}_E(M_1) - \bar{\Pi}_E(L) \quad (6.8)$$

Note that the above condition is equivalent to (3.1) and that, under condition (C.1), the term  $\bar{\Pi}_E(M_1) - \bar{\Pi}_E(L)$  is strictly larger than  $\Pi_E(M_1, L) - \Pi_E(L, L)$ . Combining conditions (6.5) and (6.8) gives the range for comparative advertising expenditures satisfying the incentive constraints for the entrant at equilibria with uncontested comparative advertising. ■

For a given  $\alpha_1$ , the condition in Lemma (5) is satisfied if the precision of the court's verdict is sufficiently high. Let  $\Delta = [\Pi_E(M_1, H) - \Pi_E(L, H)] + [\Pi_E(M_1, L) - \Pi_E(L, L)]$ . Then the inequality  $\mu \geq \mu_E(\alpha_1)$  must hold, where

$$\mu_E(\alpha_1) \equiv \frac{\Pi_E(M_2, L) - \Pi_E(M_1, L) - \alpha_1 \Delta}{\Pi_E(M_2, L) - \Pi_E(L, L) + D}.$$

Under condition (C.1) we could use a stronger condition which is independent of  $\alpha_1$ ,

$$\mu \geq \frac{\Pi_E(M_2, L) - \Pi_E(M_1, L)}{\Pi_E(M_2, L) - \Pi_E(L, L) + D}$$

Note that the critical  $\mu_E(\alpha_1) \in (0, 1)$ . Also, higher damages lower the value of  $\mu_E(\alpha_1)$ .

**Proposition 3.** *Suppose  $0 < A_c^{**}$ . If  $\alpha_1$  and  $\mu$  are such that  $\mu_{I_2}(\alpha_1) \geq \mu \geq \max\{\mu_{I_1}, \mu_E(\alpha_1)\}$  then there exists a separating equilibrium with uncontested comparative advertising, in which  $A_c = A_c^{**}$ .*

**Proof.** follows from the analysis above. ■

### 6.3. Analysis of contested comparative advertising equilibria when consumers observe the court's verdict

The effect on consumers' belief revision with contested comparative advertising is stronger than with uncontested comparative advertising. Here, the court's verdict after signal  $s_M$  works as a certification, albeit as an imperfect one.

Consider the incumbent incentive to react in state  $s_M$ . Recalling discussion in section 4 and inequality (6.4), the constraint for the incumbent to react to comparative advertising in state  $s_M$  reduces to  $\mu \geq \mu_{I_2}(\alpha_1)$ .

Consider now the separating constraint for the entrant. Given that the incumbent reacts if the signal is  $s_M$ , an entrant who learns that the signal is  $s_M$  uses comparative advertising if:

$$\alpha_1 \Pi_E(M_2, H) + (1 - \alpha_1) \{ \mu [\Pi_E(L, L) - D] + (1 - \mu) \Pi_E(M_2, L) \} - A_c \geq \bar{\Pi}_E(L) \quad (6.9)$$

In the case of no damages (namely  $D = 0$ ), constraint (6.9) reduces to impose as an upper bound for  $A_c$  the value  $\alpha_1 [\Pi_E(M_2, H) - \Pi_E(L, H)] + (1 - \alpha_1)(1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)]$ .

The condition for the existence of a range for comparative advertising expenditure satisfying the entrant's separating constraints (combining (6.5) and (6.9)) is

$$\begin{aligned} (1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)] - \mu D \leq \\ \alpha_1 [\Pi_E(M_2, H) - \Pi_E(L, H)] + (1 - \alpha_1) (1 - \mu) \Pi_E(M_2, L) - \Pi_E(L, L) - \mu D \end{aligned} \quad (6.10)$$

Or, equivalently,

$$\Pi_E(M_2, H) - \Pi_E(L, H) - (1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)] + \mu D \geq 0. \quad (6.11)$$

This condition is automatically satisfied if condition (C.1) holds. Again, we observe that (C.1) is not necessary to satisfy the separating constraints of the entrant. As  $\mu$  turns to zero condition (6.11) becomes equivalent to C.1. This is the limit case, in which the court system is useless in that it does not uncover any evidence so that advertising that contains content is equivalent to generic advertising. In the opposite case when  $\mu = 1$  the court perfectly verifies and condition (6.11) is always satisfied. We rewrite this condition as a lower bound on  $\mu$ :

$$\mu \geq \mu_E \equiv \frac{[\Pi_E(M_2, L) - \Pi_E(L, L)] - [\Pi_E(M_2, H) - \Pi_E(L, H)]}{\Pi_E(M_2, L) - \Pi_E(L, L) + D}$$

Summarizing, to support a separating equilibrium with contested comparative advertising the conditions (6.11), (6.1), and  $\mu \geq \mu_{I_2}(\alpha_1)$  have to be satisfied. The minimum amount of advertising expenditure necessary to separate is:  $A_c^{**} \equiv \max\{\underline{A}, (1 - \mu) [\Pi_E(M_2, L) - \Pi_E(L, L)] - \mu D\}$

**Proposition 4.** *Suppose  $\underline{A} < A_c^{**}$ . If  $\alpha_1$  and  $\mu$  are such that  $\mu \geq \max\{\mu_E, \mu_{I_1}, \mu_{I_2}(\alpha_1)\}$  then there exists a separating equilibrium with contested comparative advertising and  $A_c = A_c^{**}$ .*

**Proof.** The existence of an equilibrium follows from above. ■

Note that even if no damages are paid there exists a non-empty interval for comparative advertising expenditures that satisfies the incentive constraints of the entrant. Moreover, note that the contested comparative advertising equilibrium entails more information disclosure than that with uncontested comparative advertising. In fact, if quality is signaled with generic advertising or with uncontested comparative advertising, consumers only learn that average (updated) quality is  $M_1$ . While, if quality is signaled with contested comparative advertising, when the court says that the claim is true ( $\hat{q} = H$ ), consumers' updated beliefs on quality are  $M_2 > M_1$ . Thus, comparative claims followed by a court decision transmit more information to consumers than generic ads or uncontested comparative ads.

#### 6.4. Imperfectly correlated information

So far we have assumed the information of the two firms to be perfectly correlated. However, suppose that this is not the case. For instance, each firm independently undertakes a single or a series of tests providing some imprecise knowledge about the entrant's product quality. The result of the testing is private information of the firm carrying it, so that the total information in the market is richer than the individual information obtained by the firms. We show here that in such an environment, our general insights hold true. Note that the analysis of generic dissipative advertising remains unchanged. To analyze comparative advertising we maintain that consumers observe all firms' actions and the court verdict (model B). We shall make two additional remarks. First, we show here that there exist equilibria in which the entrant signals its private information to the incumbent and both firms signal information that is favorable for the entrant to consumers. This implies that consumers obtain more than the information initially available to either firm. Second, we show that there exist separating equilibria, like those with uncontested comparative advertising above, where claiming for damages occurs only if the incumbent receives signal  $s_L$ , i.e. when it knows that the entrant's quality is low. After signal  $s_M$ , the incumbent does not react to comparative ads and by so doing he reveals to consumers that he too observed  $s_M$ .

To clarify the exposition we consider the special case that the court perfectly verifies the entrant's quality (i.e.  $\mu = 1$  in our notation). Hence, if the incumbent applies for damages, no uncertainty with respect to the entrant's quality remains. A test carried out by firm  $i$  can show the failure of the entrant's product. We assume that if the true state is  $L$  then the firms' test are independent of each other and each indicates no failure with probability  $\lambda$  and failure with probability  $(1 - \lambda)$ . If the true state is  $H$  then each firm receives signal  $s_M$  with certainty. Hence, it follows that if the true state is  $L$  firms receive signals  $s_M^I$  and  $s_M^E$  with probability  $\lambda^2$ , signals  $s_M^I$  and  $s_L^E$  with probability  $\lambda(1 - \lambda)$ , signals  $s_L^I$  and  $s_M^E$  with probability  $\lambda(1 - \lambda)$ , and signals  $s_L^I$  and  $s_L^E$  with probability  $(1 - \lambda)^2$ . This information structure implies that the information that the two firms receive is positively but not perfectly correlated. Furthermore, the probability that a firm assigns to the entrant being a high type if the private signal is  $s_M$  is again  $\alpha_1 = \alpha_0 / [\alpha_0 + \lambda(1 - \alpha_0)]$ , as in the previous sections.

We focus on the following type of separating equilibrium:

**Definition 2.** *partially contested comparative advertising equilibrium*

- If the entrant receives  $s_M^E$  it chooses  $c$ ; if the entrant receives  $s_L^E$  it chooses  $n$ .
- In case  $c$  has been chosen by the entrant, the incumbent chooses  $a$  if it receives signal  $s_M^I$ ; while if it receives  $s_L^I$  it chooses  $\ell$ , claiming for damages.
- The separating beliefs must be consistent with strategies, of a partially contested comparative advertising equilibrium, such that:  $\text{prob}(c | (s_j^I, s_L^E)) = 0$ ,  $\text{prob}(c | (s_j^I, s_M^E)) = 1$ ; while  $\text{prob}(\ell | (s_M^I, s_j^E)) = 0$  and  $\text{prob}(\ell | (s_L^I, s_j^E)) = 1$ , for  $j = M, L$ .

In this type of equilibrium the belief updating is as follows: observing comparative advertising by the entrant the incumbent learns that the entrant has received signal  $s_M^E$ . If the incumbent claims for damages, the true quality is then revealed by the court to consumers. This only happens if the incumbent has received signal  $s_L^I$  — this implies that the true state is  $L$  so that the observability of the verdict is redundant.<sup>25</sup> If the entrant uses comparative advertising and the incumbent *does not* sue the entrant, consumers interpret this as both firms having received  $s_M^I$  and update their beliefs to

$$\alpha'_1 = \frac{\alpha_0}{\alpha_0 + \lambda^2(1 - \alpha_0)} > \alpha_1.$$

The expected product quality then is  $M'_1 = \alpha'_1 H + (1 - \alpha'_1)L$ .

With these preliminaries we are now in the position to write down the incumbent's and entrant's separating constraints that have to be satisfied to support a partially contested comparative advertising equilibrium.

**Lemma 6.** *There exist values for  $A_c$  satisfying the separating constraint for an entrant at a partially contested comparative advertising equilibrium if  $\lambda$  and  $\alpha_0$  are such that the condition*

$$[\Pi_E(M'_1, H) - \Pi_E(L, H)] - \lambda[\Pi_E(M'_1, L) - \Pi_E(L, L)] \geq -(1 - \lambda)D, \quad (6.12)$$

holds.

**Proof.** If the entrant receives signal  $s_L$  it can anticipate that the incumbent receives signal  $s_M$  with probability  $\lambda$  (i.e., does not react). Therefore, with probability  $\lambda$  mimicking results in gross profits for the entrant equal to  $\Pi_E(M'_1, L)$ . Therefore the separating constraint for the entrant that receives signal  $s_L^E$  is  $\Pi_E(L, L) \geq (1 - \lambda)[\Pi_E(L, L) - D] + \lambda\Pi_E(M'_1, L) - A_c$ . Which provides the lower bound for  $A_c$  as:

$$A_c \geq \lambda[\Pi_E(M'_1, L) - \Pi_E(L, L)] - (1 - \lambda)D \quad (6.13)$$

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<sup>25</sup>If consumers only observed the firms' actions we would obtain the same insights although under modified conditions, derived from the separating constraints.

Note that this inequality is similar to (6.5); only the probability of the court to make a mistake,  $1 - \mu$ , has been replaced by the probability  $\lambda$ , and the updated value for  $M$  is now  $M'_1$ .

When the entrant receives the signal  $s_M$ , it believes that the true quality is  $H$  with probability  $\alpha_1$ . Furthermore, it expects the incumbent's signal to be  $s_L$  (triggering a lawsuit) with probability  $(1 - \alpha_1)(1 - \lambda)$ . Meanwhile, consumers update quality to  $M'_1$ , based upon  $\alpha'_1$  defined above, if the incumbent does not react to a comparison ad, while the information of the entrant is still only based upon  $\alpha_1$ . Accordingly, by using advertising  $A_c$  the entrant expects gross profits to be equal to  $\Pi_E(M'_1, H)$  with probability  $\alpha_1$ , and equal to  $(1 - \lambda)[\Pi_E(L, L) - D] + \lambda\Pi_E(M'_1, L)$  with probability  $(1 - \alpha_1)$ . The expected profit by advertising, i.e.  $\alpha_1\Pi_E(M'_1, H) + (1 - \alpha_1)\{(1 - \lambda)[\Pi_E(L, L) - D] + \lambda\Pi_E(M'_1, L)\} - A_c$ , must not be lower than  $\bar{\Pi}_E(L) = \alpha_1\Pi_E(L, H) + (1 - \alpha_1)\Pi_E(L, L)$ , which is obtained by no advertising.<sup>26</sup> This gives the upper bound for  $A_c$  as equal to:

$$\alpha_1[\Pi_E(M'_1, H) - \Pi_E(L, H)] + (1 - \alpha_1)\{\lambda[\Pi_E(M'_1, L) - \Pi_E(L, L)] - (1 - \lambda)D\}. \quad (6.14)$$

Hence from (6.13) and (6.14), there exist comparative advertising expenditures that are consistent with the entrant's incentive constraints if the condition in the Lemma is satisfied. ■

The condition in the lemma has the same structure as corresponding conditions in the previous section and is always satisfied if condition (C.1) holds (although C.1 is not necessary).

Now let us turn to the incumbent's separating constraints.

**Lemma 7.** (a) *The incumbent receiving signal  $s_L^I$  uses  $\ell$  if*

$$\Pi_I(L) + D - C \geq \Pi_I(M'_1). \quad (6.15)$$

(b) *The incumbent receiving signal  $s_M^I$  uses  $a$  if*

$$\alpha'_1[\Pi_I(M'_1) - \Pi_I(H)] + (1 - \alpha'_1)[\Pi_I(M'_1) - \Pi_I(L) - D] + C \geq 0. \quad (6.16)$$

**Proof.** Part (a) is self-evident. As for part (b), if the incumbent receives signal  $s_M^I$  it can update according to  $\alpha'_1$ , as for consumers who observe that the incumbent does not file for damages. Therefore, the incumbent does not claim for damages if

$$\alpha'_1\Pi_I(M'_1) + (1 - \alpha'_1)\Pi_I(M'_1) \geq \alpha'_1\Pi_I(H) + (1 - \alpha'_1)(\Pi_I(L) + D) - C.$$

This inequality can be rewritten as in the Lemma. ■

Inequality (6.15) is always satisfied if  $D \geq C$ . For  $C > 0$  the inequality (6.16) is satisfied if  $\alpha'_1$  is sufficiently large, which is implied by  $\lambda$  sufficiently small. (Note that for a given  $\alpha_0$  the inequality is satisfied for all  $\lambda$  if  $\alpha_0[\Pi_I(M_0) - \Pi_I(H)] + (1 - \alpha_0)[\Pi_I(M_0) - \Pi_I(L) - D] + C \geq 0$ .)

<sup>26</sup>Note that this inequality is similar to (6.9) in appendix 6.2. (6.9) indicates the separation constraint for an entrant which observed signal  $s_M$  when equilibrium is with contested comparative advertising. Again the probability of the court to make a mistake,  $1 - \mu$ , has been replaced by the probability  $\lambda$ .

Summarizing, to support a partially contested comparative advertising equilibrium conditions (6.12), (6.15), and (6.16) have to be satisfied.

To obtain separation under partially contested comparative advertising, advertising expenditure for comparative advertising has to be at least the minimum amount  $A_c^{***}$  where

$$A_c^{***} \equiv \lambda[\Pi_E(M'_1, L) - \Pi_E(L, L)] - (1 - \lambda)D.$$

**Proposition 5.** *Suppose  $\underline{A} < A_c^{***}$ . If  $D \geq C$  and parameters  $\lambda$  and  $\alpha_0$  are such that (6.12) and (6.16) holds then there exists a separating equilibrium with partially contested comparative advertising in which  $A_c = A_c^{***}$ .*

Note that the expression for  $A_c^{***}$  is just the same as that for  $A_c^{**}$  in the case of the court making mistakes, with  $\lambda = (1 - \mu)$ .

Clearly this is not the only type of equilibrium that can arise. There exist parameter constellations such that the incumbent claims for damages whenever the entrant uses comparative advertising. In this case, since the court verifies the entrant's quality, consumers learn the entrant's true quality when the entrant received signal  $s_M^E$ , that is comparative advertising always allows for information disclosure.

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