Corporate-NGO Partnership for eco-labeling

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Abstract

How can an eco-label emerge from a corporate-NGO partnership? How can an environmental NGO both favor eco-label development and adoption by its corporate partner and eco-label diffusion to its partner's competitor? Treating the eco-label as a product innovation, we analyze a three-period game where a firm and an environmental NGO bargain first to develop an eco-label fulfilling their common goal, next the corporate partner adopts the label in order to vertically differentiated its product from the unlabeled one, and next its competitor can also adopt the label if the eco-labeled product is more cost effective than still supplying the differentiated, low quality product. We investigate the respective roles of market-driven incentives and corporate-NGO partnership on the adoption and the diffusion of the eco-label according to the nature of the competition.

Keywords Eco-label, Environmental quality, Product differentiation, Product innovation, NGO

JEL classification D62, L13, L15, L21, L31, Q58

1. Introduction

Corporate-NGO partnerships play an increasing role in international environmental NGO strategies to "*influence the course of conservation*" (World Wide Fund for Nature, WWF).[1] WWF was amongst the first environmental NGOs to develop such partnerships for eco-labeling. It spearheaded the Forest Stewardship Council (FSC), founded in 1993 for sustainable forest management, and the Marine Stewardship Council (MSC), founded in 1996 for sustainable fishing. The WWF's Global Forest & Trade Network (GFTN) was established in 1995 in order to initiate partnerships between WWF and companies because of "*the commitments, influence, and purchasing power of businesses to bring about market change*"[2] through the use of FSC-certified products in their supply chain. The MSC was born from a partnership between WWF and Unilever, formalized in a statement of intent *'to ensure the long-term viability of global fish*

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[1] See the WWF web page on partnerships, https://www.worldwildlife.org/pages/partnerships# (accessed 2018/04/19).

[2] See the WWF web page on GFTN, http://gftn.panda.org/ (accessed 2018/04/19).

populations and the health of the marine ecosystems on which they depend.' Such a goal results from the WWF objective to ensure "*more effective management of marine life*" and Unilever to ensure "*a future for its fish business*".[3] In 2000s, WWF and corporate partners created several new eco-labels, including the Roundtable on Sustainable Palm Oil (RSPO) in 2004, the Round Table on Responsible Soy (RTRS) in 2006, the Aquaculture Stewardship Council (ASC) in 2010, and the Global Roundtable for Sustainable Beef (GRSB) in 2012. WWF aims not only at favoring adoption of sustainable sourcing in corporate partners' supply chains but also at encouraging "*many more follow in the footsteps of early movers*" (WWF, 2014). The present paper draws on these corporate-WWF partnerships[4] to provide a theoretical framework of corporate-NGO partnership for eco-labeling and to investigate the ensuing adoption and diffusion of the eco-label.

Corporate-NGO partnerships bring benefits for each partner (Lyon, 2010, Poret, 2014). For environmental NGOs, the first advantage is "*harnessing forces for conservation*" (WWF).[5] However, 93% of NGOs surveyed by C&E (2017) seek mainly funding. Moreover, partnership provides "access to people and contacts" and greater social and/or environmental innovations for around three-quarters of them. The French study center of Corporate Social Responsibility (CSR) corroborates that NGOs need corporate network and capacity for information and innovation diffusion (ORSE, 2012). The main advantage of firms in partnership with NGOs is the improvement of their reputation and credibility. 92% of companies surveyed by C&E (2017) are motivated by this reason because NGOs benefit from high trust (GlobeScan, 2017). Partnership gives credibility to CSR strategies, including eco-labeling strategies. In addition, eco-label is essential to inform consumers of the environmental quality of credence goods and NGO certification avoids the suspicion of 'greenwashing'. In other words, NGOs can solve information asymmetry between firms and consumers (Poret, 2014). Partnerships with NGOs also reduce the risk of consumers boycott or NGOs' negative campaign (Innes, 2006, Lyon and Maxwell, 2008). Therefore, partnerships provide profit opportunities, through a growing demand of CSR from consumers and other stakeholders of firms. Indeed, C&E (2017) reports that 72% of companies mention "access to people and contact" although 31% cite "access to new market" as reasons to engage in partnership with NGOs. Finally, corporate-NGO partnerships enable the sharing of partners' expertise: corporate expertise in management (ORSE, 2012) and NGO knowledge of societal and environmental issues (C&E, 2017). In summary, corporate-NGO partnership pursues a common objective, with differentiated positive impact for each partner, through complementarity of expertise of partners.

Most theoretical literature investigates optimal policies and corporate strategies for eco-labeling ignoring corporate-NGO partnership for eco-labeling (Bonroy and Constantatos 2015). A few papers study the role of NGOs as certifying organizations

[3] See the article entitled "Sustainable Seafood: the first 20 years. A history of the Marine Stewardship Council", http://20-years.msc.org/ (accessed 2018/04/19).

[4] Poret (2014) presents other examples of corporate-NGO partnerships for eco-labeling: the partnership between Rainforest Alliance and Unilever for its tea brand Lipton, and the 'Fair Trade Sourcing Partnership' proposed by Fairtrade International to chocolatiers.

[5] https://www.worldwildlife.org/initiatives/harnessing-forces-for-conservation# (accessed 2018/04/19).

that aim at improving the quality of the environment. The NGO's eco-label is considered as an alternative of a public or a corporate eco-label (Heyes and Maxwell, 2004, Bottega and De Freitas, 2009, Fischer and Lyon, 2014) or as a competitor of other public and/or corporate eco-label (Fischer and Lyon, 2014, Brécard, 2014, 2017) or even of another NGO's eco-label (Poret, 2016) but, to the best of our knoweldge, it has never been considered as a result from partnership with a firm.[6] The present paper attempts to fill this gap.

The development of corporate-NGO partnership takes time. Poret (2014) emphasizes three stages of partnerships for CSR: (1) the formation stage, in which the NGO and the firm identify and disclose their interests in a potential partnership; (2) The implementation stage, in which they commit to common objective and resource sharing, and (3) the outcome stage, in which both partners reap the benefits of the successful partnership. The current study translates such a partnership process into two periods: In a first period, the firm and the NGO bargain to decide on the stringency of the eco-label in accordance with their common goal; During this period, the firm and its competitor provide both an unlabeled 'brown' product in an homogeneous market. In a second period, the corporate partner adopts the eco-label and offers an eco-labeled 'green' product in a vertically differentiated market in which the competitor continues to provide a brown product. Beyond the corporate-NGO partnership, a third period can occur when the competitor also decides to adopt the eco-label and to provide a green product in a green homogeneous market. The eco-label diffusion is likely to be in the interest of the environmental NGO, by enhancing the quality of the environment, but against the interest of the corporate partner, which could be better off in a differentiated market than in a homogeneous market. This paper aims at investigating the respective roles of market-driven incentives and corporate-NGO partnership on the adoption and the diffusion of the eco-label.

In order to model the dynamic game of adoption and potential diffusion of an eco-label, the present model takes advantage of the literature on adoption and diffusion of product innovation. Hence, an eco-labeled product can be treated as a green product innovation, insofar as the eco-label certifies the high environmental quality of a product. Our model is close to Bonanno and Haworth (1998) who investigate the choice between product and process innovation in a model of vertical differentiation with Bertrand or Cournot competition. It departs from their model by assuming a pre-stage of partnership development, essential for credible eco-label implementation, by focusing on a specific product innovation, an eco-labeled product, and by studying the environmental consequences of adoption and possible diffusion of the eco-label depending on the nature of the competition. Because our paper focuses on a green product innovation, it is close to Galasso and Tombak (2014) who analyze the incentive of two firms to 'swith to green'. Our framework differs from their model by endogenizing the eco-labeled environmental quality, through the choice of the corporate-NGO partnership, by

[6] Poret (2016) assumes that NGOs compete to partner with firms that consider eco-labeling their products. She formalizes such a competition without assuming a real corporate-NGO partnership for setting eco-labeling criteria. In their literature review on environmental CSR, Lyon and Maxwel (2008) stress that "*firms may ally themselves with NGOs in an effort to enhance the credibility of their CSR claims to the public, to government, and perhaps their own employees*" as in Feddersen and Gilligan (2001), but they do not model such a partnership.

assuming consumers with preferences *à la* Mussa and Rosen (1978), by assuming an endogenous unit cost of production, depending on the level of the environmental quality, and by studying the possibility of total diffusion of the green product. As Bonanno and Haworth (1998) and Galasso and Tombak (2014), we analyze and compare the cases of Bertrand and Cournot competition because the nature of the competition is likely to alter firm incentives for eco-label adoption and NGO strategies and thus the quality of the environment.

The current paper provides new insights into the role of NGO in eco-labeling when a corporate-NGO partnership is required for the development and the adoption of an eco-label by the corporate partner (the leader). In addition, it addresses the issue of the partner's competitor (the follower) incentive to, in turn, adopt the eco-label. The uniqueness of this model stems from the assumption of corporate-NGO partnership and from the analysis of the eco-label as a green product innovation in a dynamic game of adoption and possible diffusion of a product innovation leading to vertical differentiation of products. The main results are fourfold. First, in line with the literature on adoption and diffusion of a product innovation, the leader's incentive to adopt the eco-label is stronger with Bertrand than with Cournot competition. Second, the follower can only be motivated to adopt the eco-label with Cournot competition, its incentive decreasing with the stringency of the label. Third, the higher is the bargaining power of the NGO, the more stringent is the eco-label standard whatever the nature of the competition. Moreover, depending on the bargaining power of the NGO, the eco-label may be more or less stringent with Bertrand than with Cournot competition. Fourth, the quality of the environment is generally higher with Bertrand than with Cournot competition when only the leader adopts the eco-label.

The rest of the paper proceeds as follows: Section 2 presents the model. Section 3 analyzes the Nash equilibrium in cases of market competition *à la* Bertrand and *à la* Cournot and the ensuing timing of eco-label adoption. Section 4 infers the eco-labeling strategies of the firms and the NGO involved in a partnership. Section 5 concludes.

2. The model

The duopoly game consists of two or three periods, each encompassing a two-stage game. In the first stage, firms decide on environmental quality to be produced. As environmental quality is a credence characteristic, a high quality can only be perceived as such by consumers if a credible eco-label is stamped on the product. In the second stage, prices or quantities are chosen, depending on the nature of market competition, which can be Cournot or Bertrand competition.

At the initial period (Period 0), because no credible eco-label is available and because quality is costly, both firms choose the worst quality named the 'brown quality'. Meanwhile, a firm, called the leader, bargains with the environmental NGO in order to develop an eco-label that could satisfy a common goal, that is a better quality of the environment associated with a higher profit for the corporate partner during the next period (Period 1). Once the leader adopts the eco-label, Period 1 begins with competition between a green eco-labeled product and a brown unlabeled product. If the follower also adopts the eco-label, its adoption triggers the beginning of Period 2, during which both firms provide a green product. Adoption timing stems from the usual objective of firms to maximize the present value of their flows of profits (Fundenberg

and Tirole, 1985). More precisely, following sections detail assumptions used for the three actors of the game: Consumers, firms and the environmental NGO.

3.1 Consumers

The indirect utility that a consumer derives from the consumption of one unit of the product of quality q_i, at price p_i, is a usual utility function à la Mussa and Rosen (1978):

$$u_i(\theta) = r + \theta q_i - p_i \tag{1}$$

where r is the consumer's gross utility from consuming one unit of the product[7], θ an environmental consciousness parameter which is uniformly distributed over $[0,\bar{\theta}]$ with $\bar{\theta} > 1$, θq_i willingness-to-pay for quality $q_i \in [\underline{q},\bar{q}]$ and p_i the price of product i. The green eco-labeled product is denoted with a subscript g and the brown unlabeled product is denoted with a subscript b ($q_g > q_b$).

In the case of homogeneous products (brown in Period 0 and green in Period 2), because only consumers with a parameter $\theta \geq \tilde{\theta} \equiv p_i/q_i$ purchase, the global demand is defined as $X_i = 1 - p_i/(\bar{\theta} q_i)$, with $X_i = 2x_i$ and x_i the demand for product i addressed to a firm, and the inverse demand function is $p_i = (1 - 2x_i)\bar{\theta} q_i$.

In the case of differentiated market (in Period 1), the consumer indifferent between buying the brown product q_b at price p_b or the green product q_g at price p_g is characterized by $\hat{\theta} \equiv (p_g - p_b)/(q_g - q_b)$, so that demand functions are defined as follows:

$$x_g = 1 - \frac{p_g - p_b}{\bar{\theta}(q_g - q_b)} \tag{2a}$$

$$x_b = \frac{p_g - p_b}{\bar{\theta}(q_g - q_b)} - \frac{p_b}{\bar{\theta} q_b} \tag{2b}$$

By inverting this system of demand functions, the inverse demand functions can be defined as:

$$p_g = \bar{\theta}(1 - x_g) q_g - \bar{\theta}\, x_b q_b \tag{3a}$$

$$p_b = (1 - x_b - x_g)\bar{\theta}\, q_b \tag{3b}$$

3.2 Firms

In the two-stage game, firms decide first on environmental quality q_i to be provided, with $q_i \in [\underline{q},\bar{q}]$, and choose then prices p_i if they compete *à la* Bertrand or quantities x_i if they compete *à la* Cournot. Firm profits are defined by:

[7] Assume that r is low enough to ensure that the market is uncovered.

$$\pi_i = \left(p_i - c(q_i)\right)x_i \quad i = b,g, \tag{4}$$

where $c(q_i)$ is the unit production cost, assumed strictly increasing and convex in quality, with the quadratic form $c(q_i) = \frac{1}{2}cq_i^2$. To ensure profitability of the firms, assume that the unit production cost of each firm is lower than the maximum WTP for its product: $c(q_i) \leq \bar{\theta}q_i$, that is $q_i \leq 2\bar{\theta}/c$

In the case of Bertrand competition (denoted by superscript *B*) on a homogeneous market, the price war results in a competitive price equal to the unit production cost, $p_i^B = \frac{1}{2}cq_i^2$, an equitable sharing of demand, $x_i^B = \frac{1}{2}\left(1 - \frac{cq_{ib}}{2\bar{\theta}}\right)$ and zero profits. Conversely, after label adoption by only one firm, quality differentiation softens price competition and leads to positive profits.

In the case of Cournot competition (denoted by superscript *C*), firms can earn positive profits even if the products are identical. However, as previously shown by Motta (1993), firms have an interest in differentiate their product, through eco-label adoption, in order to increase their profits.

The firm decisions of eco-label adoption arise from maximization of the present value of their profits. When leader *L* and follower *F* both adopt the eco-label, adoption dates T_L^s and T_F^s maximize the present values of profits defined as follows (with market competition strategies denoted $s = B,C$):

$$\Pi_j^s(T_L^s,T_F^s) = \int_0^{T_L^s} \pi_j^{s0} e^{-rt}dt + \int_{T_L^s}^{T_F^s} \pi_j^{s1} e^{-rt}dt + \int_{T_F^s}^{\infty} \pi_j^{s2} e^{-rt}dt - K\left(T_j^s\right) \quad j = L,F \quad s = B,C \tag{5}$$

with T_L^s the leader's adoption date (with $T_L^s \geq T_0$, the incompressible delay for eco-label bargaining and development), T_F^s the follower's adoption date (with $T_F^s \geq T_L^s$). π_j^{s0} are the net cash flows before adoption of the label, including fixed bargaining cost τ for the leader, π_j^{s1} the cash flows when only the leader uses the label and π_j^{s2} the cash flows when both firms have adopted the label. $r > 0$ is the interest rate. $K\left(T_j^s\right)$ is the present value of the cost implementing the eco-label at date T_j^s. Following Katz and Shapiro (1987) and Galasso and Tombak (2014), it is defined as $K(t) = k_0 e^{-\lambda t}$, with $\lambda > r$ the rate of technical progress, that is the speed at which the adoption cost declines over time. Adoption dates can therefore be given by:

$$T_L^{s*} = \frac{1}{\lambda - r}\log\frac{\lambda k_0}{\pi_L^{s1} - \pi_L^{s0}} \tag{6a}$$

$$T_F^{s*} = \frac{1}{\lambda - r}\log\frac{\lambda k_0}{\pi_F^{s2} - \pi_F^{s1}} \tag{6b}$$

Both firms adopt if $\pi_L^{s1} - \pi_L^{s0}$ and $\pi_F^{s2} - \pi_F^{s1}$ are positive. In this case, $T_L^{s*}$and T_F^{s*} are decreasing functions of, respectively, $\pi_L^{s1} - \pi_L^{s0}$ and $\pi_F^{s2} - \pi_F^{s1}$.

When the follower never adopts the label, the adoption date of the leader results from the maximization of:

$$\Pi_L^s(T_L^s) = \int_0^{T_L^s} \pi_L^{s0} e^{-rt} dt + \int_{T_L^s}^{\infty} \pi_L^{s1} e^{-rt} dt - K\left(T_L^s\right) \quad s = B,C \tag{7}$$

and the adoption date of the leader is defined by Equation (6a). Obviously, the leader is the only adopter of the eco-label when firms compete *à la* Bertrand because $\pi_F^{B2} = \pi_F^{B0} = 0$. Conversely, in the case of Cournot competition, the follower may be interested in eco-labeling if $\pi_F^{C2} \geq \pi_F^{C1} \geq 0$. In both cases, the adoption of the eco-label by only one firm should be in the interest of both competitors, unless the cost implementing the label $K\left(T_j^s\right)$ is too high.

3.3 The environmental NGO

The environmental NGO aims at enhancing the quality of the environment. Such a goal requires the development and the diffusion of the eco-label. The corporate-NGO partnership is assumed to be the only way to develop an eco-label, because, as explained in the introduction, the NGO needs corporate expertise and funding and, also the firm's customer network. The firm also needs the NGO for product eco-labeling because a corporate label would not be credible in the eyes of consumers whereas people largely trust NGO eco-label. Unlike the NGO, the firm is likely to have no interest in the adoption of the eco-label by its competitor, because global diffusion of the eco-label would return to a homogeneous market, with fiercer competition (Motta, 1993).

The corporate-NGO partnership aims therefore to achieve a win-win situation, where both the quality of the environment and the profit of the firm are enhanced. Such a common goal can be simply translated into the weighted sum of the objective of each partner. Moreover, one can assume that the partnership focus on the environmental and economic gains in Period 1 because the possible adoption of the eco-label by the competitor in Period 2 is in the only interest of the NGO. Therefore, we assume that the partnership common goal has a short-term horizon and consist in the following maximization program:

$$\begin{aligned} &\underset{q_g}{Max}\, \alpha E^{s1} + (1-\alpha)\pi_L^{s1} \\ &\text{s.t. } E^{s1} > E^{s0} \text{ and } \pi_L^{s1} > \pi_L^{s0} \end{aligned} \tag{8}$$

with $E^{s0} = 2q_b x_b^{s0}$ and $E^{s1} = q_b x_b^{s1} + q_g x_g^{s1}$ the quality of the environment at Periods 0 and 1 when firms use strategies s and α to NGO's bargaining power, such that $\alpha \in [0,1]$.

Beyond the partnership, the NGO is likely to pursue the global environmental objective to maximize the present value of the quality of the environment. In addition to the eco-label, the NGO could implement another strategy in order to further increase the market share of the labeled product to the detriment of the unlabeled product and to bring forward the adoption date of the follower (without compromising the corporate partnership). A usual strategy for environmental NGOs, such as WWF, is to promote consumer awareness of the environmental friendly products (Bottega and De Freitas, 2009, Brécard and Chiroleu-Assouline, 2018). This strategy will be investigated in further research.

3. Market competition and timing of eco-label adoption

Depending on the adoption decision of each firm, the different possible Nash equilibria are gathered in Table 1, where one of the two firms can equally plays the role of the leader although the other one plays the role the follower.

Tab.1 Gross profit matrix according to the eco-label strategies (with *s=B, C*)

		Firm 2	
		q_b	q_g
Firm 1	q_b	π_b^{s0}, π_b^{s0}	π_b^{s1}, π_g^{s1}
	q_g	π_g^{s1}, π_b^{s1}	π_g^{s2}, π_g^{s2}

3.1 Bertrand competition

During Period 0, firms compete on prices and cannot differentiate their product with an eco-label. They price the brown product at the unit production cost, $p_b^{B0} = \frac{1}{2} c q_b^2$, and equitably share the global demand, $x_b^{B0} = \frac{1}{2}\left(1 - \frac{c q_b}{2\bar{\theta}}\right)$. They earn zero profits on the sale of the brown product. Because corporate-NGO partnership is developed during Period 0, with a bargaining cost, τ, for the leader, profits are characterized by $\pi_L^{B0} = -\tau$ and $\pi_F^{B0} = 0$.

During Period 1, after the eco-label adoption by the leader, maximization of profits (4) with respect to prices leads to the following Nash equilibrium:

$$p_g^{B1} = \frac{4\bar{\theta}\left(q_g - q_b\right) + c\left(2{q_g}^2 + {q_b}^2\right)}{2\left(4q_g - q_b\right)} q_g \tag{9a}$$

$$p_b^{B1} = \frac{2\bar{\theta}\left(q_g - q_b\right) + \left(q_g + 2q_b\right) c q_g}{2\left(4q_g - q_b\right)} q_b \tag{9b}$$

Profits of the three firms are then defined by:

$$\pi_L^{B1} = \bar{\theta}\left(q_g - q_b\right)\left(x_g^{B1}\right)^2 \tag{10a}$$

$$\pi_F^{1} = \frac{\bar{\theta}\left(q_g - q_b\right) q_b}{q_g}\left(x_b^{B1}\right)^2 \tag{10b}$$

with quantities $x_g^{B1} = \frac{4\bar{\theta} - c\left(2q_g + q_b\right)}{4\bar{\theta}\left(2q_g - q_b\right)} q_g$ and $x_b^{B1} = \frac{2\bar{\theta} + c\left(q_g - q_b\right)}{2\bar{\theta}\left(4q_g - q_b\right)} q_g$. Cost-effectiveness of green product requires that $2q_g + q_b < 4\bar{\theta}/c$, although the brown product is always cost-effective.

During Period 2, after the eco-label adoption by the follower, price war leads to minimal price $p_g^{B2} = \frac{1}{2} c q_g^2$, market share $x_g^{B2} = \frac{1}{2}\left(1 - \frac{c q_g}{2\bar{\theta}}\right)$ and profits $\pi_L^{B2} = \pi_F^{B2} = 0$.

The timing of adoption of the eco-label can be deduced from profit flows at each period, illustrated in Figure 1.[8] Denoting I_j^B the firm *j*'s incremental profit from eco-label adoption, with $I_L^B \equiv \pi_L^{B1} - \pi_L^{B0}$ and $I_F^B \equiv \pi_F^{B2} - \pi_F^{B1}$, adoption incentives can be reduced to $I_L^B = \pi_L^{B1} > 0$ and $I_F^B \equiv -\pi_F^{B1} < 0$ because price competition lead to zero-profit equilibrium in Periods 0 and 2. Therefore, it is in the interest of the firms that only the leader adopts the eco-label. Moreover, the leader is always encouraged to eco-label adoption, as long as the eco-label standard is lower than a maximal threshold, defined by $q_g^{BL} \equiv \frac{4\overline{\theta} - cq_b}{2c}$, such that $\pi_L^{B1}\left(q_g^{BL}\right) = 0$. This threshold increases with the bargaining cost, τ. The date of adoption is then defined by the maximum between T_0 and date T_L^{B*} defined in Equation (6a).

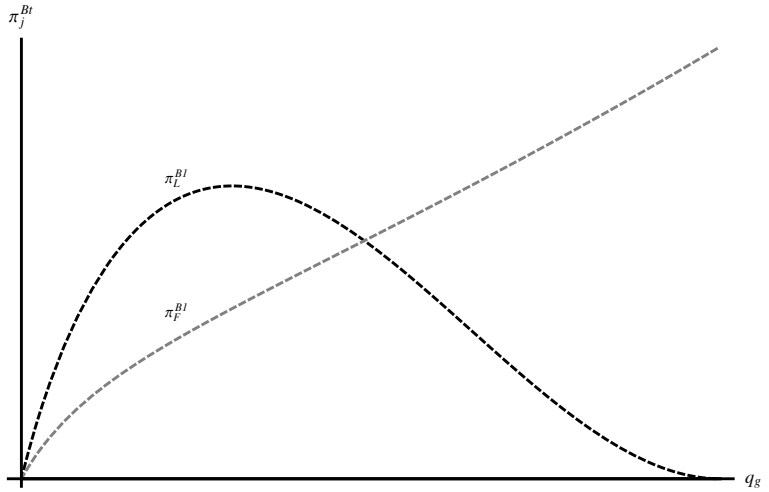

Fig.1 Effects of the eco-labeled quality on Bertrand profits during each period

Proposition 1. *When firms compete on prices, the eco-label is only adopted by the leader as long as the green minimum quality for the eco-label is lower than* $q_g^{BL} \equiv \frac{4\overline{\theta} - cq_b}{2c}$, *with* $q_b = \underline{q}$.

3.2 Cournot competition

During Period 0, maximization of profits (4) with respect to quantities leads to symmetrical Nash equilibrium $x_b^{C0} = \frac{1}{3}\left(1 - \frac{cq_b}{2\overline{\theta}}\right)$. The price is therefore equal to $p_b^0 = \frac{1}{3}\left(\overline{\theta}q_b + cq_b{}^2\right)$ and the profits are $\pi_L^{C0} = \pi_b^{CO} - \tau$ and $\pi_F^{C0} = \pi_b^{C0}$, with $\pi_b^{C0} = \overline{\theta}q_b x_b{}^2$.

During Period 1, after the eco-label adoption by the leader, the asymmetrical Nash equilibrium is characterized by:

[8] Numerical simulations have been performed using $\overline{\theta} = 3$, $c = 1$, $q_b = 1$ and $\tau = 0$.

$$x_g^{C1} = \frac{2\bar{\theta}\left(2q_g - q_b\right) - c\left(2q_g{}^2 - q_b{}^2\right)}{2\bar{\theta}\left(4q_g - q_b\right)} \tag{11a}$$

$$x_b^{C1} = \frac{2\bar{\theta} + c\left(q_g - 2q_b\right)}{2\bar{\theta}\left(4q_g - q_b\right)} q_g \tag{11b}$$

Profits are therefore defined by $\pi_L^{C1} = \bar{\theta} q_g \left(x_g^{C1}\right)^2$ and $\pi_F^1 = \bar{\theta} q_b \left(x_b^{C1}\right)^2$. Cost-effectiveness of green product requires that $\left(2q_g{}^2 - q_b{}^2\right) / \left(2q_g - q_b\right) < 2\bar{\theta}/c$, although the brown product is cost-effective if $-q_g + 2q_b < 2\bar{\theta}/c$ (that is always fulfilled when $q_g > 2q_b$).

During Period 2, Firms produces equilibrium quantity $x_g^{C2} = \frac{1}{3}\left(1 - \frac{cq_g}{2\bar{\theta}}\right)$ at price $p_g^{C2} = \frac{1}{3}\left(\bar{\theta} q_g + c q_g{}^2\right)$ and earn positive profits $\pi_L^{C2} = \pi_F^{C2} = \pi_g^{C2} = q_g \left(x_g^2\right)^2$.

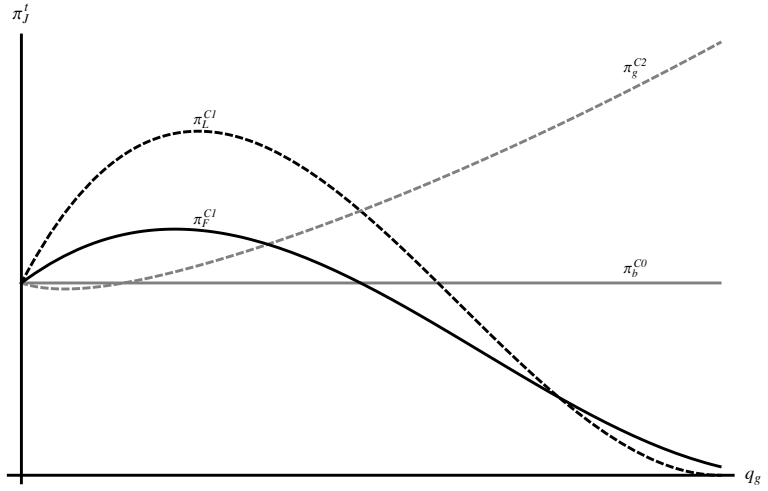

Fig.2 Effects of the eco-labeled quality on Cournot profits during each period

The timing of adoption of the eco-label crucially depends on the stringency of the eco-label resulting from the corporate-NGO partnership. Figure 2 depicts profits at each period of the game. Because π_L^{C1} is a bell-shaped function of q_g and π_L^{C0} is independent from q_g, the leader is always encouraged to eco-label adoption, as long as the eco-label standard is lower than a maximal threshold, denoted q_g^{CL}, such that $\pi_L^{C1}\left(q_g^{CL}\right) = \pi_L^{C0}$. Moreover, the adoption date is earlier when the bargaining cost is higher. Because π_F^{C1} is a U-shaped function of q_g while π_g^{C2} is a bell-shaped function of q_g and $\pi_g^{C2} - \pi_F^1\big|_{e_g = e_b} < 0$ (because $x_g^2 < x_b^1$), the follower is motivated to adopt the eco-label if q_g is lower than a given environmental quality, denoted q_g^{CF}, such that $\pi_F^{C1}\left(q_g^{CF}\right) = \pi_g^{C2}\left(q_g^{CF}\right)$

Denoting I_j^C the firm j's incremental profit from eco-label adoption, with $I_L^C \equiv \pi_L^{C1} - \pi_L^{C0}$ and $I_F^C \equiv \pi_F^{C2} - \pi_F^{C1}$, Figure 3 shows that $I_F^C < I_L^C$ for all $q_g > q_b$, which

implies that $q_g^{CF} < q_g^{CL}$.[9] Therefore, the leader is always more prone to adopt the eco-label than the follower. When the leader adopts the label, it has an interest in adopting it as soon as possible, at the date defined by the maximum between T_0 and date T_L^{C*} defined in Equation (6a). For intermediate levels of the green quality, the follower will also adopt the label, but latter than the leader in order to benefit from product differentiation during the period from T_L^{C*} to T_F^{C*} and to wait a reduced present value of the cost of implementing the eco-label. Adoption date T_F^{C*} is defined in Equation (6b).

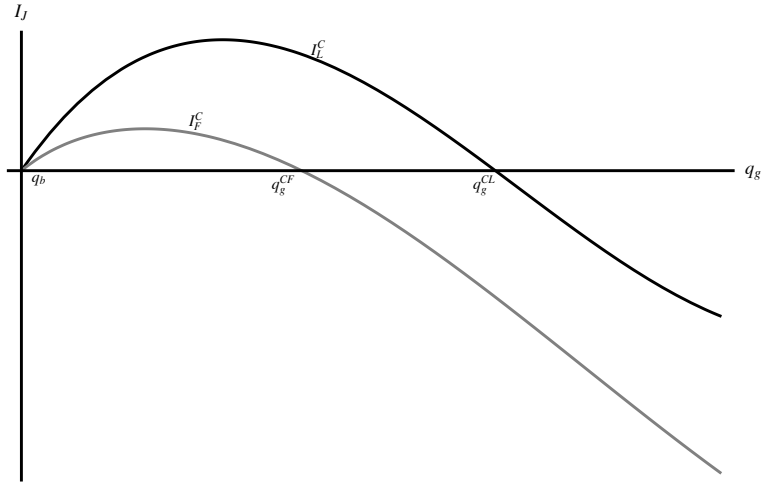

Fig.3 Effects of the eco-labeled quality on Cournot adoption incentive

Proposition 2. *When firms compete on quantities, the eco-label is likely to be adopted by the leader and by the follower. The diffusion rates decreases with the stringency of the eco-label standard:*

(i) *If* $q_g \in \left]q_b, q_g^{CF}\right]$, *both firms adopt the green product, the leader first, at time* T_L^{C*}, *and the follower latter, at time* T_F^{C*};

(ii) *If* $q_g \in \left]q_g^{CF}, q_g^{CL}\right]$, *only the leader adopts the green product at time* T_L^{C*};

(iii) *If* $q_g \in \left]q_g^{CL}, \overline{q}\right]$, *neither firm adopts the green product.*

Because the expressions of q_g^{CF} and q_g^{CL} are tricky and prevent an analytical demonstration of $q_g^{CF} > q_g^{CL}$, numerical simulations with a large set of relevant values of parameters have been performed in order to check the robustness of the results. With the set of parameters used for figures ($\overline{\theta} = 3$, $c = 1$, $q_b = 1$ and $\tau = 0$), the thresholds are $q_g^{CL} = 3.713$ and $q_g^{CF} = 2.605$.

3.3 Eco-label adoption and diffusion according to the nature of the competition

As expected, for a given vertical differentiation, Bertrand competition leads to lower prices, higher demands and lower profits than Cournot competition. Moreover, in the case of brown or green homogeneous market, Bertrand competition results in zero-profits whereas Cournot competition generates positive profits. The nature of the competition has therefore a crucial impact on incentive to adopt the eco-label.

[9] See the proof in Appendix.

Figure 4 illustrates that the leader's incentive to partner with the NGO is higher when it competes on prices. This result is in line with Galasso and Tombak (2014), who show that adoption time with Bertrand competition is lower or equal than adoption time with Cournot competition. However, in counterpart, global diffusion of the eco-label can only occur when firms compete *à la* Cournot because the follower never wants adopting the eco-label in the case of Bertrand competition. These results are summarized in Proposition 3.

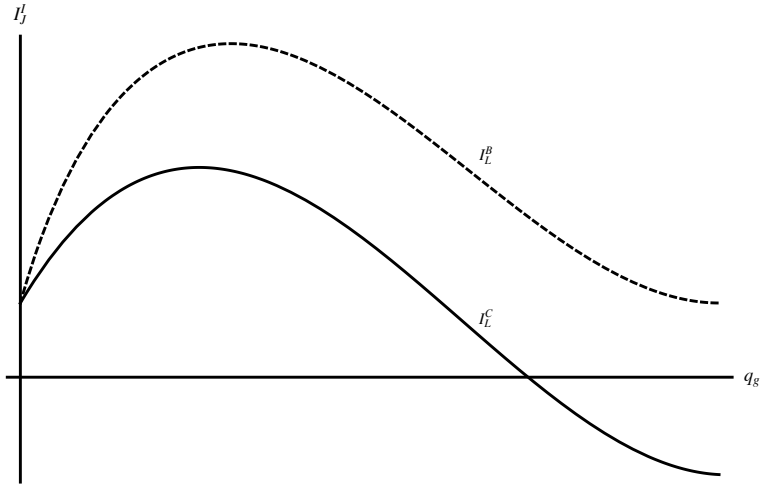

Fig.4 Effects of the eco-labeled quality on Bertand and Cournot leader's adoption incentive

Proposition 3. *The leader's incentive to adopt the eco-label is stronger with Bertrand than with Cournot Competition. Conversely, the follower may only be motivated to adopt the eco-label with Cournot competition.*

What are the ensuing effects on the quality of the environment? On the one hand, compared to Cournot competition, Bertrand competition favors high global demand and rapid adoption of the green product by the leader but, on the other hand, the brown product continues to be produced and consumed. The issue is central for the environmental NGO when it partners with a firm.

4. Corporate-NGO partnership

The corporate-NGO partnership aims to improve both the quality of the environment and the profit of the corporate partner through the development of an eco-label. The previous section has shown that, regardless of the nature of competition, the leader has an interest in vertically differentiating its product from the competing product through a credible eco-label in order to increase its profits, and has no interest in the adoption of the eco-label by its competitor because global diffusion of the eco-label would return to a homogeneous market, with fiercer competition. The issue of the quality of the environment still has to be explored before investigating the common eco-labeling strategy of both partners.

4.1 Bertrand competition

In the case of Bertrand competition, the introduction of the eco-label generates an increase in the quality of the environment in Period 1 compared to Period 0:

$$E^{B0} = \frac{2\bar{\theta} - c\,q_b}{2\bar{\theta}} q_b \leq E^{B1} = \frac{2\bar{\theta}\left(2q_g + q_b\right) - c\left(2{q_g}^2 + {q_b}^2\right)}{2\bar{\theta}\left(4q_g - q_b\right)} q_g \tag{11}$$

The inequality is fulfilled when $2\bar{\theta} > 3cq_b$ and $q_g \leq q_g^{BN}$, with $q_g^{BN} \equiv \frac{2\bar{\theta} - cq_b + \sqrt{\left(2\bar{\theta} - cq_b\right)\left(2\bar{\theta} - 3cq_b\right)}}{2c}$.

The NGO-corporate partnership aims to maximize the weighted sum of the objectives of each partner in Period 1, that is $\alpha E^{B1} + (1-\alpha)\pi_L^{B1}$. Figure 5 depicts both goals depending on green quality q_g. The participation constraints $E^{B1} > E^{B0}$ and $\pi_L^{B1} > \pi_L^{B0}$ are fulfilled for intermediate levels of green quality, such that $q_g < \overline{q}_g^{BN} < \overline{q}_g^{BL}$, with $E^{B1}\left(q_g^{BN}\right) = E^{B0}$.[10]

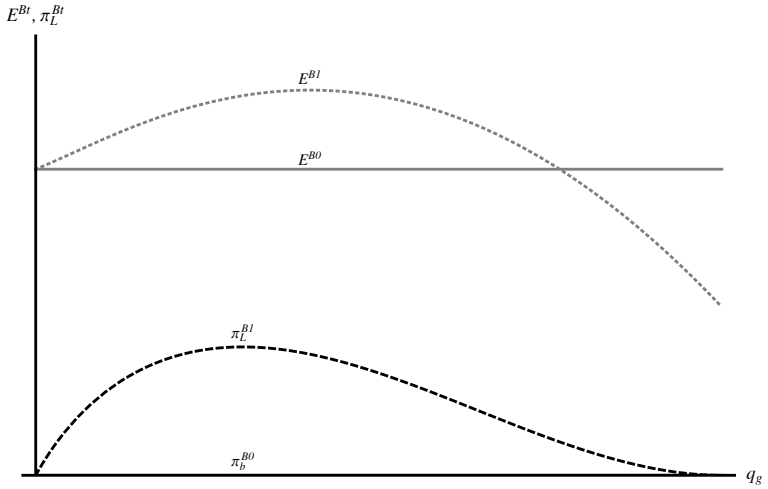

Fig.5 Effects of the eco-labeled quality on the environment and the Bertrand partner profit

The environmental standard resulting from eco-label bargaining, denoted $q_g^{B^*}$, is intermediate between the green quality maximizing the profit of the leader (chosen when $\alpha = 0$) and the green quality maximizing the quality of the environment (chosen when $\alpha = 1$).[11] The expression of $q_g^{B^*}$ is not simple. Therefore, we only give in Table 2 numerical examples of the Nash Equilibrium in Period 1 according to α using specific parameters ($\bar{\theta} = 3$, $c = 1$ and $q_b = 1$). In this case, the starting level of the quality of the environment is $E^{B0} = 0.833$ and the initial profits are zero.

[10] Note that $q_g^{BL} > q_g^{BN}$ since $q_g^{BL} - q_g^{BN} \equiv \frac{2\bar{\theta} - \sqrt{\left(2\bar{\theta} - cq_b\right)\left(2\bar{\theta} - 3cq_b\right)}}{2c} > 0$.

[11] The analytical expressions of these qualities are too complex to allow any analysis, but simulations using c=1 and $q_b = 1$, show that the quality maximizing the profit is lower than the quality maximizing the environmental quality when $\bar{\theta} \geq 2$ and higher when $\bar{\theta} \in \left[\left(2q_g + 1\right)/4\,,\,2\right]$ (ensuring $x_g^{B1} \geq 0$).

Tab.2 Green quality, profits and quality of the environment with competition *à la* Bertrand

α	0	0.25	0.5	0.75	1
$q_g^{B^*}$	2.357	2.440	2.544	2.692	2.799
E_1^B	1.033	1.039	1.044	1.047	1.049
π_L^{B1}	0.349	0.349	0.346	0.339	0.330
π_F^{B1}	0.203	0.211	0.221	0.233	0.246

Table 2 shows that, unsurprisingly, the eco-label stringency increases with the bargaining power of the NGO. A higher standard is beneficial to the environment but detrimental to the leader. Notwithstanding, the leader takes advantage of the adoption of the eco-label. For the follower, larger differentiation is more gainful. The date of adoption of eco-label is all the sooner as α is close to zero. However, this date also depends on the adoption cost of the eco-label (k_0), the discount rate (r) and the rate of technical progress in eco-labeling (λ). $T_L^{B^*}$ is equal to T_0 when λ is close to r and/or k_0 is close to zero. An increase in k_0 postpones the adoption date, although an increase of λ brings forwards the adoption date.[12]

4.2 Cournot competition

In the case of Cournot competition, the quality of the environment is likely to be the highest after the adoption of the eco-label by both firms, insofar as q_g is not too high:[13]

$$E^{C0} = \frac{2\overline{\theta} - c\,q_b}{3\overline{\theta}} q_b \leq E^{C1} = \frac{4\overline{\theta} q_g - c\left(2{q_g}^2 - q_b q_g + {q_b}^2\right)}{2\overline{\theta}\left(4q_g - q_b\right)} q_g \leq E^{C2} = \frac{2\overline{\theta} - c\,q_g}{3\overline{\theta}} q_g \qquad (12)$$

The objectives pursued by the NGO and the leader in the partnership are illustrated in Figure 6. The participative constraints are fulfilled for intermediate levels of green quality such that $q_g < \overline{q}_g^{CL} < \overline{q}_g^{CN}$, with $E^{C1}\left(q_g^{CN}\right) = E^{C0}$.[14]

[12] For instance, when $\alpha = 0.5$ and $r = 0.2$, $T_L^{B^*} = Max\left[T_0, 1.01\right]$ for $\lambda = 1$ and $k_0 = 1$ and $T_L^{B^*} = Max\left[T_0, 0.83\right]$ for $\lambda = 2$ and $k_0 = 1$.

[13] See the proof in Appendix.

[14] The analytical expressions being complex, simulations have been computed, using c=1 and $q_b = 1$, to show that the maximal qualities fulfilling the incentives constraints always satisfy $\overline{q}_g^{CL} < \overline{q}_g^{CN}$ although the quality maximizing the profit is lower than the quality maximizing the environmental quality for all $\overline{\theta}$.

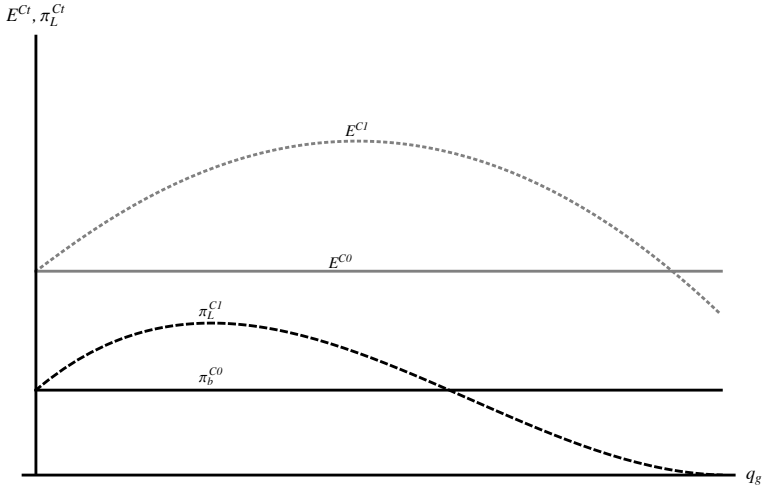

Fig.6 Effects of the eco-labeled quality on the environment and the Cournot partner's profit

The environmental standard resulting from eco-label bargaining, denoted q_g^{C*}, is intermediate between the green quality maximizing the profit of the leader and the green quality maximizing the quality of the environment. As in the Bertrand case, the expression of q_g^{C*} is tricky. Therefore, Table 3 provides examples of the Nash Equilibrium for parameters $\overline{\theta} = 3$, $c = 1$ and $q_b = 1$, for which, in Period 0, the quality of the environment is equal to 0.555 and the profits are equal to 0.231.

Tab.3 Green quality, profits and quality of the environment with competition *à la* Cournot

	α	0	0.25	0.5	0.75	1
	q_g^{C*}	2.152	2.353	2.597	2.862	3.109
Period 1	E^{C1}	0.835	0.863	0.889	0.905	0.910
	π_L^{C1}	0.414	0.410	0.394	0.367	0.334
	π_F^{C1}	0.252	0.263	0.277	0.294	0.311
Period 2	E^{C2}	0.920	0.954	0.982	0.998	0.999
	π_g^{C2}	0.295	0.290	0.278	0.261	0.241

Table 3 highlights that a higher bargaining power of the NGO increases the eco-label stringency, thus improving the quality of the environment while reducing the profit of the leader to the benefit of the follower in Period 1. However, a more demanding standard decreases the profit of both firms in Period 2, weakening the incentive of the follower to adopt the eco-label. Moreover, when λ is close to r and/or k_0 is close to zero, the leader wants to adopt the eco-label as soon as possible whereas the follower does not adopt the eco-label or adopts it at a distant date. An increase in k_0 postpones the adoption date, although an increase of λ brings forwards the adoption date.[15]

[15] For instance, when $\alpha = 0.5$ and $r = 0.2$, $T_L^{C*} = T_0$ and $T_F^{C*} = 109.27$ for $\lambda = 0.21$ and $k_0 = 0.1$, $T_L^{C*} = Max[T_0, 1.67]$ and $T_F^{C*} = Max[T_0, 8.72]$ for $\lambda = 1$ and $k_0 = 1$ and $T_L^{C*} = Max[T_0, 1.12]$ and $T_F^{C*} = Max[T_0, 3.14]$ or $\lambda = 2$ and $k_0 = 1$.

4.3 Eco-labeling strategies according to the nature of the competition

Proposition 4. *When the bargaining power of the NGO, α, increases from 0 to 1, the eco-label standard, q_g^{s*}, increases whatever the nature of the competition. When α is lower (respectively higher) than a given threshold, $\hat{\alpha}$, the eco-label is more (resp. less) stringent with Bertrand than with Cournot competition: $q_g^{B*} \geq q_g^{C*}$ (resp. $q_g^{B*} < q_g^{C*}$).*

Comparison of eco-labeling strategies between the cases of Bertrand and Cournot competition evidences that the leader has an interest in differentiating more under Bertrand than under Cournot competition (see Tables 2 and 3 for $\alpha = 0$). This result is in line with Motta (1993), who shows a similar result when both firms choose their quality levels and consumers are perfectly informed. However, the NGO has an opposite interest (see Tables 2 and 3 for $\alpha = 1$). Indeed, larger differentiation relaxes price competition, for the benefit of the firms, but discourages green consumption, to the detriment of the environment. Therefore, $q_g^{B*} \geq q_g^{C*}$ when the leader has a great bargaining power whereas $q_g^{B*} < q_g^{C*}$ when α is higher than a given threshold (equal to 0.408 in the numerical example).

Proposition 5. *For given green quality q_g, the index of environmental quality is higher with Bertrand than with Cournot competition in Periods 0 and 1 because of two effects:*
(i) The scale effect due to higher consumption of both products;
(ii) The composition effect due to the higher market share of the green product when q_g^{s*} is lower than a given threshold, $\hat{q}_g$.
The average environmental quality is better with Bertrand than with Cournot competition in Period 1 when $q_g < \hat{q}_g$.

Because the market is uncovered, comparison of the quality of the environment according to the nature of the competition requires distinguishing the scale effect from the composition effect of consumption. The scale effect arises from global consumption $x_b^{st} + x_g^{st}$, which is higher, all other things being equal, when firms compete on prices than when they compete on quantities, in such a way as $E^{Bt} > E^{Ct}$ for $t = 0, 1$. The composition effect corresponds to the share of the green product in consumption, that is $x_g^{st} \Big/ \left(x_b^{st} + x_g^{st}\right)$, which is also higher when firms compete on prices than when they compete on quantities when q_g is lower than the following threshold:

$$\hat{q}_g = \frac{4\bar{\theta} - cq_b - \sqrt{\left(8\bar{\theta} - 3cq_b\right)cq_b}}{2c} \tag{13}$$

Indeed, competition on prices exerts downwards pressure on the relative price of the green product, $p_g^{sl} \big/ p_b^{sl}$. The market share of the green product is then favored. Therefore, the average environmental quality of consumption, defined as $e^{st} \equiv E^{st} \Big/ \left(x_b^{st} + x_g^{st}\right)$, is higher with Bertrand than with Cournot competition when

$q_g < \hat{q}_g$. In the numerical example, $\hat{q}_g$ is equal to 3.209 and is higher than q_g^{B*} and q_g^{C*} for all α.[16] However, because $q_g^{B*} < q_g^{C*}$ when $\alpha > \hat{\alpha}$, the average environmental quality may be higher with Cournot than with Bertrand competition in the Nash Equilibrium in Period 1. In the numerical example, $e^{C1} > e^{B1}$ when α is higher than 0.495, but differences in the average quality are very small for all α.[17] Diffusion of the eco-label in Period 2, in the case of Cournot competition, could further improve the average and total quality of the environment in such a way as Cournot competition is more environmentally friendly than Bertrand competition ($e^{C2} = q_g > e^{B1}$).

5. Conclusion

How can an eco-label emerge from a corporate-NGO partnership? How can an environmental NGO both favor eco-label development and adoption by its corporate partner and eco-label diffusion to its partner's competitor? Treating the eco-label as a product innovation, we have investigated a two or three-period game in which a firm and an environmental NGO bargain first to develop an eco-label fulfilling their common goal, next the corporate partner adopts the label in order to vertically differentiated its product from the unlabeled one, and next its competitor can also adopt the label if the eco-labeled product is more cost effective than still supplying the differentiated, low quality product.

In this original framework, we have shown that the nature of the competition affect the stringency of the eco-label, the corporate partner incentive to adopt the eco-label and the partner competitor incentive to adopt the eco-label too. In line with the literature on adoption and diffusion of a product innovation, the model highlights that the leader (in partnership with the NGO) has a stronger incentive to adopt the eco-label in Bertrand than in Cournot competition. Moreover, the diffusion of the eco-label to the follower can only occurred when firms compete *à la* Cournot. In this case, the follower incentive to adopt the eco-label decreases with the stringency of the eco-label decided in the first period by the leader and the NGO. The stringency of the eco-label depends on the nature of the competition and on the bargaining power of the NGO, that is the weight of the quality of the environment in the common goal of the corporate-NGO partnership. The higher is the bargaining power of the NGO, the more demanding is the eco-label standard whatever the nature of the competition. When the profit criterion dominates in the partnership (*i.e.* the bargaining power of the NGO is relatively low), the eco-label is more stringent with Bertrand than with Cournot competition. However, when the environment criterion dominates (*i.e.* bargaining power of the NGO is relatively high), the eco-label is more stringent with Cournot than with Bertand competition. Finally, because Bertrand competition favors both global consumption and the market share of the green product, compared to Cournot competition, the quality of the environment is likely to be higher with Bertrand competition than with Cournot competition, although the diffusion of the eco-label does not occur in Bertrand competition.

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[16] Simulations using c=1 and $q_b = 1$, show that this result is true for all $\bar{\theta} \geq 2$

[17] For instance, when $\alpha = 0$, $e^{B1} = 1.625$ and $e^{C1} = 1.537$ and when $\alpha = 1$, $e^{B1} = 1.736$ and $e^{C1} = 1.780$.

To enrich the paper, it would be worthwhile to study how the environmental NGO could implement "private politics' *à la* Baron (2011) in order to further increase the market share of the labeled product to the detriment of the unlabeled product and to bring forward the adoption date of the follower (without compromising the corporate partnership). Such a strategy will be investigated in further research.

Appendix

Proof of proposition 2

$I_F^C < I_L^C$ because when q_g tends to q_b, $I_F\big|_{q_g=q_b} = 0$ and $I_L\big|_{q_g=q_b} = 0$ and I_L grows faster than I_F when q_g is close to q_b:

$$\left.\frac{\partial I_L}{\partial q_g}\right|_{q_g=q_b} = \frac{\left(2\overline{\theta} - c\,q_b\right)\left(14\overline{\theta} - 19c\,q_b\right)}{108\overline{\theta}} > \left.\frac{\partial I_F}{\partial q_g}\right|_{q_g=q_b} = \frac{\left(2\overline{\theta} - c\,q_b\right)\left(10\overline{\theta} - 17c\,q_b\right)}{108\overline{\theta}}$$

and $\overline{\theta} > 19c\,q_b/14$ (ensuring that I_L is an increasing function of q_g when q_g tends to q_b).

Proof of proposition 3

In order to prove that $I_L^B > I_L^C$, note $I_F\big|_{q_g=q_b} = \tau$ and $I_L\big|_{q_g=q_b} = \tau$. Moreover, we can express the inventive difference as follows:

$$I_L^B - I_L^C = \frac{q_b\left(q_g - q_b\right)\left[4\left(16q_g - q_b\right)\overline{\theta}^2 - 4\left(16q_g - q_b\right)cq_b\overline{\theta} + \left(9{q_g}^2 + 16q_bq_g - q_b^2\right)c^2q_b\right]}{36\overline{\theta}\left(4q_g - q_b\right)^2}$$

The determinant of the polynomial into brackets, equal to $\Delta = -144\left(16q_g - q_b\right)c^2q_b{q_g}^2$, is negative. This implies that the polynomial has the sign of $4\left(16q_g - q_b\right)$, which is positive. Therefore, $I_L^B > I_L^C$.

Proof of comparison between the quality of the environment at each period in the Cournot Case.

Assuming $2\overline{\theta} > c\,q_g > c\,q_b$, we have:

$$E^1 - E^0 = \frac{q_g - q_b}{\overline{\theta}\left(4q_g - q_b\right)}\left[4\overline{\theta}q_g\left(3q_g - q_b\right) - c\left(6{q_g}^2 + 3q_bq_g - 2{q_b}^2\right)\right]$$

The term into brackets is positive for

$$q_g \in \left[q_b, \frac{12\overline{\theta} - 3cq_b + \sqrt{3\left(48\overline{\theta}^2 - 56\overline{\theta}cq_b + 19c^2{q_b}^2\right)}}{12c}\right]$$

$$E^2 - E^1 = \frac{q_g - q_b}{6\overline{\theta}\left(4q_g - q_b\right)}\left[4\overline{\theta} - 2cq_g - 3cq_b\right]$$

The term into brackets is positive for $q_g \in \left[q_b, \frac{4\bar{\theta} - 3cq_b}{2c} \right]$

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