Label Battles: Competition among NGOs as Standard Setters*

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Abstract

This paper examines competition among NGOs that act as standard-setting organizations. We consider a double duopoly model wherein NGOs compete to offer firms labels for sustainability quality and firms compete to sell consumers differentiated products. We assume that NGO preferences for standard levels differ, with some being mission-driven organizations and others being market-driven organizations. We find that these two NGO types must have very different preferences to be present in the label market. Moreover, competition between these two types NGOs leads to a decrease in standard provided by mission-driven NGOs and an increase in overall weighted sustainability quality.

Keywords: labels, NGOs, vertical product differentiation, sustainability quality.

JEL classification: L13, L15, L31, Q01.

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1 Introduction

The Ecolabel Index, which is an existing directory of labels, currently tracks 463 ecolabels in 199 countries and 25 industry sectors, including the European Union organic products label; Fairtrade International, an association of 25 organizations around the world; the Marine Stewardship Council (MSC), a standard for sustainable fishing; GlobalGAP, a private sector body for the certification of agricultural products; and the Non-GMO (Genetically Modified Organism) Project, an organization offering independent verification of testing and GMO controls for products in North America.[1]

A label is a logo that indicates that a product or company has met a standard. A standard is part of a governance mechanism designed to ensure sustainable development, a tripartite standards regime that includes standard-setting organizations, certification bodies and accreditation authorities (Loconto and Busch, 2010). In this article, we consider only standard setters. Standards are set by different types of actors: governments, industries, approved certification bodies, and non-governmental organizations (NGOs). According to the 2010 Global Ecolabel Monitor, most ecolabels (58%) were operated by non-profit organizations, 18% by for-profit organizations, 8% by governments, and the remainder being composed of other actors (e.g., industry associations, hybrid for/non-profit partnerships, public-private partnerships) (Big Room Inc. and World Resources Institute, 2010).

On the corporate side, more than one-third of multinational companies have voluntary third-party certifications for environmental or social standards (Kitzmueller and Shimshack, 2012). NGOs appear to be preferred as standard-setting partners by firms in many fields, including sustainable agriculture, fishing, packaging, supply chain management, labor issues, renewable energy, forest resources, health, and safety.

The increasing presence of NGOs and the trust they arouse among citizens/consumers afford them the power to positively influence private sector behavior through constructive partnerships. Some NGOs' motivations for such collaborations with the private sector are identifiable. Their primary motivation is money. Indeed, the increasing scarcity of public funds and the increasing

[1]The Ecolabel Index was initiated in 2009 by Big Room Inc., a Vancouver-based company, and the World Resources Institute, a Washington DC-based environmental think tank (http://www.ecolabelindex.com, accessed 10.11.15).

number of NGOs force them to find new sources of funding. Because corporations enjoy relatively easy access to financial resources, NGOs are motivated to establish alliances. Another motivation for NGO collaboration with corporations is raising people's awareness of societal problems. Indeed, a partnership provides one way to sensitize corporate clients to an NGO's cause. Moreover, a positive consequence of such partnerships is an increase in notoriety: an association with a firm that occupies a strategic position in the market is one way for an NGO to strengthen its reputation, public image and political influence (Selsky and Parker, 2005; Austin and Seitanidi, 2012).[2]

The roles of standard setters and their relationships with firms these roles imply offer both opportunities and risks for NGOs. An NGO's reputation and legitimacy may increase through cooperation with a reputable partner. Conversely, an NGO's reputation may be damaged if a partner is involved in a scandal. Likewise, an NGO may face serious repercussions if a partnership sours. It may lose its credibility and legitimacy among consumers/citizens, corporations, and other organizations, and credibility and legitimacy constitute critical forms of capital for NGOs (Poret, 2014). For example, a risk of greenwashing, beyond undermining the firm's reputation, is spillover to the NGO partner. Such spillover is more likely to occur when the partnership is materialized through a product label, which connects the NGO's name to the firm's brand. Another risk is dependency. An NGO needs corporations to implement its standards to achieve its objectives and, thus, to exist. Firms offering labeled products pay license fees, which represent a revenue source, to the NGO to use its label/logo. Because of their large market shares, volumes traded and sales made, large mainstream companies are the largest revenue raisers. This creates a dangerous dependency between NGOs and conventional firms. Some mainstream companies have also developed standards in association with either NGOs or certification bodies. Finally, the development of sustainability labels has created a real market of labels whose proliferation creates competition among them. The risk is then that "a bad label drives out a good one", that is, a less stringent and less costly standard becomes leader on the market and the benchmark for the concept. The competition among NGOs as standard-setting organizations is the central point of this paper.

A good example of this phenomenon is the Lipton-Rainforest Alliance partnership and the evolution of Fairtrade label. In May 2007, Unilever, the world's largest tea company, announced plans to source its entire tea supply sustainably. The objectives of this CSR activity, as revealed

[2]For instance, the concept of fair trade has experienced an impressive expansion following the launch of the Max Havelaar label (Fairtrade) for brand-name products and private-label products sold in large retail stores (Poret, 2010).

by Unilever, were to secure its supply through a long-term partnership; to rebuild Lipton's market share; to recover potential increases in supply cost through sales growth; and to obtain a first-mover advantage in the tea market, as no other major tea brands had initiated this type of approach. These objectives suggested that an alliance with an NGO might provide the best solution for Lipton to establish a tripartite standards regime with a label. Three labels developed by NGOs were considered by Unilever: Fairtrade (or FLO), UTZ Certified, and Rainforest Alliance. Unilever chose the Rainforest Alliance based on their common approach, which includes the ability to work on an international scale with both large-scale plantations and small farmers, the use of market-based premium for farmers, the ability to help move an entire industry and the same perspective of sustainability and mainstream strategy[3] (Poret, 2010). With this partnership, the Rainforest Alliance can benefit from the notoriety and visibility of the Lipton brand, especially in Europe where the NGO and its logo were not well known. The Rainforest Alliance aims to conserve biodiversity and ensure sustainable livelihoods by transforming land-use practices, business practices and consumer behaviors. The Rainforest Alliance sustainable agriculture standard, like the UTZ Certified standard, does not offer producers a minimum guaranteed price as required by the Fairtrade scheme, thus leaving them vulnerable to market price fluctuations. Therefore, Unilever chose a less demanding standard in terms of social criteria.

Fairtrade International recently proposed the development of a Fairtrade Sourcing Partnership (FSP) with a new fair trade label. Currently, for a product to bear the Fairtrade logo, all ingredients that can be certified must be and a minimum of 20% of the total product must be composed of Fairtrade-certified ingredients. The FSP would shift this policy and use a new logo to certify products containing only one certified ingredient – sugar, cocoa, or cotton – even if the ingredient represents less than 20% of the total product. This new scheme aims to increase the volume of commodities being purchased from Fairtrade-certified farmers and to engage companies that either do not want to commit to the full cost of certifying their products or are only interested in particular commodities. This new labeling scheme raises questions, especially in the cocoa sector wherein recurring supply shortages and changing demand has moved the global cocoa value chain toward more sustainable production processes. Indeed, most major chocolatiers have announced they will be Fairtrade, UTZ Certified, or Rainforest Alliance certified by 2020. These two latter NGOs

[3]Tensie Whelan, Rainforest Alliance Executive Director, said in 2007: "We are delighted to be working with a company that understands the value of putting sustainability at the heart of its business".

are more recent and attractive to manufacturers because they have less demanding economic and social standards than the Fairtrade label. This implies the Fairtrade label was losing market share. According to organizations such as Oxfam, this loss may explain the development of the FSP. Nine companies signed up for the FSP when it launched in 2014. Indeed, Mars and other major brands, such as Rewe and Lidl, were among the first to commit to the FSP. All chocolate bars contain sugar, cocoa and other ingredients that can be certified; thus, the risk is a decrease in demand affecting producers of certified sugar, nuts and vanilla because major chocolate brands would no longer have to buy these ingredients under fair trade conditions to use a Fairtrade label. Some observers also highlight that the new certification may confuse consumers and risks marginalizing the traditional Fairtrade label and eroding its credibility.

Voluntary labels with similar criteria are increasingly being established by NGOs. This paper proposes to analyze the competition among NGOs acting as standard-setting organizations. Our aim is to examine the strategies used by some NGOs in the competitive context of the label market.

Despite the importance of NGOs presence, economic analyses of competition among NGOs are rare. Such competition is studied in their fundraising activities in the donation market. Rose-Ackerman (1982) models NGOs that differ along one dimension, ideology, to decide which portion of donor revenues to devote to fundraising efforts. The main result is that competition for donations leads NGOs to engage in excessive fundraising in the sector. In Aldashev and Verdier (2009, 2010), horizontally differentiated NGOs act as producers of goods and services in developing countries and compete with each other in fundraising activities (e.g., direct mailing, door-to-door campaigns, advertising in the media, organizing dinners). Aldashev and Verdier (2009) explain the phenomenon of the internationalization of major development NGOs similarly to that of multinational firms. Aldashev and Verdier (2010) examine a model in which NGOs allocate their time between working on a project and engaging in fundraising. They find that with free entry of NGOs, the equilibrium number of NGOs can be either larger or smaller than the socially optimal number, depending on the efficiency of the fundraising technology.

The approach of this paper is closer to the literature on the economics of labels (see Bonroy and Constantanos (2015) for a review of this topic). A substantial body of literature compares standard levels by the type of standard-setting organization: government, NGO, or industry (Heyes and Maxwell, 2004; Bottega and De Freitas, 2009; Bottega et al., 2009; Manasakis et al., 2013). Fischer and Lyon (2014, 2013) examine competition between an NGO and a for-profit industry

association. Fischer and Lyon (2014) find that the environmental benefits may be smaller in the presence of both labels than in the presence of the NGO label alone. Fischer and Lyon (2013) show that when the number of firms is fixed, the industry sets an ambitious binary standard, while the NGO sets a basic binary standard. When there is free entry into the market, the NGO sets an ambitious binary standard, and the industry declines to offer a label. In these papers, the objective of the NGO is to maximize environmental quality or minimize a specific harm, which is usually related to an externality.

Theoretically, our model is based on the quality competition literature in the case of a partially covered market. Ronnen (1991), Motta (1993), Wauthy (1996) and Amacher et al. (2005) consider quality choices using duopoly models of vertical product differentiation, where firms simultaneously choose the quality of the product and then compete on price. For consumers and firms, our model follows the hypotheses proposed in Motta (1993) and Amacher et al. (2005), who study a duopoly equilibrium with the characterization of firm quality choice under partial market coverage for both variable and fixed quality costs.

This study differs from previous works in several ways. Most importantly, we model rivalry between two labels created by different NGOs, that is, by two organizations of the same type. We nevertheless suggest that the NGOs' preferences can be very different. Some NGOs are mission-driven organizations whose activities are exclusively cause oriented, with a strong commitment to values such as ensuring fair trade or preventing child labor. Their objectives are then clearly oriented toward the stringency of their standards, that is, the quality of the label. Other NGOs collaborate with large companies and often offer made-to-measure standards. These NGOs may be seen as market-driven organizations whose objectives stimulate trade to fully promote their causes.[4] We assume that NGOs seek to maximize a utility function in which they trade off between the quality and quantity of products sold under their label. That is, in the context of NGO-created sustainability labels, NGOs may have an impact on an issue through two channels: quality or quantity. We then consider a duopolistic vertical differentiation model with two sustainability labels whose quality levels are endogenously chosen by each NGO. Our key finding is that the coexistence of both labels is possible only if the NGOs' preferences in terms of sustainability

[4]This terminology is borrowed from Raynolds (2009), who distinguishes among "mission-driven", "quality-driven" and "market-driven" corporations, a continuum that represents an increasing interest in traceability rather than in partnership.

quality are extremely different. Competition between the NGOs induces a decrease in the level of the most stringent sustainability quality standard relative to its monopoly standard. Moreover, competition induces an increase in the overall weighted sustainability quality.

The remainder of this paper proceeds as follows: Section 2 presents the model. Section 3 analyzes the firms' choices for prices and labels. Section 4 characterizes the equilibrium labeling scheme for the two NGOs and compares the results with the benchmark cases. Finally, Section 5 concludes.

2 The Model

We develop a Bertrand duopoly model of vertical differentiation. Sustainability quality is the vertical differentiation variable. It represents some composite characteristic expected to objectively and synthetically measure the attention paid by the firm to sustainable development. It can be viewed as a measure of firm CSR activities.

Sustainability quality is promoted by two NGOs acting as standard setters, A and B, which can propose two different labels with sustainability quality level s_j, with $s_j > s_0$ for $j = A$ or $j = B$. Following García-Gallego and Georgantzís (2009), it is assumed that the standard product with low sustainability quality s_0 is sold at the competitive price by a competitive fringe of firms, which do not adopt any labels. For simplicity, we assume that $s_0 = 0$. Therefore, if one of the two firms wants to sell the product at a higher price than the competitive one, potentially yielding positive profits, it has to adopt a label guaranteeing the sustainability quality of the good.

We present the model for the case where $s_A > s_B$, and the results are given for both cases, $s_A > s_B$ or $s_B > s_A$.

2.1 Firms

On the supply side of the product market, we consider two symmetric firms, 1 and 2. The firms' marginal costs depend on the chosen label and are defined as

$$c(s_j) = (c\, s_j + k)s_j \quad \text{for } j = A \text{ or } B. \tag{1}$$

The marginal cost function $c(s_j)$ has two components. The first component, $c\, s_j^2$, represents the quadratic cost of providing sustainability quality for firms. The marginal cost of meeting the label

j requirements is independent of the quantity of good produced but strictly increasing and convex in the sustainability quality level s_j. The second component, $k\, s_j$, is the cost of certification that is paid to a third party, which is not considered here. The parameter k represents the unit cost of controlling label criteria if the sustainability quality level s_j is viewed as a number of precise criteria certified by the label j.

2.2 Consumers

We adopt a vertical differentiation framework that is consistent with Mussa and Rosen (1978). Consumers can observe the label choices of firms and have the utility function $u = \theta s_j - p_j$ (and zero utility if they do not buy the differentiated good). They differ in their tastes for sustainability quality, as described by the parameter $\theta \in [\underline{\theta}, \overline{\theta}]$, where θ is uniformly distributed with unit density. The higher the quality s_j of the good, the higher the utility u obtained by consumers for any given price p_j. However, consumers with higher θ will be willing to pay more for higher sustainability quality goods. Considering that consumer awareness of sustainable development results in a higher willingness-to-pay for a sustainable product than for a standard one, the parameter $\overline{\theta}$ represents the level of consumer sustainability awareness. We assume that the consumer with the highest valuation for sustainability quality is willing to pay the unitary cost of the labeled criteria, $\overline{\theta} > k$.

Consistent with the literature on product differentiation, we assume that consumers can buy at most one unit of the good. When a product is certified by label j, consumers are certain that the quality level is s_j, as the third-party certifiers are trustworthy.

When two different labeled products are available in the market, the following threshold values allow to characterize consumers' choices

$$\begin{aligned} \theta_{AB} &= \frac{p_A - p_B}{s_A - s_B}, \\ \theta_{\emptyset B} &= \frac{p_B}{s_B}. \end{aligned}$$

Consumers characterized by $\theta > \theta_{AB}$ obtain a higher utility from consuming the good labeled by NGO A rather than the alternative good labeled by NGO B, while consumers characterized by $\theta_{AB} > \theta > \theta_{\emptyset B}$ obtain a higher utility from consuming the quality set by NGO B rather than the standard product. The utility function implies the following demand functions for the product

labeled by NGO j, $j = A, B$, and for the standard product

$$q_A(p_A, p_B, s_A, s_B) = \overline{\theta} - \theta_{AB} \quad (2)$$

$$q_B(p_A, p_B, s_A, s_B) = \theta_{AB} - \theta_{\emptyset B} \quad (3)$$

$$q_\emptyset(p_B, s_B) = \theta_{\emptyset B}. \quad (4)$$

When only one label is present in the market, the respective demand functions for the high-quality product and for the standard product are

$$q_j(p_j, s_j) = \overline{\theta} - \theta_{\emptyset j} \quad (5)$$

$$q_\emptyset(p_j, s_j) = \theta_{\emptyset j} - \underline{\theta}, \qquad \text{with } j = A \text{ or } B. \quad (6)$$

Note that in both cases, the quality market is not covered, i.e., some consumers do not buy the certified good. Partial market coverage also requires that $\underline{\theta} < \theta_{\emptyset j}$ for $j = A$ or B. More precisely, the uncovered market coverage condition implies that $\frac{p_B}{s_B} > \underline{\theta}$ at equilibrium with two standards when $s_B < s_A$, that is, $\overline{\theta} < k + \frac{3}{2}$.[5]

2.3 NGOs

In the absence of public intervention on a sustainability issue, NGOs offer their labels to firms to provide consumers with credible information about the sustainability quality of the labeled variant, which is otherwise unobservable.

The objective of the NGOs constitutes the most important hypothesis of the model. Most of the literature on ecolabels (Heyes and Maxwell, 2004; Bottega and de Freitas, 2009; Fisher and Lyon, 2013, 2014; Brécard, 2014) assumes that an NGO maximizes average environmental quality. This objective is pro-environmentally motivated and is related to the provision of a public good. Our idea is more consistent with the non-profit literature. Rose-Ackerman (1982) assumes that the managers of charities maximize revenue from fundraising. Aldashev and Verdier (2009, 2010) assume that NGOs maximize the impact of their respective projects, that is, the quantity of services they produce towards their missions. In this context, NGOs are assumed to be concerned

[5] Wauthy (1996) considers the characterization of the firm quality choice in terms of degree of population heterogeneity without making an assumption *ex ante* about whether the market is covered. Here, we verify that total market coverage is not an equilibrium.

only with their own programs, that is, the social output they individually produce (Scharf, 2014; Heyes and Martin, 2015). In the same way, we consider that an NGO cares only about the label it has developed. As the level of the standard it offers to firms has an impact on the volume or size of the market impacted by its label, the NGO is interested in both the level of its quality standard and the quantity of products with its label.

Therefore, in our model, it is assumed that NGOs realize trade-offs between the quality of their labels and the quantity of labeled products sold. Moreover, each NGO has its own preferences about the quality of the label it offers. This allows us to distinguish mission-driven NGOs from market-driven NGOs. To formalize this idea, following Poret and Chambolle (2007), we assume that the NGO objective is to maximize a Cobb-Douglas utility function that depends positively on the sustainability quality and on the quantity of labeled product sold,[6] with different preferences for quality. For NGO A

$$U_A(s_A) = s_A^{\alpha}(q_A(s_A, s_B))^{1-\alpha}, \tag{7}$$

where α is NGO A's quality preference parameter, with $\alpha \in (0, 1)$.

Likewise, NGO B's objective is to maximize the following utility function

$$U_B(s_B) = s_B^{\beta}(q_B(s_A, s_B))^{1-\beta}, \tag{8}$$

where β is NGO B's quality preference parameter, with $\beta \in (0, 1)$.

We assume that NGO A is a more mission driven than NGO B, that is, $\alpha > \beta$.

2.4 The Game

The following game is considered. In the first stage, the NGOs present in the market choose the level of standards required to obtain their label, given their respective objectives. Their choices are simultaneous.[7] In the second stage, the two firms, 1 and 2, sequentially choose whether and which label to adopt. Following Bottega et al. (2009), we assume that the choice to label is sequential. Bottega et al. (2009) argue that in real world, labeling processes are usually slow, as

[6]Poret and Chambolle (2007) specifically examine the Fairtrade label and propose that the utility of the Fairtrade certifier depends positively on the Fairtrade wholesale price, which determines small producers' revenue, and on the Fairtrade product quantity sold, which represents the number of small producers in the Fairtrade network.

[7]No analytical solution was obtained using *Mathematica* for a sequential game in which an NGO sets a standard before its rival does.

few firms adopt labels in the earlier stages of implementation. This may be explained by the fact that voluntary labeling requires firms to adapt their production or trade practices. We assume that the label choice is sequential to avoid multiplicity of equilibria. This does not modify the firms' choice at equilibrium, but it allows the selection of an equilibrium when more than one exists.[8] We assume that firm 1 is the Stackelberg leader and that firm 2 is the follower. In the third stage, if they have both chosen a label, firms set simultaneously prices. In the final stage, consumers choose whether or not to buy goods with sustainability label A or B. This game is solved by backward induction. We compare results of this game with benchmark cases in which only one NGO is present in the label market.

We denote profits as $\pi_{jj'}$ for a firm that has either chosen a label or chosen not to adopt one, strategy j with $j = A, B$ or $\emptyset$, given that its competitor has either chosen a label or chosen not to adopt one, strategy $j' = A, B$ or $\emptyset$. When a firm decides not to adopt a label, it joins the competitive fringe and thus obtains zero profit.

2.5 The Benchmark Model

In the benchmark model, we consider a non-competitive situation in the label market. For presentation, we assume that only NGO A provides a sustainability quality standard for the two firms. Then, the demand function for the sustainability quality product is given by Equation (5) with $j = A$. In the third stage of the game, if only one firm has adopted the label, it has a monopoly position on the quality good market, and its program is the following

$$\max_{p_A} \pi_{A\emptyset}(p_A, s_A) = [p_A - (cs_A + k)s_A]q_A(p_A, s_A). \tag{9}$$

The resolution yields equilibrium profits $\pi_{A\emptyset}(s_A) = \frac{s_A(\overline{\theta}-k-cs_A)^2}{4} > 0$. The other firm joins the competitive fringe and obtains zero profit ($\pi_{\emptyset A} = 0$).

If both firms choose to adopt label A, the classic Bertrand game applies, and they obtain zero profits ($\pi_{AA} = 0$).

In the second stage, firms sequentially choose to whether to adopt label A. The extensive form of the label game is depicted in Figure 1.

To simplify the analysis, we assume that if a firm is indifferent between adopting and not adopting a label because of Bertrand competition, the firm does not adopt the label because there

[8] See Ben Youssef and Lahmandi-Ayed (2008) for an identical assumption in the context of quality choice.

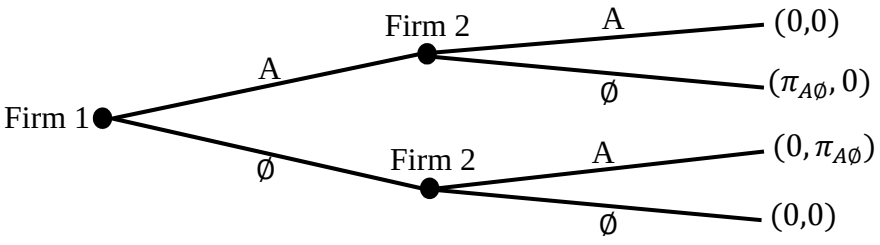

Figure 1: The label game with one standard

are internal transaction costs to organizing a tripartite standards regime. Then, it is straightforward to see that the unique subgame equilibrium is for firm 1 to adopt label A and for firm 2 to join the competitive fringe.

When only label A is present on the market, NGO A sets the sustainability quality level to maximize the following objective

$$U_A(s_A) = s_A^{\alpha}(q_A(s_A))^{1-\alpha} \text{ with } q_A(s_A) = \frac{\overline{\theta} - k - cs_A}{2}. \tag{10}$$

The unique solution to this program is $s_A^0 = \alpha\left(\frac{\overline{\theta}-k}{c}\right)$, and the total quantity of high-quality goods sold is equal to $q_A^0 = (1-\alpha)\left(\frac{\overline{\theta}-k}{2}\right)$.

3 Firm Competition

A game with two potential labels certifying the sustainability quality is considered. We begin by solving the third stage of this game in which firms choose their prices as a function of their preceding choice of labels. Then, the firms' label choice problem is solved.

3.1 Price Competition

Three types of market outcomes must be considered.

No Differentiation: When both firms choose the same label, the classic Bertrand game applies. Both firms offer the same price $p = (cs_j + k)s_j$ with $j = A$ or B, depending on the label selected. This provides zero profits for both firms ($\pi_{AA} = \pi_{BB} = 0$).

Differentiation with one label: When only one firm chooses a label, as in the benchmark model, this firm has a *de facto* monopoly position. Its program is the following

$$\max_{p_j} \pi_{j\emptyset}(p_j, sj) = [p_j - (cs_j + k)s_j]q_j(p_j, s_j), \quad \text{for } j = A \text{ or } B. \tag{11}$$

The equilibrium firm profit after adopting the label is $\pi_{j\emptyset} = \frac{s_j(\overline{\theta}-k-cs_j)^2}{4}$. The other firm joins the competitive fringe and obtains zero profits ($\pi_{\emptyset j} = 0$ for $j = A$ or B).

Differentiation with two labels: When two firms choose different labels (here, when $s_A > s_B$), they both have some market power due to product differentiation. The firm that has chosen label A now solves the following profit maximization program

$$\max_{p_A} \pi_{AB}(p_A, p_B, s_A, s_B) = [p_A - (cs_A + k)s_A]q_A(p_A, p_B, s_A, s_B). \tag{12}$$

The firm that has previously chosen label B solves the following profit maximization program

$$\max_{p_B} \pi_{BA}(p_A, p_B, s_A, s_B) = [p_B - (cs_B + k)s_B]q_B(p_A, p_B, s_A, s_B). \tag{13}$$

The first order conditions (FOC) give the equilibrium prices

$$p_A^*(s_A, s_B) = \frac{s_A}{4s_A - s_B}[2(s_A - s_B)\overline{\theta} + 2(cs_A + k)s_A + (cs_B + k)s_B], \tag{14}$$

$$p_B^*(s_A, s_B) = \frac{s_B}{4s_A - s_B}[(s_A - s_B)\overline{\theta} + (cs_A + k)s_A + 2(cs_B + k)s_A]. \tag{15}$$

These expressions imply that the high-quality firm sets a price that is higher than the price charged by the low-quality firm. Note that the closer s_B is to s_A, the closer the solution is to a Bertrand solution. Moreover, when the low-quality label becomes more stringent, the low-quality product becomes a closer substitute for the high-quality product. Price competition will intensify, so the price difference will decrease. Conversely, when the level of the high-quality standard increases, the high-quality product becomes a poor substitute for the low-quality one. Price competition will become less intense, so the price difference will increase.

The demand functions at the equilibrium prices in Stage 3 are then

$$q_A^*(s_A, s_B) = \frac{s_A}{4s_A - s_B}[2(\overline{\theta} - k) - (2s_A + s_B)c], \tag{16}$$

$$q_B^*(s_A, s_B) = \frac{s_A}{4s_A - s_B}[(\overline{\theta} - k) + (s_A - s_B)c] > 0. \tag{17}$$

These functions imply that the quantity of products labeled by NGO A is positive if

$$s_A + \frac{s_B}{2} < \frac{\overline{\theta} - k}{c}. \tag{18}$$

Two sustainability labels are present in the market only if their levels are relatively low compared to the demand/cost ratio of supplying a labeled product $\left(\frac{\overline{\theta}-k}{c}\right)$. In other words, at the price competition stage, two stringent labels can coexist only if consumers' sustainability awareness is high

and the costs related to quality and certification are low, that is, when it is cost efficient for firms and NGOs to implement and control sustainability quality, respectively.

The firm profits are then

$$\pi_{AB}(s_A, s_B) = \frac{s_A^2(s_A - s_B)\left(2(\overline{\theta} - k) - (2s_A + s_B)c\right)^2}{(4s_A - s_B)^2}, \tag{19}$$

$$\pi_{BA}(s_A, s_B) = \frac{s_A s_B(s_A - s_B)\left((\overline{\theta} - k) + (s_A - s_B)c\right)^2}{(4s_A - s_B)^2}. \tag{20}$$

It is possible to check that firm profits are concave at the level of the label it has chosen.[9]

3.2 Label Choice

In the second stage, the two firms, 1 and 2, sequentially select a label or choose not to adopt either available label. The extensive form of the certification game is depicted in Figure 2.

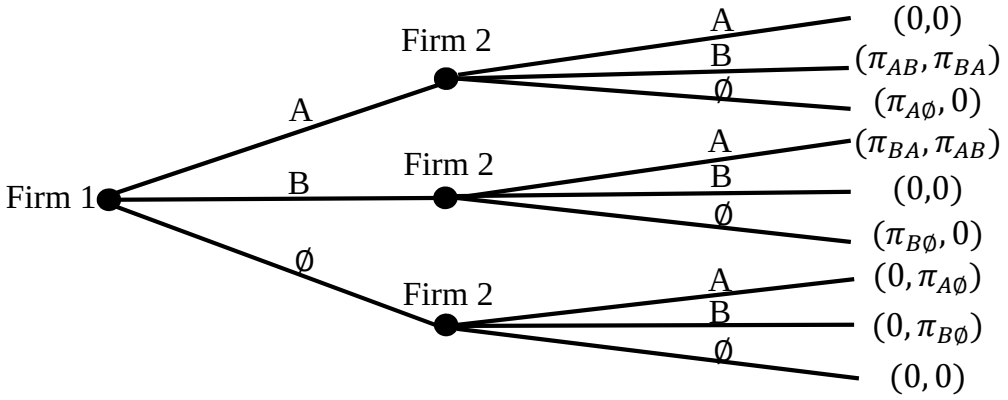

Figure 2: The label game with two standards

$$\text{When } s_A > s_B, \quad \pi_{AB} = \frac{s_A^2(s_A - s_B)\left(2(\overline{\theta} - k) - (2s_A + s_B)c\right)^2}{(4s_A - s_B)^2},$$

$$\pi_{BA} = \frac{s_A s_B(s_A - s_B)\left((\overline{\theta} - k) + (s_A - s_B)c\right)^2}{(4s_A - s_B)^2} > 0,$$

$$\pi_{A\emptyset} = \frac{s_A(\overline{\theta} - k - cs_A)^2}{4} > 0 \text{ and } \pi_{B\emptyset} = \frac{s_B(\overline{\theta} - k - cs_B)^2}{4} > 0.$$

We obtain symmetric results when $s_B > s_A$. This allows us to state the equilibrium strategies with the two possibles cases, either $s_A > s_B$ or $s_B > s_A$, in the following proposition.

[9] If we look for the solution to the quality game when quality levels are chosen by both firms simultaneously, we obtain results similar to those of Motta (1993) and Amacher et al. (2005), where the costs of providing quality are variables in terms of production, that is, $s_A = 0.40976\frac{\overline{\theta}-k}{c}$, and $s_B = 0.199361\frac{\overline{\theta}-k}{c}$, where $s_A > s_B$.

Proposition 1 (Firms' Equilibrium Strategies)**.** *In a duopoly model with vertical differentiation, the results of the label game are the following:*

(i). if $s_A < \widetilde{s_A}(s_B)$ *with* $\widetilde{s_A}(s_B) = \frac{\bar{\theta}-k}{c} - \frac{s_B}{2} - \frac{\sqrt{cs_B(4(\bar{\theta}-k)-3cs_B)}}{2c}$*, firm 1 will adopt the more stringent label, and firm 2 will adopt the less stringent label – strategy* (A, B) *if* $s_A > s_B$ *and strategy* (B, A) *if* $s_B > s_A$*;*

(ii). if $\widetilde{s_A}(s_B) \leq s_A < \min\{\frac{\bar{\theta}-k}{c} - \frac{s_B}{2}, 2(\frac{\bar{\theta}-k}{c}) - 2s_B\}$*, firm 1 will adopt the less stringent label, and firm 2 will adopt the more stringent label – strategy* (B, A) *if* $s_A > s_B$ *and strategy* (A, B) *if* $s_B > s_A$*;*

(iii). if $s_A \geq \min\{\frac{\bar{\theta}-k}{c} - \frac{s_B}{2}, 2(\frac{\bar{\theta}-k}{c}) - 2s_B\}$*, firm 1 will adopt the less stringent label, and firm 2 will not adopt any label – strategy* $(B, \emptyset)$ *if* $s_A > s_B$ *and strategy* $(A, \emptyset)$ *if* $s_B > s_A$*.*

Proof. See appendix A.1. □

The results of the label game are represented in Figure 3.

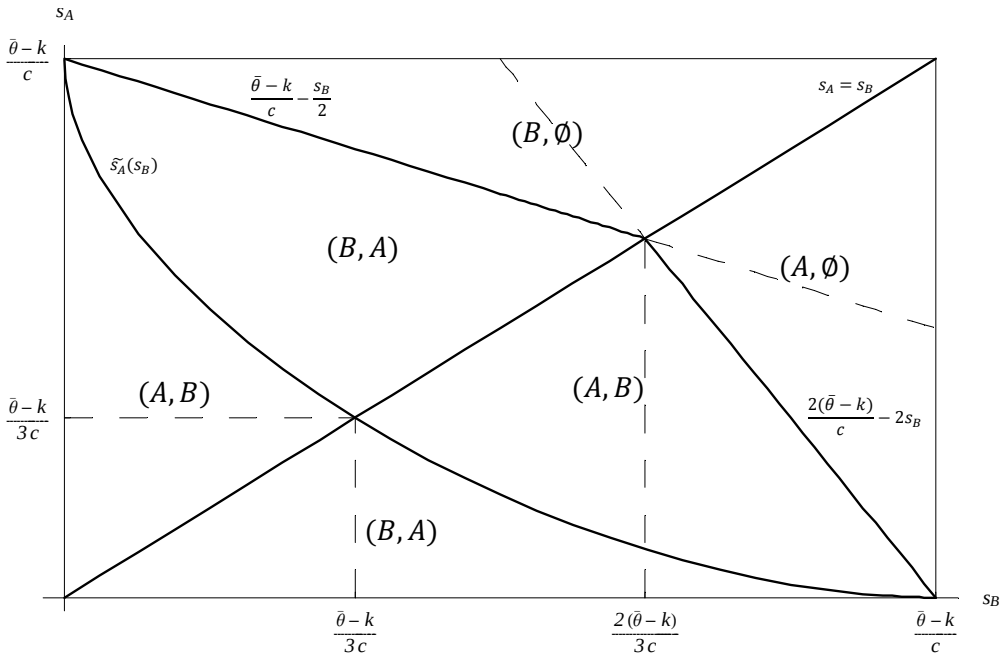

Figure 3: The label choice

The coexistence of two labeled products in the market is not possible if the levels of both labels are similar to each other and to the demand/cost ratio of supplying a labeled product $\left(\frac{\bar{\theta}-k}{c}\right)$. Nor is this possible if the level of the most stringent label is very high (case (iii) of proposition 1). First,

when both labels are stringent in relation to the demand/cost ratio of supplying a labeled product, the sustainability quality market is small. Hence, firms do not fight over a market niche. Second, when the most stringent label is too stringent, it is not profitable for the firms to choose it. In any case, the leader chooses the less stringent label to benefit from a monopoly situation in a larger niche market.

When two labeled products coexist in the market $\left(s_A < \min\{\frac{\overline{\theta}-k}{c} - \frac{s_B}{2}, 2(\frac{\overline{\theta}-k}{c}) - 2s_B\}\right)$, the leader chooses to adopt the less stringent label if $s_A > \widetilde{s_A}(s_B)$ and chooses to adopt the more stringent label if $s_A < \widetilde{s_A}(s_B)$. The follower always chooses the opposite strategy. These choices can be explained as follows. Firms have an interest in avoiding direct price competition by differentiating their products using different labels only if the sustainability quality market is largely covered, that is, if the level of the less stringent label is relatively low. Indeed, the quality level of the less stringent label defines the size of the sustainability quality market. This can be called the "market coverage" effect. It induces that an increase in the low-quality standard of its rival decreases the marginal profit from choosing the high-quality standard $\left(\frac{\partial \pi_{AB}(s_A,s_B)}{\partial s_B} < 0 \text{ when } s_A > s_B\right)$. When the less stringent label requires a low quality level, the sustainability quality market is large. Additionally, when the more stringent label also requires a relatively low quality level, it is profitable for the leader to adopt this label to take full advantage of the market coverage effect. When the most stringent label requires a intermediate quality level, it remains profitable for the leader to adopt it. In this case, the firm takes advantage of the "product differentiation" effect by setting a high price. However, when the less stringent label requires a intermediate quality level, the market size is reduced, and product differentiation through quality is also limited. As an increase in the high standard level of the rival increases the marginal return from choosing the low standard level $\left(\frac{\partial \pi_{BA}(s_A,s_B)}{\partial s_A} > 0 \text{ when } s_A > s_B\right)$, the leader chooses to adopt the less stringent label. Moreover, it is trivial to show that the follower always chooses the leader's opposite strategy. Indeed, firm 2 obtains zero profits whenever it imitates the leader's strategy by choosing the same label, while it obtains positive profits by choosing the other label.

4 NGO Competition

In this section, we analyze the strategic behaviors of NGOs as sustainability quality standards setters through the choice of the quality level required to obtain their standard.

4.1 Sustainability Quality Choice

When both labels are present in the market, we assume that NGOs simultaneously choose the sustainability quality level of their standard. The solution is presented for the case wherein $s_A > s_B$.

The maximization program of NGO A is the following

$$\max_{s_A} U_A(s_A, s_B) = s_A^{\alpha} \left(\frac{s_A(2(\overline{\theta} - k) - (2s_A + s_B)c)}{4s_A - s_B} \right)^{1-\alpha}. \tag{21}$$

From the FOC, we obtain the following best response function of NGO A

$s_A^{BR}(s_B) = \frac{4\alpha(\overline{\theta}-k)-(3\alpha-2)cs_B+\sqrt{Y_A}}{8c}$ if $s_B < \begin{cases} \frac{4\alpha^2}{4-4\alpha+3\alpha^2}\frac{\overline{\theta}-k}{c} & \text{when} \quad \alpha < \frac{2}{5} \\ \frac{2(4\alpha-1)}{3(1+2\alpha)}\frac{\overline{\theta}-k}{c} & \text{when} \quad \alpha \geq \frac{2}{5} \end{cases}$

with $Y_A = (4(\overline{\theta} - k) - 3cs_B)(4\alpha^2(\overline{\theta} - k) - (4 - 4\alpha + 3\alpha^2)cs_B)$;

otherwise, the corner solution s_B cannot be retained, as s_A is strictly higher than s_B.

The best response of NGO A is to differentiate its own label from the rival label by setting a higher sustainability quality standard when possible, that is, when the level of NGO B's standard, s_B, is relatively low.

The maximization program of NGO B is the following

$$\max_{s_B} U_B(s_A, s_B) = s_B^{\beta} \left(\frac{s_A((\overline{\theta} - k) + (s_A - s_B)c)}{4s_A - s_B} \right)^{1-\beta}. \tag{22}$$

From the FOC, we obtain the best response function for NGO B

$s_B^{BR}(s_A) = \frac{(3+2\beta)cs_A-(1-2\beta)(\overline{\theta}-k)-\sqrt{Y_B}}{2\beta c}$ if $s_A \geq \frac{1+2\beta}{3(1-\beta)}\frac{\overline{\theta}-k}{c}$

with $Y_B = ((\overline{\theta} - k) - 3cs_A)((1 - 2\beta^2)(\overline{\theta} - k) - (1 + 2\beta)(3 - 2\beta)cs_A)$;

otherwise, the corner solution s_A cannot be retained, as $s_A > s_B$.

The best response of NGO B is to differentiate its own label from the rival label by setting a lower sustainability quality standard when possible, that is, when the level of NGO A's standard, s_A, is relatively high.

We can then characterize the result as follows.

Proposition 2 (NGOs' Equilibrium Strategies)**.** *In a double duopoly model with vertical differentiation, the results of the NGOs' competition game are the following standards levels:*

(i). when $\alpha \geq \frac{1}{2(1-2\beta)}$, there is a unique equilibrium (s_A^*, s_B^*), with $s_A^* > s_B^*$;

(ii). when $\overline{\alpha}(\beta) < \alpha \leq \frac{1}{2(1-2\beta)}$ *and* $\beta < \frac{7-\sqrt{33}}{16}$*, there are two equilibria* (s_A^*, s_B^*) *and* (s_A^{**}, s_B^{**})*, with* $s_A^* > s_A^{**} > s_B^{**} > s_B^*$*;*

(iii). in the other cases, there is no equilibrium when two NGOs offer different labels.

Proof. See appendix A.2. □

The results of the NGOs' competition game are represented in Figure 4.

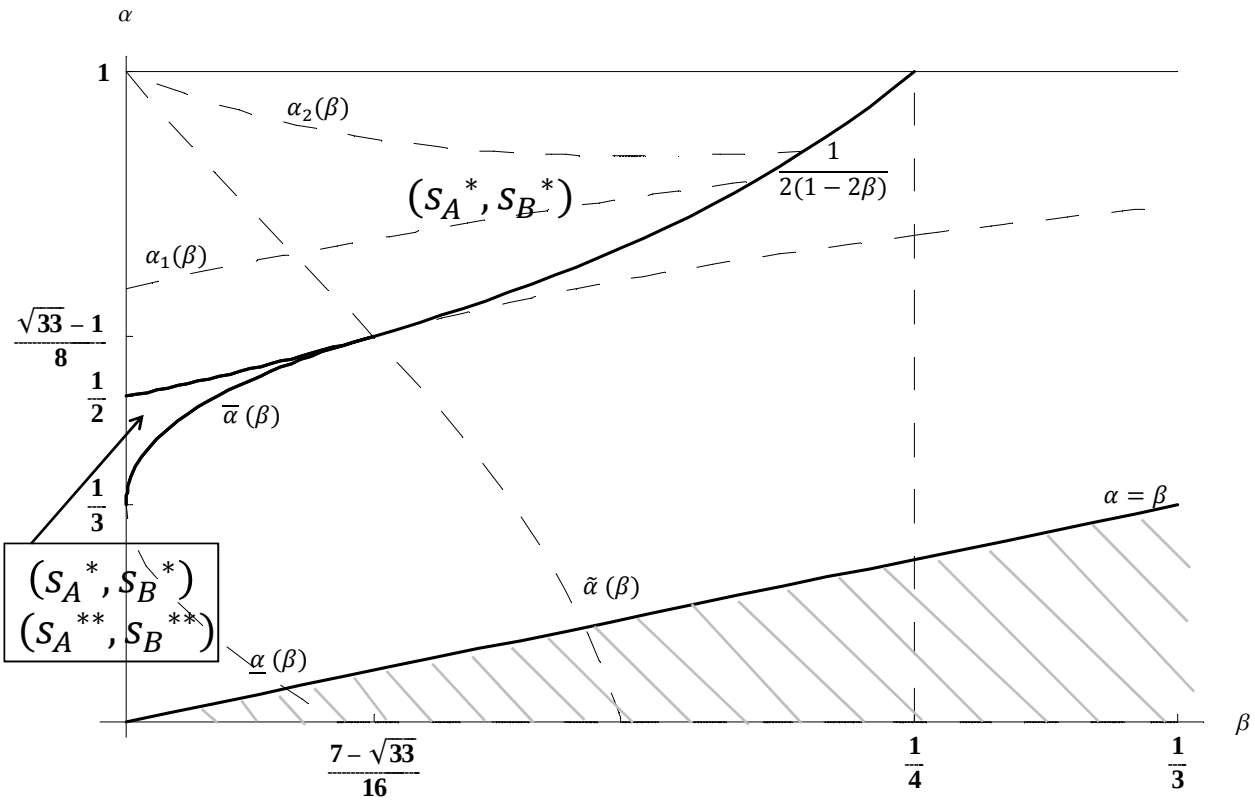

Figure 4: The quality choice

In a double duopoly model wherein NGOs compete to set quality standards through labels awarded to firms that comply with its standards, the coexistence of both labels is possible only if the NGOs' preferences for sustainability quality are extremely different. The general insight of this proposition is as follows. Firms must differentiate themselves from their rivals to generate profits, and NGOs must differentiate themselves based on the quality standards that they offer to be chosen by the firms. This implies two conditions. First, the sustainability quality market must be sufficiently large to allow these two NGOs to operate in label market. Due to the market coverage effect, the less stringent standard must be very low. As it is assumed that NGO A is

more a mission-driven organization than is NGO B ($\alpha > \beta$), the sustainability quality preference parameter of NGO B must be very low ($\beta < 1/4$). Second, due to the product differentiation effect, both NGOs must also differentiate themselves from each other by offering very different standards. Thus, the sustainability quality preference parameter of NGO A must be relatively high $\left(\alpha > \frac{1}{2(1-2\beta)}\right)$. Therefore, there is sufficient space in the label market for two sustainability quality standards when NGO A is clearly a mission-driven organization and NGO B a market-driven organization.

4.2 Impacts of NGO Competition

In this section, we compare the previous results with those obtained in a non-competitive situation, that is, the benchmark model. In these latter cases, the only NGO in the market establishes its monopoly standard at the level s_j^0, with $j = A$ or B, as determined in Subsection 2.5.

Proposition 3. *Competition between the two NGOs leads to*

(i). a decrease in the level of the standard provided by the mission-driven NGO ($s_A^* < s_A^0$) and

(ii). an increase in the level of the standard provided by the market-driven NGO ($s_B^* > s_B^0$).

Proof. See appendix A.3. □

Due to competition, NGO A decreases the level of its standard, and NGO B increases the level of its own standard. These results are explained by the fact that, in equilibrium, the quality choices of NGOs are strategic substitutes. The explanations are not symmetric, as an increase in standards levels does not mean the same thing in terms of competition for labeled products.

Indeed, one can easily check that $\frac{\partial s_A^{BR}(s_B)}{\partial s_B} < 0$ because $s_B < \frac{4\alpha^2}{4-4\alpha+3\alpha^2}\frac{\overline{\theta}-k}{c}$. If NGO B increases the level of its sustainability quality standard, this less stringent standard defines the size of the sustainability quality market, and the sustainability quality market becomes smaller. As the potential differentiation product effect is reduced, firms are less likely to choose label A. To remain in the label market or retain some market share of this smaller market, NGO A reduces the level of its own standard. In other words, an increase of the level of the less stringent standard implies an increase in competition between the two sustainability quality standards and thus between the sustainability quality products as the labeled products become more similar. Then, the response of NGO A intensifies competition.

In the same way, one can check that $\frac{\partial s_B^{BR}(s_A)}{\partial s_A} < 0$ when $\beta < \frac{1}{4}$ and $s_A < \frac{1}{1+2\beta}\frac{\overline{\theta}-k}{c}$; otherwise, $\frac{\partial s_B^{BR}(s_A)}{\partial s_A} \geq 0$. Moreover, the equilibrium level of NGO A's label s_A^* is lower than $\frac{1}{1+2\beta}\frac{\overline{\theta}-k}{c}$. If NGO A increases the level of its sustainability quality standard, the response of NGO B is to decrease the level of its own standard. An increase in the level of the more stringent standard, label A, implies decreasing competition between the labeled products and, thus, between firms. The response of NGO B intensifies this effect, that is, it reduces competition between firms. Indeed, an increase in the level of label A induces a decrease in the demand for the product labeled by NGO A and an increase in the demand for the product labeled by NGO B. As NGO B is a market-driven organization and thus places greater value on the quantity of the labeled product than on its quality, it reinforces this increase in quantity by decreasing the level of its standard. This pattern is mainly due to the benefits of relaxing price competition by decreasing s_B in response to an increase in s_A, which tends to dominate the loss in utility of doing so.

A strategic relationship between the NGOs is surprising. The fact that NGOs' quality choices are strategic substitutes intensifies or relaxes competition in the quality products market. This is explained by the NGOs' preferences. If NGO B decreases its quality, we would perhaps expect NGO A to respond by also decreasing its quality to increase demand. Instead, NGO A responds by increasing its quality. This is explained by the fact that it is a mission-driven organization.

The intuitions behind the results of proposition 3 differ from that of the incumbent NGO in the benchmark framework. If the incumbent NGO is A, competition induced by the entry of NGO B into the label market represents an increase of the level of label B, as if s_B was initially equal to s_0. As quality levels are strategic substitutes, this leads to a lower equilibrium value of the more stringent quality standard: $s_A^* < s_A^0$. On the contrary, if the incumbent NGO is B, competition induced by the entry of NGO A represents a decrease in the quality level of label A, as if s_A was initially greater than $\frac{\overline{\theta}-k}{c} - \frac{s_B}{2}$. In this case, NGO B's response is to increase of the level of its own sustainability quality standard: $s_B^* > s_B^0$.

We can attempt to compare sustainable development improvements between the benchmark model and the competitive model by using weighted sustainability quality.

Proposition 4. *Competition between the NGOs leads to an increase in overall weighted sustainability quality regardless of the benchmark model*

(i). $s_A^* q_A^* + s_B^* q_B^* > s_A^0 q_A^0 > s_A^* q_A^*$;

(ii). $s_A^* q_A^* + s_B^* q_B^* > s_B^* q_B^* > s_B^0 q_B^0$, *for all* $\alpha \in]1/3, 1[$ *and* $\beta \in]0, 1/4[$.

Proof. See appendix A.4. □

Competition allows for an improvement in overall weighted quality regardless of the monopoly situation considered as a benchmark. However, the explanation of these results differs by the benchmark model in question.

Due to competition, the mission-driven NGO A reduces the level of its sustainability quality standard and might experience a decrease in the quantity of products labeled with its standard when its preference parameter is relatively high ($\alpha > \alpha_1(\beta)$, see Figure 4 and Appendix A.4). As a result, the weighted sustainability quality of its standard decreases with the entrance of a market-driven NGO into the label market ($s_A^0 q_A^0 > s_A^* q_A^*$). Therefore, the increase in the overall weighted sustainability quality is related to the entry of NGO B, as its low standard increases the quantity of products with its sustainability label. In other words, when the benchmark case is NGO A's monopoly in the label market, the increase in overall weighted sustainability quality with the introduction of competition to the label market is due to a quantity effect.

When the benchmark case is NGO B's monopoly in the label market, that is, a situation in which a market-driven organization is the only standard setter, the entry of the opposite type of NGO as a standard setter increases the level of NGO B's standard and thus decreases the quantity of products sold at this sustainability quality standard. The quality effect overcompensates for the quantity effect in this case; therefore, the weighted sustainability quality of products with label B increases in the competitive model ($s_B^* q_B^* > s_B^0 q_B^0$). The overall weighted sustainability quality also increases through this quality effect. Indeed, the overall consumption of labeled products under competition might be lower than in the monopoly case when only NGO B is a standard setter when the preference parameter of NGO A is relatively high, ($\alpha > \alpha_2(\beta)$, see Figure 4 and Appendix A.4).

5 Conclusion

We have developed a simple model of competition between two NGOs that may have different preferences for sustainability quality. We first found that two stringent sustainability quality labels cannot coexist in a duopoly market with symmetric firms if consumer sustainability awareness is

low and/or quality- and certification-related costs are high with respect to the standard levels. A trade-off between a market coverage effect and the classic product differentiation effect exists for firms. Second, the two NGOs, which compete to offer the firms a sustainability quality label, may supply two labels with very different sustainability criteria, which implies that when two NGOs are present in the label market, one must be a mission-driven NGO and the other a market-driven NGO. Third, competition between these NGOs decreases the most stringent standard. This means that the most mission-driven NGO, which has a high-quality standard when it is alone in the label market, decreases the level of its standard when it faces competition from another NGO. This behavior is explained by the fact that NGOs' quality choices are strategic substitutes in the context of vertical differentiation. A bad label drives out a good one as the mission-driven NGO with a preference for high quality weakens its standard when a market-driven NGO is also present in the label market. Finally, competition in the label market increases overall weighted sustainability quality because the entrant market-driven NGO labels many products or the incumbent market-driven NGO increases the sustainability quality of its standard.

Our results seem to adequately explain the evolution of the label market in the fair trade sector. This analysis can be also used to analyze other sectors, such as the fisheries sector. NGOs have been the front-runners in developing ecolabeling schemes in this sector, and two main international fisheries certification programs exist, the Marine Stewardship Council (MSC) and the Friend of the Sea (FOS) (Washington and Ababouch, 2011). In this sector, the first actor in the market, MSC, created in 1997, has more stringent standards than the second actor (FOS), which was established in 2006. Indeed, according to Kalfagianni and Pattberg (2013), compared to FOS, MSC has more stringent standards, stricter compliance methods and is more inclusive.

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A Appendixes

A.1 Proof of Proposition 1

The result of the label game depends on profits comparisons.

- It is trivial to see that $\pi_{BA} > 0$ for all values of $s_A > s_B$.
- Likewise, $\pi_{AB} > 0$ when $s_A < \frac{\overline{\theta}-k}{c} - \frac{s_B}{2}$.
- Moreover, $\pi_{AB} > \pi_{BA}$ when $s_A < \frac{\overline{\theta}-k}{c} - \frac{s_B}{2} - \frac{\sqrt{cs_B(4(\overline{\theta}-k)-3cs_B)}}{2c} = \widetilde{s_A}(s_B)$, with $\widetilde{s_A}(s_B) > s_B$ when $s_B < \frac{\overline{\theta}-k}{3c}$.
- Finally, $\pi_{A\emptyset} > \pi_{B\emptyset}$ when $s_A < \widetilde{s_A}(s_B)$.

The best response strategy of firm 2 given the strategy of firm 1, $BR_2(.)$, can be deduced

$$\begin{aligned} BR_2(A) &= B \quad \forall s_A \\ BR_2(B) &= \begin{cases} A & \text{if} \quad s_A \leq \frac{\overline{\theta}-k}{c} - \frac{s_B}{2} \\ \emptyset & \text{if} \quad s_A > \frac{\overline{\theta}-k}{c} - \frac{s_B}{2} \end{cases} \\ BR_2(\emptyset) &= \begin{cases} A & \text{if} \quad s_A \leq \widetilde{s_A}(s_B) \\ B & \text{if} \quad s_A > \widetilde{s_A}(s_B). \end{cases} \end{aligned}$$

The best response strategy of firm 1, BR_1, is then the following

$$BR_1 = \begin{cases} A & \text{if} \quad s_A \leq \widetilde{s_A}(s_B) \\ B & \text{if} \quad \widetilde{s_A}(s_B) < s_A \leq \frac{\overline{\theta}-k}{c} - \frac{s_B}{2} \\ B & \text{if} \quad s_A > \frac{\overline{\theta}-k}{c} - \frac{s_B}{2}. \end{cases}$$

Therefore, when $s_A > s_B$, the equilibrium strategy is

$$\begin{cases} (A,B) & \text{if} \quad s_A \leq \widetilde{s_A}(s_B) \\ (B,A) & \text{if} \quad \widetilde{s_A}(s_B) < s_A \leq \frac{\overline{\theta}-k}{c} - \frac{s_B}{2} \\ (B,\emptyset) & \text{if} \quad s_A > \frac{\overline{\theta}-k}{c} - \frac{s_B}{2}. \end{cases}$$

The symmetric model yields the equilibrium strategy when $s_B > s_A$

$$\begin{cases} (B,A) & \text{if} \quad s_A \leq \widetilde{s_A}(s_B) \\ (A,B) & \text{if} \quad \widetilde{s_A}(s_B) < s_A \leq \frac{2(\overline{\theta}-k)}{c} - 2s_B \\ (A,\emptyset) & \text{if} \quad s_A > \frac{2(\overline{\theta}-k)}{c} - 2s_B. \end{cases}$$

A.2 Proof of Proposition 2

Solution of NGO A's maximization program:

The maximization program of NGO A is

$$\max_{s_A} U_A(s_A, s_B) = s_A^{\alpha} \left(q_A(s_A, s_B)\right)^{1-\alpha}. \tag{A1}$$

The FOC is

$$s_A^{\alpha-1}(q_A(s_A,s_B))^{-\alpha}\left[\alpha q_A(s_A,s_B) + (1-\alpha)s_A\frac{\partial q_A}{\partial s_A}\right] = 0. \tag{A2}$$

As $\frac{\partial q_A}{\partial s_A} = -\frac{2(\overline{\theta}-k)s_B + (8s_A^2 - 4s_A s_B - s_B^2)c}{(4s_A - s_B)2} < 0$, there exists at least one solution to equation (A2).

The second order condition (SOC) $\frac{\partial^2 U_A}{\partial s_A^2} < 0$ induces the following condition

$$s_A > \frac{s_B(2(\overline{\theta}-k) - cs_B))}{4\alpha(\overline{\theta}-k) - (3\alpha-2)cs_B}. \tag{A3}$$

The FOC is equivalent to the following quadratic equation in s_A

$$8cs_A^2 - 2(4\alpha(\overline{\theta}-k) - (3\alpha-2)cs_B)s_A + (2(\overline{\theta}-k) - cs_B)s_B = 0. \tag{A4}$$

The discriminant of the quadratic equation

$\Delta = 4(4(\overline{\theta}-k) - 3cs_B)(4\alpha^2(\overline{\theta}-k) - (4-4\alpha+3\alpha^2)cs_B) = 4Y_A$ is positive if and only if $s_B < \frac{4\alpha^2}{4-4\alpha+3\alpha^2}\frac{\overline{\theta}-k}{c}$.

The lower real root is a local minimum, as it does not observe the SOC (A3). The second candidate solution, the higher real root, observes the SOC (A3) and is equal to

$$\overline{s_A}(s_B) = \frac{4\alpha(\overline{\theta}-k) - (3\alpha-2)cs_B + \sqrt{Y_A}}{8c} > 0. \tag{A5}$$

It is easy to cheek that $\overline{s_A}(s_B) < \frac{\overline{\theta}-k}{2} - \frac{s_B}{2}$. The solution must also observe the additional condition, i.e., $\overline{s_A}(s_B) > s_B$.

$\overline{s_A}(s_B) \geq s_B$, if $s_B \leq \max\{\frac{4\alpha}{3(\alpha+2)}\frac{\overline{\theta}-k}{c}, \frac{2(4\alpha-1)}{3(1+2\alpha)}\frac{\overline{\theta}-k}{c}\}$;

$\overline{s_A}(s_B) < s_B$, otherwise.

As $\frac{4\alpha}{3(\alpha+2)} > \frac{4\alpha^2}{4-4\alpha+3\alpha^2} > \frac{2(4\alpha-1)}{3(1+2\alpha)}$ when $\alpha < \frac{2}{5}$ and $\frac{4\alpha^2}{4-4\alpha+3\alpha^2} > \frac{2(4\alpha-1)}{3(1+2\alpha)} > \frac{4\alpha}{3(\alpha+2)}$ when $\alpha > \frac{2}{5}$, we obtain the best response function of NGO A

(i). When $\alpha < \frac{2}{5}$, $s_A^{BR}(s_B) = \overline{s_A}(s_B)$ if $s_B < \frac{4\alpha^2}{4-4\alpha+3\alpha^2}\frac{\overline{\theta}-k}{c}$; otherwise, the corner solution $s_A^{BR}(s_B) = s_B$ cannot be retained because $s_A > s_B$ by assumption.

(ii). When $\alpha \geq \frac{2}{5}$, $s_A^{BR}(s_B) = \overline{s_A}(s_B)$ if $s_B < \frac{2(4\alpha-1)}{3(1+2\alpha)}\frac{\overline{\theta}-k}{c}$; otherwise, the corner solution cannot be retained.

Solution of NGO B's maximization program:

The maximization program of NGO B is

$$\max_{s_B} U_B(s_A, s_B) = s_B^{\beta}\left(q_B(s_A, s_B)\right)^{1-\beta}. \tag{A6}$$

The FOC is

$$s_B^{\beta-1}(q_B(s_A, s_B))^{-\beta}\left[\beta q_B(s_A, s_B) + (1-\beta)s_B\frac{\partial q_B}{\partial s_B}\right] = 0 \tag{A7}$$

As $\frac{\partial q_B}{\partial s_B} = \frac{s_A(\overline{\theta}-k-3cs_A)}{(4s_A-s_B)2} < 0$ if and only if $s_A > \frac{\overline{\theta}-k}{3c}$, there exists at least one solution to equation (A7) if and only if $s_A > \frac{\overline{\theta}-k}{3c}$. If $s_A \leq \frac{\overline{\theta}-k}{3c}$, $\frac{\partial U_B}{\partial s_B} > 0$, then $s_B^{BR}(s_A) = s_A$.

The SOC $\frac{\partial^2 U_B}{\partial s_B^2}$ is negative when $s_A > \frac{\overline{\theta}-k}{3c}$, as $\frac{\partial^2 q_B}{\partial s_B^2} = \frac{2s_A(\overline{\theta}-k-3cs_A)}{(4s_A-s_B)^3} < 0$ in this case.

The FOC is equivalent to the following quadratic equation in s_B

$$\beta c s_B^2 - ((3+2\beta)cs_A - (1-2\beta)(\overline{\theta}-k))s_B + 4\beta(\overline{\theta}-k+cs_A)s_A = 0. \tag{A8}$$

The discriminant of the quadratic equation

$\Delta = ((\overline{\theta}-k)-3cs_A)((1-2\beta)^2(\overline{\theta}-k) - (1+2\beta)(3-2\beta)cs_A) = Y_B$ is positive whatever s_A.

The higher real root is a higher than s_A, therefore it is not a valid solution.

The lower real root of the quadratic equation (A8) is

$$\underline{s_B}(s_A) = \frac{(3+2\beta)cs_A - (1-2\beta)(\overline{\theta}-k) - \sqrt{Y_B}}{2\beta c} > 0, \tag{A9}$$

with $\underline{s_B}(s_A) < s_A$ if and only if $s_A > \frac{1+2\beta}{3(1-\beta)}\frac{\overline{\theta}-k}{c} > \frac{\overline{\theta}-k}{3c}$. This induces $\beta < \frac{2}{5}$.

The best response function of NGO B is $s_B^{BR}(s_A) = \underline{s_B}(s_A)$ if $s_A \geq \frac{1+2\beta}{3(1-\beta)}\frac{\overline{\theta}-k}{c}$; otherwise, the corner solution, s_A, cannot be retained, as $s_B < s_A$ by assumption.

Quality equilibria

Simultaneously solving the two best response functions using *Mathematica* yields two possible Nash equilibrium quality standards for NGO B, s_B^* and s_B^{**}. These equilibrium candidates are real solutions if and only if

$\Delta = Y = (1-3\alpha)^2 - 4(4+\alpha(-5+3\alpha))\beta + 4(2-\alpha)^2\beta^2 > 0$, that is, if and only if

$\alpha < \underline{\alpha}(\beta) = \frac{3+2\beta(4\beta-5)-4(1-\beta)\sqrt{6\beta}}{(3-2\beta)^2} < \frac{1}{3}$ or $\alpha > \overline{\alpha}(\beta) = \frac{3+2\beta(4\beta-5)+4(1-\beta)\sqrt{6\beta}}{(3-2\beta)^2} > \frac{1}{3}$.

In this case, the two real solutions are $s_B^* = \frac{Z_B-(1-2\beta+\alpha\beta)\sqrt{Y}}{3X}\frac{\overline{\theta}-k}{c}$ and $s_B^{**} = \frac{Z_B+(1-2\beta+\alpha\beta)\sqrt{Y}}{3X}\frac{\overline{\theta}-k}{c}$,

with $Z_B = \beta(3-10\beta)\alpha^2 + (3-5\beta+4\beta^2)\alpha - 1 + 10\beta - 4\beta^2$ and

$X = 1 - \beta(\alpha - 2 + 2(1-(1-\alpha)\alpha)\beta) > 0$.

The associated values of s_A are $s_A^* = \frac{Z_A+(1+\beta-2\alpha\beta)\sqrt{Y}}{6X}\frac{\overline{\theta}-k}{c}$ and $s_A^{**} = \frac{Z_A-(1+\beta-2\alpha\beta)\sqrt{Y}}{6X}\frac{\overline{\theta}-k}{c}$,

with $Z_A = 2\beta(-3+2\beta)\alpha^2 + (3+5\beta-10\beta^2)\alpha + 1 - \beta + 4\beta^2$.

To conclude the proof we must check whether the equilibrium candidates satisfy the following four conditions.

(i). $s_B^* > 0$ and $s_B^{**} > 0$.

$s_B^* > 0$ if $Z_B > 0$, that is, if $\alpha > \alpha_1^E(\beta) = \frac{3-5\beta+4\beta^2-\sqrt{3}\sqrt{3-6\beta-37\beta^2+136\beta^3-48\beta^4}}{2\beta(10\beta-3)}$. However, $\alpha_1^E(\beta) > 0$ when $\beta < \frac{5-\sqrt{21}}{4}$, and $\underline{\alpha}(\beta) < \alpha_1^E(\beta) < \overline{\alpha}(\beta)$ when $\beta < \frac{5-\sqrt{21}}{4}$. Therefore, condition $\alpha > \overline{\alpha}(\beta)$ guarantees that $s_B^{**} > s_B^* > 0$.

(ii). $s_A^* > \frac{\overline{\theta}-k}{3c}$ and $s_A^{**} > \frac{\overline{\theta}-k}{3c}$.

$s_A^{**} > \frac{\overline{\theta}-k}{3c}$ if $Z_A - 2X > 0$, that is, if $\alpha > \alpha_2^E(\beta) = \frac{3-7\beta-14\beta^2-\sqrt{3}(1-\beta)\sqrt{3+12\beta-20\beta^2}}{4\beta(3\beta-4)}$ when $\beta < \frac{3+2\sqrt{6}}{10}$ or when $\beta > \frac{3+2\sqrt{6}}{10}$. However, $\alpha_2^E(\beta) < \overline{\alpha}(\beta)$. Therefore, condition $\alpha > \overline{\alpha}(\beta)$ guarantees that $s_A^* > s_A^{**} > \frac{\overline{\theta}-k}{3c}$.

(iii). $s_A^* < \frac{\overline{\theta}-k}{c} - \frac{s_B^*}{2}$ and $s_A^{**} < \frac{\overline{\theta}-k}{c} - \frac{s_B^{**}}{2}$.

$s_A^* < \frac{\overline{\theta}-k}{c} - \frac{s_B^*}{2} \Leftrightarrow 2 - 2(2-\alpha)\beta^2 + (1-\alpha)\beta - \beta\sqrt{Y} > 0$. This induces the condition that $2 - 2(2-\alpha)\beta^2 + (1-\alpha)\beta > 0$, which is satisfied when $\beta < \frac{1}{2}$. When $\beta > \frac{1}{2}$, the additional condition $\alpha > \alpha_3^E(\beta) = \frac{4\beta^2-\beta-2}{\beta(2\beta-1)}$ is necessary. As $\alpha_3^E(\beta) < \overline{\alpha}(\beta)$ when $\beta > \frac{1}{2}$, condition $\alpha > \overline{\alpha}(\beta)$ guarantees that $s_A^* < \frac{\overline{\theta}-k}{c} - \frac{s_B^*}{2}$.

As $s_A^{**} < \frac{\overline{\theta}-k}{c} - \frac{s_B^{**}}{2} \Leftrightarrow 2 - 2(2-\alpha)\beta^2 + (1-\alpha)\beta + \beta\sqrt{Y} > 0$, no additional condition is necessary.

(iv). $s_A^* > s_B^*$ and $s_A^{**} > s_B^{**}$.

- $s_A^* - s_B^* = \frac{(1-\alpha)-(7-5\alpha+4\alpha^2)\beta+2(2-3\alpha+4\alpha^2)\beta^2+(1-\beta)\sqrt{Y}}{2(1-\beta(\alpha-2+2(1-(1-\alpha)\alpha)\beta))}\frac{\overline{\theta}-k}{c}$.

  If $(1-\alpha)-(7-5\alpha+4\alpha^2)\beta+2(2-3\alpha+4\alpha^2)\beta^2 > 0$, that is, if

  $\alpha < \frac{-(1-5\beta+6\beta^2)+\sqrt{(1-2\beta)(1+\beta(8+\beta(-91+46\beta)))}}{8\beta(1-2\beta)} = \widetilde{\alpha}(\beta)$, $s_A^* - s_B^* > 0$.

  If $\alpha > \widetilde{\alpha}(\beta)$, a necessary condition is that $\alpha > \frac{1}{2(1-2\beta)}$.

- $s_A^{**} - s_B^{**} = \frac{(1-\alpha)-(7-5\alpha+4\alpha^2)\beta+2(2-3\alpha+4\alpha^2)\beta^2-(1-\beta)\sqrt{Y}}{2(1-\beta(\alpha-2+2(1-(1-\alpha)\alpha)\beta))}\frac{\overline{\theta}-k}{c}$.

  If $(1-\alpha)-(7-5\alpha+4\alpha^2)\beta+2(2-3\alpha+4\alpha^2)\beta^2 < 0$, that is, if $\alpha < \widetilde{\alpha}(\beta)$, an additional necessary condition is that $\alpha < \frac{1}{2(1-2\beta)}$.

  If $\alpha > \widetilde{\alpha}(\beta)$, $s_A^{**} - s_B^{**} < 0$.

As $\overline{\alpha}(\beta) \leq \frac{1}{2(1-2\beta)}\ \forall\beta$, $\overline{\alpha}(\beta) = \frac{1}{2(1-2\beta)}$ when $\beta = \frac{7-\sqrt{33}}{16}$ and $\widetilde{\alpha}(\beta) \leq \frac{1}{2(1-2\beta)}$ when $\beta \geq \frac{7-\sqrt{33}}{16}$, we obtain the following equilibria.

(i). When $\beta < \frac{7-\sqrt{33}}{16}$ and $\overline{\alpha}(\beta) < \alpha < \frac{1}{2(1-2\beta)}$, there are two equilibria: (s_A^*, s_B^*) and (s_A^{**}, s_B^{**}), with $s_A^* > s_A^{**}$ and $s_B^* < s_B^{**}$;

(ii). When $\alpha > \overline{\alpha}(\beta)$, there are a unique equilibrium: (s_A^*, s_B^*);

(iii). Otherwise, there is no equilibrium.

However, in the case where $s_B > s_A$, similar calculations show that there is no equilibrium with the assumption that $\alpha > \beta$.

A.3 Proof of Proposition 3

- $s_A^* < s_A^0 \Leftrightarrow 6\alpha X - Z_A > (1+\beta-2\alpha\beta)\sqrt{Y}$.

  $6\alpha X - Z_A > 0$ when $\alpha > \overline{\alpha}(\beta)$.

  Moreover, $(6\alpha X - Z_A)^2 - (1+\beta-2\alpha\beta)^2 Y > 0$ if $\beta < \frac{1-2\alpha+3\alpha^2}{2(2\alpha-4\alpha^2+3\alpha^3)} = \tilde{\beta}(\alpha)$.

  However, as $\tilde{\beta}(\alpha) > \alpha$, condition $\beta < \tilde{\beta}(\alpha)$ is always satisfied.

  Therefore, $s_A^* < s_A^0$.

- $s_B^* < s_B^0 \Leftrightarrow Z_A B - 3\beta X > (1 - 2\beta + \alpha\beta)\sqrt{Y}$.

  $Z_A B - 3\beta X > 0$ when $\alpha > \overline{\alpha}(\beta)$.

  Moreover, $(Z_A B - 3\beta X)^2 - (1 - 2\beta + \alpha\beta)^2 Y > 0$ for all $\alpha,\ \beta$.

  Therefore, $s_B^* > s_B^0$.

A.4 Proof of Proposition 4

Let $f(\alpha, \beta) = s_A^* q_A^* + s_B^* q_B^*$.

(i). $f(\alpha, \beta) > s_A^0 q_A^0$ because $\lim_{\beta \to 0} f(\alpha, \beta) = \frac{\alpha(1-\alpha)}{2} \frac{(\theta-k)^2}{c} = s_A^0 q_A^0$ and $\frac{\partial f(\alpha,\beta)}{\partial \beta} > 0$ for all $\alpha \in]1/3, 1[$ and $\beta \in]0, 1/4[$.

(ii). $f(\alpha, \beta) > s_B^0 q_B^0$ because $\lim_{\alpha \to 1} f(\alpha, \beta) = \frac{2\beta}{(1+2\beta)^2} \frac{(\theta-k)^2}{c} > \frac{\beta(1-\beta)}{2} \frac{(\theta-k)^2}{c} = s_B^0 q_B^0$ and $\frac{\partial f(\alpha,\beta)}{\partial \alpha} < 0$ for all $\alpha \in]1/3, 1[$ and $\beta \in]0, 1/4[$.

Additionally, it is interesting to check that

(i). $q_A^* < q_A^0$ when $\alpha > \frac{3+14\beta-\sqrt{9+36\beta-44\beta^2}}{12\beta} = \alpha_1(\beta)$, and $q_A^* \geq q_A^0$ otherwise;

(ii). $q_A^* + q_B^* > q_A^0$;

(iii). obviously, $q_B^* < q_B^0$;

(iv). $q_A^* + q_B^* < q_B^0$ when $\alpha > \frac{-1+7\beta-18\beta^2-2\beta^3+12\beta^4+(1+6(1-\beta)\beta)\sqrt{1-\beta\,(2+\beta\,(3+2\,\beta)\,(-7+6\beta))}}{4\beta\,(3+\beta-10\beta^2+6\beta^3)} = \alpha_2(\beta)$ with $\alpha_2(\beta) > \alpha_1(\beta)$, and $q_A^* + q_B^* \geq q_B^0$ otherwise;

(v). $s_A^* q_A^* < s_A^0 q_A^0$;

(vi). $s_B^* q_B^* > s_B^0 q_B^0$.