A Theory of Multi-Tier Ecolabels*

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Abstract

Certification schemes for credence goods can be binary in structure or have multiple tiers. We present a theory explaining how standard-setting organizations choose between these two forms, and compare the differing incentives of industry trade associations and non-governmental organizations (NGOs) in setting standards. For either type of scheme in autarky, the choice between a binary and a multi-tier label depends upon industry structure in subtle ways. When the two types of organization compete, however, there exists a unique equilibrium in which each organization offers a binary label. Surprisingly, the trade association offers a more stringent label than the NGO. In effect, the NGO sets a minimum quality standard that reduces the excessive product differentiation desired by the industry.

1 Introduction

Global environmental issues such as biodiversity and climate change are increasingly important to citizens around the world, but are extremely difficult for governments to address with standard policy tools. The globalization of trade and the need for international coordination on global issues make harmonized world standards for environmental problems unlikely in the foreseeable future. Global trade law also makes it difficult for governments to attempt to regulate attributes of production processes beyond their borders. In response, many groups (both industry trade associations and environmental advocacy groups) have put increasing effort into international market mechanisms involving ecolabeling.

Ecolabels can be of two types: binary or multi-tiered. Binary labels establish a threshold of performance and award a label to any product that meets or exceeds it. Binary labels include Forest Stewardship Certification (FSC) for forest products and Rainforest Alliance certification for coffee. Multi-tier labels establish a "ladder" of graduated performance levels, and award different labels depending on a product's performance. Perhaps the best known multi-tier label is Leadership in Energy and Environmental Design (LEED) certification for buildings, which offers Certified, Silver, Gold, and Platinum levels.

Ecolabels also differ according to the sponsor of the label, with some offered by non-governmental organizations (NGOs) with a mission of environmental advocacy, and others offered by industry trade associations. NGO labels include FSC and Rainforest Alliance, while industry labels include Sustainable Forestry Initiative (SFI) certification for forest products and Green Globes for buildings.

Although there is a substantial theoretical literature on ecolabels, it has ignored the possibility of multi-tiered labels, and aside from our own prior work (Fischer and Lyon 2013) it has also ignored the different objectives of NGO and industry sponsors. This paper examines when each of these types of sponsors prefers to offer a binary label as opposed to a multi-tier label, and goes on to explore the nature of equilibrium when labels from both types of sponsors compete. We seek to characterize the nature of the ecolabels that are offered by each type of sponsor in equilibrium, and to assess the impact of multi-tiered labels and of label competition on overall environmental protection.

Our model builds on the standard vertical product differentiation framework, in which all consumers prefer greener products, but differ in their willingness to pay for environmental quality. Although consumers prefer greener products, environmental quality is a credence good so consumers are unable to discern the environmental attributes of a product on their own, even after consumption. Hence they rely on ecolabels to provide information about these attributes. Two different types of organization may offer ecolabels: an NGO seeks to maximize environmental ben-

efits, while an industry trade association seeks to maximize the aggregate profits of the industry. We assume firms are of two types, having either high costs of improving environmental performance or low costs, and we study the implications of varying mix of these two types of firms.

One might expect that label variety, when set with consistent goals in mind, should always improve welfare. In this paper, we explore that expectation and find that it does not always hold. The creation of multiple tiers creates incentive compatibility constraints that require label sponsors to distort environmental standards if they wish to induce low-cost firms to choose higher levels of performance. Consequently, from either an industry profits or an environmental perspective, less can be more. The choice of label format depends both upon the cost gap between the two types of firms and the fraction of firms that have low costs.

For either type of sponsor, labels can take one of three basic forms. First, a single ambitious standard can be set that can only be achieved by low-cost firms. Second, a single basic standard can be set that can be met by all firms. Third, two separate standards can be set, with the standard for low-cost firms distorted by the need to ensure that they do not choose the basic standard intended for the high-cost firms.

We find that the NGO sets only the ambitious standard if the majority of firms have low costs. However, if low-cost firms are a minority, then the choice of label structure depends upon the cost gap between high- and low-cost firms. If the cost gap is small, then the NGO sets only the basic standard, and all firms choose to meet it. If the cost gap is large and the majority of firms are high-cost, then the NGO offers a multi-tiered label.

The industry association also sets a single ambitious standard (though one that is weaker than the NGO would set) if the fraction of low-cost firms is high enough and if the cost gap is large. In all other circumstances the industry offers a multi-tiered label. The ambitious tier of the label remains the same as in the case of a single ambitious standard, but the basic tier can take two different levels, depending upon the mix of firm types and the size of the cost gap. In particular, if the cost gap is large enough and the number of low-cost firms small enough, then the industry chooses a weaker basic label than it would otherwise.

When NGO and industry labels compete, all of the foregoing complexity disappears and there is a unique equilibrium outcome regardless of the mix of firm types or the cost gap. In equilibrium, each sponsor offers a binary label. The industry sets an ambitious binary standard that is the same as it would set in autarky, and the NGO sets a basic standard that is above what the industry would set in its multi-tier standard but below what the NGO would offer in its multi-tier standard. Thus, the industry standard ends up being more stringent than the NGO standard in equilibrium. In effect, the NGO sets a minimum quality standard that reduces the excessive product differentiation desired by the industry.

The remainder of the paper is organized as follows. Section 2 presents the basic model and the necessary and sufficient conditions for the existence of binary and multitiered labels. Section 3 characterizes the optimal labeling scheme for the NGO, and section 4 characterizes the optimal labeling scheme for the industry trade association. Section 5 analyzes the equilibrium when the two groups compete, and section 6 concludes.

2 The Model

We formulate a model with heterogeneous consumer preferences for ecolabel characteristics and heterogeneous costs for meeting ecolabel standards, depending on a firm's type. The demand side of our model uses the standard vertical product differentiation framework, in which all consumers prefer greener products, but differ in their willingness to pay for environmental quality. Unlike a representative consumer model (Fischer and Lyon 2013), this structure implies that the demand for higher-quality products depends on both their own price and the price of lower-quality substitutes.

The supply side of our model departs significantly from standard vertical differentiation models, featuring price-taking firms rather than the standard duopoly. In the standard model, there are two firms with different costs of increasing product quality; the firms differentiate, with the high-cost firm offering a low-quality product and the low-cost firm offering a high-quality product and earning higher profits (e.g., Lehmann-Grube 1997). Our model also has two classes of firms, some with low costs of improving environmental performance ("quality") and some with high costs of quality. The share of firms in each class is exogenously given, and we study the implications of varying the mix of these two classes of firms. Importantly, the firms are assumed to be price takers, recognizing that for most ecolabelled goods, individual suppliers of commodities have minimal market power. (Alternatively, one can think of our supply side as a model of Bertrand competition with capacity constraints, where undifferentiated firms within each class compete on prices.) The fixed industry size can reflect a short-run timeframe or be motivated by an (unmodeled) fixed cost of entry for each type.

Like many other papers, we treat environmental quality as a credence good, so consumers are unable to discern the environmental attributes of a product on their own, even after consumption. Hence they rely on ecolabels to provide information about these attributes. Two different types of organization may offer ecolabels: an NGO seeks to maximize environmental benefits, while an industry trade association seeks to maximize the aggregate profits of the industry.

Our assumptions regarding the certification industry depart significantly from the rest of the literature. One strand of the literature follows Lizzeri (1999), who assumes certification bodies seek to maximize their own profits, which leads them to set low standards and extract all industry rents

through high certification fees. In the case of ecolabels, however, this seems to be sharply at odds with reality, where certification bodies are chronically close to bankruptcy. Thus, we assume the certification bodies costlessly set standards that serve the objectives of either NGOs or industry members. Another strand of the literature focuses on the imperfect nature of certifications, allowing for Type I and Type II errors. Mason (2011) has explored this possibility in a setting with rational Bayesian consumers and a monopolistic certification body, while Harbaugh et al. (2012) study competition between exogenously set standards enforced by error-prone auditors. While we believe it would be of interest to model the structure of the certification industry in more detail, including the agency relationship between certification bodies and auditors (as in Lerner and Tirole 2006), we leave this task for future work, opting instead to focus on the implications of the differing objective functions of our two standard-setting bodies.

This paper builds on our own previous work (Fischer and Lyon 2013), which also studied the competition between two certification bodies with differing objectives. That paper, however, allowed each certification body to set at most one standard, so it assumed away the issue that takes center stage here, namely the incentives of certification bodies to choose between binary and multi-tiered standards. It also employed rather different models of demand and supply, using a simple representative consumer model based on that in Heyes and Maxwell (2004) and a continuum of firms with differing costs of quality. We believe the modeling choices we make in the present paper provide a better setting for exploring multi-tiered labels. The simpler treatment of the supply side of the model (two types instead of a continuum) allows us to explore a more nuanced model of demand, in which a certification body must take account of how one standard affects demand for the other. At the same time, we maintain our focus on the competition between NGO-led and industry-led ecolabels.

2.1 Consumers

We consider two quality levels for the ecolabel standards: a basic level, s^B and a more ambitious level s^A. To represent the demand for ecolabel stringency, let consumers be distributed across some range $\mu \in [0, 1]$ according to density function $f(\mu)$, with utility $u = \mu s - p$. Then we can find the consumer at μ^B who is indifferent between buying the basic ecolabel and not:

$$\mu^B s^B - p^B = 0$$

Next we identify the consumer at μ^A who is indifferent between the two qualities:

$$\mu^A s^A - p^A = \mu^A s^B - p^B.$$

Solving for these preference levels we have

$$\mu^B = \frac{p^B}{s^B}$$

and

$$\mu^A = \frac{p^A - p^B}{s^A - s^B}.$$

If $f(\mu)$ is uniform on $[0, 1]$, then $f(\mu) = 1$, and we have three groups of consumers:

- Consumers who do not buy an ecolabeled product, whose aggregate demand is

$$D^0 = \frac{p^B}{s^B};$$

- Consumers who buy the high-quality product, with aggregate demand

$$D^A = 1 - \frac{p^A - p^B}{s^A - s^B};$$

- Consumers who buy the low-quality product, with aggregate demand

$$D^B = \frac{p^A - p^B}{s^A - s^B} - \frac{p^B}{s^B} = \frac{s^B p^A - p^B s^A}{s^B(s^A - s^B)}.$$

Note that in the case of a single, uniform label U, consumer demand is

$$D^U = 1 - \frac{p^U}{s^U}.$$

2.2 Firms

On the supplier side of the market, there are N price-taking firms, each producing one unit of the product with environmental damage Z. Firms can take measures to reduce their environmental damages, with damages falling to $Z - s$ if the firm undertakes measures of stringency s. We will limit our analysis to cases where $s \geq 0$. The firms can be divided into two types, based on their costs of meeting the label requirements. For a firm of type i, the cost of adopting a label of stringency s^j is $\theta^i \left(s^j\right)^2$. Thus, costs are quadratic in label stringency and the marginal cost of quality is $2\theta^i$. Profits for firm i pursuing label j are the revenues p^j minus these costs:

$$\pi^i = p^j - \theta^i \left(s^j\right)^2.$$

Suppose there are N^A firms with low cost parameter θ^A that can afford to pursue the ambitious standard and N^B firms (having higher costs $\theta^B > \theta^A$) that are better suited for the basic label . Let $N = N^B + N^A$. [Our market scale is such that $N < 1$, since the distribution of consumers sums to 1.]

In equilibrium, supply equals demand, so $N^A = D^A$ and $N^B = D^B$. We can then work backwards to solve for prices as a function of the standards. First, we obtain the price for the basic standard: From $N = D^A + D^B = 1 - p^B/s^B$, we obtain

$$p^B = s^B(1 - N).$$

Note that this price is a function of the basic standard alone.

Next, we solve for the price of the ambitious standard: From $N^A = D^A = 1 - \frac{p^A - p^B}{s^A - s^B} = 1 - \frac{p^A - s^B(1-N)}{s^A - s^B}$, we obtain

$$\begin{aligned} p^A &= (s^A - s^B)(1 - N^A) + s^B(1 - N) \\ &= s^A(1 - N^A) - s^B N^B. \end{aligned}$$

Now we can compute profits. The profit of a low-quality firm meeting standard s^B is

$$\pi^B(s^B) = p^B - \theta^B \left(s^B\right)^2 = s^B(1 - N) - \theta^B \left(s^B\right)^2$$

and the profit of a high-quality firm meeting standard s^A is

$$\pi^A(s^A) = p^A - \theta^A \left(s^A\right)^2 = s^A(1 - N^A) - s^B N^B - \theta^A \left(s^A\right)^2.$$

Environmental damages from the industry are

$$\begin{aligned} E &= ZD^0 + [Z - s^A]D^A + [Z - s^B]D^B \\ &= Z - s^A D^A - s^B D^B \end{aligned}$$

2.2.1 Conditions for a Multi-Tier Equilibrium

The foregoing discussion assumes that the standards are such that a separating equilibrium exists. To explore these conditions, let us define the maximum *single* standard (i.e., when the other standard is absent; subscript "E" indicates this is the most environmentally friendly standard

possible) for each type that generates non-negative profits:

$$\begin{aligned} s_E^B &\equiv (1-N)/\theta^B; \\ s_E^A &\equiv (1-N^A)/\theta^A > s_E^B. \end{aligned}$$

Other useful points of reference are the profit-maximizing standards for each *individual* type (subscript "π" indicates profit maximization):

$$\begin{aligned} s_\pi^B &\equiv s_E^B/2; \\ s_\pi^A &\equiv s_E^A/2 > s_\pi^B. \end{aligned}$$

Now, for each firm type we have two constraints: 1) *Individual Rationality* (IR), which requires that profits be non-negative, and 2) *Incentive Compatibility* (IC), which requires that profits be higher with the firm's own standard than with the other type's standard.

For the high-cost firm to prefer the basic standard, we have 1) $\pi^B(s^B) \geq 0$, or

$$s^B \leq s_E^B,$$

and 2) $\pi^B(s^B) \geq \pi^B(s^A)$, or $s^B(1-N) - \theta^B \left(s^B\right)^2 - s^A(1-N^A) + s^B(N-N^A) + \theta^B \left(s^A\right)^2 \geq 0$ (which is concave in s^B), implying $(\theta^A/\theta^B)s_E^A - s^A \leq s^B \leq s^A$. We thus define the minimum incentive compatible s^B for the high-cost firm as

$$s_{\text{ICB}}^B \equiv \frac{\theta^A}{\theta^B} s_E^A - s^A.$$

Meanwhile, for the low-cost firm to prefer the ambitious standard to the alternatives, we must have 1) $\pi^A(s^A) \geq 0$ and 2) $\pi^A(s^A) \geq \pi^A(s^B)$. Note that if the high-cost firms have non-negative profits with the basic standard, then *a fortiori* the low-cost firms would have positive profits with that standard ($\pi^A(s^B) > \pi^B(s^B) \geq 0$); thus if the incentive compatibility constraint is met for the low-cost firms, then the individual rationality constraint is automatically satisfied, that is, $\pi^A(s^A) \geq \pi^A(s^B) > \pi^B(s^B) \geq 0$. Rewrite the IC constraint as $\Delta \equiv \pi^A(s^A) - \pi^A(s^B) \geq 0$, and note that $\Delta = s^A(1-N^A) - \theta^A \left(s^A\right)^2 - s^B(1-N^A) + \theta^A \left(s^B\right)^2 = (s^A - s^B)(1-N^A) - \theta^A \left(\left(s^A\right)^2 - \left(s^B\right)^2\right)$ is convex in s^B, implying that

$$s^B < \min\{s^A, s_E^A - s^A\}.$$

Since we are by assumption seeking conditions for an equilibrium in which $s^A > s^B$, the second part of the inequality is the relevant one and the maximum value of s^B that satisfies the IC

constraint for the low-cost firm is

$$s^B_{\text{ICA}} \equiv s^A_E - s^A.$$

As mentioned before, if this constraint is satisfied then so is the IR constraint for the low-cost firm. Thus, in an equilibrium with two standards, there are four constraints that must be met, the two IC constraints, the IR constraint for the high-cost firm, and the non-negativity constraint on s^B. Together, these imply that s^B satisfies

$$\max\{s^B_{\text{ICB}}, 0\} \leq s^B \leq \min\{s^B_E, s^B_{\text{ICA}}\}$$

3 NGO Standard

The NGO selects its standards to maximize total abatement: $A = N^B s^B + N^A s^A$. The NGO wants to set both standards as high as possible, subject to the individual rationality and incentive compatibility constraints. Thus, there are three options for the pair $\{s^A, s^B\}$: $\{s^A_E, 0\}, \{s^B_E, s^B_E\}$, or $\{s^A, s^B_{\text{ICA}}(s^A)\}$. (The NGO would be happy to have the high-cost firm want to adopt the more ambitious standard, so the s^B_{ICB} constraint is not a concern.) In the first option, the NGO offers an ambitious binary standard that can only be met by the low-cost firm. In the second option, the NGO offers a basic binary standard that can be met by both types of firms. In the third option, the NGO offers a multi-tier standard.

Suppose the NGO wishes to set a multi-tier standard. The relevant incentive compatibility constraint for the low-cost type is then $s^B \leq \min\{s^B_E, s^B_{\text{ICA}} = s^A_E - s^A\}$.

With a binding constraint in the separating equilibrium, the NGO chooses s^A to maximize

$$A = N^B \min\{s^B_E, s^A_E - s^A\} + N^A s^A$$

subject to the constraint that $s^A_E \geq s^A \geq s^B_E$. For $s^A \leq s^A_E - s^B_E$, the first-order condition is $\partial A/\partial s^A = N^A$, so the NGO wants to raise the ambitious standard more, and always reaches at least $s^A = s^A_E - s^B_E$. For $s^A > s^A_E - s^B_E$, the first-order condition is $\partial A/\partial s^A = N^A - N^B$. Thus, if $N^A > N^B$, the NGO prefers to go to s^A_E. If $N^A < N^B$, it stops at $s^A = \max\{s^A_E - s^B_E, s^B_E\}$.

Note that $s^A_E - s^B_E > s^B_E$ if $s^A_E > 2s^B_E$; since $s^A_E = 2s^A_\pi$, this condition holds when $s^A_\pi > s^B_E$; i.e., when the low-cost firm's profit-maximizing standard is higher than the high-cost firm's zero-profit standard. In terms of the relative costs, this situation occurs when

$$\begin{aligned}(1-N^A)/\theta^A &> 2(1-N)/\theta^B \\ \frac{\theta^A}{\theta^B} &< \frac{(1-N^A)}{2(1-N)}.\end{aligned}$$

The foregoing analysis has established the following proposition.

Proposition 1 *If the NGO offers a label without competition from the industry association, it sets: (a) an ambitious binary label at s_E^A if there are more low-cost firms than high-cost firms, i.e. $N^A > N^B$, (b) a basic binary label at $s_E^B < s_E^A$ if $N^A < N^B$ and the cost gap is narrow, i.e. $\theta^A/\theta^B > (1-N^A)/(2(1-N))$, and (c) a multi-tiered label at $(s_E^A - s_E^B, s_E^B)$ if $N^A < N^B$ and the cost gap is wide, i.e. $\theta^A/\theta^B < (1-N^A)/(2(1-N))$.*

Our results for the NGO label are summarized in Table 1.

Market Shares	$\mathbf{N}^A > \mathbf{N}^B$	$\mathbf{N}^A < \mathbf{N}^B$	
Relative Costs		$\frac{\theta^A}{\theta^B} < \frac{(1-N^A)}{2(1-N)}$	$\frac{\theta^A}{\theta^B} > \frac{(1-N^A)}{2(1-N)}$
$\mathbf{s}_N^B$	0	s_E^B	s_E^B
$\mathbf{s}_N^A$	s_E^A	$s_E^A - s_E^B$	s_E^B

Table 1: Complete Characterization of the NGO Label in Autarky

The possible equilibria are also illustrated graphically in Figure 1. When there are more low-cost firms than high-cost firms, the NGO sets a single ambitious standard targeted at the efficient firms. When the high-cost firms are more numerous, the NGO may or may not offer a multi-tier label. If the cost gap between the two types of firms is small, the NGO offers a single basic label that all firms can meet, and that pushes the high-cost firms up against their IR constraint. If the cost gap is large, the NGO offers a multi-tier label in which the basic standard is at its maximum level and the ambitious standard is distorted downwards to accomodate the low-cost firms' IC condition.

[Figure 1 here]

4 Industry Trade Association Standard

We assume the objective of the industry trade association in setting its standards is to maximize the total profits of all firms:

$$\Pi = N^B(s^B(1-N) - \theta^B\left(s^B\right)^2) + N^A(s^A(1-N^A) - s^B N^B - \theta^A\left(s^A\right)^2)$$

Next, we derive the first-order conditions, assuming the equilibrium constraints are met.

The first-order condition with respect to the ambitious standard is independent of the basic one:

$$s^A \geq 0, \quad \frac{\partial \Pi}{\partial s^A} = N^A \left((1 - N^A) - 2\theta^A s^A \right) \leq 0$$

so

$$s_I^A = s_\pi^A = s_E^A/2 > 0.$$

Thus, the industry always sets a positive standard for the low-cost producers, equal to their profit-maximizing level, regardless of a second standard.

The first-order condition with respect to the basic standard is also independent of the ambitious standard, but not of the size of the ambitiouos market segment, since a higher s^B drives down prices and profits for the A firms:

$$s^B \geq 0, \quad \frac{\partial \Pi}{\partial s^B} = N^B((1 - N) - 2\theta^B s^B) - N^A N^B \leq 0.$$

In an interior solution, if a positive basic standard is set, it equals

$$s_I^B = \frac{1 - N - N^A}{2\theta^B} = s_\pi^B - \frac{N^A}{2\theta^B}.$$

Thus, the basic standard is lower than would be profit-maximizing just for those firm types, since raising it lowers prices for the ambitious types. On the other hand, if $N^A > 1 - N$ (that is, if the type A market share is bigger than the share of consumers not purchasing a labelled product), then $s_I^B = 0$ and the industry association (constrained from choosing a negative standard for the B types) picks a single ambitious standard.

However, we also need to verify that these standards meet the conditions required to support a two-tiered equilibrium.

One set of conditions is that $s_I^B \leq \min\{s_E^B, s_{\text{ICA}}^B\}$, which results from the incentive compatibility constraints for the low-cost firm. These are necessarily met, since $s_I^B \leq s_\pi^B < s_{\text{ICA}}^B = s_E^A - s_I^A = s_\pi^A$ and $s_I^B < s_E^B$. In other words, since the s_I^A is set at the profit-maximizing standard for the low-cost firms, their profits are by definition positive and higher than with any alternative standard.

The next set of conditions is that $\max\{s_{\text{ICB}}^B, 0\} \leq s_I^B$, resulting from the incentive compatibility constraint for the high-cost firms. Substituting s_I^A, we see that

$$s_{\text{ICB}}^B = (\theta^A/\theta^B)s_E^A - s_I^A = \left(\frac{\theta^A}{\theta^B} - \frac{1}{2} \right) s_E^A.$$

If the ambitious firms have very low relative costs ($\theta^A/\theta^B < 1/2$), then $s^B_{\text{ICB}} < 0$ and the more binding condition is that $s^B_I \geq 0$, which holds strictly if $N^A < 1 - N$, i.e., if the low-cost firms have sufficiently small market size; else, $s^B_I = 0$. On the other hand, if costs are more similar ($\theta^A > \theta^B/2$), then the binding constraint is that IC constraint for the high-cost firm, i.e. $s^B_I \geq s^B_{\text{ICB}}$. Substituting and simplifying, we find that this condition (and thus the interior solution) holds strictly if

$$\frac{\theta^A}{\theta^B} < \frac{1 - N^A}{1 - N^A + N}$$

Note that if $1-N^A > N$ then $(1-N^A)/(1-N^A+N) < 1/2 < \theta^A/\theta^B$, so in this case there cannot be an interior solution (and $s^B_I = s^B_{\text{ICB}}$). If $1 - N^A > N$, then $(1 - N^A)/(1 - N^A + N) > 1/2$, and we have a potential range of costs and market shares for which a two-tiered equilibrium of $\left\{s^A_\pi, s^B_\pi - \frac{N^A}{2\theta^B}\right\}$ is supported.

On the other hand, if $\frac{\theta^A}{\theta^B} > \frac{1-N^A}{1-N^A+N} > \frac{1}{2}$, the high-cost firm incentive compatibility constraint binds and we would need to have $s^B_I = s^B_{\text{ICB}}$ to maintain a two-tiered equilibrium; otherwise the high-cost firm prefers the ambitious standard. Note that since $\left(\frac{\theta^A}{\theta^B} - \frac{1}{2}\right) < \frac{1}{2}$, this standard implies $s^B_\pi - \frac{N^A}{2\theta^B} < s^B_{\text{ICB}} < s^A_\pi$. However, this means the standard is higher than the interior solution suggests, which lowers the profits of the ambitious firms. But otherwise the high-cost firms would adopt the A standard, which is tantamount to the industry association setting $s^B_I = s^A_\pi$, which is even higher (further lowering profits).

The foregoing analysis has established the following proposition.

Proposition 2 *If the industry association offers a label without competition from the NGO, it sets: (a) an ambitious binary label at s^A_π if the number of low-cost firms is large, i.e. $N^A > 1 - N$, and the cost gap is wide, i.e. $\theta^A/\theta^B < 1/\mathbf{2}$, (b) a multi-tiered label at (s^A_π, s^B_{ICB}) if the cost gap is narrow, i.e. either $\theta^A/\theta^B > (1 - N^A)/(1 - N^A + N)$ or $\theta^A/\theta^B > 1/\mathbf{2}$ and $N^A > 1 - N$, and (c) a multi-tiered label at $(s^A_\pi, s^B_\pi - \frac{N^A}{2\theta^B})$ if the number of low-cost firms is small, i.e. $N^A < 1 - N$ and the cost gap is wide, i.e. $\theta^A/\theta^B < (1 - N^A)/(1 - N^A + N)$.*

Therefore, as long as some cost differential exists ($\theta^A/\theta^B > 0$), the industry association never wants to set a single standard to which both types would adhere. However, if costs are sufficiently dispersed, it may choose to set only a single ambitious standard, to avoid eroding *any* profits for the low-cost firms, even with a modest basic standard for the high-cost firms. The results are summarized in Table 2.

Market Shares	$\mathbf{N^A > 1-N}$		$\mathbf{N^A < 1-N}$	
Relative Costs	$\boldsymbol{\theta^A/\theta^B < 1/2}$	$\boldsymbol{\theta^A/\theta^B > 1/2}$	$\frac{\theta^A}{\theta^B} < \frac{1-N^A}{1-N^A+N}$	$\frac{\theta^A}{\theta^B} > \frac{1-N^A}{1-N^A+N} > \frac{1}{2}$
$\mathbf{s}_I^B$	0	s^B_{ICB}	$s^B_\pi - \frac{N^A}{2\theta^B}$	s^B_{ICB}
$\mathbf{s}_I^A$	s^A_π	s^A_π	s^A_π	s^A_π

Table 2: Complete Characterization of the Industry Label in Autarky

This solution is presented graphically in Figure 2. Note that the ambitious standard is always set at its autarkic profit-maximizing level. The basic standard is more complicated. If the ambitious firms outnumber the high-cost firms, and have substantially lower costs, then the association sets a single ambitious standard that only the ambitous firms can meet. Otherwise the association always offers a multi-tier label. If the ambitious firms outnumber the high-cost firms, but the cost gap is more limited, then the association sets a basic standard, one that just leaves the ambitious firms indifferent between the two standards. On the other hand, if the ambitious firms are a minority, then the basic standard is contstrained, either by its own IC constraint or the constraint that $s^B = s^B_\pi - \frac{N^A}{2\theta^B}$.

[Figure 2 here]

4.1 Two Separate Industry Groups

If each industry segment offers its own standard without regard to the standard set by the other, then the standards chosen are $s^A_I = s^A_\pi$ and $s^B_I = s^B_\pi$. This outcome ignores the fact that the basic standard set at this level draws off some demand from the ambitious standard, reducing overall industry profits, with the result that the high-cost group gains at the expense of the low-cost group. However, if they can collude on standard setting, or make monetary transfers across groups, then our Industry Association model applies.

5 Comparing the NGO and Industry Schemes

The labeling schemes offered by the NGO differ from those of the industry in terms of the structure of the label, the number of firms that choose to label, and the stringency of standards.

In terms of label structure, the NGO offers a binary label for a wider range of parameter values than does the industry. For large enough values of N^A, both the NGO and the industry will set a binary standard. More specifically, the NGO chooses a single ambitious label whenever $N^A > N^B$, or $N^A > N/2$ and the industry does so when $N^A > 1-N$, and $\theta^A/\theta^B < 1/2$. The NGO will also set a binary label when $N^A < N/2$ and $\theta^A/\theta^B > (1-N^A)/[2(1-N)]$, this time at a level s^B_E that

both types of firm can meet. The industry never offers a binary label that attracts both types of firm.

The foregoing implies that there are many cases when the industry association would offer a multi-tiered label, but the NGO would not. If $N^A > N/2$, and either $N^A < 1 - N$, and/or $\theta^A/\theta^B > 1/2$, then the NGO would set an ambitious binary label and the industry would offer a multi-tiered label. In this case, the industry label attracts greater participation than the NGO label. Alternatively, when $N^A < \min\{N/2, 1 - N\}$ and $\theta^A/\theta^B > (1 - N^A)/[2(1 - N)]$, the NGO sets a basic binary label and the industry offers a multi-tier label.

In terms of stringency, the following proposition shows that the NGO's ambitious standard s_N^A (which varies depending upon parameter values) is always strictly higher than the industry's ambitious standard, which is always set at $s_I^A = s_\pi^A$.

Proposition 3 *The NGO's ambitious standard s_N^A is greater than the industry's ambitious standard s_I^A for all parameter values.*

Proof. The industry always sets $s_I^A = s_\pi^A$. There are three possible cases to consider. First, consider the case where the NGO sets just a single ambitous standard at $s_E^A = (1 - N^A)/\theta^A$, which occurs if $N^A > N^B$. Since this is the highest level to which the low-cost firms can be pushed, it is clearly greater than $s_\pi^A = (1 - N^A)/(2\theta^A)$. Second, consider the case where the NGO sets a basic binary label at $s_N^B = s_E^B = (1 - N)/\theta^B$. Simple calculations show that the industry's ambitious label is stronger than the NGO's basic label if

$$\frac{\theta^A}{\theta^B} < \frac{1 - N^A}{2(1 - N)},$$

but this condition ensures that the NGO will not offer a binary basic label. Thus, the NGO's binary basic label is stronger than the industry's ambitious label. Finally, consider the case where the NGO offers a multi-tiered label with $s_N^A = s_E^A - s_E^B$, which it does when N^A is small and the ambitious firms have much lower costs, it is straightforward to establish that the conditions for $s_N^A = s_E^A - s_E^B > s_\pi^A = (1 - N^A)/(2\theta^A)$ reduce to

$$s_E^A - s_E^B > 0,$$

which is always true. ■

Thus, the proposition shows that the NGO always demands more of the low-cost firms than does the industry, even when the NGO is setting its basic binary label.

It is worth noting that the industry may set a more stringent standard for the high-cost firms

than does the NGO. For example, there are parameter values for which the NGO sets an ambitious binary label (which implicitly sets $s_N^B = 0$) but the industry sets a multi-tiered label with $s_I^B > 0$. Thus, the industry may attract a greater number of firms to participate in labeling than does the NGO.

6 Equilibrium with Two Multi-Tier Labels

The fact that the NGO and industry association have not only different preferences but also situations in which they would not on their own offer a second label leaves room for label competition. Unlike the case of autarky, where each organization's labeling scheme depends upon details of the parameter, we are able to show the striking result that under label competition there is a single unique equilibrium regardless of parameter values.

Proposition 4 *Under label competition, the unique equilibrium is for the industry to offer a binary label at $s_I^A = s_\pi^A$ and for the NGO to offer a binary label at $s_N^B = s_\pi^A$.*

Proof. Proposition 3 shows that $s_N^A > s_I^A = s_\pi^A$. Since s_π^A maximizes the profits of the low-cost firms, the industry will always undercut the NGO's ambitious standard with s_π^A, and the NGO will not be able to attract the low-cost firms away. When it comes to the basic label, Table 2 shows that if the industry offers a basic standard, it is always distorted below s_π^B to maintain profits for the low-cost firms. Thus, the NGO can raise the standard for the high-cost firms to at least s_π^B, and the industry can do nothing to attract those firms away. Nor can the NGO go higher than s_π^B, because then the industry could attract the high-cost firms away with a lower standard. ■

Proposition 4 provides the remarkable result that there is always a unique equilibrium under label competition, and that it involves each sponsor offering a binary label that maximizes profits for one industry segment or the other. Surprisingly, the industry label is more stringent than the NGO label—it is designed to attract the low-cost firms while the NGO label attracts the high-cost firms. Thus, with label competition between an NGO and industry association, the outcome is the same as if there were two separate industry groups!

This result is surely counterintuitive at first blush. Indeed, it runs counter to our earlier results in Fischer and Lyon (2013), which show that if each sponsor is constrained to offer only a binary label, then under mild assumptions the NGO label in autarky is more stringent than the industry label in autarky. Furthermore, that paper showed that there is always an equilibrium in which the NGO sets a more stringent standard than does the industry. It is quite remarkable, then, that when each sponsor can offer a multi-tiered label, the nature of the equilibrium is reversed!

There is a clear intuition for our results, however, which has two distinct components. First, the industry always sets its ambitious standard at the profit-maximizing level for the low-cost firms so it is impossible for the NGO to induce these firms to adopt any more stringent label. Second, the industry distorts downward the basic standard in order to increase overall industry profits, a result familiar from the vertical differentiation literature (Shaked and Sutton 1982). Thus, the NGO can raise the basic standard and improve environmental performance and it is impossible for the industry to induce these firms to adopt a weaker standard. In effect, the NGO sets a minimum quality standard that reduces the excessive product differentiation desired by the industry.[1]

7 Conclusions

In this paper, we have presented a simple theory explaining when ecolabel sponsors opt to use a binary label and when they opt for a multi-tiered label. We explored both the behavior of an NGO sponsor and an industry trade association sponsor, and characterized their differences. Perhaps most strikingly, we find that there is a simple, unique equilibrium when the two types of sponsor compete. In equilibrium, each sponsor offers a binary standard, and the industry's standard is more ambitious than that of the NGO. In effect, the NGO sets a minimum quality standard that reduces the excessive product differentiation desired by the industry.

We have made a number of simplifying assumptions that would be interesting to relax. First, we have assumed there is a fixed number of firms of each type. This could be relaxed to allow for a free-entry equilibrium. We expect this would strengthen the hand of the NGO, as industry profits would be squeezed by competition regardless of the standard set by the industry. Second, we have assumed that the creation of a label, and the certification of individual firms, is costless. We doubt that adding costs would change the qualitative nature of our results, but the question bears exploration. Third, we have assumed that compliance with the labels is complete, and that there is no fraud in the system and no errors in the certification process. Combining our model with those of Hamilton and Zilberman (2006) or Mason (2011) would allow us to explore the credibility of each label, an issue that is of great concern to practitioners. We look forward to pursuing these extensions in future work.

[1] This result is similar to the analysis of minimum quality standards in Ronnen (1991).

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Figure 1: NGO Optimum

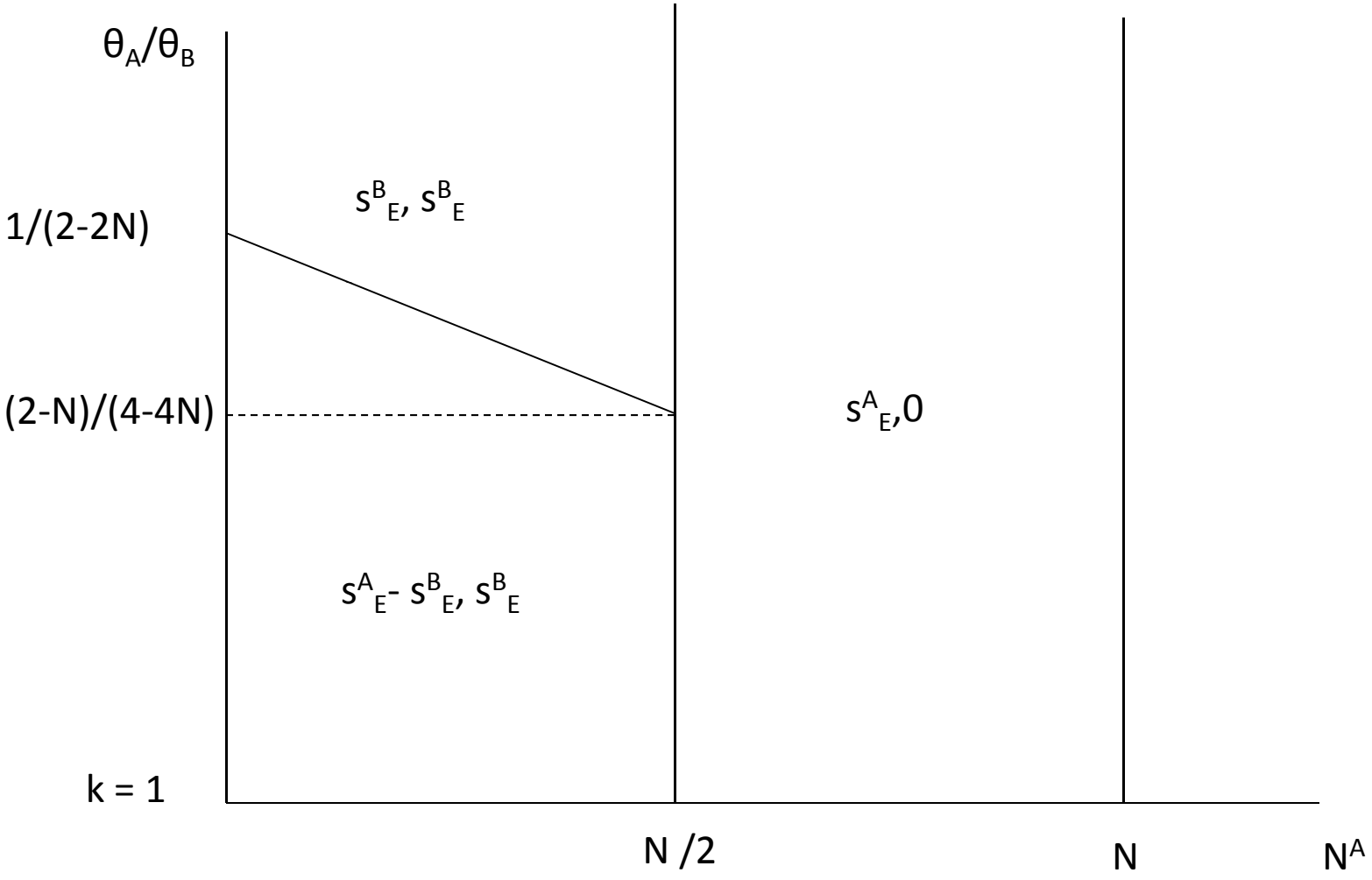

Figure 2: Industry Optimum