Marketing Science
Vol. 33, No. 3, May–June 2014, pp. 382–400
ISSN 0732-2399 (print) | ISSN 1526-548X (online)

http://dx.doi.org/10.1287/mksc.2013.0826

Persuasive Puffery

Archishman Chakraborty
Syms School of Business, Yeshiva University, New York, New York 10033, archishman@yu.edu

Rick Harbaugh
Kelley School of Business, Indiana University, Bloomington, Indiana 47405, riharbau@indiana.edu

Sellers often make claims about product strengths without providing evidence. Even though such claims are mere puffery, we show that they can be credible because talking up any one strength comes at the implicit trade-off of not talking up another potential strength. Puffery pulls in some buyers who value product attributes that are talked up or emphasized while pushing away other buyers who infer that the attributes they value are relative weaknesses. When the initial probability of making a sale is low, there are more potential buyers to pull in than to push away, so puffery is persuasive overall. This persuasiveness requires that buyers have some privacy about their preferences so that the seller does not completely pander to them. More generally, the results show how comparative cheap talk by an expert to a decision maker can be credible and persuasive in standard discrete choice models used throughout marketing, economics, and other disciplines.

Keywords: cheap talk; sales talk; comparative advertising; negative advertising; unique selling point; targeting; privacy; pandering
History: Received: October 2, 2012; accepted: September 14, 2013; Preyas Desai served as the editor-in-chief and Miguel Villas-Boas served as associate editor for this article. Published online in *Articles in Advance* March 24, 2014.

["Puffery" is] frequently used to denote the exaggerations reasonably to be expected of a seller as to the degree of quality of his product, the truth or falsity of which cannot be precisely determined. —Federal Trade Commission[1]

1. Introduction

Much of seller communication is mere "puffery" that makes vague or subjective claims about product strengths that are difficult or impossible to verify. Salespeople assure customers that a tie "looks great" or that a car "drives well." Advertisements claim that a pizza has "better ingredients" or that a pain medicine offers "fast, fast, fast relief."[2] Even more subjectively, sellers emphasize a product's stylishness or sportiness or try to make other favorable associations that help position the product. Studies find that most advertisements contain subjective claims and that many advertisements contain no objective facts (Stewart and Furse 1986, Abernethy and Franke 1996).[3]

It is often argued that puffery by salespeople and advertisers is only useful to the seller if it successfully dupes a credulous buyer (e.g., Preston 1996, Hoffman 2006). However, the argument that puffery is unambiguously bad seems at odds with the right to engage in puffery being supported by both common law and nearly a century of regulatory law.[4] Moreover, some puffery is so extreme that even a credulous buyer is unlikely to take it seriously—stores proclaim that "our service can't be beat" and salespeople insist that a shirt "looks perfect." When seller claims are not taken at face value, might they still communicate useful information to buyers?

To gain insight into long-standing questions about the effects of puffery, we analyze seller communication about unverifiable product attributes. We develop a discrete choice model where the buyer has private information about her preferences and the seller has private information about his product that can help the buyer make a better decision. The information is subjective (or otherwise unverifiable), so there is no way to directly prove the information to the buyer. We show how puffery can be informative in that it credibly communicates useful information on product attributes that would otherwise be

[1] *Better Living, Inc.*, et al. 54 F.T.C. 648 (1957), aff'd, 259 F.2d 271 (3rd Cir. 1958).

[2] The former claim by Papa John's was ruled to be permissible puffery by the 5th U.S. Circuit Court of Appeals in 2000, whereas the latter claim by Anacin was apparently never challenged.

[3] Stewart and Furse (1986) find that 58% of a sample of 1,000 television ads contain puffery. Abernethy and Franke (1996) find that across multiple studies, only 70% of television ads contain any objective information and only 34% contain more than one piece of such information.

[4] The Federal Trade Commission (FTC) 1987 Policy Statement on Deception confirmed the regulatory policy to not pursue claims designated as puffery, and in 2008, the U.S. Court of Appeals, 9th Circuit, in *Newcal Industries v. Ikon Office Solution* (No. 05-16208 (9th Cir. January 23, 2008)) found that puffery is legally nonactionable.

difficult to communicate, and we show how it can be persuasive in that it induces rational buyers to be more likely to buy a product.[5] Hence, despite the potential for misleading some credulous buyers, we find that puffery can benefit both buyers and sellers.

Consistent with the legal definition of puffery as claims about subjective features of a product, we model puffery as "cheap talk" (Crawford and Sobel 1982), rather than as verifiable messages (Milgrom 1981) or costly signals (Spence 1973, Nelson 1974). In particular, we model puffery as a form of "comparative cheap talk" that provides implicit information to buyers (e.g., Chakraborty and Harbaugh 2007, 2010). Therefore, we assume that buyers are neither completely naive nor completely skeptical about puffery but rather treat unsupported claims as providing potentially useful comparative information. For instance, even if a customer does not believe that a store has unbeatable service, the store's service might still be its relative strength, and even if a shirt does not really look perfect, it might be better-looking than it is durable. When buyers treat claims in this way, talking up one attribute of a product comes at the implicit cost of not talking up a different attribute. Hence, even though puffery is unverifiable cheap talk, it can still be credible.

Puffery makes buyers who value the talked-up or featured attribute(s) more willing to buy the product and makes buyers who value the other attribute(s) less willing to buy the product. Is there any net effect on the likelihood of a purchase, and if so, are more buyers pulled in by puffery or are more buyers pushed away? We consider a standard discrete choice model in which buyer utility is linear in the attributes, so it may seem that there should be no net effect. However, when buyers have private information about their preferences, i.e., the buyer's weights on the different attributes are uncertain as in a random coefficients model, we show that puffery increases the variation in buyer valuations, which helps the seller when the probability of a purchase is convex. Such convexity holds when the prior probability of a purchase is low so that there are more buyers to pull in and fewer buyers to push away.

Puffery can highlight the strengths of a seller's product, and it can also highlight the weaknesses of a competitor's product. We find that negative puffery, such as a negative advertisement or a salesperson talking down a competing product, is also credible and that it helps the seller when the competitor's probability of making a sale is sufficiently large. Such puffery scares away customers who were initially leaning toward the competitor's product but who value attributes that are portrayed as weaknesses, and some of them go to the seller instead. It also pushes some customers to the competitor's product who value attributes that have not been criticized. Although credible and effective, it may seem that highlighting a competitor's weaknesses would be less effective than highlighting one's own strengths, and this is true in our numerical example of a standard logit model with symmetric preferences.

Combining the case of puffery about one's own product with that of negative puffery about a competitor's product, we then consider puffery that highlights the comparative advantage of a firm's product, i.e., that highlights which attribute is best relative to that of a competitor. Such comparative advantage puffery, which could be verbal communication by a salesperson or a form of comparative advertising, can be doubly powerful in that it pulls in customers who value one attribute while simultaneously pushing them away from the competitor. We show that it helps the seller when the competitor's probability of making a sale is sufficiently large (or the seller's probability of making a sale is sufficiently small). For instance, the classic "We try harder" ad campaign of Avis is an example of comparative advertising by a smaller firm that is about a service attribute of the product.

Our assumption of random coefficients is appropriate if the seller is communicating to multiple buyers at once or if the seller is communicating to one buyer whose type is unknown.[6] If heterogeneity in consumer preferences disappears because the seller can learn the exact type of individual buyers and communicate to them separately, then the seller has an incentive to emphasize whatever attribute each buyer values more. Such "pandering" is completely discounted by buyers so that in equilibrium there is no net effect from seller communication on the buyer's probability of purchasing the product.[7] Hence, greater information about a buyer's preferences, or better ability to target communication to different buyers with different preferences, can paradoxically hurt the seller by undermining the persuasiveness of communication.

We focus on puffery of particular product attributes, but sellers may also engage in "product

[5] Following the terminology of sender–receiver games, communication in our model is "informative" in that it provides real information and may be "persuasive" in that the information induces a rational receiver to act in a way that the sender prefers. The early economics and marketing literatures define communication as persuasive if it somehow alters buyer preferences.

[6] Our results build on the early idea that simultaneous cheap talk to multiple audiences can often facilitate communication (Farrell and Gibbons 1989).

[7] The negative effects of pandering on credibility are analyzed by Che et al. (2013) in the related context of recommendations among multiple actions, e.g., a seller's recommendation to buy one good over another.

puffery," which highlights the overall strength of a product. As previously shown in the literature, if the seller has at least two products, there can be an equilibrium trade-off where pushing one product increases the probability that it is sold but also decreases the probability that another of the seller's products is sold (Chakraborty and Harbaugh 2007, 2010; Inderst and Ottaviani 2012; Che et al. 2013). From this perspective, product puffery can be seen as an implicit recommendation. For instance, a restaurant's claim to have "the world's best hotdogs" might not convince people that its hotdogs are really the best, but it can credibly convey that its hotdogs are not as bad as its hamburgers. By decreasing the probability that a potential diner fails to stop for either hotdogs or hamburgers, product puffery can increase seller profits.[8]

If communication via puffery (cheap talk) helps a seller, it may seem that communication based on verifiable statements ("disclosure" or "persuasion") must be even better, but this is not the case. First, communication via puffery has a favorable impact on buyer impressions of one attribute and a negative impact on impressions of another attribute, whereas communication of verifiable information sometimes reveals bad information on both attributes. By the unraveling argument for verifiable information, sellers will often feel compelled to reveal all verifiable information in equilibrium (e.g., Milgrom 1981, Koessler and Renault 2012). Therefore, seller types with bad information on both attributes would be hurt by disclosure of verifiable information but can still benefit from puffery. Second, puffery sometimes strikes the right balance between revealing some information but not too much information so that it is better on average for the seller than full disclosure of information. We illustrate this in §5.3 in an example that links attribute puffery with product recommendations.

This paper provides the first results on cheap talk about choice attributes in standard discrete choice models such as the logit and probit. Beyond the particular issue of seller puffery, the results apply more generally to discrete choice models in a wide range of areas such as managerial decision making, voting, and lobbying. We find that cheap talk can be credible and persuasive even in the environment that might seem least conducive to it—when the expert is pushing one particular choice regardless of the benefit to the decision maker and when the decision maker's utility is linear in the choice attributes. In the following sections, we review the related literature, outline a simple example of how puffery is persuasive, provide results on the shape of the choice probability function in discrete choice models, analyze our main model of puffery, and then extend the model in a number of directions.

2. Literature Review

A rapidly growing literature analyzes how sellers can provide information about product attributes that facilitates a better match between buyers and products (e.g., Anderson and Renault 2006, 2009; Johnson and Myatt 2006; Sun 2011; Anand and Shachar 2009, 2011; Gu and Xie 2013). We contribute to this literature by showing how communication of unverifiable soft information rather than just disclosure of verifiable hard information can improve such matching. Hence, the results from this literature focusing on verifiable information are more general than previously recognized.

The idea that puffery of one attribute might be persuasive when puffery of every attribute is not persuasive was examined by Kamins and Marks (1987). They consider puffery as part of a "two-sided argument" in which one product attribute is explicitly conceded to be weak in order to increase the credibility of claims regarding the featured attribute.[9] They find that such puffery is believed by experimental subjects and interpret the result as evidence that puffery can be successful at deceiving consumers. We model the same insight that puffery about one of multiple attributes can be persuasive, but in our model rational consumers receive useful information from the seller's decision to push a particular attribute.

Puffery of an attribute in our model can be counterbalanced by an explicit concession as in the two-sided arguments literature, or it can be counterbalanced by an implicit concession whereby buyers correctly infer that unmentioned attributes are not the product's relative strength.[10] This implicit trade-off is consistent with the long-recognized "discount effect" in which consumers often make negative inferences about the values of unmentioned attributes (e.g., see Meyer 1981, Johnson and Levin 1985, and the survey by

[8] This situation can be modeled as a nested discrete choice problem where hotdogs and hamburgers are two attributes of the restaurant, as done in §5.3.

[9] Two-sided arguments were first studied regarding propaganda strategies (Hovland et al. 1949). The marketing literature has emphasized that a buyer is less likely to attribute a seller's intentions to that of just making a sale when some negative information is provided. Our results show that credibility is still possible even when the buyer thinks the seller's only intention is to make a sale.

[10] Note that the seller still faces a trade-off from pushing one attribute or another even if some credulous buyers maintain their prior quality estimates for unmentioned attributes. However, our conclusions that puffery helps buyers make a better decision and that puffery is counterproductive when the probability of a sale is high depend on enough buyers updating rationally. Credulity is analyzed in related contexts by Inderst and Ottaviani (2012) and Hoffman et al. (2013).

Kardes et al. 2004). In our cheap talk model, puffery that raises the updated estimate of one attribute above the prior must, in equilibrium, lower the updated estimate of the other attribute below the prior. Hence, even when the underlying attributes are positively correlated, the *updated* equilibrium estimates are negatively correlated.[11]

The result that communication benefits a firm when a sale is unlikely is consistent with anecdotal evidence that puffery is most common by firms with weak market position (Preston 1996) and with the finding that comparative advertising is most useful for new and small firms rather than market leaders (Pechmann and Stewart 1991, Grewal et al. 1997). It is also consistent with long-standing experimental results that two-sided arguments increase purchase intent only when purchase intentions are initially weak (e.g., Crowley and Hoyer 1994). The underlying mechanism that higher variation in buyer valuations helps when valuations are low also fits the findings by Sun (2012) that higher variance of product reviews helps when a product's average ratings are low. In our model with multiple product attributes, if a product is strong on one dimension and weak on another dimension, then buyer valuations will vary more, and some buyers will buy the product even if overall valuations are low.[12]

A recent theoretical literature considers comparative advertising when information is verifiable or potentially so. Anderson and Renault (2009) analyze comparative information that must be accurate, Barigozzi et al. (2009) analyze comparative information that a competitor can challenge or not in court, and Emons and Fluet (2012) analyze comparative information for both the verifiable case and the case where exaggerations are costly in that they might be penalized. Our cheap talk approach shows that the insights from these models can often be extended to the case where information is not verifiable. In particular, Anderson and Renault (2009) show that small firms have the strongest incentive to reveal information about a competitor, and we find the same result in our setting.[13] As long as there are at least two attributes, even if they are both vertical attributes valued to some extent by all buyers, sales can rise because of disclosure of comparative information by pure puffery.

Our analysis of comparative advantage puffery adds to the understanding of how firms can create a "unique selling proposition" that differentiates a key attribute of the product from that of the competition (Reeves 1961). Every firm must have a comparative advantage in some attribute relative to another firm that it can credibly use puffery to highlight even if the advantage cannot be directly proven. Just as trade based on comparative advantage helps both sides, we find that comparative advertising based on a unique selling proposition for one firm can implicitly highlight the comparative advantage of the competing firm to the benefit of firms and buyers.

That sellers can credibly communicate soft information is important in view of debates in the empirical literature on the content of advertising. The standard Resnik and Stern (1977) methodology for measuring advertising content includes any information about objective product attributes even if it is not supported by evidence but excludes subjective information. This paper's results support the idea that even cheap talk about objective information can be credible and informative but also imply that excluding subjective information can underestimate the amount of information in advertisements. In fact, the results imply that the mere choice to focus on one aspect of a product such as its popularity or its convenience can provide real information.[14]

We show how information about the relative quality of different product attributes can be communicated through puffery when buyer attribute preferences are uncertain. The prior literature on cheap talk in advertising has shown how a connection between perceived quality and pricing can make seller statements about overall quality credible. Bagwell and Ramey (1993) find that cheap talk claims of high quality can be credible when a seller of a low-quality good does not want to scare away low-income buyers who correctly anticipate that high quality will imply a high price. Gardete (2013) extends this analysis to allow for a range of different qualities and finds that low-quality firms will often pool with slightly better firms so that their quality claims are to some extent exaggerated. In these models, and in Chakraborty and Harbaugh (2010, Section II.D), cheap talk is only influential if it is transmitted before the price and

[11] If there is verifiable rather than unverifiable information on multiple attributes, a skeptical buyer should also make a negative inference about an unmentioned attribute. By the unraveling argument, such skepticism should lead all but the very worst information on each attribute to be disclosed in equilibrium.

[12] Johnson and Myatt (2006) examine how revealing information increases dispersion in buyer valuations and leads to a rotation in the demand curve. They show how a seller with a niche rather than mass-market strategy prefers to reveal information, but in their model, the effect is driven by the ability to raise prices.

[13] In their model, prices are endogenous, so there is the extra consideration of how the equilibrium of the pricing game changes with comparative advertising.

[14] Relatedly, the literature on targeted advertising has shown that the choice to focus advertisements on one consumer segment or another, such as by choosing media that reach different types of consumers, reveals information about a product (Anand and Shachar 2009).

if the price is expected to vary with quality. In our approach, we show that cheap talk is influential even if prices are fixed.[15]

As long recognized in the literature, reputational concerns can provide a break on seller incentives to mislead. The reputational costs of lying in a cheap talk model can be captured implicitly by a limited bias as in Crawford and Sobel (1982) or by preference complementarities as in Chakraborty and Harbaugh (2007), by explicit treatment of reputation over multiple interactions as in Sobel (1985), by a reduced-form future cost from current exaggerations as in Ottaviani and Sørensen (2006) and Inderst and Ottaviani (2009), or by incorporation of lying costs as in Kartik (2009). In our model, the seller does not face implicit or explicit future costs from being caught lying but instead faces an immediate opportunity cost of pushing one attribute rather than another.

Chakraborty and Harbaugh (2010) provide sufficient conditions for comparative cheap talk with state-independent expert (seller) preferences to be credible; we use these in this paper. The sufficient conditions from that paper for cheap talk to be persuasive cannot be applied directly to our random coefficients environment because of the interaction between the seller's private information on attribute quality and the buyers' private information on their attribute preferences. However, we establish alternative conditions for persuasiveness that can be applied in this environment, thereby extending the applicability of comparative cheap talk to linear random coefficient models.

3. Example

Following a standard linear discrete choice model, suppose a buyer is considering product i at price p_i with value $V_i + \varepsilon_i$, where $V_i = \beta_1\theta_{i1} + \beta_2\theta_{i2} - p_i$. The seller knows the product attribute qualities $(\theta_{i1}, \theta_{i2})$ and the buyer knows their own attribute preferences (β_1, β_2). Suppose for now $i = 1$, and the only choice is to buy the product or not. The value to not buying is $V_0 + \varepsilon_0$, where $V_0 = 0$ and the independent and identically distributed (i.i.d.) additive shocks ε_i and ε_0 are known only to the buyer.

For simplicity, suppose that it is equally likely that either the first or second attribute is the strength of the product and that it is equally likely that the buyer is a type who values the first or second attribute more. In particular, suppose that $(\theta_{11}, \theta_{12})$ is $(3, 1)$ or $(1, 3)$ with equal chance and, independently, (β_1, β_2) is $(3, 1)$ or $(1, 3)$ with equal chance. The attributes are "vertical" quality measures because each attribute is valued positively, yet there is a "horizontal" fit component because different buyer types value the attributes differently. The price is fixed at $p_1 = 10$.

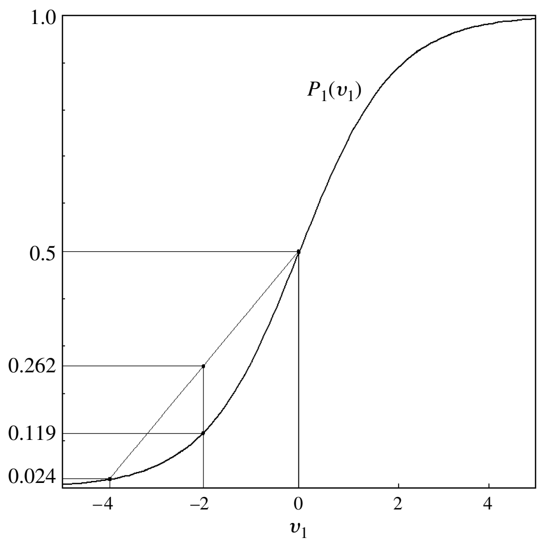
Letting v_1 be the buyer's expectation of V_1, without any communication from the seller, $E[\theta_{11}] = E[\theta_{12}] = 2$; so for the first type of buyer $v_1 = 3(2) + 1(2) - 10 = -2$, and for the second type of buyer $v_1 = 1(2) + 3(2) - 10 = -2$. If the seller indicates that attribute 1 is better, then these expected values for the two types are, respectively, $v_1 = 3(3) + 1(1) - 10 = 0$ and $v_1 = 1(3) + 3(1) - 10 = -4$, and if the seller indicates that attribute 2 is better, they are, respectively, $v_1 = 3(1) + 1(3) - 10 = -4$ and $v_1 = 3(3) + 1(1) - 10 = 0$. Notice that from the seller's perspective it has the same effect to indicate that either attribute is better. Hence, even without reputational or other factors that are likely to give an extra incentive for honesty, the seller has no incentive to lie and claim that the worse attribute is really the product's strength, so puffing up one attribute at the expense of the other is credible.

Now consider when puffery is persuasive in that it raises the likelihood of making a sale. Because V_1 is linear in the seller's information, it might seem that good news on one attribute will raise the purchase probability just as much as bad news on another attribute will lower it, so that there is no impact from pushing an attribute as the strength of the product. However, this ignores the nonlinearities induced by the distributions of ε_1 and ε_0. Assuming that they follow Gumbel distributions as in the logit model, the purchase probability is $P_1 = \Pr[v_1 + \varepsilon_1 > \varepsilon_0] = e^{v_1}/(1 + e^{v_1})$, which has the familiar S shape in Figure 1. In particular, for this case of two choices $(\partial^2/\partial v_1^2)P_1(v_1) = (1 - 2P_1)(1 - P_1)P_1$, so P_1 is convex for $P_1 \le 1/2$ and concave for $P_1 \ge 1/2$.

Communication of which attribute is the product's strength increases the variation in buyer valuations because some buyer types like the product more and others like it less than their prior expectations. Therefore, by application of Jensen's inequality, this variation helps the seller when the purchase probability is in the lower convex region. In this example, if there is no communication, then $P_1 = e^{-2}(1 + e^{-2}) = 0.119$, which is in the convex region. With puffery of one attribute, the type of buyer who cares more about that attribute has an expected value of $v_1 = 0$ and thus buys with probability $P_1 = e^0/(1 + e^0) = 0.5$, whereas the type of buyer who cares more about the other attribute has an expected value of $v_1 = -4$ and thus buys with probability $P_1 = e^{-4}/(1 + e^{-4}) = 0.024$. Therefore, the expected purchase probability is

[15] We endogenize the price in §5.2. Note that endogenous prices with multiple goods are considered by Chakraborty and Harbaugh (2003), where communication is by the buyer; by Chakraborty et al. (2006), where prices are set in auctions by competing buyers after communication by the seller; and by Inderst and Ottaviani (2012), where prices are set by competing manufacturers and communication is by a salesperson.

Figure 1 Effect of Puffery on Purchase Probability



$(0.5+0.024)/2=0.262$, which is over twice the probability without communication.

Since P_1 is concave for higher ranges of v_1, communication that increases variation in v_1 hurts rather than helps the seller. In this case, the consumer is already likely to buy a product, so the seller is better off remaining silent rather than risk losing the sale. For instance, if consumers have stronger preferences for the product attributes (the ranges of β_1 and β_2 are higher) or if the attributes are more likely to be of high quality (the ranges of θ_1 and θ_2 are higher), then this is the case. If the cost of production is low so that the price p_1 is low, then this is also the case.[16]

Because the probability of making a sale can also be interpreted as the share of potential buyers who buy the product, the convex–concave shape of the logit model captures the intuition that when market share is low there is a large pool of potential buyers who are not currently buying and might be enticed by good news about one of the attributes, while there are not many current buyers who are buying and might be pushed away by bad news about the other attribute. In contrast, when market share is high, good news about an attribute pulls in fewer buyers than bad news about the other attribute pushes away. So the seller benefits from puffery when market share is low, but the seller is hurt when market share is high.

This example imposes the simplifying assumptions that the coefficients and attributes have symmetric two-point distributions, that each buyer type values each attribute positively, that there is only one product the buyer is considering, that the price is fixed, and that the noise parameters are consistent with the logit model. In our following analysis, these assumptions are relaxed. Some attributes might be more important than others, buyers might already expect one attribute to be stronger than the other, the two attribute qualities might be positively correlated or have any other dependent distribution, some buyer types might place negative weight on some attributes, there might be multiple goods under consideration, the seller might choose to adjust the price in light of communication possibilities, and the noise parameters may follow any log-concave distribution. Nevertheless, the same result holds—puffery is credible and persuasive as long as there are at least two attributes: the buyer's preferences β are not perfectly known by the seller and the probability of making a sale is low.

[16] In this example, setting $p=10$ is optimal with puffery for a marginal cost of $c=8$. Note that without puffery, a lower price of approximately 9.2 is optimal. We endogenize the price in §5.2.

4. The Model

Building on the discrete choice model introduced above, suppose that buyer utility from product i sold by seller i is $V_i+\varepsilon_i$. Let $V_i=\beta\theta_i$, where $\theta_i=(\theta_{i1},\ldots,\theta_{iN})$ represents the N attributes of product $i=1,\ldots,n$ and $\beta=(\beta_1,\ldots,\beta_N)$ specifies the marginal utilities (buyer preferences) of the different attributes. The vector θ_i includes at least two uncertain quality attributes and also known attributes, including the product price p_i. The value of the no purchase option is normalized to $V_0=0$. Although our proofs are more general, for concreteness, we will focus the presentation on the case of two firms, $n=2$, and two uncertain quality attributes, $(\theta_{i1},\theta_{i2})$.

The seller of product $i=1$ knows the realized values of the uncertain quality attributes, but the buyer only knows their common knowledge distribution H. The buyer knows the realized values of the random coefficients β, but the seller only knows their common knowledge distribution G. Both H and G have full support on bounded convex sets with nonempty interiors. The realizations of the additive terms ε_i are also the private information of the buyer. Letting F represent the common knowledge distribution of the i.i.d. ε_i and f the corresponding density function, we assume that f is log-concave with support on the real line. We assume that the attribute preferences β and attribute qualities θ are independent of each other and of the ε_i's but allow for possible dependence within the components of θ and within the components of β.

Let v_i denote the buyer's expectation of V_i given all available information, so that these estimates and the idiosyncratic shocks ε_i determine the probability with which a product is purchased. We assume that the buyer purchases at most one product, so the probability that product i is purchased is then

$$P_i(v)=\Pr[v_i+\varepsilon_i>\max\{v_{-i}+\varepsilon_{-i}\}]. \qquad (1)$$

The seller of product 1 sends a costless, unverifiable message to the buyer $m \in \{m^1, \ldots, m^K\}$, where $K \geq 2$. A communication strategy for the seller specifies which message is sent as a function of the state θ. The buyer estimates the expected values of θ given the prior distribution, the seller's strategy, and the seller's message m. Representing these prior estimates by $a = E[\theta]$, let the buyer's updated estimates given message m^k be $a^k = E[\theta \mid m^k]$ for $k = 1, \ldots, K$. Since the buyer's utility for product i is linear in θ_i, these expected values are the only feature of the distribution of θ that matter to buyers. Assuming that every message is used in equilibrium,[17] a (perfect Bayesian) equilibrium of this cheap talk game is fully specified by the seller's communication strategy mapping θ to $\{m, \ldots, m^K\}$. The *expected* purchase probability for product i given the buyer's updated estimate a^k is then

$$\bar{P}_i(a^k) = \int_\beta P_i(\beta a^k)\, dG(\beta) \tag{2}$$

for $k = 1, \ldots, K$, where we have integrated over the random coefficients β since they are the private information of the buyer. The additive terms ε_i are already incorporated into the definition of P_i. We assume that prices are fixed, so the seller's profits are proportional to $\bar{P}_1(a^k)$. We endogenize the price in §5.2.

A communication strategy is a cheap talk equilibrium if the seller has no incentive to deviate by sending a message that is inconsistent with the strategy. If the seller can generate a higher purchase probability from any one message, the seller will always send that message; thus, the seller must be indifferent between every message used in equilibrium.[18] Hence, the equilibrium condition is

$$\bar{P}_1(a^k) = \bar{P}_1(a^{k'}) \tag{3}$$

for all $k, k' = 1, \ldots, K$.

We will show that there always exists a cheap talk equilibrium in this game that affects the buyer's estimates of the attribute qualities. Therefore, our main concern is when such communication raises the expected purchase probability above the no-communication case, i.e., when $\bar{P}_1(a^k) > \bar{P}_1(a)$. As seen from the logit example in Figure 1, the key to persuasiveness is the shape of $P_1(v)$. The following properties hold for all i.i.d. ε_i with log-concave density functions and support on the real line. This class includes the Gumbel distribution on which the logit model is based, the normal distribution on which the probit model is based, and most other standard distributions. Proofs of these properties and of subsequent propositions are in the appendix.

Shape Properties of P_i. *The purchase probability P_i is, for $j \neq i$,* (i) *convex* (*concave*) *in v_i if P_i is sufficiently small* (*large*), (ii) *convex* (*concave*) *in v_j if P_j is sufficiently large* (*small*), *and* (iii) *always quasiconcave in* (v_i, v_j).

In a standard linear random-effects model, we will show that revealing information on θ_i via puffery increases variation in v_i, so these shape properties determine the effect of such information on the probability of making a sale. Property (i) implies that, consistent with Figure 1, P_1 is first convex and then at some point concave in v_1.[19] We will use this result to show that the insight from the introductory example that puffery helps when the purchase probability is small extends generally. Property (ii) implies that P_1 is instead concave–convex in v_2. We will use this property to find a corresponding result that negative puffery of an attribute of a competitor's product helps when the probability of purchasing the competitor's product is large. Properties (i) and (ii) do not imply that P_1 is necessarily convex in (v_1, v_2) over some range, and instead, property (iii) rules this out. As we will see, property (iii) implies that to ensure that puffery affecting buyer estimates of the values of both the seller's product and a competitor's product helps rather than hurts the seller, it must convey to buyers which attribute is the comparative advantage of the product.[20]

4.1. Attribute Puffery

We first consider *attribute puffery* that, as in the introductory example, only affects buyer estimates of attributes of the seller's product $(\theta_{11}, \theta_{12})$. For communication to be informative, it must change the buyer's estimates of attribute quality, and different messages must change the estimates in different ways so as to create a trade-off between sending one message or another. Given a message m^k, the buyer's attribute estimates for the seller's product are $a_1^k = (a_{11}^k, a_{12}^k) = (E[\theta_{11} \mid m^k], E[\theta_{12} \mid m^k])$, whereas the attribute estimates for the other firm's product remain

[17] This assumption in cheap talk games, which precludes the need to specify out of equilibrium beliefs, is without loss of generality since any unexpected statement can be interpreted as equivalent to one of the messages.

[18] If the seller faces some reputational or other costs to lying, this can give a strict incentive to tell the truth. Our focus is on how puffery can be credible and persuasive even without such factors.

[19] As with the logit, P_i is always S-shaped for the probit. For $n = 1$, P_i is S-shaped for all log-concave ε_i, but if $n > 1$, then P_i might have more than one inflection point. Nevertheless, convexity (concavity) still holds for v_i low (high) enough.

[20] The convexity and concavity results are also relevant for other forms of communication, such as product samples, third-party reviews, and quality certificates. We focus on ranges of P_i where convexity or concavity holds, so Jensen's inequality applies directly. Kamenica and Gentzkow (2011) examine the optimal partial disclosure policy that a sender would like to precommit to when the sender's payoff includes both convex and concave regions.

at $a_2 = (a_{21}, a_{22}) = (E[\theta_{21}], E[\theta_{22}])$. Thus the equilibrium condition (3) is $\bar{P}_1(a_1^k, a_2) = \bar{P}_1(a_1^{k'}, a_2)$, or

$$\int_\beta P_1(\beta_1 a_{11}^k + \beta_2 a_{12}^k, \beta_1 a_{21} + \beta_2 a_{22})\, dG(\beta) = \int_\beta P_1(\beta_1 a_{11}^{k'} + \beta_2 a_{12}^{k'}, \beta_1 a_{21} + \beta_2 a_{22})\, dG(\beta) \quad (4)$$

for all k, k'.

If β and θ are symmetrically distributed, as was true in the introductory example, the seller clearly has no incentive to lie about which attribute is better. If instead buyers tend to care more about one of the attributes, buyers can "discount" puffery for that attribute so that the relative incentive to push the attribute is weakened to the point that lying is no longer worthwhile. For instance, suppose the support of the distribution of β_1 is above that of β_2. This gives the seller an incentive to push attribute 1 rather than attribute 2; however, if buyers are correctly suspicious of such a claim and heavily discount it, then the seller is better off pushing attribute 2. By continuity, there must be some intermediate degree of discounting that eliminates the seller's incentive to always push attribute 1 without creating an incentive instead to always push attribute 2. In particular, by Theorem 1 of Chakraborty and Harbaugh (2010), because the seller's (expert's) preferences do not depend on the state θ and are continuous in the buyer's (decision maker's) estimates a, the appropriate degree of discounting can always ensure that the seller's incentive to lie is eliminated and an informative equilibrium exists.

An informative equilibrium is influential if it changes buyer behavior. In equilibrium, attribute puffery pushes up the buyer's estimate for one attribute a_{1i} and pushes down the buyer's estimate for another attribute a_{1j}, but since the buyer's preferences β vary, the trade-off for each different type of buyer is not exact. Some buyers end up with a higher v_1 and some buyers with a lower v_1, which creates a mean preserving spread in v_1. If P_1 is convex in v_1, then Jensen's inequality implies that this raises the purchase probability for any given β. Therefore, integrating over all the β, the expected purchase probability $\bar{P}_1$ rises. Conversely, if P_1 is concave in v_1, then $\bar{P}_1$ falls.

The following proposition formalizes this argument. Because a rational buyer is always better off on average from more information, we focus on the gain to the seller in this and subsequent results.[21]

Proposition 1. *Attribute puffery by seller i always strictly raises (lowers) the expected purchase probability $\bar{P}_i$ if the purchase probability $P_i(v)$ without communication is sufficiently small (large) for all v.*

As an example, consider a random coefficients logit model for the case where the attribute qualities θ_{1j} for the seller's good are i.i.d. uniform on $[0, 1]$, so the prior without communication is $a_1 = (E[\theta_{11}], E[\theta_{12}]) = (1/2, 1/2)$. Letting message m^1 correspond to the ranking $\theta_{11} \geq \theta_{12}$ and message m^2 correspond to the opposite ranking, the updated estimates are $a_1^1 = (E[\max\{\theta_{11}, \theta_{12}\}], E[\min\{\theta_{11}, \theta_{12}\}]) = (2/3, 1/3)$ and $a_1^2 = (E[\min\{\theta_{11}, \theta_{12}\}], E[\max\{\theta_{11}, \theta_{12}\}]) = (1/3, 2/3)$. As shown in Figure 2, panel (a), these are the respective conditional means for the triangles above and below the $\theta_{11} = \theta_{12}$ line. By the law of iterated expectations, the unconditional mean a_1 lies on a line joining these conditional means as shown in the figure. We assume that the attribute qualities θ_{2j} are uniform i.i.d. on $[1/10, 11/10]$, so that the other product is known to be of higher quality on average, $a_2 = (E[\theta_{21}], E[\theta_{22}]) = (3/5, 3/5)$. The (fixed) prices are $p_1 = p_2 = 10$.

In this example, the seller has no reason to "lie" by puffing up the wrong attribute because pushing either attribute will have the same effect on the purchase probability. This is seen from the seller's indifference or isoprobability curves representing the combinations of buyer estimates of θ_{11} and θ_{12} that give the same expected purchase probability $\bar{P}_i(a_i)$. Given that the same curve passes through $a_1^1 = (a_{11}^1, a_{12}^1)$ and $a_1^2 = (a_{11}^2, a_{12}^2)$, the seller has no reason to misreport the ranking and claim $\theta_1 \geq \theta_2$ when, in fact, $\theta_1 < \theta_2$, or vice versa.

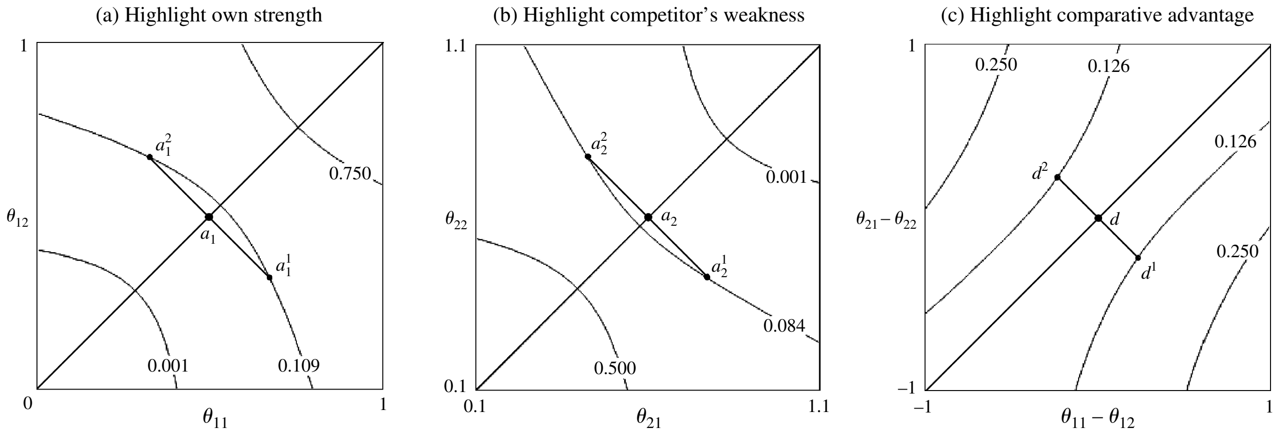
Because the other product is better on average, the purchase probability without communication is low, so P_1 is convex in $v_1 = \beta_1 a_{11} + \beta_2 a_{12}$, and hence $\bar{P}_1$ is convex in $a_1 = (a_{11}, a_{12})$. Therefore, as seen from the shape of the isoprobability curves, $\bar{P}_1$ is convex along the line connecting a_1^1 and a_1^2, implying that the probability is higher at either endpoint than in the interior, including the prior a_1. In this example, the expected purchase probability rises from the prior of $\bar{P}_1(a_1) = 5.9\%$ to $\bar{P}_1(a_1^k) = 10.9\%$.[22]

In any cheap talk game, there is also a "babbling equilibrium" that is completely uninformative in that the receiver believes that the messages are uncorrelated with the sender's information and so the sender has no incentive to make the messages correlate. Such an equilibrium leads to buyer purchase probabilities

[21] In particular, puffery of the form we examine partitions the information space so that the buyer is more informed in the sense of Blackwell (1953) and hence always benefits in expectation for a fixed price. The buyer can still lose for some realizations; e.g., if the realized values of both attributes are below the mean, then a buyer who purchases the good based on puffery of one attribute will regret the purchase.

[22] This convexity approach to proving persuasiveness differs from the quasiconvexity approach in Theorem 2 of Chakraborty and Harbaugh (2010). Quasiconvexity is not always preserved by integration, so showing quasiconvexity in $P_i(v_i)$ is not sufficient to show quasiconvexity in $\bar{P}_i(a_i)$.

Figure 2 **Attribute Puffery, Negative Puffery, and Comparative Advantage Puffery**



that are the same as the priors, so our above discussion on the gains from puffery can also be interpreted as the gains from an informative cheap talk equilibrium relative to the babbling equilibrium.[23]

We have focused discussion on the simplest case of a two-message equilibrium, but other equilibria can also exist. Our results on the persuasiveness of puffery extend to all influential cheap talk equilibria. For a low probability of making a sale, there always exist more informative equilibria, which involve additional messages that further subdivide, possibly with mixing, the two regions in Figure 2, panel (a).[24] Claims that both attributes are better on average than the prior can be credible given that the seller faces the opportunity cost of not focusing on just one attribute. In equilibrium, such a message can only be moderately favorable about both attributes, because otherwise, the seller would never send a more focused message. Hence, the classic Miller Lite slogan "tastes great, less filling" can convey that the beer is better than expected on both dimensions, but not particularly impressive on either.

4.2. Negative Puffery

We now consider *negative puffery*, where the seller of one product highlights a weak attribute of a competitor's product. For instance, a salesperson at one car dealership criticizes a car sold by another dealership, or a negative advertisement by a firm focuses on a weakness of a competing firm's product.

For our definition of negative puffery, we assume that communication by the seller of product 1 affects buyer estimates of the attributes of product 2, and also, to distinguish it from other forms of puffery, we assume that it has no effect on buyer estimates of product 1. Therefore, the equilibrium condition is $\bar{P}_1(a_1, a_2^k) = \bar{P}_1(a_1, a_2^{k'})$, or

$$\int_\beta P_1(\beta_1 a_{11} + \beta_2 a_{12}, \beta_1 a_{21}^k + \beta_2 a_{22}^k)\, dG(\beta) = \int_\beta P_1(\beta_1 a_{11} + \beta_2 a_{12}, \beta_1 a_{21}^{k'} + \beta_2 a_{22}^{k'})\, dG(\beta) \quad (5)$$

for all k, k', where (a_{11}, a_{12}) is unaffected by the messages. Following previous arguments, even if there are asymmetries in the distributions of θ or β, Theorem 1 of Chakraborty and Harbaugh (2010) implies that there is an influential cheap talk equilibrium satisfying this condition.

Negative puffery pulls some buyers away from the competing firm, but it also pushes toward them buyers who care more about the noncriticized attribute. It might seem that the net result is positive when the competitor has a large number of likely buyers to pull away, and this is indeed the case. Property (ii) shows that P_1 is concave–convex in v_2, so any communication that increases the variation in v_2 in order to pull in some buyers and push away other buyers helps the seller of good 1 when v_2 is large. This can be seen directly for the logit where $(\partial^2/\partial v_j^2)P_i(v) = P_i P_j(2P_j - 1)$, so P_i is concave in v_j for v_j sufficiently low such that $P_j \leq 1/2$ and convex in v_j for v_j sufficiently high such that $P_j \geq 1/2$.

The following proposition uses this result on the shape of P_i in v_j and Jensen's inequality to show that the seller is better or worse off from negative puffery depending on the competitor's prior probability of making a sale.

[23] All seller types benefit equally when the probability of a sale is low, and the buyer always benefits from more information given a fixed price, so a Pareto dominance argument can be made for communication relative to babbling.

[24] The existence of multimessage equilibria in our environment is implied by Theorem 3 of Chakraborty and Harbaugh (2010). For the symmetric case, there is always an equilibrium with three messages in which two of the messages indicate the strength of one attribute and the middle message indicates that both attributes are similar and better than the prior, as Crutzen et al. (2013) show in a different but related model.

Proposition 2. *Negative puffery by seller i about an attribute of product j always strictly raises (lowers) the expected purchase probability $\bar{P}_i$ if the purchase probability $P_j(v)$ of product j without communication is sufficiently large (small) for all v.*

Figure 2, panel (b) shows isoprobability curves for the expected purchase probability of product 1 when the seller of product 1 provides information on the competing product 2. As described earlier, each θ_{2j} is uniform i.i.d. on $[0.1, 1.1]$ so that the expected values without communication are $a_2 = (3/5, 3/5)$. Letting message 1 indicate $\theta_{21} \geq \theta_{22}$ and message 2 indicate $\theta_{21} < \theta_{22}$, the expected values with negative puffery are $a_1^1 = (E[\theta_{21} \mid m^1], E[\theta_{22} \mid m^1]) = (1/10 + 2/3, 1/10 + 1/3) = (23/30, 13/30)$ and $a_2^2 = (E[\theta_{21} \mid m^2], E[\theta_{22} \mid m^2]) = (13/30, 23/30)$. Because the other product is better on average, the purchase probability for that good is high, so P_1 is convex in $v_2 = \beta_1 a_{21} + \beta_2 a_{22}$, and hence $\bar{P}_1$ is convex in $a_2 = (a_{21}, a_{22})$. Therefore, analogous to the attribute puffery case, $\bar{P}_1$ is convex along the line connecting a_2^1 and a_2^2. The firm's expected purchase probability is increasing toward the lower left; thus, as seen in the figure, negative puffery helps the firm.

Because some of the buyers who are pushed away from the competitor end up buying neither product, it might seem that negative puffery is less effective at gaining customers than directly pushing an attribute of one's own product, as described in the previous section. In this example, negative puffery raises the expected purchase probability from 5.9% to 8.4% rather than 10.9%, so indeed, it is less effective.

4.3. Comparative Advantage Puffery

Now suppose that the seller makes comparative statements that reveal attribute information about its product and a competing product so that there are four variables on which the seller provides information. We focus on a two-message equilibrium that increases product differentiation by simultaneously indicating that one product is relatively better on one attribute and the other product is relatively better on another attribute. Such communication can thus be seen as focusing on the horizontal component of product information.

We define *comparative advantage puffery* as having two features that distinguish it from other forms of puffery. First, it affects both attributes of each product (and none others more generally), so the equilibrium condition is $\bar{P}_1(a_1^1, a_2^1) = \bar{P}_1(a_1^2, a_2^2)$, or

$$\int_\beta P_1(\beta_1 a_{11}^1 + \beta_2 a_{12}^1, \beta_1 a_{21}^1 + \beta_2 a_{22}^1)\, dG(\beta)$$
$$= \int_\beta P_1(\beta_1 a_{11}^2 + \beta_2 a_{12}^2, \beta_1 a_{21}^2 + \beta_2 a_{22}^2)\, dG(\beta). \quad (6)$$

Second, each product's expected quality averaged over the uncertain β's is the same for each message,

$$E[\beta_1 a_{i1}^1 + \beta_2 a_{i2}^1] = E[\beta_1 a_{i1}^2 + \beta_2 a_{i2}^2] \quad (7)$$

for $i = 1, 2$. This captures the idea of comparative advantage puffery as affecting only the distribution of attributes but not overall quality. The constraints (7) can be seen as reducing the four dimensions of information to just two dimensions, so that our previous existence results still apply. More formally, because the number of dimensions exceeds the number of equality constraints, by Proposition 5 of Chakraborty and Harbaugh (2010, in their online appendix), we are assured of an influential equilibrium.

From shape property (iii), we know that P_1 is (strictly) quasiconcave in (v_1, v_2) and, by linearity of v_i, therefore, quasiconcave in (a_1, a_2) for given β. This implies that P_1 cannot be strictly convex in (a_1, a_2). However, the lack of convexity of P_1 in the four-dimensional (a_1, a_2) space does not preclude convexity in lower subdimensions. Constraint (7) restricts variation to a two-dimensional subspace, and the equilibrium condition further restricts the space to a single dimension. For P_1 small enough, we find that P_1 is strictly convex along this one-dimensional line of variation.[25]

To see this result, consider Figure 2, panel (c), which shows the same situation as in panels (a) and (b) except that the seller of product 1 makes statements that buyers interpret as about the comparative advantage of product 1. As shown in the figure, message 1 indicates that product 1 is relatively better at attribute 1 compared with product 2, $\theta_{11} - \theta_{12} \geq \theta_{21} - \theta_{22}$. And message 2 indicates that product 1 is relatively better at attribute 2 compared with product 2, $\theta_{12} - \theta_{11} > \theta_{22} - \theta_{21}$ (or, equivalently, that product 2 is relatively better at attribute 1). The expected values for the differences are $d = (a_{11} - a_{12}, a_{21} - a_{22}) = (0, 0)$ without communication and $d^k = (a_{11}^k - a_{12}^k, a_{21}^k - a_{22}^k)$ for messages $k = 1, 2$. The expected purchase probability of product 1 increases toward the upper left and lower right as the estimates move away from the prior $(0, 0)$, and the two isoprobability curves through the updated estimates represent the same expected purchase probability. Even though $\bar{P}_1$ is not convex in (a_1, a_2) nor in the differences $(a_{11} - a_{12}, a_{21} - a_{22})$, it is convex along the line joining d^1 and d^2, which includes the prior $d = (0, 0)$, so the expected purchase probability of product 1 rises. In this example, it more than doubles from 5.9% without communication to 12.6% with comparative advantage puffery.

[25] This argument provides a weaker sufficient condition for persuasiveness than that required in Theorem 2 of Chakraborty and Harbaugh (2010).

The following proposition uses the approach in Figure 2, panel (c) to show how puffery that provides information on the comparative advantage of a product increases the expected purchase probability.

Proposition 3. *Puffery of an attribute that is the comparative advantage of product i relative to that of product j always strictly raises (lowers) the expected purchase probability $\bar{P}_i$ if the purchase probability $P_i(v)$ without communication is sufficiently small (large) for all v.*

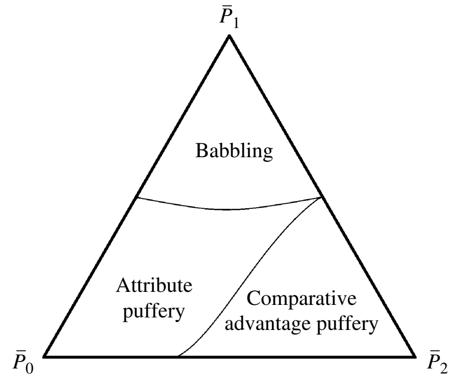
This result can help inform the policy debate over when comparative advertising should be encouraged. The FTC has explicitly encouraged comparative advertising about "objectively measurable attributes or price" (Federal Trade Commission 1979). Our results imply that comparative advertising about subjective attributes can highlight the comparative advantage of a product and thereby direct consumers to products that have relative strengths in areas that they value.

Before comparing in more detail these three different forms of puffery that focus on product attributes, suppose that the seller of a single good makes statements that push the overall quality of its product or denigrate the overall quality of a competitor's product. Because the firm's incentive is to always push its own product, it might seem that there is no possibility to credibly reveal information through such puffery. In fact, in equilibrium, communication is possible, but it involves a trade-off in which a positive statement about the seller's own product is also treated as good news about the competitor's product, whereas a negative statement about the competitor's product is treated as bad news for both products.[26]

Although credible, such communication can lower the purchase probability for the firm making the comparison. From Theorem 2 of Chakraborty and Harbaugh (2010), the seller is worse off from cheap talk if $\bar{P}_1(a)$ is quasiconcave in (a_1, a_2), whereas from shape property (iii), $P_1(v)$ is quasiconcave in (v_1, v_2) for all values where v_i is linear in a_i. This implies that, as uncertainty about the buyer's preferences β becomes smaller and $P_1(v)$ converges to $\bar{P}_1(a)$, puffery that affects the estimated overall quality of both the seller's good and the competitor's good makes the seller worse off. An implication of this result is that our restriction above in which comparative advantage puffery leaves overall expected quality unchanged is necessary to ensure that such puffery benefits the seller.

[26] This is consistent with the finding that negative advertising hurts buyer impressions of the firm doing the advertising (e.g., Jain and Posovac 2004). Puffery of this form is analyzed more formally in an earlier version of this paper.

Figure 3 **Most Persuasive Form of Puffery**



4.4. Puffery Forms Compared

When are the different forms of puffery most persuasive? Propositions 1–3 show that puffery is better than no communication (or the babbling equilibrium) when the purchase probability is low, but these analytic results do not rank the gains from the different forms of puffery. From the numerical results for the example in Figure 2, comparative advantage puffery was most persuasive, but this result was only for particular parameter values. We now consider this problem further. In our cheap talk environment, the same messages can be interpreted in different ways by the buyer, so formally, the question is when different equilibria (and hence different equilibrium interpretations of the messages) are most persuasive.[27]

The probability simplex in Figure 3 shows the most persuasive equilibrium based on prior expected purchase probabilities for the seller and competitor, $\bar{P}_1$ and $\bar{P}_2$, and the probability of no sale, $\bar{P}_0$. The calculations use the same example in Figure 2 except that we allow θ_{i1} and θ_{i2} to have more general support on $[b_i, 1+b_i]$ for $i = 1, 2$. The b_i shift parameters allow the quality ranges for each product to vary and, given that prices and preferences are fixed, fully determine the prior expected probabilities. To allow for direct comparisons of the different forms of puffery, we continue our focus on two-message equilibria that are symmetric in that they divide the relevant state spaces equally through the prior.

Comparative advantage puffery does best in the bottom right region where $\bar{P}_2$ is high and $\bar{P}_1$ is low. Since P_1 is convex in v_1 when P_1 is low and it is convex in v_2 when P_2 is high, revealing information that increases variation in both v_1 and v_2 helps the seller, which is the feature of comparative advantage puffery. This is the case in the example

[27] In practice, the literal content of the message, e.g., whether it refers to a competitor explicitly, is likely to help buyers infer the intended meaning. Note that, in any given equilibrium, all seller types receive the same payoff, so if one type of seller prefers one equilibrium, all seller types prefer it.

of Figure 2 where we assume that the competitor is better, $\theta_{1j} \backsim U[0, 1]$, $\theta_{2j} \backsim U[0.1, 1.1]$, implying prior expected probabilities of $\bar{P}_1 = 5.9\%$, $\bar{P}_2 = 59.6\%$, and $\bar{P}_0 = 34.5\%$. As indicated, the expected purchase probability $\bar{P}_1$ rises to 10.9% with attribute puffery, to 8.4% with negative puffery, and up to 12.6% with comparative advantage puffery.

Attribute puffery does best in the bottom left region where $\bar{P}_0$ is high, so both $\bar{P}_1$ and $\bar{P}_2$ are low, in which case P_1 is convex in v_1 and concave in v_2. With attribute puffery, the seller benefits from increased variation in v_1, but unlike comparative advantage puffery, it avoids a loss from increased variation in v_2. Changing the example from Figure 2 so that the seller and competitor are symmetric, $\theta_{1j} \backsim U[0, 1]$, $\theta_{2j} \backsim U[0, 1]$, implies prior probabilities of $\bar{P}_1 = \bar{P}_2 = 28.0\%$ and $\bar{P}_0 = 44.0\%$. In this case, $\bar{P}_1$ rises to 30.9% with attribute puffery, falls to 27.0% with negative puffery, and rises to 30.0% with comparative advantage puffery.[28]

Finally, no communication (babbling) does best when $\bar{P}_1$ is high and the seller does not want to risk scaring away likely buyers. Changing the example from Figure 2 so that the seller is better than the competitor, $\theta_{1j} \backsim U[0.1, 1.1]$, $\theta_{2j} \backsim U[0, 1]$, the prior probabilities are $\bar{P}_1 = 59.6\%$, $\bar{P}_2 = 5.9\%$, and $\bar{P}_0 = 34.5\%$. In this case, $\bar{P}_1$ falls to 57.0% with attribute puffery, to 54.7% with negative puffery, and to 55.7% with comparative advantage puffery.

We find that negative puffery is never the best strategy. Negative puffery affects v_2, so it is most effective when $\bar{P}_2$ is high, but high $\bar{P}_2$ implies low $\bar{P}_1$, which means the seller is not realizing the gains from revealing information about its own product. Hence, in the one case where negative puffery is desirable, comparative advantage puffery that increases variation in both v_1 and v_2 does even better.

For concreteness, we have focused on shifts in the distributions of attribute quality, but the same effects can be found by varying other parameters. If the competitor has lower costs and can set a lower price, then it will have a higher expected purchase probability, which makes comparative advantage puffery more attractive. If there are other common knowledge attributes that make the competitor more popular, the competitor will have a higher probability of making a sale, so again comparative advantage puffery is more attractive. The degree of product differentiation can also affect the persuasiveness of different puffery forms. If the seller and competitor are relatively similar in all aspects, then both cannot have high purchase probabilities, so attribute puffery may be more attractive. This effect is strengthened if there are many competing products that are all ex ante similar, in which case the purchase probabilities for the seller and for any given competitor will both be low, thereby favoring attribute puffery that focuses on the seller's own product.

Because the model follows the random coefficients discrete choice framework used throughout marketing and economics, standard numeric methods can be used to check the effects of puffery in any given situation. The model can also be readily extended in a number of directions, some of which we pursue in the following section.

5. Extensions and Applications

5.1. Buyer Privacy and Pandering

We have assumed that the seller (expert) does not know the buyer's (decision maker's) exact attribute preferences β. Therefore, the trade-off from pushing one attribute at the expense of another is not exact for each buyer—some buyers end up with a higher v_1 and some buyers with a lower v_1, which increases variation in v_1 and allows puffery to be persuasive. If the β coefficients are known, then the seller has an incentive to pretend that whatever attribute the buyer cares more about is the product's strength. Anticipating such pandering, the buyer discounts such claims so that the seller receives a correspondingly smaller gain from pushing that attribute. In equilibrium, the trade-off must be exact so that v_1 is the same for each message, because otherwise, the seller would always choose whatever message induced the higher v_1; however, even though the buyer gains some information on the attributes, the buyer's decision is completely unaffected.

The following proposition formalizes this argument for our linear random coefficients model and extends it to negative puffery and comparative advantage puffery.

Proposition 4. *Attribute puffery, negative puffery, and comparative advantage puffery influence buyer behavior if and only if the buyer's preferences β are the buyer's private information.*

Because influential communication that benefits both the buyer and the seller is only possible if a buyer can conceal her relative preferences for different attributes from the seller, this result offers insight into why buyers (and other decision makers) might value privacy about their product attribute preferences.[29] It is particularly relevant for online advertising due to the increasing ability to customize and target advertisements based on consumer preferences. If a seller

[28] By symmetry, $\bar{P}_2$ also rises to 30.0% with comparative advantage puffery, so both firms benefit.

[29] A buyer may also want to conceal the overall strength of her preferences because the seller prefers not to communicate attribute information to a buyer who is already likely to purchase the product.

learns which buyers care more about which product attributes and can micro-target buyers accordingly with different advertisements that emphasize different strengths of the product, then the credibility of advertisements is undermined to the detriment of both buyer and seller.[30]

We have analyzed the linear random coefficients model that is widely used in marketing and economics. If buyer valuations are nonlinear in the attributes, then puffery can still affect the purchase probability even if buyer attribute preferences are common knowledge. If v_1 is strictly convex (concave) in (a_1, a_2) over the relevant range, then since P_1 is monotonic in v_1, P_1 is strictly quasiconvex (quasiconcave) in (a_1, a_2); thus puffery affecting (a_1, a_2) always helps (hurts) the seller.[31] For instance, if the two attributes are not substitutes as implied by the linear model but are perfect complements, then P_1 is an increasing function of the concave function $\min\{a_1, a_2\}$. In this case, the seller prefers that the buyer has average estimates of each attribute, so communicating which attribute is better hurts the seller. In addition, if the two attributes are not bundled but are really two separate choices, e.g., different products of the same firm, the buyer will choose the one with the maximum expected value, so P_1 is an increasing function of the convex function $\max\{a_1, a_2\}$. In this case, the seller always gains from communication that effectively recommends which product is better, as seen in an example in §5.3 below.

As seen from this case of multiple goods sold by the same seller, the argument that targeting by an individual advertiser undermines communication does not apply to an advertising platform such as Google Ads, which benefits from generating consumer interest in multiple different products. The platform's choice to display an ad for a particular product can be seen as an implicit recommendation that, based on the platform's information on both the product and the consumer's preferences, the product is likely to be a good match.[32] This recommendation then increases the probability that the buyer clicks on an ad. Goldfarb and Tucker (2011) find that online advertisements are more effective when they can be targeted using consumer information, which is consistent with the platform using its information to effectively recommend products.

5.2. Endogenous Prices

We have shown that pure cheap talk can influence buyer behavior even when the seller's price is fixed. The assumption of fixed prices fits many cases of direct salesperson communication to a buyer, it allows the results to be compared with experimental research in marketing that uses fixed prices, and it also allows the model to be applied to other persuasion environments without explicit prices, such as managerial communication within a firm or political communication. However, the assumption is less appropriate for other situations such as large advertising campaigns where the firm might adjust prices based on the campaign's effect on demand.

Incorporation of price changes is straightforward for the monopoly case. We assume that the seller first communicates via puffery and then adjusts the price based on the equilibrium distribution of buyer valuations induced by the message. For the simplest case of symmetric distributions of attribute qualities and preferences, in a two-message equilibrium the distribution of demand is exactly the same from either message so the prices will be the same as well. With more messages, or asymmetries, the prices will differ. However, the model is essentially the same with the difference that the seller's payoffs need to incorporate the gains from adjusting the price.[33]

Proposition 5. *If the seller first communicates via puffery and then sets the price p_1, attribute puffery, negative puffery, and comparative advantage puffery all increase seller profits if the purchase probability $P_1(v)$ is sufficiently small for all v.*

The additional gain to the seller from adjusting the price implies that, contrary to the fixed price case, the seller might still benefit from puffery when the purchase probability is high. As is known from verifiable information games, information that changes the demand curve so as to lower quantity demanded at the current price can still increase profits if the smaller group of buyers is willing to pay a sufficiently higher price (Lewis and Sappington 1994, Johnson and Myatt 2006).

If we consider strategic price responses by multiple firms, the same approach can be applied in which cheap talk is preplay communication before the pricing game. As long as there is a unique equilibrium of the pricing game, which changes continuously with

[30] If the buyer does not know whether the seller knows her preferences, then the adjustment for pandering will be incomplete, so the seller can still benefit, and if information is verifiable, then targeting can still be persuasive even if buyers anticipate seller pandering as shown by Hoffman et al. (2013).

[31] This follows from direct application of Theorem 2 of Chakraborty and Harbaugh (2010). See that paper for examples of quasiconcave and quasiconvex expert preferences.

[32] The different sellers of advertised products are likely to also have private information that affects their bidding for ad positions (Athey and Ellison 2011, Chen and He 2011).

[33] We assume that buyers do not interpret unexpected deviations from the equilibrium price as information about product attributes. If unit costs increase with attribute quality, then there is the complication that higher prices can be a signal of quality as in the price signaling literature, e.g., Milgrom and Roberts (1986).

the buyer attribute estimates, then the firm that is communicating will still have a payoff function that is continuous in the estimates, so the same results on the credibility of cheap talk can be applied. The main difference is that price changes by the other firm can affect the gains or losses from puffery. If the distributions of attributes and coefficients are symmetric, then puffery provides information that effectively implies greater product differentiation, so we would expect puffery to lead to higher prices that increase the gains to the firm but decrease the gains to consumers. However, in asymmetric environments, this may not be the case. For instance, if comparative advantage puffery leads the larger firm to lower its price, any gains to the smaller firm from such puffery might be counteracted by having to lower its price in response.[34] Hence the effect of puffery on price setting by multiple firms is an open question.

In addition to adjusting their prices, other strategic responses are likely to require further analysis. First, other firms might also engage in puffery. If firms only have information about their own products, the same tools we use in this paper can be applied. If they share the same information, the game becomes one of multisender cheap talk and a different approach is required.[35] Second, the ability to communicate attribute information should change the incentives of firms to invest in product attributes and, particularly, might induce them to focus their investments on different strengths. Johnson and Myatt (2006) consider such product design issues when product information can be revealed to buyers, whereas Kalra and Li (2008) show how firms can signal quality through specialization. Finally, we also expect that the equilibrium number of firms in the market will adjust along with changes in firm profitability.

5.3. Puffery vs. Disclosure

We have analyzed persuasion via puffery about "soft information," whereas most of the literature on seller communication has emphasized persuasion via disclosure of verifiable "hard information." When there is no way to verify information, puffery is the only method by which communication can occur. It might seem that the seller is always better off when there is hard evidence available on a product's quality, but this is not the case. With hard information, standard "unraveling" arguments imply that a seller will be compelled in equilibrium to reveal all information, even if it is quite unfavorable (e.g., Milgrom 1981).[36] Therefore, even if a seller benefits on average from revealing information, some seller types will win while others lose. In contrast, when puffery benefits the seller, it benefits all types of sellers regardless of whether their private information is favorable, so some sellers who would be hurt by disclosure of hard information are helped by puffery about soft information. For instance, in the example of Figure 2, panel (a), types below the isoprobability curve through $a_1 = (1/2, 1/2)$, which includes all types $(\theta_{11}, \theta_{12}) < (1/2, 1/2)$, are hurt by full disclosure while every type benefits from puffery. Note that buyers benefit on average from puffery but sometimes lose and always benefit more from full disclosure.

Perhaps more surprising, the coarse partition of the seller's information revealed by puffery is sometimes preferable on average for the firm both to have no information disclosure and to have full information disclosure. As an example, consider a version of the model where a single firm sells two products; e.g., a restaurant has two dishes of which the customer can choose only one. The utility from dish j of the firm $(i = 1)$ is $\beta_j\theta_{1j} - p_{1j} + \varepsilon_{1j}$, where $\beta_j = 10$ and $p_{1j} = 5$. Assuming that $\varepsilon_{11} = \varepsilon_{12}$ so that the error terms are perfectly correlated and that they follow the Gumbel distribution, the model is a nested logit, and the purchase probability is $\bar{P}_1(a_{11}, a_{12}) = e^{10\max\{a_{11}, a_{12}\}-5}/(1 + e^{10\max\{a_{11}, a_{12}\}-5})$. Notice that we are assuming fixed coefficients so $\bar{P}_1 \equiv P_1$. Since the max function is convex, this is no longer a linear model, and there is an incentive from this convexity to disclose information even without random coefficients. In particular, because increasing functions of convex functions are quasiconvex, $\bar{P}_1$ is quasiconvex in (a_{11}, a_{12}) even in the region where $\bar{P}_1$ is concave in v_1, so cheap talk always benefits the seller.

Assuming θ_{11} and θ_{12} are i.i.d. uniform on $[0, 1]$ as before, without any communication, $a_{11} = a_{12} = 1/2$, so the customer randomly picks a dish, and the purchase probability is $\bar{P}_1(1/2, 1/2) = e^0/(1 + e^0) = 1/2$. If the restaurant pushes its best dish, which it can do credibly by the same arguments as before, then $\max\{a_{11,} a_{12}\} = 2/3$, and the purchase probability is $\bar{P}_1(2/3, 1/3) = \bar{P}_1(1/3, 2/3) = e^{5/3}/(1 + e^{5/3}) = 0.841$ for all θ. With full disclosure of the qualities of each dish, the ex ante expected probability of making a sale is $\int_0^1\int_0^1 e^{10\max\{\theta_{11}, \theta_{12}\}-5}/(1+e^{10\max\{\theta_{11}, \theta_{12}\}-5})\, d\theta_{11} d\theta_{12} = 0.719$, so the seller is worse off in expectation from full disclosure (when it is possible) than from partial disclosure via puffery. Because puffery of the better dish

[34] Anderson and Renault (2009) find that such a pattern can arise in their model of comparative advertising with verifiable information, but the smaller firm still benefits overall.

[35] Such cheap talk has been analyzed with state-dependent preferences (Battaglini 2002) but not in our environment of state-independent preferences. A complication in some contexts such as online reviews is that buyers might be unsure which sender is the source of a message (Mayzlin 2006).

[36] Milgrom (1981) considers one-dimensional quality. Koessler and Renault (2012) analyze conditions under which firms fully reveal product match information.

has already raised the purchase probability up into the region where P_1 is concave in a_{11} and a_{12}, further disclosure of information would hurt, on average.

This example and the quasiconvexity result prove the following proposition.

Proposition 6. *Suppose, contrary to the linear model, that $\bar{P}_1$ is strictly quasiconvex in (a_{11}, a_{12}) for all $\bar{P}_1$. Then partial disclosure via puffery is always persuasive even when $\bar{P}_1$ is concave in v_1 and can be more persuasive than full disclosure.*

This result is related to the literature on optimal disclosure policies. Kamenica and Gentzkow (2011) show that partial disclosure can sometimes outperform full disclosure on average when the sender can precommit to the disclosure policy before obtaining any information. In our multidimensional environment, partial disclosure can also do better than full disclosure. Moreover, communication via cheap talk does not require precommitment to partial disclosure—to the contrary, it is always credible to reveal some information but not generally credible to reveal all information.

5.4. Additional Attributes

We have focused on the case where the seller only has private information on two attributes of its product and possibly the corresponding attributes of a competitor's product. The model still applies when there are more product attributes about which the seller has private information. In the symmetric case where the distributions of the coefficients on each attribute are identical, similar results as from Chakraborty and Harbaugh (2007) can be applied to show that a complete ranking of the different attribute values is credible. For instance, a buyer might infer the ranking from the relative amount of emphasis that the seller gives to multiple different attributes. As the number of attributes increases, such a rank revealing equilibrium reveals more and more information and in the limit is equivalent to full disclosure.

If the distributions are too asymmetric to apply the above result, the case of more than two attributes can be analyzed in essentially the same way as the two-attribute case. It is still possible to puff up one of the attributes at the expense of any of the other attributes, and in addition, one can consider any combination of attributes as itself an attribute known to the seller. So it becomes possible to highlight one attribute or one group of attributes as better than the average of the other attributes. Analysis of negative puffery and comparative advantage puffery can be similarly extended.

5.5. Message Space Constraints

We find that for unverifiable information, it is often only credible and persuasive to push one attribute. Separate from this credibility constraint, there might also be constraints on the message space. For instance, there might be a "bandwidth" constraint that limits the seller's ability to provide information—there might be sufficient time to discuss only one attribute with a customer or sufficient space to highlight only one attribute in an advertisement. In a verifiable message game, such constraints can have a large effect on equilibrium communication (Mayzlin and Shin 2011, Hoffman et al. 2013).

In a simple two-message equilibrium, the bandwidth constraint can be seen as forcing the seller to focus on only one attribute, but the constraint is not binding because in equilibrium the seller does that anyway. In practice, the constraint might facilitate communication by highlighting the trade-off that the seller faces between pushing one attribute or another. A bandwidth constraint might also facilitate communication when there is a multimessage equilibrium in which different messages push one attribute over the other to greater or lesser degrees. The amount of time or space that is devoted to one attribute over another might naturally be interpreted by buyers as indicating the relative strengths of the attributes.

Given the role that message constraints might play in highlighting the comparative nature of equilibrium communication, it might be desirable to restrict the message space in order to to explicitly emphasize comparative messages. For instance, a problem with product rating websites is fake reviews that promote a firm's product or denigrate a competitor's product (Mayzlin et al. 2014). Although these websites sometimes allow users to rate the product on different attributes, e.g., hotel cleanliness and hotel comfort, the format does not encourage comparative cheap talk. If instead of rating a product from 1 to 5 on each attribute, suppose the user were forced to rank the relative strengths and weaknesses of the product, e.g., allocate only one "5," one "4," one "3," etc. to the different attributes. Because communication would then be comparative, even "fake" reviews by the seller could credibly emphasize the product's relative strengths.

5.6. Extreme Exaggerations

Puffery sometimes takes the form of extreme exaggerations, such as Panasonic's claim that the 3DO was the "most advanced home gaming system in the universe." A standard explanation for extreme claims is that they gain attention for their shock or amusement value (e.g., Hoffman 2006). Another explanation is that they are "metamessages" that make the puffery nature of the statement more apparent to buyers and to the courts (Parmentier 1994). Our approach shows that in addition to gaining attention, extreme claims by a firm can also provide implicit comparative information on attributes of a product—Anacin's claim of "fast, fast, fast relief" does not mention whether the relief is long-lasting. Similarly, such claims may provide implicit comparative information on different products that a firm sells—the Dunkin' Donuts slogan "best coffee in America" does not mention doughnuts.

Extreme messages appear to be more common in advertising than in direct salesperson communication. Presumably, a salesperson already has the buyer's attention, so the need to grab attention with extreme claims is less. And a salesperson engaged in verbal communication has less concern for legal scrutiny, so the need to establish a puffery defense is also weaker. Our model does not analyze these factors but adds to the existing explanations in showing that, at least in some cases, extreme claims can also provide comparative information.

6. Conclusion

Previous research has assumed that puffery cannot be credible and has argued that puffery either is harmful because it misleads credulous buyers or is harmless because it is ignored by skeptical buyers. We suppose that buyers are neither completely credulous nor completely skeptical but that they interpret puffery as providing implicit comparative information on product attributes. Puffery can then be credible and can also be persuasive in that it makes buyers more likely to purchase the product. Consistent with this perspective on how buyers interpret puffery, studies find that many buyers do not just raise their opinion of product attributes that are featured in an advertisement but also lower their opinion of attributes that are not featured. Further research is needed to determine whether such adjustments are sufficiently large and frequent that puffery informs more buyers than it misleads.

Following the definition of puffery as being about subjective soft information, we model puffery as a cheap talk game. The implications are very different from seller communication based on persuasion games with objective hard information. As shown early on in the literature on persuasion games, if sellers are not allowed to lie about objective information, then in equilibrium they should voluntarily reveal information to consumers. Therefore, restrictions on the ability to exaggerate play a central role in reducing information asymmetries about hard information. In our model with subjective information where statements cannot be verified or falsified, we show that allowing sellers some freedom to make unverifiable claims can still help reduce information asymmetries. Hence, the distinction between cheap talk and persuasion games is consistent with the legal emphasis on allowing puffery for subjective information but restricting it for objective information.

Much of the policy debate over seller puffery has focused on how exactly to draw the line between subjective statements that sellers can make without proof and objective statements that require proof. When there is confusion over whether a statement is subjective or objective, even sophisticated buyers might believe puffery without adjusting for seller incentives.[37] Further research on how consumers react to puffery, and how heterogeneity in consumer responses affects equilibrium communication, is necessary for a more complete understanding of the role of puffery in seller communication. Because we follow a standard discrete choice model that is widely used in the empirical analysis of consumer choice, our theoretical predictions can be readily tested using experimental and field data.

Acknowledgments

The authors thank the referees, the editor Preyas Desai, Shanker Krishnan, Dina Mayzlin, André de Palma, Jeremy Sandford, Jiwoong Shin, K. Sudhir, James Taylor, Matthijs Wildenbeest, and seminar and conference participants at the University of Missouri Economics Department, the Yale School of Management Marketing Department, the Indian School of Business, the 2011 International Industrial Organization Conference at Boston University, the Fourth Conference on the Economics of Advertising and Marketing at the Higher School of Economics in Moscow, and the 2012 INFORMS Marketing Science Conference.

Appendix

Proof of Shape Properties. Generalizing from the logit, the probability that product $i = 1, \ldots, n$ will be purchased is

$$P_i(v) = \Pr[v_i + \varepsilon_i > \max\{v_{-i} + \varepsilon_{-i}\}] = \int_{-\infty}^{\infty} f(x) \prod_{k \neq i} F(v_i - v_k + x)\, dx. \tag{8}$$

Then, for $i \neq j$,

$$\frac{\partial P_i}{\partial v_j} = -\int_{-\infty}^{\infty} f(v_i - v_j + x) f(x) \prod_{k \neq i, j} F(v_i - v_k + x)\, dx \equiv -h(v_i - v_j, \{v_i - v_k\}_{k \neq i, j}) < 0 \tag{9}$$

so that P_i is decreasing in v_j. Prékopa (1973) shows that if a function $g(y, x)$ is log-concave in (y, x), then $\int g(y, x)\, dx$ is log-concave in y. Applying this result to the above function, since f is log-concave and hence so is F, and since products of log-concave functions are log-concave, the product $f(v_i - v_j + x) \prod_{k \neq i, j} f(x) F(v_i - v_k + x)$ is log-concave in (v_j, x). Hence, h is log-concave in v_j and so unimodal in v_j. If the mode is infinite, then P_i is either a strictly decreasing globally concave or a strictly decreasing globally convex function of v_j—in either case a contradiction with the fact that

[37] Given the difficulty of verifying information, the opposite pattern may also arise—buyers may be so skeptical of seller claims as to treat even "objective" information as puffery and adjust accordingly.

P_i is a probability and so bounded in $[0,1]$. We conclude that h has a finite mode $\bar{v}_j$ in v_j (that possibly depends on v_{-j}) so that P_i is strictly concave in v_j for $v_j < \bar{v}_j$ and strictly convex in v_j for $v_j > \bar{v}_j$. This proves part (ii). By use of this result on the shape of P_i in v_j, we can now use this to determine the shape of P_i in v_i (or, equivalently, P_j in v_j). Since $P_j = 1 - \sum_{j \neq i} P_i$, we conclude that P_j is an increasing function of v_j, which is strictly convex in v_j for v_j sufficiently small and strictly convex in v_j for v_j sufficiently large. This proves part (i).

For part (iii), note that each term $f(x)\prod_{k\neq i} F(v_i - v_k + x)$ in (8) is log-concave in (v, x). Therefore, by the same result of Prékopa (1973) used above, the probability $P_i(v)$ is log-concave in v and hence quasiconcave. □

Proof of Proposition 1. Suppose that for all possible v_1 the purchase probability is sufficiently low that $P_1(v)$ is convex in v_1 as established in shape property (i). In equilibrium, from (4), the expected purchase probability $\bar{P}_1(a_1^k, a_2)$ is the same for any message m^k. Consequently, the payoff from attribute puffery is

$$\begin{aligned}
&\bar{P}_1(a_1^k, a_2)\\
&= \int_\beta P_1(\beta_1 a_{11}^k + \beta_2 a_{12}^k, \beta_1 a_{21} + \beta_2 a_{22})\, dG(\beta)\\
&= \sum_{k=1}^K \Pr[m^k] \int_\beta P_1(\beta_1 a_{11}^k + \beta_2 a_{12}^k, \beta_1 a_{21} + \beta_2 a_{22})\, dG(\beta)\\
&= \int_\beta \sum_{k=1}^K \Pr[m^k] P_1(\beta_1 a_{11}^k + \beta_2 a_{12}^k, \beta_1 a_{21} + \beta_2 a_{22})\, dG(\beta)\\
&> \int_\beta P_1\left(\sum_{k=1}^K \Pr[m^k](\beta_1 a_{11}^k + \beta_2 a_{12}^k), \beta_1 a_{21} + \beta_2 a_{22}\right) dG(\beta)\\
&= \int_\beta P_1(\beta_1 a_{11} + \beta_2 a_{12}, \beta_1 a_{21} + \beta_2 a_{22})\, dG(\beta) = \bar{P}_1(a_1, a_2),
\end{aligned} \tag{10}$$

where $\bar{P}_1(a)$ is the expected purchase probability without communication. For the inequality, we use the strict convexity of P_1, Jensen's inequality, and the full dimensionality assumption for the random coefficients β. Even though the expected purchase probability is equal across messages, as required in equilibrium, the full dimensionality assumption guarantees that the arguments βa_1^k are not identical (except for a zero measure of β) whenever the estimates a_1^k are different across messages. The opposite inequality obtains, if all possible v lie in the region where the purchase probability is sufficiently high, that P_1 is strictly concave. □

Proof of Proposition 2. From shape property (ii), P_1 is a decreasing function of v_2 that is strictly concave for v_2 sufficiently low and strictly convex otherwise. The result then follows from arguments analogous to the proof of Proposition 1. □

Proof of Proposition 3. Recall that we restrict the equilibrium to satisfy $E[\beta_1 a_{i1}^1 + \beta_2 a_{i2}^1] = E[\beta_1 a_{i1}^2 + \beta_2 a_{i2}^2]$ or $E[\beta_1](a_{i1}^1 - a_{i1}^2) = E[\beta_2](a_{i2}^2 - a_{i2}^1) = z$ (> 0, w.l.o.g.). Since $\Pr[m^1]a_{ij}^1 + \Pr[m^2]a_{ij}^2 = a_{ij}$ by the law of iterated expectations, we may write

$$\begin{aligned}
v_i^1(\beta) &\equiv \beta_1 a_{i1}^1 + \beta_2 a_{i2}^1 - p_i\\
&= \beta a_i + \beta_1(a_{i1}^1 - a_{i1}) + \beta_2(a_{i2}^1 - a_{i2}) - p_i\\
&= \beta a_i + \left[\frac{\beta_1}{E[\beta_1]} - \frac{\beta_2}{E[\beta_2)}\right](1 - \Pr[m^1])z - p_i,
\end{aligned} \tag{11}$$

and similarly,

$$v_i^2(\beta) \equiv \beta a_i - \left[\frac{\beta_1}{E[\beta_1]} - \frac{\beta_2}{E[\beta_2]}\right](1 - \Pr[m^2])z - p_i. \tag{12}$$

For any given β and real number t, and each $i = 1, 2$, define $v_i(t, \beta) = \beta a_i + (\beta_1/(E[\beta_1]) - \beta_2/(E[\beta_2])) t - p_i$. Notice that at $t = -(1 - \Pr[m^2])z$, $v_i(t, \beta) = v_i^2(\beta)$, while at $t = (1 - \Pr[m^1])z$, $v_i(t, \beta) = v_i^1(\beta)$. Consider now the purchase probability of product 1 given β as a function of t:

$$\begin{aligned}
P_1(t, \beta) &= \int f(x) F(v_1(t, \beta) + x) F(v_1(t, \beta) - v_2(t, \beta) + x)\, dx\\
&= \int f(x) F\left(\beta a_i - \left[\frac{\beta_1}{E[\beta_1]} - \frac{\beta_2}{E[\beta_2]}\right] t - p_1 + x\right)\\
&\quad \cdot F(\beta(a_1 - a_2) - (p_1 - p_2) + x)\, dx.
\end{aligned} \tag{13}$$

So

$$\begin{aligned}
\frac{\partial P_1(t, \beta)}{\partial t} &= -\left[\frac{\beta_1}{E[\beta_1]} - \frac{\beta_2}{E[\beta_2]}\right] h\left(\beta a_1 - \left[\frac{\beta_1}{E[\beta_1]} - \frac{\beta_2}{E[\beta_2]}\right] t\right.\\
&\qquad \left. - p_1, \beta(a_1 - a_2) - (p_1 - p_2)\right),
\end{aligned} \tag{14}$$

where the function h has been defined and its properties described in the shape properties proof. By use of these properties, we conclude that P_1 is strictly convex in t for a sufficiently low purchase probability in which case, using arguments identical to those in the proof of Proposition 1, we conclude that the equilibrium purchase probability is greater than that with no communication. Similar arguments complete the proof for when P_1 is strictly concave in t. □

Proof of Proposition 4. Propositions 1–3 have already shown sufficiency. For necessity, suppose instead the β's are common knowledge. For attribute puffery, the equilibrium condition (4) simplifies to

$$\begin{aligned}
&P_1(\beta_1 a_{11}^k + \beta_2 a_{12}^k, \beta_1 a_{21} + \beta_2 a_{22})\\
&\qquad = P_1(\beta_1 a_{11}^{k'} + \beta_2 a_{12}^{k'}, \beta_1 a_{21} + \beta_2 a_{22}),
\end{aligned} \tag{15}$$

implying $\beta_1 a_{11}^k + \beta_2 a_{12}^k = \beta_1 a_{11}^{k'} + \beta_2 a_{12}^{k'}$ for all k, k'. This restriction, combined with the law of iterated expectations identity, $\sum_k \Pr[m^k](\beta_1 a_{11}^k + \beta_2 a_{12}^k) = \beta_1 a_{11} + \beta_2 a_{12}$, implies that $\beta_1 a_{11}^k + \beta_2 a_{12}^k = \beta_1 a_{11} + \beta_2 a_{12}$ for all k. Thus, the purchase probability with any cheap talk message is the same as the prior probability:

$$\begin{aligned}
&P_1(\beta_1 a_{11}^k + \beta_2 a_{12}^k, \beta_1 a_{21} + \beta_2 a_{22})\\
&\qquad = P_1(\beta_1 a_{11} + \beta_2 a_{12}, \beta_1 a_{21} + \beta_2 a_{22}).
\end{aligned} \tag{16}$$

For negative puffery, (5) simplifies to

$$\begin{aligned}
&P_1(\beta_1 a_{11} + \beta_2 a_{12}, \beta_1 a_{21}^k + \beta_2 a_{22}^k)\\
&\qquad = P_1(\beta_1 a_{11} + \beta_2 a_{12}, \beta_1 a_{21}^{k'} + \beta_2 a_{22}^{k'}),
\end{aligned} \tag{17}$$

which combined with the identity $\sum_k \Pr[m^k](\beta_1 a_{11}^k + \beta_2 a_{12}^k) = \beta_1 a_{11} + \beta_2 a_{12}$ again implies that P_1 must be the same as the prior for all messages. For comparative advantage puffery, the equilibrium condition (6) simplifies to

$$P_1(\beta_1 a_{11}^1 + \beta_2 a_{12}^1, \beta_1 a_{21}^1 + \beta_2 a_{22}^1) = P_1(\beta_1 a_{11}^2 + \beta_2 a_{12}^2, \beta_1 a_{21}^2 + \beta_2 a_{22}^2). \tag{18}$$

The restrictions (7) simplify to

$$\beta_1 a_{i1}^1 + \beta_2 a_{i2}^1 = \beta_1 a_{i1}^2 + \beta_2 a_{i2}^2, \tag{19}$$

which combined with the identities

$$\Pr[m^1](\beta_1 a_{i1}^1 + \beta_2 a_{i2}^1) + \Pr[m^2](\beta_1 a_{i1}^2 + \beta_2 a_{i2}^2) = \beta_1 a_{i1} + \beta_2 a_{i2} \tag{20}$$

imply that $\beta_1 a_{i1}^1 + \beta_2 a_{i2}^1 = \beta_1 a_{i1} + \beta_2 a_{i2}$. Then

$$P_1(\beta_1 a_{11}^k + \beta_2 a_{12}^k, \beta_1 a_{21}^k + \beta_2 a_{22}^k) = P_1(\beta_1 a_{11} + \beta_2 a_{12}, \beta_1 a_{21} + \beta_2 a_{22}) \tag{21}$$

for $k = 1, 2$, so again P_1 is the same as the prior for all messages. □

Proof of Proposition 5. Let $\bar{P}_1(p_1, a)$ be the expected purchase probability given price p_1 and estimates a. Let $p_1^*(a)$ be the maximand of

$$\Pi_1(p_1, a) = \bar{P}_1(p_1, a)(p_1 - c_1), \tag{22}$$

where c_1 is constant unit costs, and let $\Pi_1^*(a) = \bar{P}_1(p_1^*(a), a)(p_1^*(a) - c_1)$ be maximized profits. We wish to show that $\Pi_1^*(a)$ is strictly convex in a over subsets of the four-dimensional θ space as restricted by puffery.

Let $\lambda \in (0, 1)$ and a, a' be any two distinct estimates satisfying the attribute puffery restriction in which a_2 is fixed. As shown in Proposition 1, for $P_1(v)$, sufficiently small $\bar{P}_1$ is convex in a under this restriction. Then

$$\begin{aligned}
&\lambda \Pi_1^*(a) + (1-\lambda)\Pi_1^*(a') \\
&= \lambda \bar{P}_1(p_1^*(a), a)(p_1^*(a) - c_1) + (1-\lambda)\bar{P}_1(p_1^*(a'), a')(p_1^*(a') - c_1) \\
&\geq \lambda \bar{P}_1(p_1^*(\lambda a + (1-\lambda)a'), a)(p_1^*(\lambda a + (1-\lambda)a') - c_1) \\
&\quad + (1-\lambda)\bar{P}_1(p_1^*(\lambda a + (1-\lambda)a'), a')(p_1^*(\lambda a + (1-\lambda)a') - c_1) \\
&> \bar{P}_1[p_1^*(\lambda a + (1-\lambda)a'), \lambda a + (1-\lambda)a'](p_1^*(\lambda a + (1-\lambda)a') - c_1) \\
&= \Pi_1^*(\lambda a + (1-\lambda)a'),
\end{aligned} \tag{23}$$

where the first inequality follows from the definition of p_1^* (note that this inequality is strict if p_1^* is unique) and the second inequality follows from the strict convexity of $\bar{P}_1$.

Identical arguments apply for the negative puffery restriction that a_1 is fixed and for the comparative advantage puffery restriction that variation in (a_1, a_2) is restricted by (7). □

References

Abernethy AM, Franke GR (1996) The information content of advertising: A meta-analysis. *J. Advertising* 25(2):1–17.

Anand B, Shachar R (2009) Targeted advertising as a signal. *Quant. Marketing Econom.* 7(3):237–266.

Anand B, Shachar R (2011) Advertising, the matchmaker. *RAND J. Econom.* 42(2):205–245.

Anderson SP, Renault R (2006) Advertising content. *Amer. Econom. Rev.* 96(1):93–113.

Anderson SP, Renault R (2009) Comparative advertising: Disclosing horizontal match information. *RAND J. Econom.* 40(3):558–581.

Athey S, Ellison G (2011) Position auctions with consumer search. *Quart. J. Econom.* 126(3):1213–1270.

Bagwell K, Ramey G (1993) Advertising as information: Matching products to buyers. *J. Econom. Management Strategy* 2(2):199–243.

Barigozzi F, Garella PG, Peitz M (2009) With a little help from my enemy: Comparative advertising as a signal of quality. *J. Econom. Management Strategy* 18(4):1071–1094.

Battaglini M (2002) Multiple referrals and multidimensional cheap talk. *Econometrica* 70(4):1379–1401.

Blackwell D (1953) Equivalent comparisons of experiments. *Ann. Math. Statist.* 24(2):265–272.

Chakraborty A, Harbaugh R (2003) Cheap talk comparisons in multi-issue bargaining. *Econom. Lett.* 78(1):357–363.

Chakraborty A, Harbaugh R (2007) Comparative cheap talk. *J. Econom. Theory* 132(1):70–94.

Chakraborty A, Harbaugh R (2010) Persuasion by cheap talk. *Amer. Econom. Rev.* 100(5):2361–2382.

Chakraborty A, Gupta N, Harbaugh R (2006) Best foot forward or best for last in a sequential auction? *RAND J. Econom.* 37(1):176–194.

Che Y-K, Dessein W, Kartik N (2013) Pandering to persuade. *Amer. Econom. Rev.* 103(1):47–79.

Chen Y, He C (2011) Paid placement: Advertising and search on the internet. *Econom. J.* 121(556):309–328.

Crawford VP, Sobel J (1982) Strategic information transmission. *Econometrica* 50(6):1431–1450.

Crowley AE, Hoyer WD (1994) An integrative framework for understanding two-sided persuasion. *J. Consumer Res.* 20(4):561–574.

Crutzen BSY, Swank OH, Visser B (2013) Confidence management: On interpersonal comparisons in teams. *J. Econom. Management Strategy* 22(4):744–767.

Emons W, Fluet C (2012) Non-comparative versus comparative advertising of quality. *Internat. J. Indust. Organ.* 30(4):352–360.

Farrell J, Gibbons R (1989) Cheap talk with two audiences. *Amer. Econom. Rev.* 79(5):1214–1223.

Federal Trade Commission (1979) Statement of policy regarding comparative advertising. Statement, FTC, Washington, DC. http://www.ftc.gov/statement-of-policy-regarding-comparative-advertising.

Gardete PM (2013) Cheap-talk advertising and misrepresentation in vertically differentiated markets. *Marketing Sci.* 32(4):609–621.

Goldfarb A, Tucker CE (2011) Privacy regulation and online advertising. *Management Sci.* 57(1):57–71.

Grewal D, Kavanoor S, Fern EF, Costley C, Barnes J (1997) Comparative versus noncomparative advertising: A meta-analysis. *J. Marketing* 61(4):1–15.

Gu Z, Xie Y (2013) Facilitating fit revelation in the competitive market. *Management Sci.* 59(5):1196–1212.

Hoffman DA (2006) The best puffery article ever. *Iowa Law Rev.* 91(5):101–140.

Hoffman F, Inderst R, Ottaviani M (2013) Hypertargeting, limited attention, and privacy: Implications for marketing and campaigning. Working paper, Bocconi University, Milan.

Hovland CI, Lumsdaine AA, Sheffield FD (1949) *Experiments on Mass Communication* (Princeton University Press, Princeton, NJ).

Inderst R, Ottaviani M (2009) Misselling through agents. *Amer. Econom. Rev.* 99(3):883–908.

Inderst R, Ottaviani M (2012) Competition through commissions and kickbacks. *Amer. Econom. Rev.* 102(2):780–809.

Jain SP, Posovac SS (2004) Valenced comparisons. *J. Marketing Res.* 41(1):46–58.

Johnson JP, Myatt DP (2006) On the simple economics of advertising, marketing, and product design. *Amer. Econom. Rev.* 96(3):756–784.

Johnson RD, Levin IP (1985) More than meets the eye: The effects of missing information on purchase evaluations. *J. Consumer Res.* 12(2):169–177.

Kalra A, Li S (2008) Signaling quality through specialization. *Marketing Sci.* 27(2):168–184.

Kamenica E, Gentzkow M (2011) Bayesian persuasion. *Amer. Econom. Rev.* 101(6):2590–2615.

Kamins MA, Marks LJ (1987) The impact of using two-sided claims on product attitude and purchase intention. *J. Advertising* 16(4):6–15.

Kardes FR, Posavac SS, Cronley ML (2004) Consumer inference: A review of processes, bases, and judgment contexts. *J. Consumer Psych.* 14(3):230–256.

Kartik N (2009) Strategic communication with lying costs. *Rev. Econom. Stud.* 76(4):1359–1395.

Koessler F, Renault R (2012) When does a firm disclose product information? *RAND J. Econom.* 43(4):630–649.

Lewis T, Sappington D (1994) Supplying information to facilitate price discrimination. *Internat. Econom. Rev.* 35(2):305–327.

Mayzlin D (2006) Promotional chat on the Internet. *Marketing Sci.* 25(2):155–163.

Mayzlin D, Shin J (2011) Uninformative advertising as an invitation to search. *Marketing Sci.* 30(4):666–685.

Mayzlin D, Dover Y, Chevalier JA (2014) Promotional reviews: An empirical investigation of online review manipulation. *Amer. Econom. Rev.* Forthcoming.

Meyer RJ (1981) A model of multiattribute judgments under attribute uncertainty and information constraint. *J. Marketing Res.* 18(4):428–441.

Milgrom PR (1981) Good news and bad news: Representation theorems and applications. *Bell J. Econom.* 12(2):380–391.

Milgrom P, Roberts J (1986) Price and advertising signals of product quality. *J. Political Econom.* 94(4):796–821.

Nelson P (1974) Advertising as information. *J. Political Econom.* 82(4):729–754.

Ottaviani M, Sørensen PN (2006) Reputational cheap talk. *RAND J. Econom.* 37(1):155–175.

Parmentier RJ (1994) *Signs in Society: Studies in Semiotic Anthropology* (Indiana University Press, Bloomington).

Pechmann C, Stewart DW (1991) How direct comparative ads and market share affect brand choice. *J. Advertising Res.* 31(6):47–55.

Prékopa A (1973) On logarithmic concave measures and functions. *Acta Sci. Math.* 34:335–343.

Preston IL (1996) *The Great American Blow-up: Puffery in Advertising and Selling* (University of Wisconsin Press, Madison).

Reeves R (1961) *Reality in Advertising* (Knopf, New York).

Resnik A, Stern BL (1977) An analysis of information content in television advertising. *J. Marketing* 41(1):50–53.

Sobel J (1985) A theory of credibility. *Rev. Econom. Stud.* 52(4): 557–573.

Spence M (1973) Job market signaling. *Quart. J. Econom.* 87(3): 355–374.

Stewart DW, Furse DH (1986) *Effective Television Advertising: A Study of 1000 Commercials* (Lexington Books, Lanham, MD).

Sun M (2011) Disclosing multiple product attributes. *J. Econom. Management Strategy* 20(1):195–224.

Sun M (2012) How does the variance of product ratings matter? *Management Sci.* 58(4):696–707.