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Greening or greenwashing? How consumers' beliefs influence firms' advertising strategies on environmental quality

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Abstract

When consumers have ambiguous beliefs about the green quality of products, firms may be tempted to "greenwash". The degrees of optimism and confidence of consumers then play a crucial role in firms' advertising strategies, which can be either informative and/or persuasive. We find conditions under which advertising efforts and environmental quality are substitutes and thus lead to greenwashing.

Keywords: ambiguity, vertical differentiation, information, advertising, greenwashing.

JEL classification: D11, D21, D83, L15, Q59

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1 Introduction

Although most consumers consider it important to protect the environment and recognize that their consumption habits may negatively impact the environment, they also find it difficult to determine which products are truly "environmentally friendly". Many consumers have developed a distrust of producers' claims on their products' environmental performance (European Union, 2020a, 2013), suspecting firms of "greenwashing". Indeed, 53.3% of environmental claims in the European Union are "*vague, misleading or unfounded*" (European Union, 2020b).

Firms' advertising strategies play a crucial role in shaping consumers' beliefs about the "green" (credence) quality of their products. Firms can use two types of advertising (Bagwell, 2007): first, *informative advertising*, to correct consumers' imperfect information by disclosing (true) information about quality; and second, *persuasive advertising*, to change consumers' tastes by embellishing a product's quality (*i.e.*, by greenwashing).

How do firms combine information and persuasion in their environmental advertising strategies to influence consumer beliefs? How are firms' advertising strategies affected by a product's environmental quality? This paper addresses these issues using an original modeling of consumers' beliefs in a usual Bertrand duopoly framework.

While the literature generally uses a Bayesian approach to model uncertainty about product quality (Bagwell & Riordan, 1991; Daughety & Reinganum, 2008; Janssen & Roy, 2010), our analysis is based on the concept of neo-additive capacities developed by Ellsberg (1961), who models optimistic and pessimistic attitudes toward uncertainty based on experimental studies. In line with Eichberger, Kelsey, and Schipper (2009), we consider that belief formation depends on two related components: confidence and optimism. This assumption is introduced in a simple Bertrand duopoly game with differentiated products to infer firms' advertising strategies, particularly the key conditions for greenwashing.

We show that the complementarity or substitutability between information, persuasion, and environmental quality depends on the level of relative cost of the advertising tools. At extreme values of relative cost, information and persuasion tend to be substitutes, while at intermediate values they tend to be complements. When the relative cost of persuasion is relatively low and consumers are somewhat pessimistic, the high-quality firm engages in greenwashing by prioritizing persuasion over quality. When the relative cost of information is relatively low and consumers are confident, the high quality firm substitutes information for quality.

2 The model

The central assumption is that consumers have ambiguous beliefs about quality q_i of good i . As in Chateauneuf, Eichberger, and Grant (2007), beliefs are characterized by a neo-additive capacity rather than a probability distribution. Consider a simple framework with two firms producing vertically differentiated products. Firm h produces the high quality variant $q_h \in [q_{min}, q_{max}]$ while firm l produces the low quality variant $q_l \equiv q_{min}$. Consumers are assumed to be fully informed about the low quality, but imperfectly informed about the high quality. For simplicity, assume $q_{min} = 0$ and $q_{max} = 1$. Perceived qualities are defined as:

$$\begin{aligned} E(q_h) &= (1 - \delta)q_h + \delta\alpha q_{max} + \delta(1 - \alpha)q_{min} = (1 - \delta)q_h + \delta\alpha \equiv \Delta \\ E(q_l) &= q_{min} = 0 \end{aligned} \tag{1}$$

with $(1 - \delta)$ the degree of confidence and $\delta \in [0, 1]$ the degree of ambiguity. For $\delta = 0$, consumers have perfect information about quality q_h . α is the degree of consumer optimism, with $\alpha \in [0, 1]$: a weight $\delta\alpha$ is assigned to the optimistic view that product h is of the best quality q_{max} ; a weight $\delta(1 - \alpha)$ to the pessimistic view that product h is of the worst quality q_{min} .

Consumers have heterogeneous preferences over perceived quality: Parameter θ represents consumers' willingness-to-pay for perceived quality and is uniformly distributed over $[0, 1]$. A consumer of type θ maximizes the following indirect utility when consuming a good of quality q_i at price p_i :

$$v_i(\theta) = m - p_i + \theta E(q_i) \text{ for } i = h, l \tag{2}$$

The market is fully covered: m , denoting consumers' reservation price for a low-quality good, is sufficiently large that consumers buy one unit of either the low-quality product or the high-quality product.

Two firms compete in a two-stage game. In the first stage, given exogenous differentiated qualities q_h and q_l , Firm h chooses its advertising strategies.¹ In the second stage, firms compete on prices. Both firms are fully informed about qualities and consumers' beliefs.

In the advertising stage, Firm h can influence consumers' beliefs about high quality

¹As consumers are fully informed about quality q_l , the low quality firm (Firm l) does not use advertising.

through two advertising tools d and a :

- *informative advertising* makes consumers' beliefs more accurate by disseminating information about the product's true quality. The informative advertising effort, d (disclosure), entails a unit cost w_d . Formally, d increases the degree of confidence $(1 - \delta(d))$, which decreases the distance between perceived quality Δ and actual product quality q_h , with $\delta_d = \partial\delta(d)/\partial d < 0$, $\delta_{dd} = \partial\delta_d/\partial d \geq 0$;
- *persuasive advertising* increases consumers' perception of quality by embellishing the product quality. The persuasive advertising effort, a , entails a unit cost w_a . Formally, a increases the degree of optimism $\alpha(a)$, with $\alpha_a = \partial\alpha(a)/\partial a > 0$, $\alpha_{aa} = \partial\alpha_a/\partial a \leq 0$.

Persuasive advertising is our indicator of greenwashing: it consists of increasing the perceived quality with no relation to the true quality. Note that when the true quality is underestimated, persuasive advertising may bring the perceived quality closer to the true quality, however it is still greenwashing, as it shapes consumers' beliefs without any connection to actual quality. Conversely, *informative advertising* can only be done in link with actual quality.

The perceived quality is thus a function of q_h , d and a defined as follows:

$$\Delta(q_h, d, a) = (1 - \delta(d))q_h + \delta(d)\alpha(a) \quad (3)$$

Equation 3 highlights a key property of advertising strategies: informative advertising enhances confidence and undermines the role of persuasive advertising, however the reverse is not true.

The profits are defined as follows:

$$\pi_h(p_h, a, d) = (p_h - c(q_h)) D_h - w_d d - w_a a \quad (4a)$$

$$\pi_l(p_l) = (p_l - c(q_l)) D_l \quad (4b)$$

with D_i the demand addressed to firm i and $c(q_i)$ the unit production cost, defined as $c(q_i) = cq_i^2$ with $c > 0$ ($i = h, l$). The advertising strategy can be interpreted as a production decision, where the producer chooses production factors (persuasion and information) to shape consumers' beliefs.

The model is solved backwards. In the second stage, prices maximizing profits are:²

$$p_h = \frac{2}{3}(\Delta + cq_h^2) \quad (5a)$$

$$p_l = \frac{1}{3}(\Delta + cq_h^2) \quad (5b)$$

Demands are then:

$$D_h = \frac{2\Delta - cq_h^2}{3\Delta} \quad (6a)$$

$$D_l = \frac{\Delta + cq_h^2}{3\Delta} \quad (6b)$$

and profits are:

$$\pi_h = \frac{(2\Delta - cq_h^2)^2}{9\Delta} - w_a a - w_d d \quad (7a)$$

$$\pi_l = \frac{(\Delta + cq_h^2)^2}{9\Delta} \quad (7b)$$

Hereafter, to ensure the positiveness of the high-quality demand, we assume that $2\Delta > cq_h^2$.

3 Persuasive and informative advertising

We describe how perceived quality, $\Delta(q_h, d, a)$, is altered by Firm h 's advertising efforts, a and d , and the quality level, q_h .

Table 1: Perceived quality derivatives

with $\Delta_k = \frac{\partial \Delta}{\partial k}$ and $\Delta_{kh} = \frac{\partial^2 \Delta}{\partial k \partial h}$

$\Delta_a = \delta(d)\alpha_a > 0$	$\Delta_d = \delta_d(\alpha(a) - q_h) > 0, \forall \alpha(a) < q_h$	$\Delta_{q_h} = (1 - \delta(d)) > 0$
$\Delta_{aa} = \delta(d)\alpha_{aa} < 0$	$\Delta_{da} = \delta_d \alpha_a < 0$	$\Delta_{q_h a} = 0$
$\Delta_{ad} = \delta_d \alpha_a < 0$	$\Delta_{dd} = \delta_{dd}(\alpha(a) - q_h) < 0, \forall \alpha(a) < q_h$	$\Delta_{q_h d} = -\delta_d > 0$
$\Delta_{aq_h} = 0$	$\Delta_{dq_h} = -\delta_d > 0$	$\Delta_{q_h q_h} = 0$

Table 1 shows that perceived quality always increases with the true quality and the level of persuasive advertising, while it only increases with informative advertising when consumers underestimate the true quality ($\Delta(q_h, a^*, d^*) < q_h$, *i.e.* $\alpha(a) < q_h$).

²Note that rational (Bayesian) consumers could infer the true goods' quality by observing market prices (Daughety & Reinganum, 2008; Janssen & Roy, 2010). Here, we overlook this potentially informative role of prices.

Result 1 *When consumers overestimate quality, increasing informative advertising is counterproductive, as it decreases perceived quality. Firm h thus uses persuasive advertising only. In contrast, when consumers underestimate the actual quality, Firm h can use both types of advertising.*

This result has notable implications for greenwashing: when consumers are optimistic about quality, greenwashing is the only advertising tool used as it draws perceived quality away from actual quality. In contrast, when consumers are pessimistic, both types of advertising are used, and persuasive advertising reduces the gap between perceived and actual quality: greenwashing, which aims to exaggerate the quality perceived by consumers, actually brings it closer to actual quality.

In the remaining parts of the paper, we address the case whereby consumers underestimate quality. Firm h maximizes its profit (defined in equation 7) with respect to the efforts of information (d) and persuasion (a). First-order conditions (FOC) provide the implicit inverse demand functions of information d^* and persuasion a^* :

$$w_d = \frac{(4\Delta(q_h, d^*, a^*)^2 - c^2 q_h^4)}{9\Delta(q_h, d^*, a^*)^2} \Delta_d \quad (8a)$$

$$w_a = \frac{(4\Delta(q_h, d^*, a^*)^2 - c^2 q_h^4)}{9\Delta(q_h, d^*, a^*)^2} \Delta_a \quad (8b)$$

3.1 Degree of substitution of information and persuasion

How does Firm h combine information and persuasion to maximize its profit? Increasing informative advertising enhances consumer confidence in quality, though it reduces the effectiveness of persuasion on consumer belief. Therefore, Firm h can either increase its persuasion expenditures to counteract the effect of information on optimism weight (where communication tools are complements) or decrease its persuasion effort because it is less effective (communication tools are thus substitutes). Overall, the nature of the relationship between advertising tools depends on the relative cost of the instruments and on the degree of confidence and optimism.

By rearranging the first-order conditions 8, we obtain:

$$\frac{\Delta_d}{\Delta_a} = \frac{w_d}{w_a} \quad (9)$$

Equivalently:

$$f(d, a) \equiv \frac{\Delta_d}{\Delta_a} - \frac{w_d}{w_a} = 0 \quad (10)$$

Using the implicit function theorem, the relationship between the two forms of advertising can be characterized by:

$$\frac{\partial d}{\partial a} = -\frac{f_a}{f_d} = -\frac{\Delta_{da}\Delta_a - \Delta_{aa}\Delta_d}{\Delta_{dd}\Delta_a - \Delta_{da}\Delta_d} \quad (11)$$

Persuasion and information are thus substitutes if $\frac{\partial d}{\partial a} < 0$; that is, if:

$$(I) \begin{cases} \frac{\Delta_{dd}}{\Delta_{ad}} > \frac{\Delta_d}{\Delta_a} = \frac{w_d}{w_a} \\ \frac{\Delta_{da}}{\Delta_{aa}} > \frac{\Delta_d}{\Delta_a} = \frac{w_d}{w_a} \end{cases} \quad \text{or} \quad (II) \begin{cases} \frac{\Delta_{dd}}{\Delta_{ad}} < \frac{\Delta_d}{\Delta_a} = \frac{w_d}{w_a} \\ \frac{\Delta_{da}}{\Delta_{aa}} < \frac{\Delta_d}{\Delta_a} = \frac{w_d}{w_a} \end{cases} \quad (12)$$

These substitutability conditions can also be presented in terms of the degree of confidence and optimism :

$$(I) \begin{cases} \delta(d) > \frac{\delta_d^2}{\delta_{dd}} \\ \alpha(a) > q_h + \frac{\alpha_a^2}{\alpha_{aa}} \end{cases} \quad \text{or} \quad (II) \begin{cases} \delta(d) < \frac{\delta_d^2}{\delta_{dd}} \\ \alpha(a) < q_h + \frac{\alpha_a^2}{\alpha_{aa}} \end{cases} \quad (13)$$

Persuasion and information are complements in the opposite cases. Table 2 and Figure 1³ summarize the different cases.

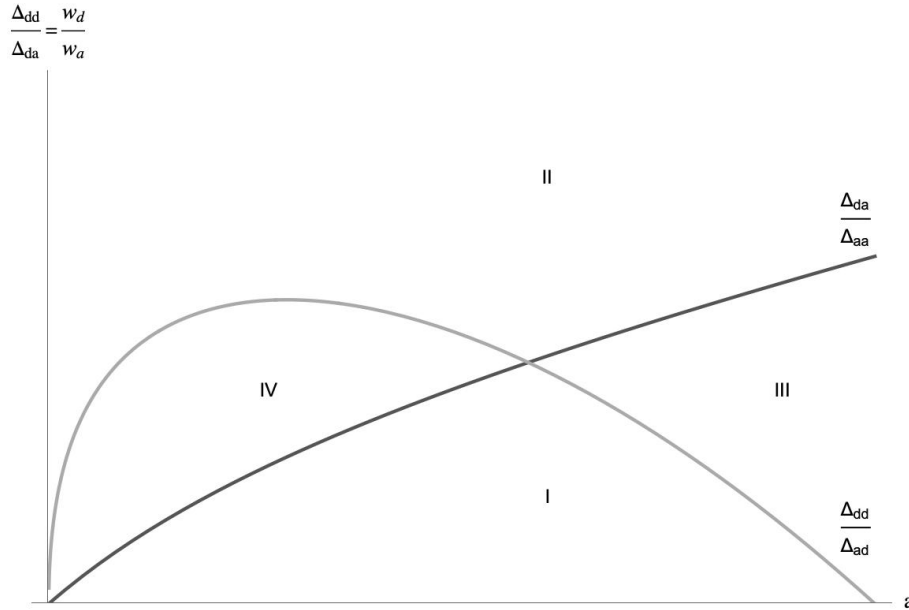


Figure 1: Partition of the relative cost of advertising

In case I, the degree of confidence, $1 - \delta(d)$, is low *and* the degree of optimism, $\alpha(a)$, is large. Thus, the marginal impact of d on Δ is higher than that of a . Since the relative cost

³Functional forms used for the simulations are $\alpha(a) = (\frac{a}{a+1})^{1/2}$ and $\delta(d) = 1 - (\frac{d}{d+1})^{1/2}$.

Table 2: Interaction between advertising tools and quality according to consumers' beliefs and the relative prices of advertising

Beliefs	Low optimism $\alpha(a) \leq q_h + \frac{\alpha_a^2}{\alpha_{aa}}$	High optimism $q_h + \frac{\alpha_a^2}{\alpha_{aa}} < \alpha(a) < q_h$	
Low confidence $\delta(d) \geq \frac{\delta_d^2}{\delta_{dd}}$	IV a and d complements a and q_h substitutes d and q complements	I a and d substitutes a and q_h complements d and q_h complements	$\frac{w_d}{w_a} \leq \frac{\Delta_{dd}}{\Delta_{ad}}$
High confidence $\delta(d) < \frac{\delta_d^2}{\delta_{dd}}$	II a and d substitutes a and q_h substitutes d and q_h substitutes	III a and d complements a and q_h complements d and q_h substitutes	$\frac{w_d}{w_a} \geq \frac{\Delta_{dd}}{\Delta_{ad}}$
	$\frac{w_d}{w_a} \geq \frac{\Delta_{da}}{\Delta_{aa}}$	$\frac{w_d}{w_a} \leq \frac{\Delta_{da}}{\Delta_{aa}}$	Relative prices

of d compared to a is low, and its relative efficiency is high, firm h prefers to substitute d to a . Case II is symmetric, with high confidence and low optimism. In both cases, d and a are substitutes.

In case III, both confidence and optimism are high. Here, the marginal impacts of d and a are low and the relative cost of d to a is intermediate. Hence, Firm h prefers to increase both rather than use a single instrument. It therefore avoids a too-rapid decrease in the marginal effect of each instrument on perceived quality. Case IV is symmetric, with low confidence and optimism. In both cases, d and a are complements.

Result 2 *Whether advertising instruments are substitutes or complements depends on the degree of consumer confidence and optimism and the relative cost of the two advertising instruments. When both degrees of optimism and confidence are high or low, and the relative cost of d to a is intermediate, the instruments are complements. Otherwise, they are substitutes.*

3.2 Impact of quality on advertising strategies

The level of exogenous quality of Firm h affects its advertising strategies. Intuitively, quality substitutes for information when the degree of confidence is large, and for persuasion when the degree of optimism is low.

Using the implicit function theorem, these effects can be characterized by:⁴

$$\frac{\partial d^*}{\partial q_h} = -\frac{f_{q_h}}{f_d} = -\frac{\Delta_{dq_h}\Delta_a}{\Delta_{dd}\Delta_a - \Delta_{da}\Delta_d} \quad (14)$$

$$\frac{\partial a^*}{\partial q_h} = -\frac{f_{q_h}}{f_a} = -\frac{\Delta_{dq_h}\Delta_a}{\Delta_{da}\Delta_a - \Delta_{aa}\Delta_d} \quad (15)$$

Table 2 shows the relationship between quality q_h and the two advertising tools. When the level of optimism is low (cases II and IV), the firm may choose to increase persuasive advertising instead of increasing quality, as it is relatively more efficient and less expensive. The firm then increases its profit by increasing perceived quality without increasing the real product quality, supporting the "greenwashing strategy". Conversely, if quality is relatively high, Firm h has no real interest in choosing higher levels of persuasive advertising to increase optimism, as optimism plays a lower role in quality perception. Thus, quality and persuasive advertising are substitutes.

When optimism is relatively high, but perceived quality is still lower than actual quality (cases I and III), persuasion is not easily substituted by quality, because optimism plays an important role in quality perception. Therefore, to maximize profit, the firm must combine quality and persuasion to achieve sufficient increase in consumer perceived quality. Thus, quality and persuasive advertising are complements.

In cases IV and I, the level of confidence is low. Increasing quality is of little interest if the firm does not also attempt to increase confidence, as the impact on the perceived quality would be too low. Thus, quality and informative advertising are complements. They are substitutes otherwise (cases III and II).

Result 3 *Persuasive advertising and quality tend to be substitutes when the level of optimism is relatively low, and tend to be complements otherwise. Informative advertising and quality tend to be substitutes when the level of confidence is relatively high, and tend to be complements otherwise.*

4 Conclusion and discussion

Consumers frequently have limited knowledge of a product's true quality, especially when credence claims relate to environmental quality. We use the relevant neo-additive capacity framework from the economics of risk to model consumers' imperfect knowledge of quality as a function of two parameters: confidence and optimism.

⁴Recall that $\Delta_{q_h q_h} = 0$.

In this context, firms' advertising strategies can take two forms: informing consumers about quality and/or persuading consumers that the quality is higher than they believe. Our paper focuses on the factors that encourage persuasion (greenwashing) or fair disclosure, depending on consumer beliefs.

First, we show that *informative advertising* enhances consumer confidence and weakens the influence of persuasive advertising, while *persuasive advertising* increases consumer optimism without affecting the effect of informative advertising. Moreover, when the relative cost of both advertising instruments is sufficiently high or low, information and persuasion tend to be substitutes, with the firm having an incentive to favor the less-costly instrument. Conversely, they tend to be complements when the relative cost is intermediate.

Second, persuasion substitutes for quality when consumers are pessimistic, providing an opportunity for greenwashing. Alternatively, information substitutes for quality when consumers are confident, as this type of advertising is less useful. However, a high relative cost of persuasive advertising compared to informative advertising reduces firms' incentive to greenwash, thus benefiting fair disclosure.

These results provide important lessons for public policy. When the policymaker aims to clarify information about environmental quality (or any other welfare-enhancing credence attribute) and challenge the process of greenwashing, it is in the policymaker's best interest to subsidize informative advertising (to increase the relative cost of persuasive to informative advertising) *only* when consumers are sufficiently optimistic that they are not overly influenced by persuasive advertising. An eco-labeling policy used with a widely-dispersed information campaign may also be effective in enhancing consumer optimism about products with a credible label, and thereby reduce the effectiveness of persuasive advertising. The European Union's recent proposal for a directive on "green claims" is moving in this direction by harmonizing the requirements for environmental claims and by imposing penalties in the case for proven greenwashing.⁵

References

- Bagwell, K. (2007). The economic analysis of advertising. *Handbook of industrial organization*, 3, 1701–1844.
- Bagwell, K., & Riordan, M. H. (1991). High and declining prices signal product quality. *The American Economic Review*, 224–239.

⁵<https://environment.ec.europa.eu/topics/circular-economy/green-claims> (accessed 2023/07/05).

- Chateauneuf, A., Eichberger, J., & Grant, S. (2007). Choice under uncertainty with the best and worst in mind: Neo-additive capacities. *Journal of Economic Theory*, 137(1), 538–567.
- Daughety, A. F., & Reinganum, J. F. (2008). Imperfect competition and quality signalling. *The RAND Journal of Economics*, 39(1), 163–183.
- Eichberger, J., Kelsey, D., & Schipper, B. C. (2009). Ambiguity and social interaction. *Oxford Economic Papers*, 61(2), 355–379.
- Ellsberg, D. (1961). Risk, ambiguity, and the savage axioms. *The quarterly journal of economics*, 643–669.
- European Union. (2013). Attitudes of europeans towards building the single market for green products. *Special Eurobarometer*, 367.
- European Union. (2020a). *Attitudes of europeans towards the environment* (Special Eurobarometer No. 501).
- European Union. (2020b). *Environmental claims in the eu – inventory and reliability assessment*.
- Janssen, M. C., & Roy, S. (2010). Signaling quality through prices in an oligopoly. *Games and Economic Behavior*, 68(1), 192–207.