GREEN CLUBS*

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Abstract

This paper treats programs in which firms voluntarily agree to meet environmental standards as green clubs: clubs, because they they provide non-rival but excludable reputation benefits to participating firms; green, because they also generate environmental public goods. We compare three common program sponsors—governments, industry, and environmental groups. We find that if monitoring of the club standard is perfect, a government constrained from regulating club size may prefer to leave sponsorship to industry if the welfare weight on public-good benefits is low, or to environmentalists if the welfare weight is high. If monitoring is imperfect, an important question is whether consumers can infer that a club is too large for its standard to be credible. If they can, then the government may deliberately choose an imperfect monitoring mechanism, as a way of regulating club size indirectly. If they cannot, then this reinforces the government's preference for delegating sponsorship.

Keywords: Voluntary environmental programs; Green products; Clubs; Public goods

1. Introduction

Voluntary environmental programs—programs in which firms volunteer to meet environmental performance standards—are by now a well-established part of the environmental-policy toolkit, and are widely viewed as potentially useful substitutes for, or complements to, mandatory environmental regulation.[2] Börkey et al. (1999) count over 50 VEPs in the U.S., over 300 in the European Union, and over 30,000 (mostly local ones) in Japan. In a more recent survey, Carmin et al. (2003) count as many as 150 VEPs in the U.S. Government-sponsored programs include the Voluntary Reporting of Greenhouse Gases Program of the DOE and the Energy Star program of the EPA and DOE jointly. Industry-sponsored programs include the Encouraging Environmental Excellence (E3) program of the American Textile Manufacturers Institute and the Sustainable Forestry Initiative of the American Forestry and Paper Association. Programs sponsored by third-party NGOs include the Co-operative Sanctuary Program (for golf courses) of the Audubon Society and the Alliance for Environmental Innovation program of the Environmental Defense Fund.[3]

Concurrent with this development, a large literature has emerged to analyze these programs, both theoretically and empirically.[4] Focusing here on the theoretical literature, a central question addressed in this literature is why firms might voluntarily commit to exceed regulatory requirements. Suggested benefits include pre-emption of potentially more onerous future regulations (Segerson and Miceli, 1998; Lyon and Maxwell, 2003), higher prices offered by "green consumers" (Arora and Gangopadhyay, 1995; Bagnoli and Watts, 2003;

[2] Tietenberg (1998) characterizes VEPs as being part of the "third wave" of information-based pollution control policies, after legal regulation (the first wave) and market-based instruments (the second wave).

[3] There are also programs that operate world-wide, such as the Finance Initiative of the United Nations Environment Programme, the Sustainable Development Framework of the International Council on Mining & Metals (an industry association), and the ISO 14001 program of the International Organization for Standardization (a Geneva-based NGO).

[4] For excellent reviews, see Khanna (2001), Koehler (2007), and Lyon and Maxwell (2008).

Besley and Ghatak, 2007), reduced shirking by more motivated “green employees” (Brekke and Nyborg, 2008), and lower financing costs required by “green investors” (Graff Zivin and Small, 2005; Baron, 2007). Other issues that have been examined are the difficulty of monitoring or verifying what the various logos or ecolabels provided by programs stand for (Mason, 2006; Hamilton and Zilberman, 2006), and potential perverse effects of ecolabeling (Mattoo and Singh, 1994; Dosi and Moretto, 2001; Rodriguez-Ibeas, 2007).

Except for informal discussions by Börkey et al. (1999) and some empirical analysis by Carmin et al. (2003), however, the literature has to our knowledge never examined the potential implications of the fact—evident from the examples above—that program sponsors tend to fall into three groups: government agencies, industry associations, and third-party NGOs (usually environmental groups).[5] Our aim in this paper is to tease out some of these implications, using a very simple theoretical model. We thereby draw on an important insight from the political science literature on environmental governance, namely Prakash's (2000) observation that the economic theory of clubs can be brought to bear on voluntary environmental programs.[6]

In their review of club theory, Cornes and Sandler (1996) define a club as “a voluntary group of individuals who derive mutual benefit from sharing one or more of the following: production costs, the members' characteristics, or a good characterized by excludable benefits.” To see the parallel with voluntary programs, interpret “individuals” to mean firms, and consider the example of a forest certification program that promotes sustainable forest

[5] Börkey et al. (1999) also discuss a fourth program category, “negotiated agreements” between government and industry. Such agreements, common particularly in the Netherlands and Japan, can be viewed as a hybrid between government- and industry-sponsored programs.

[6] Prakash and co-author Potoski have since elaborated on this observation in a series of publications (e.g., Potoski and Prakash, 2005; Prakash and Potoski, 2006, 2007) but have never developed it formally within an economic framework. In a forthcoming edited volume by these same authors targeted at a political-science audience (Potoski and Prakash, in press), we contribute a chapter in which we sketch out some of the ideas that we develop formally and expand upon here.

practices. The program establishes a benchmark of best practices, and if a firm volunteers to satisfy the benchmark (become a club member), it may seek certification and thereby the right to display the program's seal or logo on its advertising materials and products. This comes at a cost (the membership fee), but also confers a "goodwill" or branding benefit on the firm (the non-rival but excludable good shared by club members); specifically, if consumers know about and trust the certification program, they may be willing to pay a premium for products that bear the program logo.

Note that consumers are more likely to know about a program when more firms participate in it. The per-firm cost of producing the program's reputational benefit therefore likely declines with program size, as of course does each firm's share of any fixed program costs. On the other hand, the per-firm cost of *maintaining* the program's reputation, through monitoring participants' compliance with the program, likely increases with program size, as do the usual overhead costs of bureaucracy and coordination. This parallels two further club properties commonly assumed in the literature, namely initial economies of scale in production of the club good, but eventual "congestion" or "crowding" that diminishes net benefits per member. The initial economies provide the rationale for creating a club, but the eventual congestion limits the club's optimal size.

To emphasize these many parallels, we hereafter refer to VEPs as "green clubs." Central to our analysis, however, is one feature that differentiates these clubs from conventional ones: in addition to providing their members with the club good of a reputational benefit, green clubs also generate environmental benefits. Forest certification programs, for example, aim to preserve habitat and thereby protect biodiversity; energy-efficiency programs aim to reduce emissions and other harms associated with energy production and use. Moreover, these environmental benefits are a public good: they accrue to individuals regardless of whether they purchase program-certified products.

To capture these features, we develop a model that combines elements of club theory with elements of the theory on private provision of public goods.[7] Using this model, we examine how the three classes of club sponsors identified above—government agencies, industry associations, and environmental groups—are likely to differ in terms of their management decisions, given plausible differences in their objective functions and constraints. We assume, for example, that environmentalist clubs aim to maximize the public-good spillover to the environment, whereas industry clubs maximize the profits of member firms. As for government clubs, although we assume that they aim to maximize social welfare—a combination of private and public benefits—we also recognize that these clubs face unique constraints. In particular, whereas privately-run clubs are free to determine how large they want to be, government clubs do not have this freedom: legal requirements of "equal treatment" imply that they cannot arbitrarily exclude firms merely to achieve a desired club size. Moreover, if the very reason for establishing a "voluntary" club is to provide an *alternative* to government regulation, then government sponsors are likely to be constrained from regulating club size even indirectly, through taxes or subsidies.[8] To capture these constraints, most of our

[7] Cornes and Sandler (1996) review the latter theory as well. See Kotchen (2005, 2006) for applications to green markets.

[8] As noted by Carmin et al. (2003), voluntary environmental programs "emerged as an alternative means for improving environmental conditions *outside* the regulatory development process" (emphasis added). Similarly, Lyon and Maxwell (2003), citing a report by the US EPA (EPA, 2001), point out that government agencies often promote voluntary environmental agreements precisely because they lack the statutory authority to establish a mandatory program. Alternatively, even if they have such authority, they may promote the agreements to avoid high transaction costs of mandatory regulations. In either case, the role of the agency is typically limited to establishing a voluntary standard that all firms in an industry are invited to meet. A case in point is the Energy Star program, which was established under the 1992 Energy Policy Act, but significantly expanded in scope under the Clinton administration's 1993 Climate Change Action Plan after attempts to introduce a BTU tax had failed. The program allows any manufacturer of a wide range of products to use the Energy Star logo on its product label, as long as the product meets specific energy-efficiency standards.

analysis of government clubs focuses on the case where, conditional on the club's standard, club size is determined under open access to all firms.

After laying out the model in the next section and solving for the socially optimal club configuration in Section 3, we consider in Section 4 what club size emerges under open access. We show that this depends on two opposing externalities: the standard congestion externality from club theory and the standard free-riding externality from the theory on private provision of public goods. If these externalities cancel each other out, it is possible for open access to implement the socially optimal club size. Sections 5, 6, and 7 then examine the club configurations that emerge under government, environmentalist, and industry sponsorship respectively, and how each compares to the socially optimal configuration. Sections 8 and 9 extend the model to allow for imperfect enforcement of the club standard and for heterogeneity of consumers or firms. Section 10 concludes.

2. Model Setup

Consider an industry with N identical firms, each of which is capable of producing one unit of a particular consumption good, using either a conventional production technology or a "green" technology that has a higher level of environmental friendliness. Let $\theta \geq 0$ denote a firm's chosen level of green production, where $\theta = 0$ corresponds to conventional production. Green production is assumed to be more costly: each firm's cost of producing a unit of output is $d + \alpha\theta$, where d is the unit cost of conventional or "dirty" production and α is the additional marginal cost of green production.

Demand for the industry's output comes from N identical consumers, each of whom purchases one unit of the good and has preferences of the form

$$U(\theta) = b + f(\theta) + \beta g(\Theta).$$

The utility function has three components, which we treat as additively separable for simplicity: b is the consumer's private benefit from consuming the conventionally produced good; $f(\theta)$ is the additional private benefit from green consumption, such as warm glow or improved health; and $g(\Theta)$ is the public-good benefit derived from the aggregate green consumption Θ of all consumers combined. The parameter $\beta \geq 0$ is a shift parameter, capturing the relative importance of the public benefits of green consumption. Both $f(\cdot)$ and $g(\cdot)$ are assumed to be strictly increasing and strictly concave, with $f(0) = g(0) = 0$ and $f'(0) > \alpha$. To simplify the exposition, we assume that $b = d$, so that the conventionally produced good yields no surplus and must be priced at cost d. The green good is priced at $d + p$, so that p denotes the price premium that it fetches over the conventional good.

We assume that green production is not observable to consumers, and that it is not credible for producers to claim green production at any level unless they are certified by a green club.[9] It follows that, without a club, producers would never engage in green production (i.e., they would always choose $\theta = 0$), as they would be unable to charge a price premium to cover their additional cost of $\alpha\theta > 0$.

We consider the case of a single green club that requires its members to meet a benchmark standard of θ. We assume initially, though relax this assumption later, that the club can

[9] Our setup of consumer preferences and producer costs is similar to that in Besley and Ghatak's (2007) model of corporate social responsibility. Besley and Ghatak, however, treat green goods as experience goods rather than credence goods, implying that consumers can monitor each firm's θ directly (albeit possibly imperfectly) and do not need certifying organizations.

perfectly monitor and enforce its standard. The club thus provides a mechanism that makes its members' green production at level θ fully credible to consumers. There are, however, costs $C(n)$ associated with managing the club, which increase in the number of member firms n. Overall club costs are shared equally among members, so that each member must pay the average cost $c(n) = C(n)/n$. Treating n as continuous, we assume that $c(n)$ is U-shaped, reaching an interior minimum at club size $\check{n}$.

Note that, by our assumptions that each firm is capable of producing only one unit of the green good and that consumers buy at most one unit, a club with n members can supply only n consumers. Note also that, by our assumption that the club sets a single standard for all its members, the level of the public good it provides is $\Theta = n\theta$.

3. Social Planner

We begin by deriving the socially optimal club standard and size. Let W denote social welfare, equal to

$$W = n[f(\theta) - \alpha\theta - c(n)] + N\beta g(n\theta). \tag{1}$$

The first term in brackets represents the net private benefit from the club, equal to n times the additional private benefit $f(\theta)$ that each green consumer enjoys, less the additional production costs $\alpha\theta$ and club-management costs $c(n)$ that each green producer incurs. The second term represents the public benefit from the club, enjoyed by all N consumers.

The first-order conditions characterizing an interior maximum of W with respect to θ and n are

$$f'(\theta) + N\beta g'(n\theta) = \alpha \tag{2}$$

and

$$f(\theta) + N\beta g'(n\theta)\theta = \alpha\theta + c(n) + nc'(n). \tag{3}$$

Condition (2) equates the marginal benefits—both private and public—of green consumption to the marginal costs of green production. Condition (3) equates the marginal benefits and costs of increasing the club size. The latter costs include the change $c(n) + nc'(n)$ in *total* club costs that results from an additional member joining.[10]

The two conditions combined implicitly define the socially optimal standard and club size as functions of the model parameters α, β, and N. Ignoring the dependence on α and defining $B \equiv N\beta$, we can write the solution to the social planner's problem as $(\theta^s(B), n^s(B))$. The parameter B is useful because it captures the weight of the public-good benefit in the welfare function, which depends on the number of consumers in the economy and those consumers' preferences for the public good.[11] It is straightforward to show that the socially optimal club standard and size are both increasing in this weight, and thereby in the aggregate benefits of any public-good spillover from green production.[12]

4. Open-Access Equilibrium

We now consider what club size n emerges under open access to the club. We do so initially without specifying how θ is determined, but then consider in particular the socially optimal

[10] A sufficient condition for the welfare maximum to be interior is that over some discrete interval $(\underline{\theta}, \overline{\theta})$ of θ values, the private benefits of green consumption net of production costs strictly exceed the club costs at $\check{n}$: that is, $f(\theta) - \alpha\theta - c(\check{n}) > 0$. Hereafter, we assume this to be the case.

[11] Note however that, although the B components N and β enter the welfare function in the same way, the special case where $B = 0$—implying that green production generates only private benefits—can only arise if $\beta = 0$.

[12] Evaluating (3) at $\check{n}$ shows that $n^s > \check{n}$, so $c'(n^s) > 0$ for any B. Using this, Cramer's rule applied to conditions (2) and (3) gives

$$\frac{d\theta^s}{dB} = \frac{Ng'n(2c' + nc'')}{|H|} > 0 \quad \text{and} \quad \frac{dn^s}{dB} = \frac{-Ng'nf''\theta}{|H|} > 0,$$

where the determinant of the Hessian $|H| = nf''N\beta g''\theta^2 - (nf'' + N\beta g''n^2)(2c' + nc'') > 0$.

standard θ^s. This allows us to highlight some of the tensions at play in our subsequent analysis of different institutional arrangements.

Whether firms join the club and consumers purchase the certified good depends on the standard θ and the good's price premium p over the conventionally produced good. Firms have an incentive to join the club as long as $p \geq \alpha\theta + c(n)$, while consumers have an incentive to purchase the certified good as long as $f(\theta) \geq p$. Note that the public-good benefit does not factor into the consumers' willingness to pay, because the public good can be enjoyed even without purchasing the club-certified good; those who do not purchase the green good simply free-ride on the public-good provision by others.[13] For a given standard θ, the club will expand until both inequalities bind, so that

$$f(\theta) - \alpha\theta - c(n) = 0. \tag{4}$$

No further expansion is then feasible, as the surplus $f(\theta) - \alpha\theta$ available to cover club costs has been dissipated.

Equation (4) implicitly defines a function $\hat{n}(\theta)$ that maps any given club standard to the resulting equilibrium club size under open access.[14] This function has slope

$$\hat{n}'(\theta) = \frac{f'(\theta) - \alpha}{c'(\hat{n}(\theta))}, \tag{5}$$

[13] We assume that any single consumer's purchase of the green good will have a negligible effect on the overall level of the public good.

[14] Strictly speaking, $\hat{n}(\theta)$ is a correspondence rather than a function, because for given θ, condition (4) holds at two values of n: one where average club costs are declining ($n < \check{n}$) and one where they are increasing ($n > \check{n}$). We ignore the former value, because under open access it does not represent a stable equilibrium: any accidental entry at $n < \check{n}$ will reduce average club costs and thus make club surplus—the left-hand side of (4)—positive. This will then attract further entry until $n > \check{n}$. Note also that the function is defined only on the interval $[\underline{\theta}, \overline{\theta}]$, where $f(\underline{\theta}) - \alpha\underline{\theta} - c(\check{n}) = f(\overline{\theta}) - \alpha\overline{\theta} - c(\check{n}) = 0$.

is strictly concave, and has an interior maximum where $f'(\theta) = \alpha$. The function is shown in Figure 1, the other parts of which we will return to shortly. Note that the open-access club size is not monotonic in the standard; in general, two different standards give rise to green clubs of the same size. This follows simply because the surplus $f(\theta) - \alpha\theta$ available to cover given club costs is inversely U-shaped in the standard.

Consider now the club size $\hat{n}(\theta^s)$ that emerges under open access if the club standard is set at the socially optimal level for a given value of B, and consider how it compares to the socially optimal club size n^s. The socially optimal club size is determined by equation (3), which has two additional terms that do not appear in equation (4). These terms reflect the social marginal benefit of an increase in club size from higher provision of the public good, $Bg'(n\theta)\theta$, and the social marginal cost from higher club administration costs, $nc'(n)$. Corresponding to these terms are two externalities that arise under open access, which have opposite effects on the equilibrium club size. Specifically, $Bg'(n\theta)\theta$ corresponds to the standard *public-good externality* from the theory on private provision of public goods: consumers' free-riding on such provision through other consumers' purchases creates a tendency for the open-access club to be suboptimally small. On the other hand, $nc'(n)$ corresponds to the standard *congestion externality* from club theory: firms' ignoring the increase in club management costs imposed on other firms when they join the club creates a tendency for the club to be suboptimally large.

This suggests the interesting possibility that the two externalities may exactly offset each other at the socially optimal standard, in which case open access will give rise to the socially optimal club size. It turns out that this condition does in fact hold at a particular value B^c of the weight placed on the public-good benefits.[15]

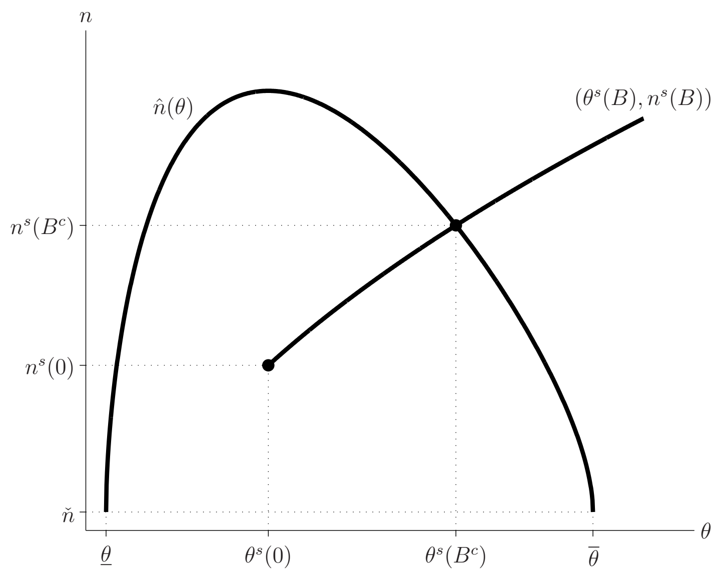


FIGURE 1. Locus of socially optimal standards and club sizes $(\theta^s(B), n^s(B))$ given different weights B on public-good benefits, and locus of open-access equilibrium club sizes $\hat{n}(\theta)$ given different standards θ.

Figure 1 illustrates this special case and shows more generally when open access will result in a club that is suboptimally small or large. As mentioned previously, the inversely U-shaped curve represents the open-access equilibrium condition. The curve traces out the locus of (θ, n) combinations at which per-firm net private benefits are zero (hereafter, we drop the qualifier "net" as understood). Everywhere inside the curve, these benefits are positive, while everywhere outside, they are negative. The upward-sloping curve traces out the locus of (θ, n) combinations that are socially optimal at different values of B. Recall that both the socially optimal standard θ^s and the socially optimal club size n^s increase in B, so that the bottom-left point $(\theta^s(0), n^s(0))$ of the locus is the social optimum with no public benefits at all. Equivalently, this is the point where total *private* benefits—the

[15] This follows because at weight $B = 0$ and standard $\theta^s(0)$, the open-access club size is $\hat{n}(\theta^s(0)) > \check{n}$. The congestion externality is therefore positive, while the public-good externality is zero. But since $\theta^s(B)$ is easily shown to be unbounded from above, there must exist some weight $\overline{B}$ such that $\theta^s(\overline{B}) = \overline{\theta}$, resulting in open-access club size $\hat{n}(\theta^s(\overline{B})) = \check{n}$. The public-good externality is then positive, while the congestion externality is zero. By continuity, there must then also exist a weight $B^c \in (0, \overline{B})$ where the two externalities are equal at open-access club size $\hat{n}(\theta^s(B^c))$.

first component of the welfare function—are maximized. The point where the two curves intersect implicitly defines the critical weight B^c referred to above.

If the club standard is set at the socially optimal value θ^s given $B = B^c$, then the club size that emerges under open access, $\hat{n}(\theta^s)$, is the socially optimal size n^s. In effect, consumers' free-riding is exactly offset by firms' ignoring congestion costs. If $B < B^c$, however, public-good benefits are relatively small, so that the congestion externality dominates and open access results in a club that is too large. Alternatively, if $B > B^c$, public-good benefits are relatively large, so that the public-good externality dominates and open access results in a club that is too small.

5. Government Clubs

The first institutional arrangement we examine is a government-sponsored club, which we assume aims to maximize social welfare. As discussed in the introduction, however, government-sponsored clubs generally cannot regulate club size—either directly, by prohibiting or mandating firm entry, or even indirectly, through economic incentives. Instead, they are limited to setting a voluntary standard that all firms in an industry are invited to meet. Although we briefly consider the optimal incentives that a government would *want* to put in place to regulate club size indirectly, our main focus will be on the more realistic case where the government cannot affect club size at all.

If the government were able to use incentives, one incentive it might use is an admission fee τ over and above the average club administration costs $c(n)$. Since this fee acts as an additional cost for firms, which all else equal reduces their incentive to join the club, equilibrium condition (4) would become

$$f(\theta) = \alpha\theta + c(n) + \tau. \tag{6}$$

Comparing this with first-order condition (3) shows that the government could implement the socially optimal club if it set the standard at θ^s and the fee at level

$$\tau^s = n^s c'(n^s) - Bg'(n^s\theta^s)\theta^s. \tag{7}$$

In effect, the admission fee would force entering firms to internalize the net effect of both externalities associated with membership. Note that τ^s may be either positive or negative, depending on whether the congestion externality or the public-good externality dominates. In the latter case, the optimal policy would be to subsidize club membership, in order to promote more public-good provision.

An equivalent mechanism to the admission fee would be a tax τ on the green good. Such a tax drives a wedge between the premium p_c paid by consumers, and the premium p_f received by firms, such that $p_c = p_f + \tau$, and club entry would continue until $f(\theta) - p_c = 0$ and $p_f - \alpha\theta - c(n) = 0$. Combining these three conditions yields the same equilibrium condition (6). Hence setting the tax τ as in equation (7) would again implement the socially optimal club, and again the tax could be negative, implying a subsidy on the green good.

We hereafter assume that the government is unable to impose any taxes or subsidies. Its only instrument is the club standard, with club size determined under open access. How, if at all, this affects the club outcome turns out to depend crucially on the degree to which the green good provides any public-good benefits, as parameterized by B. To see this, note that the government's optimization problem can be written as

$$\max_{\theta,n} W = n[f(\theta) - \alpha\theta - c(n)] + Bg(n\theta) \quad \text{s.t.} \quad f(\theta) - \alpha\theta - c(n) = 0, \tag{8}$$

which is equivalent to

$$\max_{\theta} W = Bg(\hat{n}(\theta)\theta). \tag{9}$$

Clearly, in the extreme case where the green good provides only private benefits (i.e., $B = 0$), the sponsor will be indifferent between all feasible club standards, and even indifferent about establishing a club in the first place. The reason is simply that, under open access, all private benefits from the club are dissipated. As a result, the open-access club makes no contribution to social welfare, at any standard.

The dissipation of private benefits also implies that if the green good *does* provide public-good benefits (i.e., $B > 0$), then the sponsor will choose θ so as to maximize those benefits alone. Moreover, since the parameter B enters the objective function in (9) as a multiplicative constant, the solution must be independent of its value. That is, regardless of how important public-good benefits are, the government sponsor will choose the *same* standard θ^g, resulting in the same open-access club size $n^g = \hat{n}(\theta^g)$.

Figure 2 illustrates the government's optimization problem by adding level curves representing combinations of θ and n that yield the same level of public-good spillovers $n\theta$. The government chooses the highest level curve subject to the open-access constraint represented by the $\hat{n}(\theta)$ curve, and because neither these level curves nor the constraint depend on B, the solution is always the same point (θ^g, n^g).

The figure shows also that this solution lies exactly at the crossing point of the locus of social optima with the open-access constraint, i.e., at the critical point $(\theta^s(B^c), n^s(B^c))$

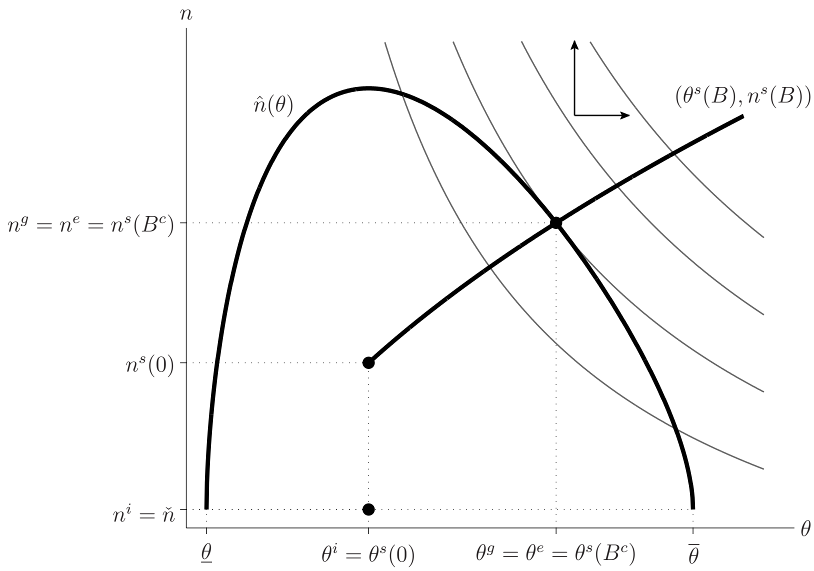


FIGURE 2. Optimum (θ^g, n^g) for a government club if regulating club size is not feasible, (θ^e, n^e) for an environmentalist club, and (θ^i, n^i) for an industry club.

discussed in the previous section. To see why this must be the case, recall that B^c is the critical weight on public-good benefits where, if the standard is set at the socially optimal value $\theta^s(B^c)$, open access gives rise to the socially optimal club size. Mathematically, this implies that at B^c, the combination $(\theta^s(B^c), n^s(B^c))$ must solve problem (8), and must therefore coincide with the government's solution at any B. More generally, we can see that the government's solution is socially optimal *only* at B^c, and the constant standard θ^g and club size n^g are both suboptimally low (high) if $B > (<) B^c$.

Summarizing, we find the following:

Proposition 1. *If the government can regulate club size either directly or indirectly* (*via a tax or subsidy*), *it can implement the socially optimal club. If it cannot regulate club size, then it will be indifferent about sponsoring a club or not having one at all if* $B = 0$*. If* $B > 0$*, however, the government prefers establishing a club and always chooses the same standard,* *which results in the same club size. The government club is socially optimal if* $B = B^c$*, but yields a too low (high) standard and club size if* $B > (<) B^c$*.*

6. Environmentalist Clubs

We now consider the alternative of an environmental group that establishes a club to certify a particular good as green, with the explicit objective of maximizing $\Theta = n\theta$, the level of the environmental public good. In principle, the group may be able to choose not just the club characteristics (θ, n), but also the premium p charged for the club-certified good. In doing so, however, it is constrained by the requirements that consumers must be willing to buy the green good, so that p cannot exceed their willingness to pay $f(\theta)$, and that firms must be willing to join the club, so that p must cover their average production and club costs $\alpha(\theta) + c(n)$.[16]

At any solution to the club's problem, both constraints must bind. This implies that the optimal premium and club size, conditional on the standard, are precisely those that result from open-access entry of firms to the club, as analyzed in Section 4. The club's optimization problem can therefore be written as

$$\max_{\theta,n} E = n\theta \quad \text{s.t.} \quad f(\theta) - \alpha\theta - c(n) = 0, \tag{10}$$

or equivalently

$$\max_{\theta} E = \hat{n}(\theta)\theta. \tag{11}$$

[16] We assume that the environmental group neither subsidizes the club with outside funds nor taxes the club to generate such funds.

Since B does not enter the club's objective function, the solution (θ^e, n^e) is identical at any $B > 0$.[17] Moreover, just as we found was true of the government club's solution, the environmentalist club's solution coincides with the social optimum at critical weight B^c. Underlying this is again the fact that open access fully dissipates the club's net private benefits, leaving only the public benefits $Bg(n\theta)$. But since those benefits increase monotonically in the level $n\theta$ of the public good, the environmentalist club's problem of maximizing the latter along the $\hat{n}(\theta)$ curve must yield the same solution as the social planner's problem at B^c.

Proposition 2. *If an environmentalist group sponsors the club, then it will at all $B > 0$ choose the same standard, resulting in the same club size. The environmentalist club is socially optimal at B^c, but yields a too low (high) standard and club size at $B > (<)B^c$.*

Combining Propositions 1 and 2 yields the following additional result:

Proposition 3. *If an environmentalist group sponsors the club, then its optimum at all $B > 0$ coincides with that of a government constrained from regulating club size.*

This final result suggests an alternative policy option available to the government, if indeed it cannot regulate club size: instead of creating and administering the club itself, it can simply encourage an environmentalist group to do so. In fact, if direct government sponsorship of a club gives rise to any transaction or political costs that a non-government sponsor can avoid, then this alternative option will be *strictly* preferable.

[17] Mathematically, the solution applies even at $B = 0$, but it is implausible that an environmentalist group would want to maximize public-good provision if consumers placed zero weight on the resulting benefits.

7. Industry Clubs

Industry-sponsored clubs are focused on the profits of their members. We assume an industry club will only expand its membership if doing increases the profits of existing members. Equivalently, its objective is to maximize average club profits.

The industry club's problem is therefore

$$\max_{p,\theta,n} \pi = p - \alpha\theta - c(n), \quad \text{s.t.} \quad f(\theta) \geq p,$$

where the constraint requires that consumers must be willing to pay the price premium for the green good. Since the club has no reason to leave the consumer with any surplus, the constraint must bind at the solution. Substituting the constraint into the objective function leaves the problem

$$\max_{\theta,n} \pi = f(\theta) - \alpha\theta - c(n),$$

with first-order conditions

$$f'(\theta) = \alpha \tag{12}$$

$$c'(n) = 0. \tag{13}$$

Condition (12) shows that the industry club will choose the socially optimal standard $\theta^s(0)$ that would apply if the green good provided only private benefits. Intuitively, this standard maximizes those benefits given any club size. Condition (13) shows that the club will at the same time choose the most efficient club size in terms of minimizing per-member club management costs, namely $\check{n}$.

Note that, because public-good spillovers have no effect on consumers' willingness to pay for the green good, and therefore no effect on firm profits, the solution is again independent of B. In effect, the industry club is the polar opposite of the environmentalist club; whereas the latter focuses solely on public-good benefits, the industry club focuses solely on private benefits.

Nevertheless, because the industry club maximizes average rather than total private benefits, its solution $(\theta^i, n^i) = (\theta^s(0), \check{n})$ is never socially optimal, even when $B = 0$. This is because the industry club has no reason expand the club beyond $\check{n}$, given that doing so increases average club costs and thereby reduces existing members' profits. In contrast, expanding the club increases welfare as long as the increase $nc'(n)$ in overall club costs falls short of the social benefit $f(\theta) - \alpha\theta - c(n)$ that an additional member generates. Since $c'(\check{n}) = 0$ and $f(\theta) - \alpha\theta - c(\check{n}) > 0$ at $\theta^s(0)$,[18] the socially optimal club size $n^s(0)$ must exceed $\check{n}$.

Proposition 4. *If industry sponsors the club, then it chooses standard $\theta^s(0)$, which equals (is less than) the social optimum at $B = (>)\ 0$, and it chooses club size $\check{n}$, which is lower than the social optimum at any B.*

As with the environmentalist-club solution, it is again of interest to compare the industry-club solution to that of the government. Key to this comparison is that, whereas all private benefits are dissipated at the government's solution, the industry solution has strictly positive private benefits. As a result, when $B = 0$, so that private benefits are all that matters to the government, it strictly prefers the industry solution. When $B = B^c$, on the other hand, welfare is strictly higher at the government's own solution, since that solution then

[18] Recall footnote 10.

coincides with the social optimum. By continuity, there must be an intermediate weight $\hat{B} \in (0, B^c)$ at which both solutions yield the same welfare. It can be shown, moreover, that welfare increases more rapidly with B when evaluated at the government solution than when evaluated at the industry solution.[19] It follows that the industry-club solution dominates at all $B < \hat{B}$, but the government's own solution dominates at all $B > \hat{B}$.

Combined with our earlier result that the government solution coincides with the environmentalist-club solution, this result implies that the conclusion at the end of the previous section must be amended:

Proposition 5. *The government is indifferent between sponsoring its own club and encouraging an environmentalist club only if B exceeds a critical value $\hat{B} \in (0, B^c)$. At lower B values, it instead strictly prefers encouraging an industry-sponsored club over either alternative.*

Intuitively, encouraging an industry-sponsored club allows the government to indirectly restrict club size and thereby minimize private-benefit dissipation. Even though the industry club will "undershoot" by restricting club size further than is socially optimal, the resulting welfare loss is at low B values smaller than that from the open-access "overshoot " that arises with the government or environmentalist clubs.

8. Monitoring and Enforcement

Up to this point, we have assumed that whereas green production is not verifiable by consumers, a green club is able to enforce its benchmark standard θ perfectly. However, a club

[19] Letting W^g denote the former and W^i the latter, we have that $\partial W^g/\partial B = g(n^g\theta^g) > g(\check{n}\theta^s(0)) = \partial W^i/\partial B$, since $g(\cdot)$ is increasing and $n^g\theta^g = n^s(B^c)\theta^s(B^c) > \check{n}\theta^s(0)$.

may not be able to perfectly monitor its members. If so, member firms may have an incentive to produce at a lower standard $\tilde{\theta}$, to save on production costs.

8.1. *Exogenous probability of detecting cheating*

To understand the implications of imperfect club monitoring, consider the simplest case where (*i*) the club detects any such cheating immediately, with a probability $q < 1$ that does not depend on $\tilde{\theta}$ and that we initially treat as exogenous; (*ii*) the cost of achieving this detection probability does not depend on θ or, if it does, is incurred by firms themselves when they submit to monitoring; (*iii*) the time horizon is infinite and if a cheating firm is detected, it is forever expelled from the club; and (*iv*) consumers are aware of all this, and rationally refuse to pay a premium for goods from a club whose members have no incentive to comply with the club standard.[20]

Assumption (*i*) implies that any cheating by firms will simply take the form of setting $\tilde{\theta} = 0$, i.e., producing the conventional version of the good while claiming to produce the green version. Assumption (*ii*) implies that the cost of monitoring can be absorbed in average club management cost $c(n)$ or firm production costs $\alpha\theta$ (or some mix of both). Assumption (*iii*) can be used to derive the minimum premium firms must receive to be deterred from cheating. To see this, consider first a firm that always complies with the standard θ, thereby earning rents $p - \alpha\theta - c(n)$ each period. Letting $\delta \equiv 1/(1 + r)$ denote its discount factor,

[20] A variety of organizations aim to promote such awareness. In the U.S., for example, the GreenerChoices.org website of the non-profit Consumers Union—which also publishes the *Consumer Reports* magazine—provides information on over 60 green certification programs, including details about monitoring procedures. Its page on the Sustainable Forestry Initiative reports, among other things, that the program requires third-party verification by outside auditing firms, and has in the past expelled 16 members for failure to comply, with another 10 members resigning for the same reason.

and V_0 the present value of its infinite stream of rents, we have

$$V_0 \equiv [p - \alpha\theta - c(n)] + \delta V_0 = \frac{p - \alpha\theta - c(n)}{1 - \delta}. \tag{14}$$

Consider next a firm that successfully cheats by pretending to produce at standard θ, but actually produces at standard 0. This firm gets the same price p and still incurs the club membership cost $c(n)$, but incurs no cost of producing θ. Letting V_1 denote the present value of the firm's expected stream of rents if it cheats for just one period, but then reverts to complying with the standard, we have[21]

$$V_1 \equiv (1 - q)[p - c(n) + \delta V_0]. \tag{15}$$

It can be shown that in order to deter a firm from cheating at all, it is sufficient to deter it from cheating just once, i.e., to have $V_1 \leq V_0$.[22] Substituting from (14) and (15) yields the equivalent inequality

$$\frac{(1 - \delta)(1 - q)}{q}\alpha\theta \leq p - \alpha\theta - c(n). \tag{16}$$

That is, as long as the club premium p leaves club members with per-firm private benefits (hereafter "rents") of at least $[(1 - \delta)(1 - q)/q]\alpha\theta$ when they comply, the risk of losing these rents forever with probability q is sufficient to deter them from cheating.[23]

Assumption (*iv*) then implies that consumers will be prepared to pay this premium p if and only if it satisfies condition (16) in addition to satisfying their participation constraint

[21] If inspections occurred at the end rather than the beginning of each period, the expression would instead be $V_1 = p - c(n) + (1 - q)\delta V_0$. Qualitatively, our results would go through unchanged.

[22] This follows because cheating any finite number of times must end with cheating a just once. Moreover, we can write $V_\infty = V_1 + \delta(1 - q)(V_\infty - V_0)$ or, rearranging, $(V_\infty - V_0) = (V_1 - V_0)/[1 - \delta(1 - q)]$. If therefore $V_1 \leq V_0$, then also $V_\infty \leq V_0$, implying that cheating an infinite number of times is deterred as well.

[23] Note that, as one would expect, this minimum rent is decreasing in the detection probability q and the weight δ that the firm places on forgone future rents, but increasing in compliance costs $\alpha\theta$.

$f(\theta) \geq p$. Combining these conditions yields what we refer to hereafter as the "no-cheating constraint":

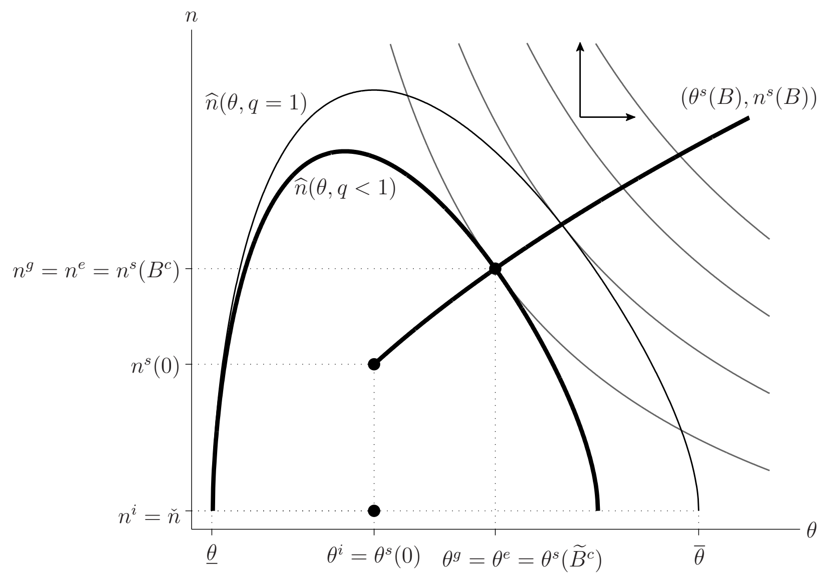
$$f(\theta) - \alpha\theta - c(n) \geq \frac{(1-\delta)(1-q)}{q}\alpha\theta \equiv x(q,\delta)\alpha\theta. \tag{17}$$

For a given standard θ, the club's equilibrium size under open access is now implicitly defined by this constraint evaluated at equality. Let $\hat{n}(\theta, q)$ denote this equilibrium club size, expressed as a function of θ and q.[24] Clubs larger than $\hat{n}(\theta, q)$ are not feasible, as the correspondingly higher average club costs would leave member firms with rents too low to induce compliance with the standard. The club standard would therefore become non-credible, and consumers would not be prepared to pay any premium p.[25]

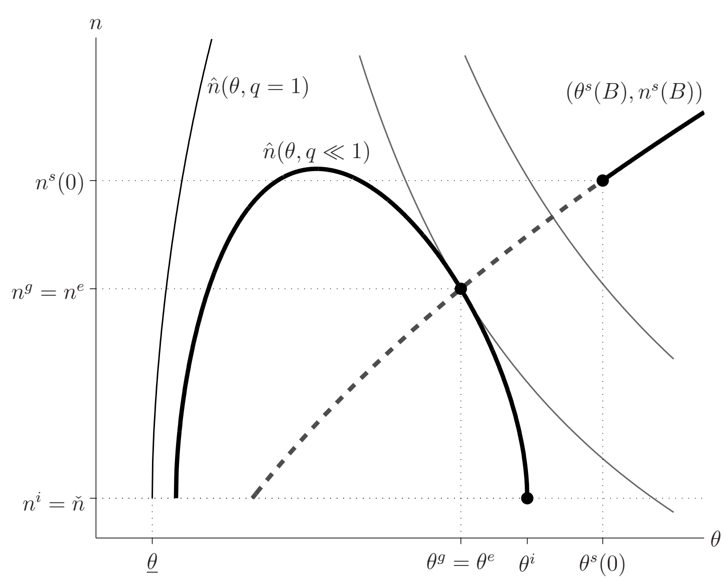
Figure 3 plots the $\hat{n}(\theta, q)$ function in (θ, n) space, for a relatively high value of q in panel (a) and a relatively low value in panel (b). The figure shows that as q falls, the feasible set of (θ, n) combinations shrinks both vertically and laterally, with the maximum feasible club size occurring at a progressively lower standard. The set shrinks vertically because, for a given standard θ, raising firms' rents to satisfy the no-cheating constraint requires reducing average club costs $c(n)$. This in turn requires reducing the club size. The set shrinks laterally because, for a given club size n, raising firms' rents requires increasing the surplus $f(\theta) - \alpha\theta$ gross of club costs. This in turn requires lowering the standard from high values, and raising it from low values. Moreover, the required change in the standard is greater (in absolute value), the higher the initial standard, since high standards come with high compliance costs, and thereby a greater temptation to cheat.

[24] We again ignore values of $n < \check{n}$ that satisfy condition (17) with equality, as these yield unstable equilibria.

[25] Clubs of size $\hat{n}(\theta, q)$ are therefore stable: any accidental entry expanding the club will leave members paying production and club costs without any offsetting premium, which should induce exit; any accidental exit will leave members with rents above the minimum required for compliance, which should induce entry.



(a)



(b)

FIGURE 3. Effect of imperfect monitoring on the various optima.

We now consider how imperfect monitoring affects the results of the foregoing sections. Starting with the government club, it is obvious that if the government could subsidize firms with outside funds, it could satisfy the no-cheating constraint simply by providing a large enough subsidy.[26] Given our assumption that the government is unable to do so, however, its optimum must now leave firms with rents $x(q, \delta)\alpha\theta^g$.

Importantly, this is not necessarily a negative from the government's point of view. To the contrary, at all values of B for which the social optimum lies inside the feasible set, welfare evaluated at the government's solution is (somewhat counterintuitively) decreasing in q, and therefore higher when monitoring is imperfect.[27] This is because the no-cheating constraint limits the degree to which private rents are dissipated under open access, and at low values of B, the government places a high value on these private rents.

As Figure 3 indicates, the way in which the government sponsor optimally increases firms' rents is by reducing both the standard and club size.[28] Panel (a) of the figure shows that as long as q is high enough for the $\hat{n}(\theta, q)$ curve to cross the $(\theta^s(B), n^s(B))$ locus, the government optimum still coincides with the social optimum for some weight $\widetilde{B}^c$ on public-good benefits; this weight is just smaller than B^c. Eventually, however, at low enough q, even the social optimum at $B = 0$, which maximizes total club rents, leaves individual firms in the club with insufficient rents to meet the no-cheating constraint. This is the situation shown in panel (b), where point $(\theta^s(0), n^s(0))$ lies outside the feasible set. The government optimum

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26 Specifically, recalling (7), a subsidy that exceeds the (possibly negative) subsidy $Bg'(n^s\theta^s)\theta^s - n^s c'(n^s)$ required under perfect monitoring by an amount $x(q, \delta)\alpha\theta^s$.

27 The Lagrangian associated with the government's constrained optimization problem is

$$\mathcal{L} = n[f(\theta) - \alpha\theta - c(n)] + Bg(n\theta) + \lambda[f(\theta) - \alpha\theta - c(n) - x(q, \delta)\alpha\theta].$$

Letting W^g again denote welfare at the government's solution, we have by the envelope theorem that $dW^g/dq = \partial\mathcal{L}/\partial q = -\lambda(\partial x/\partial q)\alpha\theta$. The latter expression is negative for all values of B such that the social optimum lies inside the constraint, because λ is then negative (as is $\partial x/\partial q$).

28 Eliminating the multiplier λ from the first-order conditions of the government's problem leaves equation $[f'(\theta) - \alpha - x(q, \delta)\alpha]\theta + nc'(n) = 0$ in addition to the constraint. Cramer's rule then gives

$$\frac{d\theta^g}{dq} = \frac{x_q\alpha\theta(2c' + nc'')}{D} > 0 \quad \text{and} \quad \frac{dn^g}{dq} = \frac{-x_q\alpha\theta f''\theta}{D} > 0,$$

where $D \equiv f''\theta c' + (f' - \alpha - x\alpha)(2c' + nc'') < 0$.

at these low values of q involves a standard and club size smaller than those at any social optimum.[29]

It turns out that, regardless of the value of q, the government's optimal combination (θ^g, n^g) is again independent of B. This follows from rewriting its problem

$$\max_{\theta,n} W = n[f(\theta) - \alpha\theta - c(n)] + Bg(n\theta) \quad \text{s.t.} \quad f(\theta) - \alpha\theta - c(n) = x(q,\delta)\alpha\theta \tag{18}$$

as

$$\max_{\theta} W = x(q,\delta)\alpha\hat{n}(\theta,q)\theta + Bg(\hat{n}(\theta,q)\theta). \tag{19}$$

The objective function of (19) is a monotonic transformation of $\hat{n}(\theta,q)\theta$. The solution to (19) is therefore identical to that of the transformed problem

$$\max_{\theta} E = \hat{n}(\theta,q)\theta. \tag{20}$$

Since B does not feature in the transformed problem, the solution must be independent of this parameter.

Note that the objective function of (20) is just that of the environmentalist club, which now also faces the modified constraint $\hat{n}(\theta,q)$. It is immediate therefore from (20) that its solution with imperfect monitoring still coincides with the government solution, regardless of the value of q.

As for the industry club, even though its solution maximizes per-firm rents, those rents will at low enough detection probabilities still fail to deter cheating. As shown in panel

[29] Note however that even at these government optima with "highly" imperfect monitoring, private benefits are still positive. If $B = 0$, so that welfare at the government optimum with perfect monitoring is zero, imperfect monitoring therefore still improves welfare. By continuity, the same must be true for some range of positive B values.

(b) of Figure 3, the club then has to lower its standard θ^i below $\theta^s(0)$, so as to reduce firms' compliance costs and thereby their incentive to cheat. In other words, because the industry club already maximizes the left-hand side of the no-cheating condition (17), its only alternative if that condition fails is to reduce the right-hand side. It does so by lowering its standard, while still keeping its club size at the rent-maximizing value $\check{n}$.

Overall then, allowing for imperfect monitoring has only minor implications for our foregoing analysis:

Proposition 6. *If enforcement of the standard is imperfect, most results of Propositions 1–4 go through unchanged. Welfare may be higher at the government and environmentalist solutions, however, and the optimal standard and club size of the government and environmentalist clubs both decline in the probability q of detecting cheating. At low enough q, the optimal standard of the industry club declines as well.*

The one result that does change importantly is Proposition 5, i.e., the government's strict preference, at low enough values of B, for encouraging an industry club rather than sponsoring a club itself or encouraging an environmentalist club. If monitoring is sufficiently imperfect, this preference becomes reversed: regardless of B, the government then always prefers either sponsoring a club itself or encouraging an environmentalist club. Intuitively, this is again because the no-cheating constraint limits the dissipation of private benefits under open access. This limits welfare loss from the "overshoot" of club size mentioned at the end of the previous section. Eventually, if q drops below a critical value $\hat{q}$, this loss becomes smaller than the loss from the industry club's "undershoot" of club size.[30]

[30] Letting $(\theta^g(q), n^g(q))$ denote the solution to (18) for given q, the probability $\hat{q}$ is implicitly defined by $n^g(q)[f(\theta^g(q)) - \alpha\theta^g(q) - c(n^g(q))] = \check{n}[f(\theta^s(0)) - \alpha\theta^s(0) - c(\check{n})]$. A proof that welfare at the government solution exceeds welfare at the industry solution for all $q < \hat{q}$ is available upon request.

Proposition 7. *At detection probabilities below a critical value $\hat{q}$, the government strictly prefers sponsoring a club itself or encouraging an environmentalist club to encouraging an industry club.*

8.2. *Endogenous probability of detecting cheating*

We now relax the assumption that the detection probability q is exogenous, and assume instead that club sponsors have at least some control over this variable. To understand how endogeneity of q affects the foregoing analysis, it is useful to first consider the extreme case where increasing q is costless.

Key to the analysis for the government club is where the social optimum lies relative to the boundary of the feasible set under perfect monitoring, $\hat{n}(\theta, 1)$. As we saw earlier, depending on B the social optimum may lie either inside, on, or outside this boundary. If $B < B^c$, the social optimum lies inside, implying that at the socially optimal standard θ^s, the government would like to restrict club size below its open-access value. In this situation, endogeneity of q dramatically changes the government's optimization problem: this is because, through purposely lowering q and thereby shrinking the feasible-set boundary, it now *can* restrict club size and thus achieve the social optimum. Specifically, if it sets the club standard at θ^s and sets q such that $\hat{n}(\theta^s, q) = n^s$, the socially optimal club size n^s will emerge under open access. Paradoxically, therefore, even though raising q is costless, the government club optimally chooses an *im*perfect mechanism for detecting cheating.

If $B > B^c$, on the other hand, then the social optimum lies outside the $\hat{n}(\theta, 1)$ boundary, and the government would therefore like to expand club size beyond its open-access value. Because such expansion would leave firms with negative rents, however, and since subsidies are ruled out, the best the government can do is drive rents to zero. It does so by raising q to 1, i.e., choosing perfect enforcement.

Consider next the environmentalist club, whose optimum, loosely speaking, also lies outside the $\hat{n}(\theta, 1)$ boundary, in the sense that its objective function everywhere increases in both n and θ. It, too, therefore optimally raises q to 1. Doing so maximizes the feasible set, and thereby the level of public-good provision that the club can induce.

Lastly, the industry club's optimum $(\theta^s(0), \check{n})$ lies strictly in the interior of the $\hat{n}(\theta, 1)$ boundary. As a result, the club has no reason to monitor perfectly; any detection probability large enough to deter cheating at its optimum will do. Specifically, letting q^i denote the critical detection probability given by $\hat{n}(\theta^s(0), q) = \check{n}$, the club is indifferent between any detection probability in the range $[q^i, 1]$.

Proposition 8. *If q is endogenous and raising q is costless, then at $B < B^c$, the government club deliberately chooses an imperfect detection mechanism, in order to achieve the social optimum. At $B \geq B^c$ it chooses perfect detection, as does the environmentalist club. The industry club is indifferent between any detection probability large enough to deter cheating at its optimum.*

In general, of course, measures that improve the detection of cheating—more detailed record keeping, more frequent or intrusive inspections—come with positive costs. Because these monitoring costs must be recouped from club members, they reduce club members' rents, and thereby shrink the feasible set. It turns out, however, that monitoring costs have an ambiguous effect on the different clubs' optimal level of monitoring.

Suppose, for example, that a club responds to an increase in monitoring costs by reducing its monitoring efforts, and thereby its detection probability q. Doing so reduces the club's monitoring expenditures, which all else equal expands the feasible set. At the same time, however, it increases members' incentive to cheat, which, by raising the minimum rents required to deter cheating, all else equal shrinks the feasible set. The net effect on the feasible set is ambiguous, and the club may end up worse off overall. More specifically, one can show (by numerical example) that the environmentalist club may respond to an increase in monitoring costs by choosing a lower, imperfect detection probability; it will do so if the feasible set expands as a result, thereby allowing for more public-goods provision. On the other hand, the government and industry clubs may respond by choosing a *higher* detection probability, paradoxically increasing their monitoring effort, the more costly monitoring is.

Proposition 9. *If q is endogenous and raising q is costly, the optimal detection probability of an environmentalist club may decrease, while that of an industry or government club may increase.*

It should be emphasized that the first result of Proposition 8, namely the deliberate choice of imperfect detection by a government club at $B < B^c$, depends crucially on the club's ability to regulate club size indirectly through q. This in turn depends on the assumed ability of consumers to infer the maximum club size $\hat{n}(\theta, q)$ at which cheating is deterred, and their resulting refusal to buy from a larger club. Without the latter assumption, we are back to full rent dissipation under open access. This leaves the government incapable of deterring cheating other than through raising q to 1, possibly at considerable cost.

But then, given that environmentalist and industry clubs *can* restrict entry and sustain a rent premium, which reduces monitoring costs, encouraging outside sponsorship can only become more attractive to the government. Specifically, the presence of monitoring costs should expand the range of low B values at which the government strictly prefers to encourage an industry club over sponsoring a club itself.[31] At the same time, whenever monitoring costs induce an environmentalist club to combine entry restrictions with imperfect monitoring, the government must strictly prefer the environmentalist club solution to its own. To see why, note that, since rents are fully dissipated at the government club solution, and since the no-cheating constraint always binds at the environmentalist club solution, the difference between welfare at the two solutions reduces to

$$W^e - W^g = n^e x(q^e, \delta)\alpha\theta^e + B[g(n^e\theta^e) - g(n^g\theta^g)] > 0.$$

If the environmental group chooses imperfect monitoring ($q^e < 1$), the first term on the right-hand side must be strictly positive. Moreover, by revealed preference on the part of the environmental group, $n^e\theta^e \geq n^g\theta^g$, implying that the second term is non-negative.

Proposition 10. *If consumers cannot infer the maximum club size at which cheating is deterred, then the government club cannot regulate club size indirectly through q, which can only make encouraging outside sponsorship more attractive.*

9. Heterogeneous Consumers or Firms

In this section, we briefly explore two additional extensions of the model, leaving full mathematical details to an appendix available upon request. One extension is to allow for heterogeneity of consumer preferences for the green good; the other is to allow for heterogeneity of firm costs of green production.

[31] By revealed preference, if $W^i = W^g$ at some $\hat{B}$ when the government optimally chooses $q < 1$, then we must have $W^i \geq W^g$ at that same $\hat{B}$ if the government is constrained to choosing $q = 1$. In general, the inequality will be strict.

A simple way of introducing consumer heterogeneity is to have consumers place different weights on the private benefits $f(\theta)$ from green consumption. Ordering consumers by declining values of this weight, let $\gamma(n)$ denote the weight of the n-th consumer (so $\gamma'(n) < 0$), and define $\Gamma(n) \equiv \int_0^n \gamma(m)\, dm$. In effect, this makes the aggregate demand curve for θ declining rather than constant.

Similarly, to introduce firm heterogeneity, let firms have different marginal costs of green production. Ordering them by increasing marginal cost, let $\alpha(n)$ denote the marginal cost of the n-th firm (so $\alpha'(n) > 0$), and define $A(n) \equiv \int_0^n \alpha(m)\, dm$. This makes the aggregate supply curve for θ increasing.

One implication of generalizing the model in this way is that firm heterogeneity, but not consumer heterogeneity, will induce an industry club to adopt a higher club standard. Consumer heterogeneity implies, for a given club size, the presence of inframarginal consumers with higher willingness to pay for a given standard. This has no effect on the industry club's incentive to raise that standard, however, because the premium earned by all member firms depends only on the *marginal* consumer's willingness to pay. In contrast, firm heterogeneity implies, for a given club size, the presence of inframarginal club members with lower marginal costs of producing to a given standard. This increases the club's incentive to raise its standard, because the *average* firm's cost of doing so falls.[32]

Consumer and firm heterogeneity both affect the industry club's optimal size, reducing it below $\check{n}$ and thereby causing the marginal consumer and firm to drop out. With consumer heterogeneity, this increases the club's average profits because the new marginal consumer has a higher willingness to pay, raising the equilibrium premium earned by members. With

[32] This cost is $\alpha(\check{n})$ for a club with homogeneous firms, but $A(\check{n})/\check{n} < \alpha(\check{n})$ for a club with heterogeneous firms.

firm heterogeneity, the club's average profits increase because the remaining firms will on average have lower production costs.

A further implication of both types of heterogeneity is that, even with perfect or costless monitoring, the government optimum will no longer exactly coincide with the environmentalist optimum. To see why, recall from (19) that rent dissipation under open access in effect transforms the government's objective function to $x(q,\delta)\alpha n\theta + Bg(n\theta)$, which in turn is a monotonic transformation of the environmentalist sponsor's objective function $n\theta$. When either consumers or firms are heterogeneous, however, only the *marginal* rent is dissipated, leaving strictly positive inframarginal rents (aggregated over all club members) of respectively $\Gamma(n)f(\theta) - \alpha\theta - nc(n)$ or $nf(\theta) - A(n)\theta - nc(n)$. In general, these rent expressions cannot be written as a monotonic transformation of $n\theta$, implying that the government and environmentalist optima will differ.

Of course, as long as the degree of heterogeneity is "small," the difference between the government and environmentalist optima will be small as well. The government may then still prefer to encourage an environmentalist club over establishing a club itself if, as discussed at the end of the previous section, it cannot deter cheating by offering a rent premium, or if there are any transaction or political costs associated with direct government sponsorship of a club.

10. Conclusion

The model developed in this paper treats voluntary environmental programs as green clubs: clubs, because they provide non-rival but excludable reputation benefits to participating firms; green, because they also generate environmental public goods. We have used this model to examine how three common types of program sponsors—government agencies, industry associations, and environmental groups—are likely to differ in terms of their management decisions, and how the resulting club configurations compare to the social optimum.

Our analysis highlights three key factors that drive our results. One is the weight on public-good benefits in the social welfare function, which determines the socially optimal club standard and size. Because the environmentalist club cares only about the public good, its optimum is independent of this weight; as a result, the environmentalist club maximizes welfare only if the weight happens to take on a critical value. Similarly, because the industry club cares only about per-firm profits, its optimum is independent of the weight as well, and turns out to never be socially optimal.

The second factor is the government club's inability to regulate club size, either directly or through taxes and subsidies. Its optimum is therefore driven by dissipation of the club's private benefits under open access, leaving it to maximize public-good provision alone. This implies that the optima of the government and environmentalist clubs coincide. It also implies that, since private benefits are not dissipated at the industry optimum, the government may strictly prefer leaving club sponsorship to an industry association if the welfare weight on public-good benefits is low.

The third factor plays a role only if monitoring of the club standard is imperfect. It concerns the ability of consumers to infer that a club is too inclusive for its standard to be credible, in the sense that congestion leaves its members with insufficient rents to deter cheating. If consumers *can* make this inference, then club rents are no longer fully dissipated under open access. This may then allow the government to attain the social optimum, through deliberately choosing an imperfect monitoring mechanism. If consumers *cannot* tell whether a club has become too inclusive, then we are back to full rent dissipation, leaving firms with no incentive to comply with any standard. A government club must then spend whatever it takes to detect cheating with certainty, whereas privately-run clubs can save on detection costs by restricting firm entry.

We believe that our model provides a useful starting point for further analysis of the institutional arrangements of green clubs. Future work might consider different sources of private benefits captured by these clubs, such as avoided costs of mandatory regulations, or dynamic benefits from learning by doing. It might also consider different sources of club congestion, such as free-riding by late entrants on efforts by earlier ones, or lower willingness to pay by consumers for products of less "select" clubs. Other extensions might consider "menus" of standards offered by clubs, as well as competition between clubs with possibly different sponsors. An example of the former are the certified, silver, gold, and platinum standards offered by the Leadership in Energy and Environmental Design (LEED) certification program. An example of the latter are the Green Globes and National Green Building programs, both of which compete with LEED.

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