



Green and guilty: The interplay of environmental quality and greenwashing[☆]

Federico Boffa^{a,c,d} , Piersilvio De Bortoli^{a,b}, Andrea Nicolodi^{a,b} 

^a Free University of Bozen-Bolzano, Italy

^b University of Trento, Italy

^c Collegio Carlo Alberto, Italy

^d Istituto di Ricerca sulla Crescita Economica Sostenibile (IRCrES) / Consiglio Nazionale delle Ricerche (CNR), Strada delle Cacce, 73 - Torino (TO) 10135, Italy

ARTICLE INFO

JEL classification:

D82

L13

L15

Keywords:

Greenwashing

Environmental quality

Consumer sophistication

Market structures

ABSTRACT

We develop a model with environmentally-conscious consumers whose utility depends on their perception of imperfectly observable firms' environmental investments, and consumers differ in their level of sophistication. Firms can engage in greenwashing, i.e., in sending a costly message overstating their level of actual investments. We show that in equilibrium firms engage in greenwashing, and that greenwashing is complement to authentic green investments, rationalizing the available empirical evidence. We also show that both greenwashing and genuine investment decrease when consumers' sophistication increases, and that a two product monopolist induces less (more) greenwashing and actual investments than two single product duopolists when products are substitutes (complements). Our findings imply a novel tradeoff between policies aimed at discouraging greenwashing or at fostering consumers' awareness and the equilibrium level of genuine environmental investments.

1. Introduction

The proliferation of inflated, often fake, environmental claims in consumer markets presents a striking empirical puzzle. A widespread view holds that such claims, often referred to as greenwashing, are substitutes for genuine green investments. However, there is evidence that firms most likely to engage in greenwashing are those making substantial, authentic environmental investments. [Kathan et al. \(2025\)](#), for example, shows that companies with higher ESG scores frequently engage in more significant greenwashing activities, challenging the association of greenwashing to environmentally negligent firms.

We develop a theoretical framework where firms choose the level of authentic environmental investment, which is imperfectly observed by consumers, and can costly send messages that overstate their investment. In a setting in which consumers' utility depends on their perception of firms' environmental investments, and consumers differ in their level of sophistication, we show that firms profitably overstate their level of actual environmental investment (i.e., engage in greenwashing), and that authentic green investments and greenwashing are complements, so costly increases in environmental quality enhance the profitability of exaggerated claims. As a result, we show that, in equilibrium, both under monopoly and under competition, the level

of greenwashing increases with the amount of authentic environmental investments. Additionally, we show that increasing the level of consumers' sophistication reduces firms' level of greenwashing but, because of the complementarity identified above, it also reduces the level of authentic environmental investments. Finally, we show that Bertrand competition yields more authentic investment and more greenwashing than Cournot competition, while competition triggers more (less) actual investments and more greenwashing than monopoly if products are substitutes (complements).

We contribute to the literature on strategic communication and biased quality disclosure, which examines how firms – and, in general, senders – selectively reveal or strategically manipulate information. A recent model ([Mezzetti, 2025](#)) shows that a biased sender can manipulate rational receivers if the direction of the sender's bias is unknown.

We extend this framework and consider a sender with a known, unidirectional bias, who partially persuades receivers through biased messages, leveraging their limited sophistication.

We also connect to the broader literature on responsible investing and externality control, including ([Bisceglia et al., 2023](#)), who

[☆] The authors gratefully acknowledge participants at the “Adige Workshop” and at the “Internal UNIBZ Workshop” at the Free University of Bolzano, as well as Michele Bisceglia, Claudio Mezzetti and Paolo Roberti for their useful feedback. Andrea Nicolodi wishes to thank CONSOB for the support in carrying out his research program. The views and opinions expressed in this paper are those of the authors and do not necessarily reflect those of CONSOB.

* Corresponding author.

E-mail address: Federico.Boffa@unibz.it (F. Boffa).

analyze the efficiency of socially responsible investing mechanisms in controlling firms' externalities.

At the policy level, our analysis suggests a novel trade-off in the implementation of measures against greenwashing and to promote consumers' knowledge, which should also consider the negative effects on authentic investments. An alternative interpretation would be that policies aimed at curbing greenwashing or at fostering consumers' awareness should be associated to a strengthening of regulations on environmental investments, e.g., by imposing minimum quality standards.

2. Model

Consumers. Each good i produced in an economy, with $i = 1, \dots, N$, is characterized by a level of environmental quality η_i . Consumers benefit from environmental quality, but they are unable to precisely observe it before purchase. They then form a perception of it $\hat{\eta}_i$. Higher perceived environmental quality is in turn associated to higher utility.

Given the baseline utility α , the price of the product p_i , the consumer's income I and a parameter of complementarity/substitutability across products θ , the consumer utility is then:

$$U(p_i, q_i, \hat{\eta}_i) = \sum_{i=1}^N (\alpha + \hat{\eta}_i) q_i - \frac{\beta}{2} \left(\sum_{i=1}^N q_i^2 + \theta \sum_{i \neq j} q_i q_j \right) + I - \sum_{i=1}^N p_i q_i \quad (1)$$

We thus introduce the parameter of perceived environmental quality $\hat{\eta}_i$ in an otherwise standard individual demand function, which is given by:

$$q_i(p_i, q_{-i}, \hat{\eta}_i) = \frac{1}{\beta} (\alpha + \hat{\eta}_i - p_i) - \theta \sum_{j \neq i} q_j \quad (2)$$

where q_{-i} denotes the set of quantities of all goods other than i . In the rest of the analysis, we will consider a two-product industry.

We assume $\theta \in [-1, 1]$. Positive (negative) values of θ indicate that the products are substitutes (complements), with larger (smaller) values indicating stronger substitutability (complementarity). When $\theta = 0$, the products are independent.

A representative consumer can have different levels of sophistication $s \in [0, 1]$. A more sophisticated consumer, with a relatively high s , is better able at recognizing the actual investment, hence her perception will be closer to it. A less sophisticated consumer, with a relatively low s , is less able to recognize the true level of quality, so her perception will lie closer to an unverifiable message m_i sent by the firm, on which we will return later. Firms know the level of sophistication of the representative consumer.

Firms. For each product i , firms simultaneously choose their true environmental quality (η_i), product price (p) and the disclosure level through the unverifiable message (m_i) to maximize profits:

$$\pi(p_i, \eta_i, m_i) = \sum_{i=1}^N (p_i \cdot q_i - k_\tau \tau_i^2 - k_\eta \eta_i^2) \quad (3)$$

where $\tau_i = m_i - \eta_i$ represents the level of firm's greenwashing on product i , given by the difference between the unverifiable message m_i on the extent of environmental investments, and its actual value, and k_τ and k_η are the unit cost of an increase in the extent of greenwashing and of authentic quality respectively.¹

The cost of actual environmental investment ($k_\eta \eta_i^2$) includes capital and operational outlays for activities such as research into greener technologies, more sustainable sourcing or retooling production facilities to reduce waste. Convexity reflects the diminishing returns of actual environmental investments.

¹ In our model, in equilibrium, $m_i \geq \eta_i$, reflecting the fact that firms may have an incentive to overstate their level of environmental investments, and not to understate it. Hence, $\tau_i \geq 0$.

The misreporting or greenwashing cost ($k_\tau \tau_i^2$) captures the cost arising from deceptive communication, with the magnitude of misrepresentation being τ_i . Convexity here intuitively stems from the notion that the marginal persuasion cost increases with the amount of greenwashing. For example, communication campaigns turn increasingly expensive, at the margin, as the level of deception increases. Observe that the cost of greenwashing is unrelated to consumers' level of sophistication. Hence, irrespective of the effectiveness of greenwashing in affecting consumers' quality perception $\hat{\eta}_i$, a firm bears the greenwashing cost. Notice that, in our model, there are no economies or diseconomies of scope, and investment in quality and greenwashing are product-specific. The ranking, in terms of authentic investment and greenwashing, therefore does not depend on cost considerations.

Since environmental quality is only imperfectly observable by consumers, firms can affect perceived quality either by investing in true environmental improvements (η_i) or through greenwashing, by setting $m_i > \eta_i$. In particular, given a level of the representative consumer's sophistication s , the perceived quality, $\hat{\eta}_i$, is defined as²:

$$\hat{\eta}_i(s) = (1 - s)m_i + s\eta_i \quad (4)$$

3. Comparative analysis of market structures

We analyze how a firm's incentives to invest in genuine environmental quality and engage in greenwashing are shaped by the prevailing market structure. We will compare a multi-product monopolist, producing two products, to two single-product firms producing differentiated products (substitutes if $\theta > 0$, complements if $\theta < 0$).

Monopoly. Consider first an industry with a monopolistic firm that produces two differentiated products. The firm maximization problem takes the following form:

$$\max_{p_i, \eta_i, m_i} \pi(p_i, \eta_i, m_i) = \sum_{i=1}^2 (p_i q_i - k_\tau \tau_i^2 - k_\eta \eta_i^2)$$

We restrict here attention on the non-verifiable message and on the level of investment in true environmental quality, from which the level of greenwashing follows, as the difference between the two. At the optimum,

$$\eta_i^M = \frac{\alpha}{4k_\eta \beta (1 + \theta) - (1 - s)^2 \frac{k_\eta}{k_\tau} - 1}, \quad (5)$$

$$m_i^M = \left[1 + (1 - s) \frac{k_\eta}{k_\tau} \right] \cdot \frac{\alpha}{4k_\eta \beta (1 + \theta) - (1 - s)^2 \frac{k_\eta}{k_\tau} - 1} \quad (6)$$

where the superscript M denotes monopoly.

The level of greenwashing $\tau_i^M = m_i^M - \eta_i^M$, given by

$$\tau_i^M = (1 - s) \frac{k_\eta}{k_\tau} \eta_i^M \quad (7)$$

increases with the level of authentic environmental investment η_i^M .

Observe, finally, that $\frac{\partial \eta_i^M}{\partial \theta} < 0$, so that more complementarity across products positively affects the equilibrium level of actual green investments, as it increases the marginal returns of quality investment due to the positive feedback loops, among complementary products, of the level of quality of each product on the others.

² In the limiting case of complete consumer naïveté ($s = 0$), individuals accept the firm's claims at face value. Conversely, in the limiting case of full consumer sophistication ($s = 1$), consumers can be regarded either as directly perfectly able to observe the actual investment, or to rationally perfectly infer the actual investment from the signal, as in standard signaling models with rational agents, since (Spence, 1973).

Duopoly. We now move to a duopolistic setting with two symmetric single-product firms, producing two differentiated products. We start with Cournot duopoly. In equilibrium,³

$$\eta_i^C = \frac{\alpha}{2k_\eta\beta(2 + \theta) - (1 - s)^2 \frac{k_\eta}{k_\tau} - 1} \quad (8)$$

$$m_i^C = \left[1 + (1 - s) \frac{k_\eta}{k_\tau} \right] \cdot \frac{\alpha}{2k_\eta\beta(2 + \theta) - (1 - s)^2 \frac{k_\eta}{k_\tau} - 1} \quad (9)$$

where the superscript *C* denotes Cournot.

Instead, in a market characterized by price competition, à la Bertrand, equilibrium values are given by:

$$\eta_i^B = \frac{\alpha}{2k_\eta\beta(2 - \theta)(1 + \theta) - (1 - s)^2 \frac{k_\eta}{k_\tau} - 1} \quad (10)$$

$$m_i^B = \left[1 + (1 - s) \frac{k_\eta}{k_\tau} \right] \cdot \frac{\alpha}{2k_\eta\beta(2 - \theta)(1 + \theta) - (1 - s)^2 \frac{k_\eta}{k_\tau} - 1} \quad (11)$$

where the superscript *B* denotes Bertrand.

Turning to the equilibrium level of greenwashing, we obtain:

$$\tau_i^C = (1 - s) \frac{k_\eta}{k_\tau} \eta_i^C \quad (12)$$

$$\tau_i^B = (1 - s) \frac{k_\eta}{k_\tau} \eta_i^B \quad (13)$$

for the Cournot and the Bertrand case respectively.

We are now ready to state the following:

Proposition 3.1. *The level of greenwashing τ_i , increases with the level of investment in authentic environmental quality η_i , both under monopoly and under competition*

Proof. By inspecting (7), (12), (13), for monopoly, Cournot competition and Bertrand competition respectively, one can easily notice that τ_i is directly proportional to η_i in each of the three cases. ■

The Proposition emphasizes the complementarity between genuine environmental investment and greenwashing, which rationalizes the empirical evidence on the association between authentic green investments and greenwashing. The intuition behind this result revolves around the benefits and costs of actual environmental investments as well as of greenwashing. Both η_i and τ_i raise demand, albeit in different proportions depending on consumer's sophistication *s*. Their costs k_η and k_τ do not vary with quantity. Hence, the returns on a unit of both greenwashing and environmental investment is increasing with quantity. The increase in demand triggered by either one of them thus incentivizes firms to increase the other one as a result.

By inspecting (7), (12), (13), one can additionally notice that, as intuitive, greenwashing is scaled up when the cost of quality improvement is high relative to the cost of misrepresentation (i.e., when (k_η/k_τ) is high), or when consumer sophistication is low.

We now move to the effects of consumers' sophistication on greenwashing. We state the following:

Proposition 3.2. *The equilibrium level of greenwashing, and in turn the equilibrium level of actual environmental investments, is decreasing in consumers' sophistication both under monopoly and under competition.*

Proof. By inspecting (5), (8), (10), one can see that $\frac{\partial \eta_i}{\partial s} < 0$ ■

The intuition behind this result can be grasped in two steps. Notice first that less sophisticated consumers are easier to fool, given the equation governing perceived quality (4), which implies a higher return

to costly messages on unsophisticated consumers. Firms' incentives to greenwash are thus higher with unsophisticated consumers. The second step involves the complementarity between greenwashing and environmental investments, established in Proposition 3.1, which explains the increase of the latter.

Finally, we move to the analysis of the ranking, in terms both of actual investment and of greenwashing, among monopoly, Cournot and Bertrand competition. We state the following:

Proposition 3.3. *When products are substitutes ($\theta > 0$), the level of authentic environmental investments (η_i) and greenwashing (τ_i) are largest under Bertrand competition and smallest for monopoly, with values for Cournot competition at an intermediate level. Instead, when products are complements ($\theta < 0$), both environmental quality and greenwashing are largest under monopoly, followed by Bertrand competition and Cournot competition. Finally, when products are independent ($\theta = 0$), monopoly and competition yield the same outcome.*

Proof. The proof follows directly from inspecting (5), (8), (10), for $\theta > 0$ (substitutes) and $\theta < 0$ (complements). ■

The visual representation of the ranking for different values of θ is presented in Fig. 1. To get the intuition for these results, consider first the case of substitute goods, in which competitive rivalry yields more authentic investment than monopoly, in an effect similar to the fear to be left behind or the escape competition effects identified in the innovation literature (Aghion et al., 2005). The effect is particularly strong under the fiercer Bertrand competition. Through the above discussed complementarity mechanism, this reflects into a higher amount of greenwashing.

Finally, when products are complements, in addition to the persistence of the above identified escape competition effect, the standard double marginalization effect dating back to Cournot (Cournot, 1838) emerges. Competing firms producing complement goods do not internalize the positive effect of own's investment and greenwashing activity on the rival's profit, and underinvest as a result. The latter effect prevails in the ranking between monopoly and competition, inducing higher actual investment and greenwashing activity under monopoly.

Fig. 1 provides a set of simulations of equilibrium levels of environmental quality (η_i) and greenwashing (τ_i) as functions of consumer sophistication (*s*), illustrating how these outcomes depend on market structure and the degree of product differentiation (θ).

4. Conclusion

We offer a new perspective on the relation between greenwashing and actual environmental investments by developing a framework with environmentally conscious consumers caring about the perceived level of firms' environmental investment. We show that genuine environmental investment and deceptive communication are complements, in line with the available empirical evidence, but perhaps contrary to conventional wisdom. We show that raising consumer sophistication is a bittersweet elixir. Policymakers must therefore carefully consider the trade-off, and, when implementing policies aimed at curbing greenwashing, they should associate them with a stronger regulation to support environmental investments. Future work will explicitly model the regulatory process in the presence of greenwashing, and look more deeply into consumers' role, by modeling the probability that they detect firms' greenwashing activity, as well as their resulting reaction. Finally, an empirical test of our results is warranted.

³ Existence conditions are: $2k_\tau\eta_i(s + 2k_\eta\eta_i\beta + \theta) > k_\tau + s^2k_\tau\eta_i$.

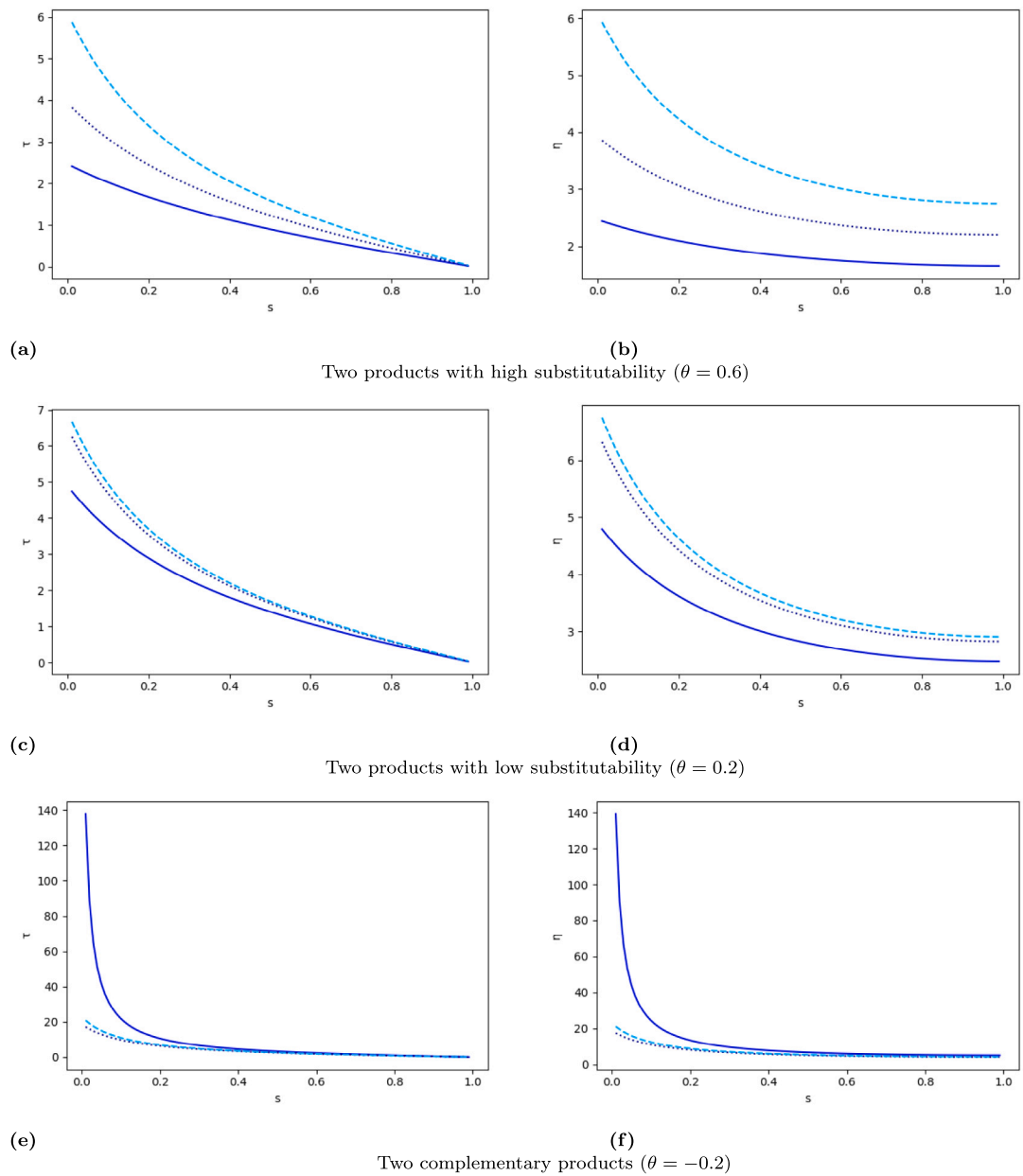


Fig. 1. Greenwashing (τ) and true environmental quality (η) against consumer sophistication (s) under symmetric costs ($k_\tau = k_\eta = 0.7$). Market structures: monopoly (solid blue), Cournot duopoly (dotted dark blue), Bertrand duopoly (dashed light blue).

Appendix A. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.econlet.2025.112744>.

Data availability

No data was used for the research described in the article.

References

Aghion, P., Bloom, N., Blundell, R., Griffith, R., Howitt, P., 2005. Competition and innovation: An inverted-U relationship. *Q. J. Econ.* 120 (2), 701–728.

Bisceglia, M., Piccolo, A., Schneemeier, J., 2023. Externalities of responsible investments. *RR J. Finance Working Paper*.
 Cournot, A.A., 1838. *Recherches sur les principes mathématiques de la théorie des richesses*. Hachette, Paris, English translation, *Researches into the Mathematical Principles of the Theory of Wealth* N. T. Bacon (Trans.), Macmillan, 1897.
 Kathan, M.C., Utz, S., Dorfleitner, G., Eckberg, J., Chmel, L., 2025. What you see is not what you get: ESG scores and greenwashing risk. *Financ. Res. Lett.* 74, 106710.
 Mezzetti, C., 2025. Manipulative disclosure. *RAND J. Econ.* 56 (2), 184–193.
 Spence, M., 1973. Job market signaling. *Q. J. Econ.* 87 (3), 355–374.