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Abstract

Is green consumerism beneficial to the environment and the economy? To shed light on this question, we study the political economy of environmental regulations in a model with neutral and green consumers where the latter derive some warm glow from buying a good of higher environmental quality produced by a profit-maximizing monopoly, while the good bought by neutral consumers is provided by a competitive fringe. Consumers unanimously vote for a standard set at a lower than first-best level, or for a tax delivering the first-best environmental protection level. Despite its under-provision of environmental protection, the standard dominates the tax from a welfare perspective due to its higher productive efficiency, i.e., a smaller gap between the environmental qualities of the two goods supplied. In stark contrast, voters unanimously prefer a tax to a standard when the willingness to pay for greener goods is small enough.

Key Words: environmental regulation, corporate social responsibility, green consumerism, product differentiation, tax, standard, green label, political economy.
JEL codes: D24, D62, Q41, Q42, Q48.

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1 Introduction

1.1 Green consumerism, corporate social responsibility and environmental policies

When firms and customers are only motivated by their self-interest, they tend to ignore their negative impact on the environment, which leads to excessive pollution and overexploitation of open-access natural resources such as water and clean air. This in turn calls for public intervention to fix, or at least mitigate, this market failure. This traditional view is contradicted by the many private initiatives to reduce the negative impacts of human activities on the environment. For instance, some consumers accept to pay a higher price in order to purchase more environmentally-friendly products. This phenomenon is sometimes referred to as 'green consumerism'. On the supply side, firms often reduce their emissions of pollutants and their use of natural resources beyond what is mandated by regulations. They engage in costly eco-labelling of their products and production processes. They endorse the so-called Corporate Social Responsibility (CSR) policy and code of conduct.

CSR is now very popular among managers and policy makers. It is part of most business school curricula. There is wide evidence that consumers care about CSR as many of them are willing to pay more for greener or fair trade products. The positive view of CSR and green consumerism contrasts with Friedman's famous criticism published in 1970 in The New York Times (Friedman, 1970). In an article provocatively entitled 'The Social Responsibility of Business is to Increase its Profits', Milton Friedman criticized CSR for being undemocratic. He argued that, with CSR, the businessman 'decides whom to tax by how much and for what purpose'. In a democratic society, 'the machinery must be set up to make the assessment of taxes and to determine through a political process the objectives to be served'.

Our objective is to go beyond Friedman's criticism and to better understand the interplay between "public" and "private" politics in the context of CSR.[1] To this end, we develop a model encompassing simultaneously social decisions taken democratically (through majority voting over either an environmental quality standard or an environmental tax), green consumerism (with a fraction of consumers deriving warm glow from buying a greener product) and CSR. We take Friedman's criticism on board by reconciling CSR with profit-maximization (with a single-profit maximizing firm producing the high quality good) in a context where social decisions are taken democratically.[2]

We model an economy with a continuum of citizens of two types, dubbed neutral and green, who all consume one unit of a polluting good. While all consumers suffer in the same way from aggregate pollution, green consumers derive warm glow from their individual consumption decision. They value the environmental quality of the products they purchase. The polluting good is produced under perfect competition except in its green version which is supplied by only one firm (called the "green firm"). The motive for supplying greener goods is pure profit-maximization: the green firm pays the cost of higher environmental performance to move away from perfect competition and to exert some market power on green consumers.

We contrast two forms of public intervention: a standard on environmental performance and a tax on pollution. In both cases, the timing of decisions is the same: citizens first vote over the instrument's level, and then consumers and producers decide what to produce (and consume) at what price. We first examine the choice of a minimal quality standard. The green firm might decide to go beyond the standard if charging a price premium for higher environmental performance is profitable. This decision depends on the green consumers' taste

[1]In the words of Benabou and Tirole (2010, p.15), "While the invisible hand of the market and the more visible one of the state have been the objects of much research, we still know little about the decentralized correction of externalities and inequality."

[2]Benabou and Tirole (2010, p15) argue that "there are three possible understandings of corporate social responsibility: the adoption of a more long-term perspective, the delegated exercise of philanthropy on behalf of stakeholders, and insider-initiated corporate philanthropy. The latter two understandings build on individual social responsibility." Our approach is consistent with the second perspective, where "profit maximization and CRS are consistent." (Benabou and Tirole, 2010, p.11).

(willingness to pay) for environmental quality. When it is low enough, supplying a green version of the good is not profitable. All firms then produce the same environmental quality which is set collectively at its first-best level by citizens. When the green consumers' taste for environmental quality is high enough, the green firm produces a good whose quality is higher than the brown one, but not directly affected by the standard. Voters unanimously prefer a quality standard lower than its first-best level. The intuition for this result is that neutral voters free ride on the higher quality of the good consumed by green voters, while green voters have the same political preferences as neutral ones because the green firm captures all their warm glow with limit pricing. A higher taste for environmental quality increases the green good's quality and thus the free-riding effect, resulting in a lower unanimously chosen value of the standard. For a large enough taste for environmental quality, the average quality produced may even exceed its first-best level.

Next we consider the choice of an environmental tax. Unlike with a standard, the green firm always finds it profitable to produce a green version of the good, however small the willingness to pay for environmental quality is. Hence, two different environmental qualities are produced, and the tax affects both the brown and green goods' qualities. Assuming that tax proceeds are redistributed in a lump sum way to them, consumers are unanimous as to their most-preferred value of the tax level (for the same reason as with the standard) which is such that the average quality is set at its first-best level. Yet this outcome is inefficient as the first-best allocation requires a single environmental quality.

Comparing the standard and the tax, we obtain that the standard dominates the tax from a welfare perspective. The reason for this result differs according to the intensity of preferences for environmental quality. When it is low, the standard perfectly decentralizes the first-best outcome with a single good produced, while the tax entails a wedge between the two qualities produced (productive inefficiency). When the taste for environmental quality is large enough, the productive efficiency advantage of the standard over the tax (lower wedge between two goods' qualities) trumps the standard's allocative inefficiency disadvantage (inefficient average quality level).

Looking now at how voters evaluate the standard *vs* the tax, we obtain a trade-off between an *environmental protection* effect and a *tax stealing* effect. On the one hand, the environmental protection effect favors the tax, because a higher tax increases both the brown and green qualities, resulting in a larger impact on average equality, than a higher standard. On the other hand, the tax stealing effect favors the standard, since there is an extra cost of increasing environmental quality with the tax as all the fiscal benefit of providing a higher environmental quality is captured by the green firm and therefore lost by consumers/voters. We obtain that voters unanimously prefer a tax to a standard when the warm glow effect is small enough, because the lower quality of the brown good with a standard allows the neutral voters to free ride on the green ones, and the latter to benefit from a lower priced good (compared to the standard).

Going back to CRS, we obtain that it is not welfare improving in the presence of consumers/voters enjoying a warm glow from "doing the right thing", even when firms maximize profit and when corrective policies are taken by (unanimous) majority voting (to answer Friedman's criticism). In our setting, the conjunction of CSR with green consumerism leads to either a substandard policy, or to productively inefficient taxes.

1.2 Related literature

Our paper builds on the literature on self-regulation and corporate social responsibility (see Ambec and Lanoie, 2008, and Kitzmueller and Shimshack, 2012, for surveys). Most studies aim at assessing the profitability of voluntary environmental protection and CSR strategies. Some previous works have analyzed the interplay between environmental policies and firms' or consumers green behavior using different approaches. For instance, Fleckinger and Glachant (2011) analyze a game between a social-welfare maximizing regulator and a profit-maximizing firm with frictions in the regulation process. They show that self-regulation can be a firm's strategy to preempt more stringent future regulations. In the same vein, the Private Politics approach (Baron 2001, Heyes and Kapur, 2012, Daubanes and Rochet, 2019) assumes that CSR and environmental policies result from combined pressure from lobbies (firms) and NGOs (consumers/citizens). We depart from those studies by modeling explicitly the collective decision process that determines environmental policy. Other papers highlight that CSR might crowd-out donation and charity (Kotchen, 2006, Besley and Ghatak, 2007), or analyze price competition and product differentiation with green consumers (Eriksson, 2004, Conrad, 2005). However, they do not endogenize environmental regulations using a political economy approach. The paper closest to ours is Calveras *et al.* (2007) which also models green consumers with warm-glow preferences who vote on environmental regulations. They show that the presence of green consumers might lead to laxer regulations when a majority of voters free-ride on their contribution to the environment. We provide a more negative view of green consumerism when such behavior is used by firms to obtain market power: *all* consumers (neutral and green) vote for a laxer minimal quality standard. Moreover, we analyze the political outcome when an environmental tax is implemented instead of an environmental standard.

Our paper also contributes to the literature comparing second-best policies, such as a tax and a standard in the case of environmental externalities (see for instance Weitzman 1974; Bovenberg *et al.* 2008; Fowlie and Muller 2019; Jacobsen 2013; Carson and LaRiviere 2018). Compared to this literature, we study the welfare dominance of standards even without behavioral anomalies such as limited attention (Allcott *et al.* 2012) or temptation (Tsvetanov and Segerson 2014). Bovenberg *et al.* (2008) study second-best policies designed to reduce deadweight loss from externalities and obtain numerically that standards may also be preferred to taxes, because of higher lump-sum compensation costs with the tax.

The paper closest to ours in this literature is Jacobsen *et al.* (2017), which demonstrates the possible superiority of standards in a model of public good provision where agents differ in how much they value the total amount of public good, and where the cost of public good provision is convex.[3] Agents who value more the good provide more of it, creating an inefficient wedge in the marginal cost of production. They then obtain that, for any amount of public good, a standard is always more efficient than a uniform price instrument such as the tax. They also introduce heterogeneity in the cost of provision, which resembles our warm glow effect, and show how the two types of heterogeneity push in opposite directions on efficiency of the policies.[4] Our analysis goes further, as it endogenizes the amount of the environmental good offered by explicitly modeling its political determination.

The structure of the paper is straightforward. The next section presents our setting, with section 3 studying the environmental quality standard, and section 4 the environmental tax. Section 5 compares the two instruments, and section 6 concludes by focusing on the robustness of our results to various assumptions. The more convoluted proofs are relegated to an appendix.

2 The setting

2.1 The model

We consider a good whose production or consumption generates environmental externalities, typically pollution. We index pollution abatement by the continuous variable x that we call the good's *environmental quality* . A higher value of x reflects, for instance, the use of a cleaner source of energy to produce electricity, a less polluting car, food grown with less pesticide or

[3]This heterogeneity, unlike in your paper, drives the private contribution to the public good. Under our assumption of a continuum of agents, each agent's consumption decision has an infinitesimal impact on the total level of environmental protection and is then unaffected by how much agents care for this aggregate level. Our assumption is more in line with global pollution problems such as climate change.

[4]To be precise, they show that the tax is efficient if agents are homogenous in their valuation of the public good but heterogeneous on their cost of providing it like in our model. This result differ from our because they do not launder preferences when they measure welfare.

water, a manufactured product that can be more easily recycled, etc. Alternatively, one can see x as a 'public good' contribution to society in the corporate social responsibility (CSR) sense, e.g. better working conditions, transparency, banning of child labor, investment in education, infrastructure, etc. The cost of supplying one unit of the good with environmental quality x is denoted $c(x)$ where $c(.)$ is an increasing, twice differentiable and convex function of x, with $c(0) = 0$ and $c'(0) = 0$ (to guarantee interior solutions).

On the demand side, we consider a continuum of mass one of consumers who are divided into two types, green and neutral, with respective shares α and $1 - \alpha$. The types are denoted by subscripts g and n, respectively. All consumers obtain the same private value v from consuming one unit of the good, regardless of its environmental quality. Both types of consumers also enjoy the same benefit $b(X)$ from the average environmental quality X, which is the level of environmental protection in the economy.[5] The function $b(.)$ is strictly increasing, twice differentiable and strictly concave: $b'(x) > 0$ and $b''(x) < 0$. Neutral consumers rationally do not care directly about the pollution generated by their own purchase decision: they do not value the environmental quality of the good they consume, since their own consumption does not impact the average environmental quality in the economy. Their utility when they purchase the good at price p is $v - p + b(X)$. By contrast, green consumers enjoy a 'warm glow' from contributing to environmental protection above the minimal environmental quality standard, that we denote x_0.[6] Let ω be the green consumers' willingness to pay for environmental quality when above standard. The parameter ω is hereafter referred to as the *level* of green consumerism while α is the *share* of green consumerism. Green consumers' utility when purchasing a good of environmental quality x at price p is $v - p + \omega x + b(X)$ when $x > x_0$,

[5]Note that average and total environmental qualities are equal with a continuum of consumers of mass one as assumed.

[6]Assuming rather that green consumers care more about environmental protection X than neutral consumers would not induce them to consume higher quality goods than the latter, with a continuum of consumers, unlike with warm glow.

and $v - p + b(X)$ otherwise.[7]

On the supply side, a competitive industry is supplying the standard (or "brown") version of the good with environmental quality x_0. Perfect competition drives down profit to zero. We assume that only one firm (firm 1) can supply higher environmental quality than the standard, $x_1 > x_0$.[8] So, firm 1 has a monopoly position on the green version of the good (called the green good).

We first analyze the socially desirable amount of environmental quality, which will constitute our main benchmark.

2.2 First-best environmental quality

The first-best environmental quality maximizes social welfare defined as the sum of consumers' utility and firms' profit. We follow the canonical approach first proposed by Hammond (1988) and Harsanyi (1995) who advocate to exclude all external preferences, even benevolent ones, when computing a social welfare function. This means that we "launder" the green consumers' preferences by assuming away the warm-glow part of their utility.[9] We denote the welfare

[7]The alternative formulation where the warm glow factor is modeled as $\omega(x - x_0)$ would not affect our results - see the concluding section. This alternative formulation would have the morally unappealing characteristic that green consumers' utility would increase when neutral voters consume dirtier goods (i.e., lower x_0), other things kept equal.

[8]This assumption can be justified by the ownership of a particular technology or the long-term development of a reputation of being greener. For instance, the firm is the only one that can credibly commit to issue a label of better environmental quality. See the concluding section for the robustness of our results to this assumption.

[9]See Goodin (1986) for a description of the various grounds for laundering preferences. More specifically, Benabou and Tirole (2010, p.15) write "We saw that prosocial behaviour by investors, consumers and workers is driven by a complex set of motives: intrinsic altruism, material incentives (defined by law and taxes) and social- or self-esteem concerns. (...) The pursuit of social- and self-esteem per se is a zero-sum game" which may then call for laundering the preferences of these agents. For instance, "The buyer of a hybrid car feels and looks better, but makes his neighbours (both buyers and non-buyers of hybrid cars) feel and look worse–a 'reputation stealing' externality" (Benabou and Tirole, 2010, p.6). Finally, observe that our laundering of preferences only affects our normative assessment of the equilibrium allocation, as opposed to the description of this equilibrium. See the concluding section for a discussion of the impact of this assumption.

level in the economy as

$$W(x_0, x_1) = v - (1-\alpha)c(x_0) - \alpha c(x_1) - b((1-\alpha)x_0 + \alpha x_1). \tag{1}$$

Both types of consumers are then characterized by the same welfare function, $v + b(x) - c(x)$, so that there is no reason to produce two different quality levels. Maximizing welfare with respect to x, we obtain the first-best level of environmental quality x^{FB} characterized by the following first-order condition:

$$b'(x^{FB}) = c'(x^{FB}), \tag{2}$$

which equates the marginal benefit and marginal cost of increasing x. Average first-best environmental quality is $X^{FB} = x^{FB}$.

We investigate successively two forms of public intervention: an environmental quality standard and a tax on pollution. In both cases, the timing of decisions runs as follows. First, consumers vote over the value of the instrument (level of the standard or of the tax). Second, firms set simultaneously their prices and environmental quality given the policy enacted. Third, consumers make their purchase decisions.

3 Environmental standard

In this section, we study the setting of an environmental quality standard x_0 imposed on all firms. We solve the model by backward induction. In a first sub-section, we study the firms' behavior as well as the choice by consumers of which variant of the good to consume.

3.1 Firms' and consumers' behavior

Competition among producers of the good with minimal quality x_0 drives down its equilibrium price towards its costs, $p_0 = c(x_0)$. Firm 1 has exclusive capacity to supply greener goods for technological or legal reasons (e.g. process or product protected by a patent), or because it acquired a reputation for being green. Firm 1 charges p_1 for a good of environmental quality x_1. Green consumers buy green goods whenever[10]

$$v - p_1 + \omega x_1 + b(X) \geq v - p_0 + b(X).$$

We first assume that $x_1 > x_0$ and compute the profit-maximizing price for firm 1. We then check that firm 1 makes a positive profit and that $x_1 > x_0$ at that price. If it is not the case, then firm 1 prefers to offer $x_1 = x_0$ for $p_1 = p_0$.

The maximum price p_1 compatible with green consumers buying quality x_1 rather than x_0 is

$$p_1 = c(x_0) + \omega x_1. \tag{3}$$

Firm 1's profit is then

$$\begin{aligned} \pi_1 &= \alpha[p_1 - c(x_1)] \\ &= \alpha[\omega x_1 + c(x_0) - c(x_1)], \end{aligned}$$

where we have used the one-to-one relationship between firm 1's price and quality defined in

[10] We make the simplifying assumption that green consumers buy from firm 1 when they are indifferent between the offerings of firms 0 and 1.

(3). Maximizing π_1 with respect to x_1, we obtain:

$$\frac{\partial \pi_1}{\partial x_1} = \alpha\left(\omega - c'(x_1)\right),$$

so that the profit-maximizing quality level, denoted by x_1^S (where the superscript S denotes the fact that firms are constrained by a standard) is such that[11]

$$c'(x_1^S) = \omega, \tag{4}$$

with the corresponding profit-maximizing price given by

$$p_1^S = \omega x_1^S + c(x_0). \tag{5}$$

Firm 1 uses its monopoly power to capture all the green consumer surplus created by the warm glow effect of consuming a greener-than-x_0 product. Firm 1 then chooses its quality level to equate the marginal cost of providing a higher quality with the marginal benefit to the firm (through a larger price), which is equal to the willingness to pay for environmental quality ω.

To check whether the environmental quality x_1^S is profitable for firm 1, first observe that, if $x_1^S > x_0$, firm 1 for sure makes a positive profit as long as consumers buy the green good. This is due to the fact that the cost function c is convex: since x_1^S is set so that its marginal cost to firm 1 is equal to its marginal benefit (the constant ω), the marginal cost of producing all inframarginal quality values below x_1^S is always strictly smaller than its cost ω, resulting in a positive profit.

Note from (4) that x_1^S does not depend on x_0, but increases with ω (since the cost function is convex). We then obtain the following proposition.

[11] We concentrate on interior solutions since $c'(0) = 0$.

Proposition 1 *With a standard set at x_0, firm 1 chooses $x_1 = x_1^S$ (given by equation (4)) if $x_0 < x_1^S$, and chooses $x_1 = x_0$ (and $p_1 = p_0$) if $x_0 > x_1^S$.*

In words, a lax standard allows firm 1 to exert its market power, sell a green good and capture the extra surplus from green voters. A standard that is stringent (in the sense that its marginal cost is larger than ω) results in firm 1 producing the same good as the competitive fringe, at the same price.

The following definition will prove useful later on.

Definition 1 *We denote by ω_1^S the unique value of ω such that $x_1^S = x^{FB}$.*

3.2 Collective choice of an environmental standard

We now examine the choice of minimal environmental performance for the product x_0 set as a standard. We first define the utility of both types of consumers as a function of x_0, when firm 1 chooses its price p_1 and quality x_1. The utility of neutral consumers is

$$U_n^S(x_0) = \begin{cases} v - c(x_0) + b(X^S) & \text{if} \quad x_0 < x_1^S, \\ v - c(x_0) + b(x_0) & \text{if} \quad x_0 \geq x_1^S, \end{cases} \tag{6}$$

with $X^S = \alpha x_1^S + (1-\alpha)x_0$ and $x_1^S = c'^{-1}(\omega)$ following equation (4). The utility of green consumers is given by

$$U_g^S(x_0) = \begin{cases} v - p_1^S + \omega x_1^S + b(X^S) & \text{if} \quad x_0 < x_1^S, \\ v - c(x_0) + b(x_0) & \text{if} \quad x_0 \geq x_1^S. \end{cases}$$

Replacing p_1^S by its formulation (5), the utility of green consumers if $x_0 < x_1^S$ can be simplified to

$$\begin{aligned} U_g^S(x_0) &= v - \omega x_1^S - c(x_0) + \omega x_1^S + b\left(X^S\right) \\ &= v - c(x_0) + b\left(X^S\right). \end{aligned} \tag{7}$$

We then obtain that $U_n^S(x_0) = U_b^S(x_0)$, but for reasons differing according to whether x_0 is smaller or larger than x_1^S. When $x_0 \geq x_1^S$, the standard is set so high that it is too costly for firm 1 to differentiate its offering, and all consumers, whether neutral or green buy the brown good at a price equal to its cost $c(x_0)$. When $x_0 < x_1^S$, firm 1 does differentiate its offering and the warm-glow part of the green consumers' utility is entirely captured by firm 1 through its pricing.

The unanimity approved standard is the value of x_0 maximizing either the first or the second line in (6). The second line is maximized with first-best environmental quality: $x_0 = x^{FB}$. It is the preferred standard when a single good is supplied. The first line of (6) peaks at a standard denoted x_0^{SV} defined by the following first-order condition (FOC):

$$c'(x_0^{SV}) = (1-\alpha)b'\left(\alpha x_1^S + (1-\alpha)x_0^{SV}\right). \tag{8}$$

The marginal cost of the standard on the left-hand side should be equal to its marginal benefit on the right-hand side. Compared to the case of the first-best level x^{FB} in (2), the marginal benefit is deflated by $1-\alpha$ because, with two environmental qualities x_0^{SV} and x_1^S, increasing the standard only affects the contribution of neutral consumers to environmental protection $X = \alpha x_1^S + (1-\alpha)x_0^{SV}$. The chosen standard is always strictly positive (since $x_0^{SV} = 0$ would imply that $b'(X^{SV}) = 0$, a contradiction with our assumption that $b'(.) > 0$). Moreover, applying the implicit function theorem on (8), we obtain the following proposition.

Proposition 2 *The unanimity-chosen standard x_0^{SV} is lower than first-best, and is decreasing with ω and α, with $x_0^{SV} > 0$.*

Both α and ω decrease the marginal benefit from the standard (through a higher environmental quality of the green good for ω, and through a higher proportion of agents consuming this good for α), and so decrease x_0^{SV}.

Let $\tilde{\omega}$ be the unique value of ω that equalizes the neutral consumers' utility with a unique good provided with $x = x^{FB}$, and with a brown good x_0^{SV} and a green good x_1^S as defined below.

Definition 2 *We denote by $\tilde{\omega}$ the unique value of ω such that:*

$$b(\alpha x_1^S + (1-\alpha)x_0^{SV}) - c(x_0^{SV}) = b(x^{FB}) - c(x^{FB}), \tag{9}$$

with x_1^S, x_0^{SV} and x^{FB} defined by (4), (8) and (2) respectively.

We establish the following proposition, proved in the appendix.

Proposition 3 *If $\omega < \tilde{\omega}$, the unanimity chosen standard implements the first-best environmental protection level x^{FB}. If $\omega > \tilde{\omega}$, green consumerism leads to a suboptimal standard $x_0^{SV} < x^{FB}$ with green goods. The threshold $\tilde{\omega}$ decreases with α.*

The citizens' choice of standard depends on green consumers' willingness to pay for environmental quality. If ω is low, the green version of the good is not supplied. All citizens vote for the first-best standard. Environmental protection is at the efficient level. All the benefit from production goes to consumers. When ω is high enough, supplying a green version of the product becomes profitable. Products are differentiated on environmental quality: one version with the standard quality $x_0 = x_0^{SV}$ and the green version with quality $x_1^S > x_0^{SV}$. The green good supplier makes profit by extracting the green consumer's willingness to pay for environmental quality. All consumers vote for a standard x_0^{SV} which is lower than x^{FB}, but for different reasons. The green consumers lower the standard from x^{FB} to reduce the price paid for the green good. The neutral consumers free-ride on the environmental protection driven by the green consumers' demand. Overall the standard fails to fix the two market failures that are the environmental externalities and the market power exerted by the green firm.

The intuition for the impact of α on $\tilde{\omega}$ is that the utility with $x_0^{SV} < x_1^S$ increases with α (thanks to a better environmental quality for given x_0^{SV}) while the utility with the first-best is unaffected, so that voters prefer $x_0^{SV} < x_1^S$ (rather than $x_0 = x^{FB}$) for a lower value of ω when α increases.

Figure 1 recapitulates the results obtained with a standard, and shows how the first-best and majority-chosen standard levels and average environmental quality in the economy vary with the willingness to pay for green products ω.[12]

Insert Figure 1

The first-best standard and corresponding environmental protection $X^{FB} = x^{FB}$ (black curve) do not vary with the willingness to pay for environmental quality ω. When $\omega < \tilde{\omega}$ the first-best standard is unanimity preferred to any other and a single good is produced at the voting equilibrium. When ω reaches $\tilde{\omega}$, both a brown (dashed curve) and a green (full curve) goods are supplied at the voting equilibrium. The economy switches to an equilibrium with differentiated products and a lower standard x_0^{SV}. Lemma 1 in the proof of Proposition 3 implies that $x_1^S < x^{FB}$ when $\omega = \tilde{\omega}$. The switch towards a new majority voting equilibrium then occurs discontinuously, with a decrease in the environmental quality of both goods (compared to the unique first-best level) which reduces overall environmental

[12] All figures are based on $c(x) = \gamma x^2/2$, $b(x) = Log(2 + 2x)$, with $\gamma = 0.8$ and $\alpha = 0.2$.

protection $X^{SV} = \alpha x_1^S + (1-\alpha)x_0^{SV}$ (the blue dotted curve in Figure 1). In other words, the environmental quality decreases discontinuously at the precise point where the green good is supplied.

As the level of green consumerism ω increases beyond $\tilde{\omega}$, the environmental quality of the green good x_1^S improves while the standard x_0^{SV} becomes laxer. Environmental protection X^{SV} improves driven by the demand for environmental quality by green consumers, although it is still under-provided. It reaches its first-best level when the taste for environmental quality ω becomes high enough that the green consumer's demand compensates the lower standard. In particular, the environmental quality of green goods should exceed the first-best level $x_1^S > x^{FB}$ at that point. Moreover, environmental protection X^{SV} exceeds the first-best level X^{FB} when ω is large enough.[13]

It is worth noticing that the collectively-chosen standard x_0^{SV} would not be recommended by a benevolent social planner when the green good is supplied with a standard x_1^S and $\omega > \tilde{\omega}$. Maximizing social welfare defined in (1) with respect to x_0 with $x_1 = x_1^S = c'(\omega)$ leads to a second-best standard x_0^{SB} given by the following first-order condition:

$$c'(x_0^{SB}) = b'\left(\alpha x_1^S + (1-\alpha)x_0^{SB}\right). \tag{10}$$

Comparing (8) and (10), we obtain that their respective solutions x_0^{SV} and x_0^{SB} are such that $x_0^{SV} < x_0^{SB}$. A welfare-maximizing social planner would solve the free-riding problem by not deflating the marginal benefit by $(1-\alpha)$ in the first-order condition (see (8)). The social planner then recommends a higher standard of environmental quality and, therefore, a higher environmental protection $X^{SB} = ax_1^S + (1-\alpha)x_0^{SB} > X^{SV}$, than the one unanimously voted upon.

We summarize our main results with a standard before moving to a tax. When ω is

[13] Indeed as ω tends toward infinity, x_0^{SV} tends toward 0 (see (8)), so that X^{SV} tends toward αx_1^S which tends toward infinity as seen from (4).

low enough, green consumerism is not effective in the sense that a single-quality good is produced, with its majority-chosen level equal to its first-best level. When ω is high enough, the individuals unanimously prefer a standard lower than its first-best level. Neutral voters free ride on the higher quality of the good consumed by green voters, and green voters have the same political preferences as neutral ones because the monopoly firm producing the high quality good captures all their warm glow through a larger price. The unanimously chosen value of the standard decreases with the intensity of warm glow ω, while the high quality good increases with ω. If ω is higher than ω_1^S, the average quality in the case the standard is voted upon may exceed its first-best level thanks to the very large quality bought by green consumers.

4 Environmental tax

4.1 Firms' and consumers' behavior

We now move to another policy instrument to mitigate environmental externalities: a tax on pollution. We denote by e the pollution emitted in the absence of any pollution abatement effort by firms, namely when they produce a good of quality $x = 0$. Environmental quality x then corresponds to the reduction in polluting emissions from that point. Pollution is taxed at a linear rate τ. The total cost of supplying one unit of the product with environmental performance x is $c(x) + \tau(e - x)$. The brown good producers choose the value of x that minimizes their cost given the price of their product p_0. The environmental quality they choose is denoted by x_0^τ and satisfies the following FOC:

$$\tau = c'(x_0^\tau), \tag{11}$$

where the marginal cost of environmental quality equals the tax rate. The competitive price per unit of product is defined by the zero-profit condition:

$$p_0^\tau = c(x_0^\tau) + \tau(e - x_0^\tau). \tag{12}$$

The firm supplying green goods of quality x_1 is able to charge to green consumers a maximal price of:

$$p_1^\tau = \omega x_1 + p_0^\tau = \omega x_1 + c(x_0^\tau) + \tau(e - x_0^\tau), \tag{13}$$

with x_0^τ and p_0^τ defined by (11) and (12). Firm 1's profit with environmental performance x_1 is:

$$\pi_1 = \alpha[p_1^\tau - c(x_1) - \tau(e - x_1)] = \alpha[\omega x_1 + c(x_0^\tau) - c(x_1) + \tau(x_1 - x_0^\tau)], \tag{14}$$

where the last equality is obtained by substituting p_1^τ as defined by (13). Differentiating π_1 with respect to x_1 yields:

$$\frac{\partial \pi_1}{\partial x_1} = \alpha\left[\omega - c'(x_1) + \tau\right],$$

so that profit is maximized at a quality level x_1^τ satisfying the following FOC:

$$\tau + \omega = c'(x_1^\tau). \tag{15}$$

Environmental performance increases profits through two channels: higher revenue (thanks to a larger price made possible by the green consumer's preference for greener goods) and lower tax paid. The best green strategy equalizes marginal cost to the sum of the green consumer's willingness to pay and the tax rate. Firm 1 chooses $x_1^\tau = c'^{-1}(\omega + \tau)$ and charges

$p_1^\tau = \omega x_1^\tau + c(x_0^\tau) + \tau(e - x_0^\tau)$. The following proposition, proved in the appendix, shows that firm 1's profit is always positive when it chooses $x_1 = x_1^\tau$.[14]

Proposition 4 *With a tax, we have that $\pi_1 > 0$ with $x_1 = x_1^\tau > x_0^\tau$ for all $\omega > 0$.*

As soon as firm 1 produces a good greener than x_0, it can increase discontinuously its price by ωx_1, while the other terms in its profit function (the gain in tax bill and the increase in production costs) are continuous in x_1.

A fundamental difference between the environmental tax and the standard is their impact on environmental performance for the green product. In Section 3, we have shown that the standard x_0 has no direct impact on the level of environmental quality imbedded in the green good x_1^S, see (4). The standard only affects the decision whether to supply a greener good or not through p_1. By contrast, the tax impacts directly the green good's environmental performance x_1^τ as shown in (15). A higher tax increases both environmental performances x_0^τ and x_1^τ while a higher standard x_0 does not change x_1^S as long as supplying the green good is profitable.

It is worth mentioning that, although both environmental qualities x_0^τ and x_1^τ depend on the tax rate, the incremental environmental quality of green goods, $x_1^\tau - x_0^\tau$ as well as the incremental marginal cost $c'(x_1^\tau) - c'(x_0^\tau)$ do not. More precisely, the wedge between marginal costs of production always equals the green consumers' willingness to pay for environmental quality ω at equilibrium, namely $c'(x_1^\tau) - c'(x_0^\tau) = \omega$. This productive inefficiency of environmental protection increases with the level of green consumerism ω.

4.2 Collective choice of the environmental tax

To compute the utility of both types of consumers, we need to specify how the revenue collected by taxing pollution is redistributed. We assume a lump-sum redistribution to all

[14] Provided of course that consumers' willingness to pay is high enough to compensate for the tax paid: $v \geq p_0^\tau$ and $v + \omega x_1^\tau \geq p_1^\tau$.

consumers as a benchmark.[15] After redistributing the revenues from taxing the green firm 1, $\alpha\tau(e - x_1^\tau)$, and the brown good producers, $(1-\alpha)\tau(e - x_0^\tau)$, utilities are:

$$U_n^\tau(\tau) = v - p_0^\tau + b(X^\tau) + \tau[\alpha(e - x_1^\tau) + (1-\alpha)(e - x_0^\tau)],$$

for neutral consumers, and,

$$U_g^\tau(\tau) = v + \omega x_1^\tau - p_1^\tau + b(X^\tau) + \tau[\alpha(e - x_1^\tau) + (1-\alpha)(e - x_0^\tau)],$$

for green consumers. Substituting the prices p_0^τ and p_1^τ defined in (12) and (13) respectively, we end up with the following utility for both consumers' types, $i \in \{n, g\}$:

$$U_i^\tau(\tau) = v - c(x_0^\tau) - \alpha\tau(x_1^\tau - x_0^\tau) + b(\alpha x_1^\tau + (1-\alpha)x_0^\tau). \tag{16}$$

As with the environmental standard, we obtain the same utility for both types of consumers, because the warm-glow effect is fully captured by firm 1's pricing. By contrast, firm 1's profit differs and is higher than with the standard (compare (7) and (16)), by the amount $\alpha\tau(x_1^\tau - x_0^\tau)$, which is the amount of tax saved by the firm (and thus lost to consumers).

Majority voting over the tax rate will then result in a unanimous decision. Maximizing the consumers' utility defined in (16) with respect to τ, we obtain the FOC

$$[-c'(x_0^\tau) + \tau\alpha + (1-\alpha)b'(X^\tau)]\frac{dx_0^\tau}{d\tau} - \alpha(x_1^\tau - x_0^\tau) + [-\tau\alpha + \alpha b'(X^\tau)]\frac{dx_1^\tau}{d\tau} = 0.$$

At this stage of our analysis, the following assumption proves useful because it guarantees that τ has the same impact on both qualities.

Assumption 1 *Let* $c(x) = \gamma\frac{x^2}{2}$.

[15] Other popular ways to recycle tax revenue, and their impact on our results, are discussed in the concluding section.

Under Assumption 1, the FOC for τ simplifies to

$$c'(x_0^{\tau V}) + \alpha\gamma(x_1^{\tau V} - x_0^{\tau V}) = b'(X^{\tau V}), \tag{17}$$

where $X^{\tau V} = \alpha x_1^{\tau V} + (1-\alpha)x_0^{\tau V}$ and where the superscript τV refers to the allocation obtained when the tax rate is set at its most-preferred level by consumers–*i.e.*, for $\tau = \tau^V$ satisfying (17). The left-hand term is the marginal cost of increasing environmental quality through a higher tax while the right-hand term is the marginal benefit. The cost to consumers is twofold: higher production costs and more tax revenue captured by the green firm.

The comparison of the FOC for the standard in (8) with the one with the tax (17) is instructive, as we can see that $x_0^{\tau V}$ differs from x_0^{SV} for two reasons. First, the tax impacts both x_0 and x_1 while the standard has no impact on x_1. Consequently, the full marginal benefit and not only the share $1-\alpha$ is considered in the first-order condition (17). Second, taxing is more costly to voters than using the standard because part of the welfare saved by improving environmental quality is captured by the green firm. The first effect favors a higher environmental performance with tax than standard while the second goes in the opposite direction. Numerical simulations[16] indeed show that the comparison between x_0^{SV} and $x_0^{\tau V}$ can go both ways, with $x_0^{SV} > x_0^{\tau V}$ when α is low enough (but strictly positive).

We now introduce the following threshold level for ω.[17]

Definition 3 *The threshold ω_1^τ is the unique value of ω such that $\tau^V = 0$ (if $\tau^V > 0$ for all ω, then we set $\omega_1^\tau = \infty$).*

The following proposition, proved in the Appendix, compares the majority-chosen allocation with a tax and with a standard, and how the former is affected by ω.

[16]With the same functional forms and parameter values as those reported in footnote 12.

[17]Note that, under Assumption 1, ω_1^τ is such that $b'(\alpha\omega_1^\tau/\gamma) = \alpha\omega_1^\tau$, which exists provided that $b(.)$ is concave enough, for instance if $\lim_{x\to\infty} b'(x) = 0$.

Proposition 5 *When $\tau^V > 0$ and under Assumption 1, we have:*

(a) $X^{\tau V} = X^{FB}$,

(b) $x_1^{\tau V} > x_1^S$,

(c) τ^V *and* $x^{\tau V}$ *decrease with* ω *and* α*, while* $x_1^{\tau V}$ *increases with both,*

(d) τ^V *is the second-best tax rate.*

The tax allows to obtain the first-best environmental protection, but with productive inefficiencies since x_0 is set “too low” and x_1 “too high”. These inefficiencies increase with both the level and share of green consumerism ω and α respectively. The majority-chosen tax rate decreases with these two parameters, as environmental protection relies more on the green consumers’ behavior.

The last part Proposition 5 establishes that the majority-chosen tax would be the one also chosen by a benevolent social planner. It indeed maximizes social welfare defined in (1) with $x_0 = x_0^\tau$ and $x_1 = x_1^\tau$ as defined in (11) and (15) respectively.

Note that, except for (d), all items in Proposition 5 hold only when the tax rate is strictly positive, which turns out to happen when the level of green consumerism ω is lower than ω_1^τ by Definition 5. When $\omega \geq \omega_1^\tau$, the majority-chosen tax is nil. Brown firms make no abatement effort $x_0^{\tau V} = 0$ while the quality of the green product is driven by the demand from green consumers as with the standard $x_1^{\tau V} = x_1^S = \omega/\gamma$. Due to the high taste for environmental quality ω, environmental protection is higher than first-best $X^{\tau V} = \alpha\omega/\gamma > X^{FB}$.

We summarize the main results obtained with the tax, before moving to the comparison between tax and standard. Unlike with a standard, green consumerism is effective even when small, since two goods of different qualities are produced as soon as $\omega > 0$. Voters are unanimous as to their most-preferred value of the tax level (for the same reason as with the standard) which is such that the average quality is set at its first-best level (but with two different quality levels produced which is inefficient).

5 Comparison of instruments

We consider sequentially two approaches: normative and positive. We first compare the welfare levels attained with the majority-chosen levels of the standard and of the tax. We then move to the voting game to figure out which of the two instruments would be collectively chosen by citizens. We assume that Assumption 1 holds throughout the section.

5.1 Welfare analysis of instrument choice

Following our definition of social welfare in (1), the welfare induced by the majority-chosen standard x_0^{SV} is:

$$W\left(x^{FB}, x^{FB}\right) = v - c\left(x^{FB}\right) + b\left(x^{FB}\right) \text{ if } \omega < \tilde{\omega}$$

$$W\left(x_0^{SV}, x_1^S\right) = v - (1-\alpha)c\left(x_0^{SV}\right) - \alpha c\left(x_1^S\right) + b\left(X^{SV}\right) \text{ if } \omega > \tilde{\omega}$$

The welfare with the majority-chosen tax τ^V is:

$$W\left(x_0^{\tau V}, x_1^{\tau V}\right) = v - (1-\alpha)c\left(x_0^{\tau V}\right) - \alpha c\left(x_1^{\tau V}\right) + b\left(X^{\tau V}\right) \text{ if } \omega < \omega_1^\tau$$

$$W\left(0, x_1^S\right) = v - \alpha c\left(x_1^S\right) + b\left(\alpha x_1^S\right) \text{ if } \omega > \omega_1^\tau$$

Comparing the welfare levels we obtain the following proposition, proved in the Appendix.[18]

Proposition 6 *Welfare is higher with the majority-chosen standard when $\omega < \tilde{\omega}$ and $\omega > \omega_1^\tau$. Welfare can be higher with the majority-chosen tax for intermediary values of ω: $\tilde{\omega} < \omega < \omega_1^\tau$.*

The intuition for this proposition runs as follows. When $\omega < \tilde{\omega}$, the majority-chosen standard corresponds to the first-best allocation and dominates, from a welfare perspective, the

[18]The proof of Proposition 6 shows that $\tilde{\omega} < \omega_1^S < \omega_1^\tau$.

majority-chosen tax. Both instruments generate the same overall, first-best, environmental quality, but the tax does it inefficiently since the environmental quality of the green good x_1 is too high while the brown good's quality x_0 is too low.[19] When $\omega > \omega_1^\tau$, the environmental quality of the green good is the same with the two instruments x_1^S. The standard gives more flexibility to choose the environmental quality of the brown good x_0 than the tax which impacts also the green good quality. Indeed a strictly positive tax would induce too much environmental protection X, therefore, pollution is not taxed and brown firms do not make any abatement effort while they should. The standard forces them to abate pollution without impacting the environmental quality of the green good. When $\tilde{\omega} < \omega < \omega_1^\tau$, the environmental qualities with the tax are both more extreme than with the standard, but the overall environmental protection is first-best with the tax, and too large with a standard. There is then a trade-off between allocative and productive efficiency, and the comparison of welfare levels across instruments can go both ways – see Figure 2(a) and 2(b).

Insert Figures 2(a) and 2(b)

To summarize this subsection, the standard dominates the tax when they are set by majority voting (Proposition 6), except in specific circumstances in the latter case (see Figure 2(b)). We will now see that this ranking is not maintained when we allow voters to choose their most-preferred instrument.

5.2 Political economy of instrument choice

Assuming that both goods are produced under the standard (*i.e.*, $\omega > \tilde{\omega}$ so that $x_1^S > x_0$), we can express consumers' utility as a function of minimal quality x_0 as the only endogenous

[19]This result is reminiscent of Jacobsen *et al.* (2017), although the "wedge" in the marginal costs of public good provision is not driven by differences in the individual valuations of the public good (here $b(X)$).

variable for both instruments. The environmental qualities of both types of goods characterized in (4), (11) and (15) boil down to $x_1^S = \omega/\gamma$, $x_0^\tau = \tau/\gamma$ and $x_1^\tau = (\omega+\tau)/\gamma$. We therefore obtain a simple relationship between the incremental environmental quality of the green good with tax, the green consumerism parameter and the green good environmental quality with a standard:

$$x_1^\tau - x_0^\tau = \frac{\omega}{\gamma} = x_1^S. \tag{18}$$

Substituting into the first line of (6) and (16) yields the utility of both types of consumers as a function of the neutral good quality x_0 with standard:

$$U^S(x_0) = v - c(x_0) + b\left(\alpha\frac{\omega}{\gamma} + (1-\alpha)x_0\right), \tag{19}$$

and with tax:

$$U^\tau(x_0) = v - \alpha\omega x_0 - c(x_0) + b\left(\alpha\frac{\omega}{\gamma} + x_0\right). \tag{20}$$

A closer look at the two functions U^S and U^τ highlights the trade-off in the choice of instruments. On the one hand, the tax has a larger impact on average environmental protection than the standard because it increases the environmental quality of both types of goods instead of only the brown one. This *environmental protection effect* shows up into the benefit functions in (19) and (20) where the minimal environmental quality x_0 is impacting fully environmental protection $X^\tau = \alpha\frac{\omega}{\gamma} + x_0$ with tax in (20) but only a fraction $1-\alpha$ (the share of neutral consumers) with standard as $X^S = \alpha\frac{\omega}{\gamma} + (1-\alpha)x_0$ in (19). On the other hand, there is an extra cost of increasing environmental quality with the tax as all the fiscal benefit of providing higher environmental quality is captured by the green firm and therefore lost by consumers. This *tax stealing effect* shows up in the welfare through the extra term $\alpha\omega x_0$. It depends solely on two parameters: the share of green consumers α and their willingness to pay ω.

Proposition 7 *Assume that voters first vote over whether the instrument used should be the tax or the standard, and then vote over the level of the majority-chosen instrument. There exists a threshold value of* ω*, denoted by* $\hat{\omega}$*, with* $\tilde{\omega} < \hat{\omega} < \omega_1^\tau$*, such that (a) all voters prefer a tax to a standard if* $\omega < \hat{\omega}$*, (b) all voters prefer a standard to a tax if* $\omega > \hat{\omega}$*.*

The intuition for this result runs as follows (see also Figure 3, where the utility with a tax is depicted in red, and with a standard in blue). When ω is low, the standard is set at its first-best level, with only one good provided with environmental quality x^{FB}. The tax also generates the same first-best environmental quality but on average, with two different quality levels ($x_0^{\tau V} < x^{FB} < x_1^{\tau V}$). The neutral consumers are better-off with the tax, since they buy a lower priced good while enjoying the same environmental protection. Green consumers are also better-off, even though firm 1 captures all the warm glow they experience, because the lower cost of the brown good drives down the price they pay for the green good.[20] When ω is large enough, all voters rather prefer the standard to the tax. Take $\omega = \omega_1^\tau$ for instance. Both the majority-chosen tax and standard generate the same value of the high quality good, but the standard allows voters to choose their most-preferred value of x_0, while the tax imposes that $x_0^{\tau V} = 0$. By continuity, and given that utilities increase with ω, there is a threshold value of ω, denoted by $\hat{\omega}$ and such that $\tilde{\omega} < \hat{\omega} < \omega_1^\tau$, below (resp., above) which voters unanimously prefer the tax to the standard (resp., the standard to the tax). For low values of ω ($\omega < \hat{\omega}$), voters then choose to regulate the environment with a tax, while the second-best analysis rather calls for a standard.

Insert Figure 3

[20]Recall that our measure of (first-best) welfare launders the warm glow effect, which explains why (unlaundered) utility levels are larger than (first-best) welfare levels.

6 Conclusion and Robustness

We have developed a model with neutral and green consumers where the latter derive a warm glow from buying a good of higher environmental quality produced by a profit-maximizing monopoly. Looking first at a quality standard, we obtain that warm glow is not effective when small, in the sense that a single good, whose quality is unanimously set at its first-best level, is provided in that case. When the warm glow effect is large enough, the quality standard is unanimously set at a lower-than-first-best level, with neutral consumers free-riding on green consumers, and the latter sharing the same preferences as the former because the monopoly firm captures all their warm glow through limit pricing. Turning then to a tax on pollution rather than a standard, we obtain that this tax drives a wedge between the two goods' qualities as soon as it is positive. Voters unanimously prefer a tax delivering the average first-best quality level.

Comparing the majority-chosen levels of the standard and of the tax, we obtain that the standard dominates the tax from a welfare perspective: either because it decentralizes the first-best allocation (when warm glow is small enough), or because the wedge between the low and high quality goods is lower (productive efficiency), even though it does not deliver the first-best average quality that the tax generates (allocative efficiency). This is in stark contrast with the individual preferences, since voters unanimously prefer a tax to a standard when warm glow is small enough, because the lower quality of the brown good with a standard allows the neutral voters to free ride on the green ones, and the latter to benefit from a lower-priced good (compared to the standard).

We now discuss the robustness of these results to the lifting of the main simplifying modeling assumptions.[21] First, the model assumes perfect competition for the neutral goods, and an extreme form of imperfect competition (monopoly) for the green good. How would

[21]See Appendices at the end of the paper, to appear in a supplementary file on the journal's website.

our results change if we were to move closer to perfect competition for green goods as well (moving our model closer to Calveras *et al.* 2007)? Going all the way to perfect competition for the green good as well, we obtain that most our results hold through: neutral consumers' preferences are unchanged, and a green good of the same quality x_1^S is offered provided that the warm glow parameter ω is large enough. The first-best level is unaffected. The main difference lies in the preferences of the green voters, who most-prefer a higher standard level than neutral consumers (since warm glow is not captured anymore by the firm). The majority-chosen standard level remains the same as with imperfect competition for the green good as long as green voters represent less than a majority ($\alpha < 1/2$) which is the empirically relevant case. Similar results hold for taxation as well, and the welfare ranking of instruments is not affected (as long as $\alpha < 1/2$, when comparing the majority voting equilibrium levels). Our results are then mostly robust to the specific assumption of monopoly for the green good.

Second, modeling the warm glow benefit as $\omega(x_1 - x_0)$ rather than as ωx_1 does not impact our results. More precisely, the only difference made is that the price charged by the green good producer is lower with this formulation (since this firm captures all the warm glow enjoyed by green producers). This has no impact on any other result obtained in the paper.

Third, what is the impact of laundering preferences in our welfare assessments? Note that unlaundered welfare (defined as the sum of consumers' utilities and firms's profits) would call for two qualities of the good to be produced at the first-best (with $x_1 > x_0$), since warm glow now appears as a socially acceptable benefit of the green good. When comparing welfare across instruments, the fact that taxation always induces a larger quality level for the green than for the brown good is now less of a drawback, since first-best welfare calls for such a difference. Taxation is then more appealing when welfare is not laundered than when it is.

Fourth, how would our results vary in the presence of several types of green consumers differing in their warm glow parameter? As long as this individual parameter is observed by firms, and that firms can offer as many variants of the green goods as there are types of green consumers, our results would carry through. What about the case where firms offer fewer variants than types, and where types are individually unobservable? Take for instance the limit case where there is a single green good and a continuum of types (whose distribution is known to the monopoly firm). In that case, the firm has to leave some rent to the "greenest" consumers, and faces an intensive vs extensive margin trade-off, since a higher price generates more revenue from green buyers, but induces the least green consumers to switch to the brown version of the good. We surmise that most of our results would still hold in this more complex setting, but we leave its study to future research.

Finally, how would other ways to redistribute tax proceeds affect our results? An obvious alternative would be to make transfers to firms rather than to consumers. If these transfers were made proportional to firms' market share, they would result in lower prices for both goods (thanks to competitive pressures on the brown good's price, which in turn would decrease the ability of firm 1 to post a high price) but in the same green good quality x_1^τ (as the effect of the higher quality on the rebate exactly cancels out its effect on p_1) and also in the same utility for both types of consumers. In a nutshell, consumers benefit from lower prices, rather than from government transfers, and all our results carry through to this case. Likewise, a feebate (which refunds the revenue collected from taxing brown producers with a subsidy per unit of abatement above a threshold quality level) would not affect our results: both prices would remain the same as with a lump sum transfer to consumers, and consumers' utilities would also remain the same, if the subsidy rate were set for convenience at the same level as the tax rate.

A Proof of Proposition 3

To show that $\tilde{\omega}$ is unique, remark that x^{FB} does not depend on ω, therefore the right-hand side of (9) does not vary with ω. On the other hand, the left-hand side increases with ω since its derivative with respect to ω equals $\alpha b'(\alpha x_1^S + (1-\alpha)x_0^{SV})\frac{dx_1^S}{d\omega} > 0$ by making use of (8). Furthermore, $x_1^S = 0$ when $\omega = 0$, and therefore $b(\alpha x_1^S + (1-\alpha)x_0^{SV}) - c(x_0^{SV}) = \max_x\{b((1-\alpha)x) - c(x)\} < \max_x\{b(x) - c(x)\} = b(x^{FB}) - c(x^{FB})$ by definition of x_0^{SV} and x^{FB}. For ω high enough that $x_1^S = x^{FB}$, we have $b(\alpha x_1^S + (1-\alpha)x_0^{SV}) - c(x_0^{SV}) = \max_x\{b(\alpha x_1^{FB} + (1-\alpha)x) - c(x)\} \geq b(x^{FB}) - c(x^{FB})$. Therefore $b(\alpha x_1^S + (1-\alpha)x_0^{SV}) - c(x_0^{SV})$ is lower than $b(x^{FB}) - c(x^{FB})$ for $\omega < \tilde{\omega}$ and becomes higher for $\omega > \tilde{\omega}$.

Note that the penultimate step in the preceding paragraph has proved the following lemma, which will prove useful later on in the paper.

Lemma 1 $\tilde{\omega} < \omega_1^S$

We know that x^{FB} is constant with ω (see (2)), that $x_0^{SV} < x^{FB}$ and is decreasing with ω (see Proposition 2), that x_1^S is increasing in ω and may be lower or larger than x^{FB} (since $x_1^S = 0$ when $\omega = 0$, while it tends towards infinity as ω grows). Hence, the following three cases exhaust all the possible ones.

Case (a) $x_1^S < x_0^{SV} < x^{FB}$

In this case, we can show that $x_0^{SV} \leq x^{FB}$. For any standard $x_0 < x_1^S$, the utility $U_n(x_0)$, defined in the first line of (6), is increasing with x_0 up to x_1^S. It also increasing with x_0 above x_1^S– i.e., as defined in the second line of (6), up to $x_0 = x^{FB}$. It is then decreasing above x^{FB}. Therefore $U_n(x_0)$ is single-peaked at $x_0 = x^{FB}$. Note that $x_1^S < x_0^{SV}$ implies $\omega < \tilde{\omega}$ because then $b(\alpha x_1^S + (1-\alpha)x_0^{SV}) - c(x_0^{SV}) < b(x_0^{SV}) - c(x_0^{SV}) \leq b(x^{FB}) - c(x^{FB})$ where the last inequality is due to the definition of x^{FB} which maximizes $b(x) - c(x)$ with respect to x.

Case (b) $x_0^{SV} < x^{FB} < x_1^S$

For any standard $x_0 < x_1^S$, the utility $U_n(x_0)$ -defined in the first line of (6)- is increasing up to x_0^{SV} and then decreasing for $x_0 > x_0^{SV}$. When $x_0 > x_1^S$, $U(x_0)$ - defined in the second line of (6)- is decreasing with x_0 because $x_0 > x^{FB}$ by assumption. Hence $U_n(x_0)$ is single-peaked at $x_0 = x_0^{SV}$. Now $x_1^S > x^{FB}$ implies $\omega > \tilde{\omega}$ because $\max_x b(\alpha x_1^S + (1-\alpha)x) - c(x) > b(\alpha x^{FB} + (1-\alpha)x^{FB}) - c(x^{FB}) = b(x^{FB}) - c(x^{FB})$.

Case (c) $x_0^{SV} < x_1^S < x^{FB}$

Then $U(x_0)$ is double-peaked: a first peak at $x_0 = x_0^{SV}$ on the range $[0, x_1^S]$ - when $U_n(x_0)$ is defined by the first line of (6)- and a second peak at $x_0 = x^{FB}$ for x_0 above x_1^S. The two peaks have respective values $v - c(x_0^{SV}) + b(\alpha x_1^S + (1-\alpha)x_0^{SV})$ and $v - c(x^{FB}) + b(x^{FB})$. As shown at the beginning of the proof, the first peak is lower than the second peak when $\omega < \tilde{\omega}$ and becomes higher when $\omega > \tilde{\omega}$.

Finally, to find the impact of α on $\tilde{\omega}$, we define $f(\omega, a) = b(\alpha x_1^S + (1-\alpha)x_0^{SV}) - c(x_0^{SV}) - \left[b(x^{FB}) - c(x^{FB})\right] = 0$ with $f(\tilde{\omega}, \alpha) = 0$. Using the envelope theorem for x_0^{SV}, we have $\frac{\partial \tilde{\omega}}{\partial \alpha} = -\frac{\partial f(\omega,\alpha)/\partial \alpha}{\partial f(\omega,\alpha)/\partial \omega}$. Using the envelope theorem, we obtain $\frac{\partial f(\omega,\alpha)}{\partial \alpha} = b'(X^{SV})(x_1^S - x_0^{SV}) > 0$, $\frac{\partial f(\omega,\alpha)}{\partial \omega} = b'(X^{SV})\alpha \frac{\partial x_1^S}{\partial \omega} > 0$, so that $\tilde{\omega}$ decreases with α.

B Proof of Proposition 4

Firm 1's profit function is concave in x_1, with a maximum at $x_1 = x_1^\tau > x_0^\tau$ when $\omega > 0$. From (14), we obtain that $\lim_{x_1 \to x_0^{\tau+}} \pi_1 = \alpha \omega x_0^\tau > 0$,so that π_1 is a fortiori positive when maximized at $x_1 = x_1^\tau$.

C Proof of Proposition 5

(a) Under Assumption 1, when $\tau^V > 0$ the FOC (17) simplifies to $b'(X^{\tau V}) = \gamma X^{\tau V} = c'(X^{\tau V})$.

(b) Under Assumption 1, $x_1^{\tau V} = \frac{\tau^V + \omega}{\gamma} > x_1^S = \frac{\omega}{\gamma}$when $\tau^V > 0$.

(c) Under Assumption 1, and using (11) and (15), we have that $X^{\tau V} = \frac{\tau^{\tau V} + \alpha\omega}{\gamma} = X^{FB}$, where the last equality comes from (a). Since X^{FB} which does not depend on α nor on ω, so that $\tau^{\tau V}$ (and thus $x_0^{\tau V}$) decreases with α and with ω. Since $X^{\tau V}$ does not change with α nor ω, we then have that $x_1^{\tau V}$ increases with both.

(d) The second-best tax $\tau^{\tau B}$ maximizes the welfare with product differentiation defined as the sum of the benefit from consuming the good, v, and of protecting the environment, $b(X)$, net of production costs, $W^{\tau B}(\tau) = W(x_0^\tau, x_1^\tau) = v - (1-\alpha)c(x_0^\tau) - \alpha c(x_1^\tau) + b(X^\tau)$, where $X^\tau = (1-\alpha)x_0^\tau - \alpha c(x_1^\tau)$, with x_0^τ and x_1^τ defined by (11) and (15) respectively. Differentiating with respect to τ, and using $dx_0^\tau/d\tau = dx_1^\tau/d\tau = 1/\gamma$ by Assumption 1 we obtain the first-order condition on the solution $\tau^{\tau B}$: $b'(X^{\tau B}) = \alpha c'(x_1^{\tau B}) + (1-\alpha)c'(x_0^{\tau B})$. Using (11) and (15) with $c'(x) = \gamma x$ under Assumption 1, the latter FOC can we rewritten as (17).

D Proof of Proposition 6

First, under Assumption 1, ω_1^S and ω_1^τ defined in Definitions 1 and 3 are such that $\omega_1^S = b'(\frac{\omega_1^S}{\gamma})$, $\alpha\omega_1^\tau = b'(\frac{\alpha\omega_1^\tau}{\gamma})$ and, therefore, $\omega_1^S = \alpha\omega_1^\tau < \omega_1^\tau$, so that $\tilde{\omega} < \omega_1^S < \omega_1^\tau$.

(a) When $\omega < \tilde{\omega}$, we obtain the first-best welfare level with the standard (since $x_1^S = x_0^{SV} = x^{FB}$), while with the tax, the environmental qualities of both goods are distorted (with $x_0^{\tau V} < x^{FB}$ and $x_1^{\tau V} > x^{FB}$). Welfare is thus higher with the standard than with the tax.

(b) When $\omega > \omega_1^\tau$, we have that $x_1^S = \omega/\gamma = x_1^{\tau V}$ since $\tau^V = 0$. Since (i) $W(x_0, x_1^S)$ is concave in x_0 with a maximum at x_0^{SB}, and (ii) $x_0^{\tau V} < x_0^{SV} < x_0^{SB}$, we have that welfare is higher with the standard than with the tax.

(c) When $\tilde{\omega} < \omega < \omega_1^\tau$, Figure 2 shows that the welfare can be higher with the standard (case (a) with $\alpha = 0.2$) or, reversely, with the tax (case (b) with $\alpha = 0.6$) when ω is close but higher than $\tilde{\omega}$.

E Proof of Proposition 7

Recall that all individuals have the same utility function when voting over the instrument. We then define the utility level attained at the majority voting equilibrium by voters as $U^{\tau V} = U^{\tau}(\tau^V)$ with a tax, and $U^{SV} = U^S(x_0^{SV})$ with a standard. We now study the comparative statics of $U^{\tau V}$ and U^{SV} as function of ω, starting with U^{SV}.

(i) $\omega < \tilde{\omega}$: $U^{SV} = v + b(x^{FB}) - c(x^{FB}) = W^{FB}$.

(ii) $\omega > \tilde{\omega}$: We have $U^{SV} = v + b(X^{SV}) - c(x_0^{SV})$,so that, using the envelope theorem,

$$\frac{dU^{SV}}{d\omega} = \frac{\alpha}{\gamma} b'(X^{SV}) > 0, \tag{21}$$

and $\frac{d^2U^{SV}}{d\omega^2} = \frac{\alpha}{\gamma} b''(X^{SV}) \frac{dX^{SV}}{d\omega} < 0$, so that U^{SV} is increasing and concave over $\omega > \tilde{\omega}$. We now move to the comparative statics of $U^{\tau V}$.

(iii) $\omega < \omega_1^{\tau}$: We have $U^{\tau V} = v + b(X^{\tau V}) - c(x_0^{\tau V}) - \alpha \tau^V \frac{\omega}{\gamma}$so that, using the envelope theorem, $\frac{dU^{\tau V}}{d\omega} = \frac{\alpha}{\gamma} \left[b'(X^{\tau V}) - \tau^V \right] = \frac{\alpha^2 \omega}{\gamma} > 0$, where we have made use of the FOC (17) for τ^V and (18) to obtain the second line. We then have that $\frac{d^2U^{\tau V}}{d\omega^2} = \frac{\alpha^2}{\gamma} > 0$,so that $U^{\tau V}$ is increasing and convex over $\omega < \omega_1^{\tau}$.

(iv) $\omega > \omega_1^{\tau}$: We have $U^{\tau V} = v + b(\frac{\alpha\omega}{\gamma})$, so that

$$\frac{dU^{\tau V}}{d\omega} = \frac{\alpha}{\gamma} b'(\frac{\alpha\omega}{\gamma}) > 0, \tag{22}$$

and$\frac{d^2U^{\tau V}}{d\omega^2} = \frac{\alpha^2}{\gamma^2} b''(\frac{\alpha\omega}{\gamma}) < 0$,so that $U^{\tau V}$ is increasing and concave. Moreover, we have that $X^{SV} > X^{\tau V}$ (since $x_1^{\tau V} = x_1^S > 0$ and $x_0^{SV} > x_0^{\tau V} = 0$ for $\omega > \omega_1^{\tau}$), so that comparing (21) and (22), we have that $\frac{dU^{SV}}{d\omega} < \frac{dU^{\tau V}}{d\omega}$.

We now put all the pieces together. We have that $U^{SV} = U^{\tau V} = W^{FB}$ for $\omega = 0$. For $0 < \omega < \tilde{\omega}$, we have that $U^{SV} = W^{FB}$ is invariant with ω while $U^{\tau V}$ is strictly increasing with ω so that $U^{SV} < U^{\tau V}$. We have that $\lim_{\omega \to \infty} U^{\tau V} = lim_{\omega \to \infty} U^{SV}$. U^{SV} and $U^{\tau V}$ are both concave and increasing over $\omega \in [\omega_1^\tau, \infty]$, with a larger slope for $U^{\tau V}$. It then means that $U^{SV} > U^{\tau V}$ for $\omega = \omega_1^\tau$. Since both $U^{\tau V}$ and U^{SV} are continuously increasing over $\omega \in [\tilde{\omega}, \omega_1^\tau]$, there is a unique threshold value of ω , denoted by $\hat{w}$, belonging to this interval, so that voters are better off with a majority-chosen tax if $\omega < \hat{w}$, and better off with a majority-chosen standard if $\omega > \hat{w}$.

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Figure 1: Environmental Standard

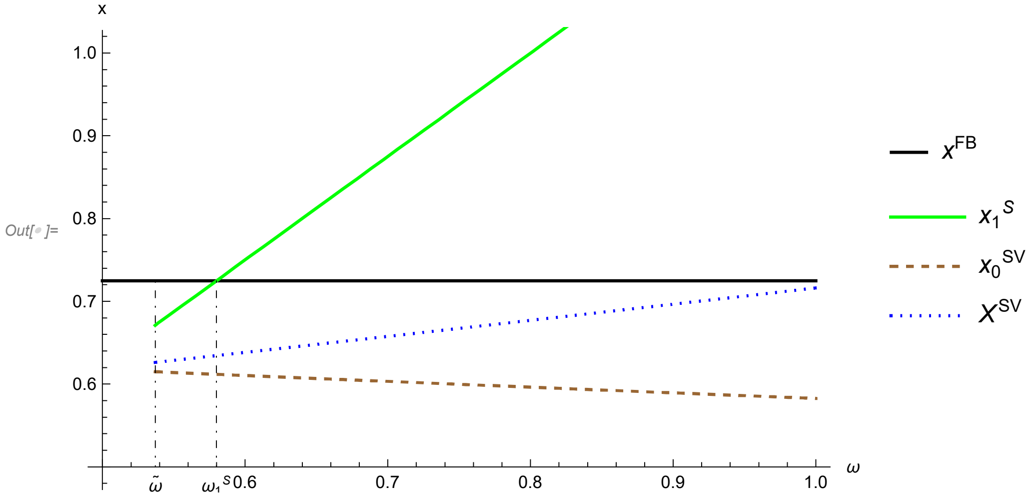


Figure 2(a): Welfare Levels at Majority Voting Equilibrium, α=0.2

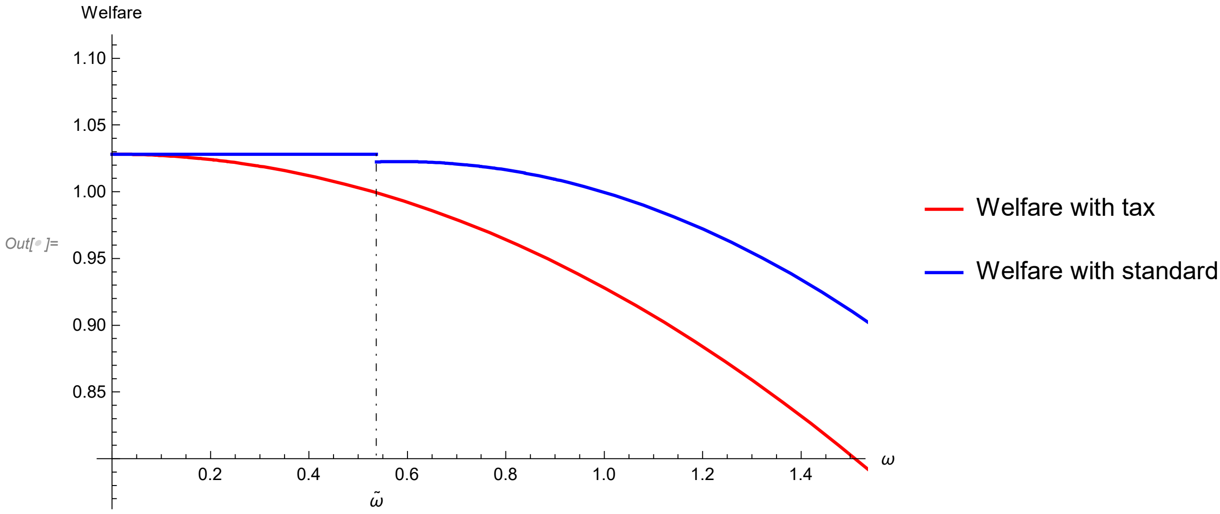


Figure 2(b): Welfare Levels at Majority Voting Equilibrium, α=0.6

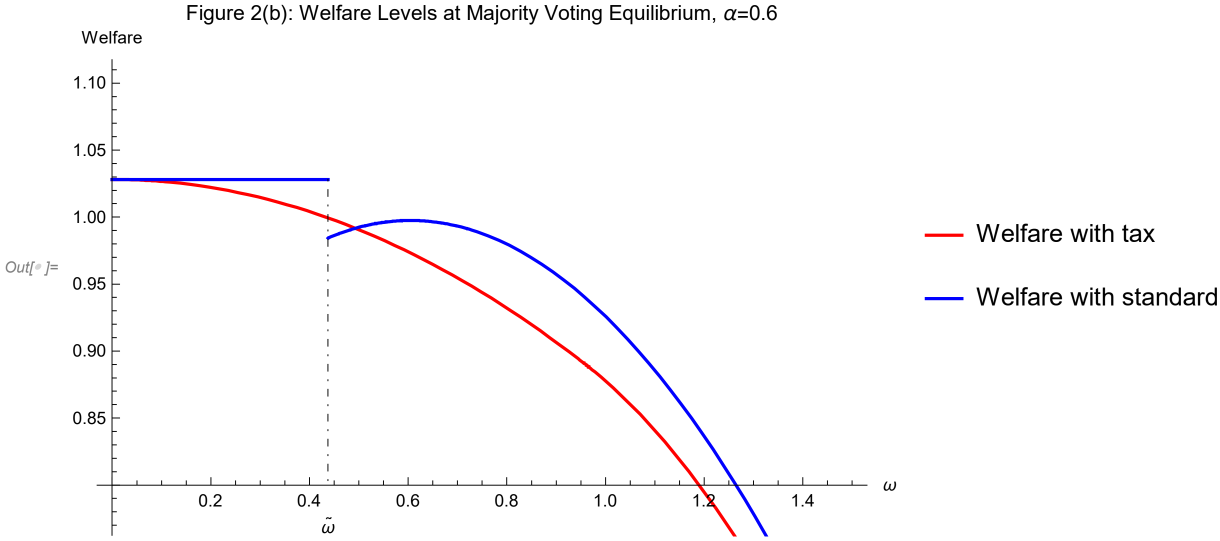
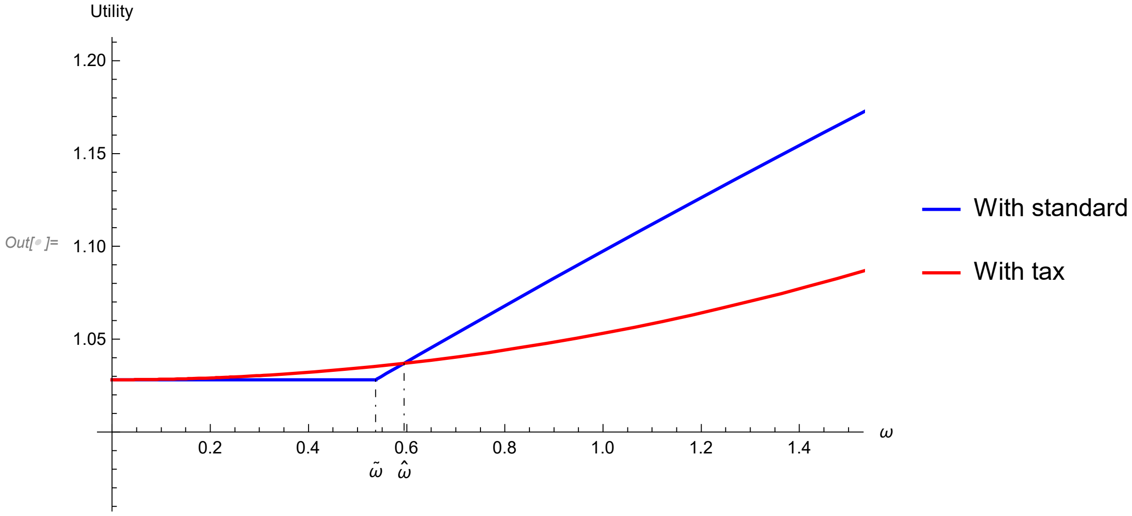


Figure 3: Utility Levels at Majority Voting Equilibrium



Online appendices to appear in supplemental file on the journal's website

A Perfect competition

To isolate the effect of market power exerted by Firm 1, let's assume that green consumers can find green good for all levels of environmental protection at competitive price (as in Calveras *et al.* 2007).

A.1 Standard

The good is priced at production cost for all level of environmental qualities: $p_1 = c(x_1)$ and $p_0 = c(x_0)$. The green consumer's utility when buying the green good $x_1 > x_0$ at price $p_1 = c(x_1)$ at is $v + \omega x_1 - c(x_0)$. Maximizing with respect to x_1 yields x_1^S defined as $c'(x_1^S) = \omega$, i.e. the same than with market power. The market equilibrium is with product differentiation if $x_1^S > x_0$ and $v - p_1 + \omega x_1^S > v - p_0$, which leads to $\omega x_1^S > c(x_1^S) - c(x_0)$. It means that the taste for greener quality ω should be such $\omega > c'^{-1}(x_0)$ and $c(x_0) > c(c'^{-1}(\omega)) - \omega c'^{-1}(\omega)$. Under Assumption 1, the first condition leads to $\gamma\omega > x_0$ while the second is always met. We can therefore define the threshold level $\tilde{\omega}_n^c(x_0) = \frac{x_0}{\gamma}$.

Note that the welfare under product differentiation is as before:

$$W(x_0) = v - \alpha c(x_1^S) - (1-\alpha)c(x_0) + b(\alpha x_1^S + (1-\alpha)x_0)$$

The green consumer's utility with product differentiation is:

$$U_g(x_0) = v - c(x_1^S) + \omega x_1^S + b(\alpha x_1^S + (1-\alpha)x_0).$$

Maximizing the above utility yields a corner solution: a green consumer is in favor of the highest standard that allow enjoying the warm-glow effect which holds as long as $x_1^S > x_0$. The preferred standard is $x_1^S - \epsilon$ with $\epsilon \to 0$, which yields approximately $U_g(x_1^S) = v - c(x_1^S) + \omega x_1^S + b(x_1^S)$.

The neutral consumer's utility:

$$U_n(x_0) = v - c(x_0) + b(\alpha x_1^S + (1-\alpha)x_0).$$

Since the utility is the same than with market power, the preferred standard is x_1^S defined in

(9). Under product differentiations, consumers disagree on the standard to implement, the green ones being in favor of a higher one. The elected standard depends on the relative share of each population α as in Calveras *et al.* (2007).

- *Neutral consumers majority*: $\alpha < 1/2$.
  The elected standard depends on green consumers' purchase. It is first-best x^{FB} for low ω such that green consumers do not buy greener goods, that is if $\omega \leq \tilde{\omega}_n^c(x^{FB})$. Otherwise, the elected standard is x_1^S and the market equilibrium is with differentiated product.

- *Green consumers majority*: $\alpha > 1/2$.
  Under product differentiation, the green consumers prefer the highest standard lower than their quality choice x_1^S which yields them $U_g(x_1^S) = v - c(x_1^S) + \omega x_1^S + b(x_1^S)$. The utility with product differentiation is higher if $U_g(x_1^S) > v - c(x^{FB}) + b(x^{FB})$. That is with ω higher than a threshold $\tilde{\omega}_g^c(x^{FB})$ such that $U_g(x_1^S) = v - c(x^{FB}) + b(x^{FB})$ which leads to:

$$b(x^{FB}) - c(x^{FB}) = b(x_1^S) - c(x_1^S) + \omega x_1^S.$$

  The elected standard is x^{FB} for $\omega < \tilde{\omega}_g^c(x^{FB})$ and $x_1^S - \epsilon$ if $\omega > \tilde{\omega}_g^c(x^{FB})$.

A.2 Tax

Equilibrium prices are $p_1 = c(x_1) + \tau(e - x_1)$ and $p_0 = c(x_0) + \tau(e - x_0)$. Green consumers' utility is $v + \omega x_1 - c(x_1) - \tau(e - x_1)$. It is maximized at x_1^τ defined as before in (**??**). Same for $x_0 = x_0^\tau$ defined in (11).

The consumer's utilities are:

$$U_g(\tau) = v + \omega x_1^\tau - c(x_1^\tau) + b(\alpha x_1^\tau + (1-\alpha)x_0^\tau) + \tau(1-\alpha)(x_1^\tau - x_0^\tau)$$

$$U_n(\tau) = v - c(x_0^\tau) + b(\alpha x_1^\tau + (1-\alpha)x_0^\tau) + \tau(1-\alpha)(x_1^\tau - x_0^\tau)$$

The FOCs characterize the preferred tax. Under Assumption 1, the preferred tax for the green consumers is such that:

$$b'(X^\tau) + (1-\alpha)\gamma(x_1^\tau - x_0^\tau) = c'(x_1^\tau),$$

where $(1-\alpha)(x_1^\tau - x_0^\tau)$ is the marginal benefit of having more revenue assigned to green consumers from increasing tax. Symmetrically, the tax preferred by neutral consumers is such that:

$$b'(X^\tau) = c'(x_0^\tau) + \alpha\gamma(x_1^\tau - x_0^\tau),$$

where $\alpha(x_1^\tau - x_0^\tau)$ is the direct marginal cost of a tax increase. Using $x_1^\tau - x_0^\tau = \omega$, we can rewrite the first-order conditions for the preferred tax respectively:

$$b'(X^\tau) = c'(x_1^\tau) - (1-\alpha)\omega,$$

and

$$b'(X^\tau) = c'(x_1^\tau) + \alpha\omega,$$

which shows that neutral consumers' preferred tax rate is lower than the one preferred by green consumers. Furthermore, by comparing with (17) shows that the neutral consumers' preferred tax rate is the same with and without market power.

B Unlaundered welfare

The first-best allocation with the alternative definition of welfare as the sum of the *unlaundered* consumer's utilities and firm's profits calls for $x_1 > x_0$, since maximizing

$$\begin{aligned} & (1-\alpha)(v - c(x_0) + b(X)) + \alpha(v - c(x_1) + \omega x_1 + b(X) \\ = \; & v + b(X) - (1-\alpha)c(x_0) - \alpha c(x_1) + \alpha\omega x_1 \end{aligned}$$

implies that

$$\begin{aligned} c'(x_0) &= b'(X), \\ c'(x_1) &= b'(X) + \omega. \end{aligned}$$

C Tax Recycling : Earmarked tax to firms

If the tax proceeds

$$R = \tau\left[\alpha(e - x_1) - (1-\alpha)(e - x_0)\right]$$

are redistributed to firms according to their market share, the brown good producers obtain a transfer equal to

$$(1-\alpha)[p_0 - c(x_0) - \tau(e - x_0) + R] = (1-\alpha)[p_0 - c(x_0) - \alpha\tau(x_1 - x_0)].$$

The zero-profit condition leads to a price $p_0^\tau = c(x_0) + \alpha\tau(x_1 - x_0)$. This price is obviously lower than when revenue is refunded to consumers because the net tax payment of each brown firm is $\alpha\tau(x_1 - x_0)$ which is lower than $\tau(e - x_0)$ because by definition $e > x_1$ and $\alpha < 1$. Firm 1 then has to cut the price of its green good to $p_1^\tau = p_0^\tau + \omega x_1 = \omega x_1 + c(x_0) + \alpha\tau(x_1 - x_0)$. Its profit is thus:

$$\pi_1 = \alpha(p_1^\tau - c(x_1) - \tau(e - x_1) + R) = \alpha(p_1 - c(x_1) + \tau(1-\alpha)(x_1 - x_0)).$$

With this refunded rule, Firm 1 receives a net transfer. Differentiating with respect to x_1, we obtain

$$\frac{d\pi_1}{dx_1} = \alpha[\frac{dp_1}{dx_1} - c'(x_1) + \tau(1-\alpha)],$$

with

$$\frac{dp_1}{dx_1} = \omega + \tau\alpha,$$

which yields the same first-order condition than with a lump sum rebate to consumers, $c'(x_1^\tau) = \omega + \tau$. Substituting prices into the utility functions shows that both types of consumers obtain the same welfare as in (16).

D Tax Recycling : Feebate

A feebate refunds the revenue collected from taxing brown producers with subsidy σ per units of abatement above a threshold x^F. Both σ and x^F have to be defined, and are linked to the tax rate τ by the budget balance condition:

$$\tau(1-\alpha)(x^F - x_0) = \sigma\alpha(x_1 - \hat{x}),$$

with $x^F \in [x_0, x_1]$. The brown producers' profit is the same than with the tax and, therefore, so are the prices $p_0^F = c(x_0) + \tau(x^F - x_0)$ and $p_1^F = \omega x_1 + p_0$. The green producer's profit becomes

$$\pi_1 = \alpha[p_1^F + \sigma(x_1 - x^F) - c(x_1)] = \alpha[\omega x_1 + c(x_0) + \tau(x^F - x_0) + \sigma(x_1 - x^F) - c(x_1)].$$

Environmental performance x_1 increases revenue through two channels: a higher price p_1^F and larger subsidies for performance above x^F. The first-order condition yields: $c'(x_1^\sigma) = \omega + \sigma$. The subsidy provides similar incentives than the tax. We then set $\sigma = \tau$ so that the above budget balance condition is satisfied for $x^F = \alpha x_1 + (1-\alpha)x_0 = X$.

The utility of both types of consumers is:

$$U_i^F(\sigma) = v - c(x_0^\tau) - \tau(x^F - x_0^\tau) + b(\alpha x^\tau + (1-\alpha)x_0^\tau).$$

With $x^F = \alpha x_1 - (1-\alpha)x_0$, we obtain:

$$U_i^F(\sigma) = v - c(x_0^\tau) - \tau\alpha(x_1^\tau - x_0^\tau) + b(\alpha x^\tau + (1-\alpha)x_0^\tau).$$

which is the same utility when the tax is refunded to consumers in (16).