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Abstract

We examine the design of policies for promoting the consumption of green products under preference and income heterogeneity using organic food products as an example. Two instruments are considered: a price subsidy for the organic food products and a tax on the conventional products. Under income disparity, consumers with high income always prefer a socially optimal subsidy to a socially optimal tax, while low-income consumers prefer a tax on conventional products. When environmental policy is determined by the median voter, the policies implemented tend to be stricter than socially optimal policies if income differences are large.

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1 Introduction

When choosing between two otherwise identical products some consumers are willing to pay a higher price for a product with a reduced environmental impact. The price premium paid is typically interpreted as an indication of demand for environmental quality, a public good.[1] Yet, 'green' products often have different consumptive characteristics than their 'brown' counterparts. A prominent example of such products are organic food products. Their production has a reduced environmental impact but the products themselves may have distinct quality than conventional foods. Indeed, studies based on both surveys and actual purchasing data suggest that some consumer groups choose organic products primarily out of a concern for animal welfare and environment while others find organic products appealing because of health, food quality and taste considerations.[2] Different attitudes towards the private good and the public good aspects of green products may also appear in voting decisions. For instance, Hamilton et al. (2003) show that consumers may support regulation limiting pesticide use in

[1] See, e.g., Wasik (1996), Blend and van Ravenswaay (1999), Teisl et al. (1999), Bjorner et al. (2004). The different reasons behind environmentally conscious purchasing behavior and its implications for policy-making have been studied by Oberholzer-Gee (1997), Brekke et al. (2003), and Bruvoll and Nyborg (2004), among others.

[2] See e.g. Millock et al. (2004) and Wier and Calverley (2002), Thompson and Kidwell (1998) and the references therein. However, not all consumers think that organic products are 'better' than conventional products. The perception that organic products might be safer and more 'natural' than conventional counterparts appeals to certain consumer groups, whereas other groups are interested in the health benefits offered by highly processed foods that are rich in 'artificial' minerals and vitamins. (See Ippolito 2003).

agriculture (a public good) even if they are not willing to pay for pesticide-free food (a private good) and vice versa.

When the consumptive characteristics of the products are different, as described above, environmental policy may treat people differently not only because consumers value a better environment differently but also because some consumers consume more of the related private product than others. For instance, if demand for a green products is greater among high-income consumers, encouraging consumption of this product may channel benefits to groups that are already well off in the society. It is important to study voting behavior with regard to environmental policy when consumption of green products and distribution of income are intertwined.

There are only a few papers that examine the implications of income distribution on environmental policies preferred by the majority of consumers.[3] Eriksson and Persson (2003) show that if private products and environmental quality are both normal goods, more equal income distribution generates less pollution. Marsiliani and Renström (2002) reach a similar conclusion in a quite different setting: a marginal increase in inequality starting from a completely egalitarian income distribution lowered the pollution tax accepted by the majority. McAusland (2003) in turn considers an economy that produces dirty and clean products and where agents have heterogenous endowments of capacities to produce the products. An increase in a voter's share of the capacity to produce either clean or dirty products may make him prefer a weaker environmental policy. There are two effects working in opposite directions: the traditional

[3] In contrast, there is an extensive literature on the distribution of benefits and costs of environmental regulation. A typical issue analyzed is whether environmental taxes are regressive. For instance, West (2004) and West and Williams (2004) have studied the cost distribution of alternative policies for reducing vehicle pollution, and Brooks and Sethi (1997) have examined the benefit distribution of reducing air toxics. See also Metcalf (1999) and the references therein.

income effect, which increases the demand for all normal goods (including the environment) and a terms of trade effect that makes dirty products more expensive. While recognizing income inequality, none of these studies analyzes how distinct preferences for a public good and the consumptive characteristics of green products affect policy choices.[4]

The aim of this paper is to study policies designed to encourage demand for green products under joint production of a private and public good using organic food products as an example. Our main interest is in how income and preference heterogeneities influence policy-making. Our model is simple, yet powerful enough to allow us to analyze the demand for organic products when consumers value the environmental benefit (public good) associated with organic products equally but value the consumptive characteristics of the organic and conventional products differently. Consumers differ in disposable income and will be classified on this basis as either rich or poor. In our model, either group may have stronger preferences for the consumptive characteristics of organic products. We also extend previous analyses by considering two alternative policy instruments: a price subsidy for organic products and a tax on conventional products. As consumers have different income levels and preferences, the tax and subsidy schemes will treat the consumer segments differently. The comparison of the different instruments is of utmost importance for policy design as support for organic products frequently appears on political agendas (COM (2004) 415 final).

We first derive and discuss the socially optimal subsidy and tax levels. We then use the median-voter approach to illustrate the role of distributional issues and preference heterogeneity in environmental regulation when policy choices are contingent on

[4] In Eriksson and Persson (2003), voters differ in how much they value environmental quality, but it is assumed that the orderings of individuals are identical in the two dimensions of income and perceived environmental quality; the rich always experience higher environmental quality than the poor.

acceptance by the majority of voters. Our results indicate that if there are no income differences among consumers and the intervention is carried out by a welfare maximizing government, a commodity tax and a subsidy are equally good choices for the consumers. However, if there are income differences, rich consumers prefer a socially optimal subsidy for the organic products to a tax on conventional products while poor consumers prefer a tax on conventional products. It is noteworthy that this result is independent of preferences with respect to organic products. In addition, the results show that the tax and subsidy rates which the median voter would impose tend to be higher than the socially optimal ones if income disparity is substantial.

In the following section, we present the modelling framework. In section 3, we study alternative economic instruments that are socially optimal. In section 4, we contrast socially optimal policies with politically determined policies. Section 5 concludes.

2 The set-up

We consider consumers that differ in two characteristics: level of income and preference for organic products. Total population is normalized to one and consists of two different groups. The proportion of rich consumers in the population is α and the proportion of poor consumers is $1-\alpha$. As we wish the income distribution to have the realistic feature that mean income in the economy is higher than median income, we assume that $\alpha < 1-\alpha$. We denote the gross income of a consumer in group i by w_i for $i = \alpha, 1-\alpha$, with $w_\alpha \geq w_{1-\alpha}$.[5] In addition, let $\overline{w} = \alpha w_\alpha + (1-\alpha) w_{1-\alpha}$ denote average gross income.

Consumers derive utility from the consumption of a conventional product, c, and

[5] As a benchmark, we will consider the situation where there are no income differences. Even in that case, we will call those in group α rich consumers and those in group $1-\alpha$ poor consumers.

an organic product, h. The marginal utility derived from the consumption of one additional unit of the organic product is not the same for the two consumer groups. The preferences of the two groups are represented by the quasilinear utility functions

$$u_{\alpha} = c_{\alpha} + \frac{\ln h_{\alpha}}{\beta} + B\left(\overline{h}\right) \tag{1}$$

and

$$u_{1-\alpha} = c_{1-\alpha} + \beta \ln h_{1-\alpha} + B\left(\overline{h}\right), \tag{2}$$

where the degree of difference in preferences is captured by the parameter β. When $\beta \neq 1$, the consumers do not value the private benefit generated by consumption of the organic product in the same manner. When $0 < \beta < 1$, the rich consumers value the consumption of the organic product more than the poor do. When $\beta > 1$, the preferences become reversed and the marginal utility of the consumption of the organic product is higher for the poor. This formulation implies that if the valuation of one group increases, the valuation of the other group necessarily decreases; however, this is a convenient assumption as it allows us to focus on the degree of preference heterogeneity which disappears when β approaches unity.

The last term in (1) and (2) denotes the positive externality, or public good, generated by consumption of the organic product. The amount of public good is determined by the aggregate consumption of the organic product, $\overline{h} = \alpha h_{\alpha} + (1-\alpha) h_{1-\alpha}$. In what follows, we assume that the marginal utility of public good provision is a constant, i.e. $B\left(\overline{h}\right) = b\overline{h}$.

The budget constraint of a consumer in group i is

$$\widehat{w}_i = p_c c + p_h h \text{ for } i = \alpha, 1-\alpha,$$

where $\widehat{w}_i$ denotes the disposable income of a consumer in group i. The price of the conventional and organic products are denoted by p_c and p_h, respectively, net of possible

subsidies and taxes.

We assume that each consumer takes the aggregate consumption of organic product as given when choosing how much of each product to consume. Hence, the demand for the organic product in each group is

$$h_\alpha = \frac{p_c}{p_h \beta} \text{ and } h_{1-\alpha} = \frac{p_c \beta}{p_h}. \tag{3}$$

Demand for the conventional product is determined as a residual and is

$$c_i = \frac{\widehat{w}_i - p_h h_i}{p_c} \text{ for } i = \alpha, 1-\alpha.$$

3 Socially optimal environmental policy

We consider two alternative policy instruments for promoting demand for the organic product. We first study the effects of a price subsidy for the organic product and then of a tax on the conventional product. The subsidy for the organic product is assumed to be financed by an income tax, and the tax revenue collected from taxing the conventional product is distributed back to the consumers as lump-sum transfers. As the two consumer groups have different income levels and different preferences, these two schemes will treat the consumers in the two groups differently.

In what follows we normalize the price of the conventional product to one and let $p_h = p$ in the absence of taxes and subsidies. In the social optimum reflecting both the private and public good components, the marginal social benefit of one additional unit of the organic product must equal the marginal cost of the organic product, p. Therefore, in order to obtain a meaningful solution to the welfare maximization problem of the government, it must be that $p > b$. Throughout the analysis, we assume that this is the case.

3.1 Subsidy for the organic product

Under the subsidy scheme, the prices are $p_h = p - s$ and $p_c = 1$. The subsidy is financed by an income tax and hence $\widehat{w}_i = (1-\tau) w_i$, where τ is the income tax rate. The government budget constraint is then

$$\tau \overline{w} = s\overline{h}^s(s) \;\Leftrightarrow\; \tau = \frac{s\overline{h}^s(s)}{\overline{w}},$$

where $\overline{h}^s(s)$ denotes the aggregate demand under the subsidy scheme.

From (3) we have that the demand for the organic product for the two consumer types are

$$h^s_\alpha(s) = \frac{1}{(p-s)\beta} \text{ and } h^s_{1-\alpha}(s) = \frac{\beta}{(p-s)} \tag{4}$$

and the demand for the conventional product for type i is

$$c^s_i(s) = \left(1 - \frac{s\overline{h}^s(s)}{\overline{w}}\right) w_i - (p-s)\, h^s_i(s). \tag{5}$$

The aggregate demand for the organic product is $\overline{h}^s(s) = \frac{\frac{\alpha}{\beta}+(1-\alpha)\beta}{(p-s)}$.

The indirect utility for the different consumer types is given by

$$v^s_\alpha(s) = \frac{1}{\beta}\ln h^s_\alpha(s) + c^s_\alpha(s) + b\overline{h}^s(s) \tag{6}$$

and

$$v^s_{1-\alpha}(s) = \beta \ln h^s_{1-\alpha}(s) + c^s_{1-\alpha}(s) + b\overline{h}^s(s). \tag{7}$$

Taking into account that the rich consumers constitute fraction α of population and the poor consumers fraction $1-\alpha$, the aggregate welfare may be written as

$$W^s = \alpha v^s_\alpha(s) + (1-\alpha)\, v^s_{1-\alpha}(s).$$

Using equations (4) and (5), the aggregate welfare can be reformulated as

$$W^s = \frac{\alpha}{\beta}\left(\ln\frac{1}{(p-s)\beta} - 1\right) + (1-\alpha)\beta\left(\ln\frac{\beta}{(p-s)} - 1\right) + \overline{w} - s\overline{h}^s(s) + b\overline{h}^s(s).$$

The problem of the government is to choose s to maximize the aggregate welfare. The first-order condition for welfare maximization is

$$\frac{\partial W^s}{\partial s} = (b-s)\frac{\partial \overline{h}^s(s)}{\partial s} = 0.$$

Therefore, the socially optimal subsidy for the organic product is simply $s^o = b$, where superscript o refers to a social optimum.[6]

Solving for the demand for the organic product for the two groups gives

$$h^s_\alpha(s^o) = \frac{1}{(p-b)\beta} \text{ and } h^s_{1-\alpha}(s^o) = \frac{\beta}{(p-b)}, \tag{8}$$

with the socially optimal aggregate demand then

$$\overline{h}^s(s^o) = \frac{\frac{\alpha}{\beta} + (1-\alpha)\beta}{(p-b)}.$$

3.2 Tax on the conventional product

In the case of a tax on the conventional product, $p_h = p$ and $p_c = 1+t$. We assume that the tax revenue is distributed back to consumers as a lump-sum transfer, T. Hence, the disposable income of a consumer in group i is $\widehat{w}_i = w_i + T$ and the government budget constraint is

$$T = t\overline{c}^t(t),$$

where superscript t refers to the tax scheme and $\overline{c}^t(t) = \alpha c^t_\alpha(t) + (1-\alpha)c^t_{1-\alpha}(t)$.

We proceed here as in the previous subsection: we first solve for the demand for organic and conventional product as a function of the tax rate and then analyze the welfare maximization problem of the government.

[6] It is straightforward to show that the second-order condition for welfare maximization is satisfied and $s^o = b$ therefore constitutes a global maximum.

The demands for the organic product again follow directly from (3) and are

$$h_{\alpha}^{t}(t)=\frac{1+t}{p\beta} \text{ and } h_{1-\alpha}^{t}(t)=\frac{\beta(1+t)}{p}. \tag{9}$$

Using the demands for the organic product and the budget constraints, we can express the aggregate demand for the conventional product as

$$\overline{c}^{t}(t)=\overline{w}-p\overline{h}^{t}(t), \tag{10}$$

where $\overline{h}^{t}(t)=\frac{1+t}{p}\left(\frac{\alpha}{\beta}+(1-\alpha)\beta\right)$. Therefore, consumption of the conventional product in group i is

$$c_{i}^{t}(t)=\frac{w_{i}+t\left(\overline{w}-p\overline{h}^{t}(t)\right)-ph_{i}^{t}}{1+t}. \tag{11}$$

Under the tax scheme, the indirect utility for the respective consumer types is:

$$v_{\alpha}^{t}(t)=\frac{1}{\beta}\ln h_{\alpha}^{t}(t)+c_{\alpha}^{t}(t)+b\overline{h}^{t}(t) \tag{12}$$

and

$$v_{1-\alpha}^{t}(t)=\beta\ln h_{1-\alpha}^{t}(t)+c_{1-\alpha}^{t}(t)+b\overline{h}^{t}(t). \tag{13}$$

Combining these indirect utilities and using equations (9) and (11), we again obtain the aggregate welfare,

$$\begin{aligned} W^{t} &= \alpha v_{\alpha}^{t}(t)+(1-\alpha)v_{1-\alpha}^{t}(t) \\ &= \frac{\alpha}{\beta}\left(\ln\frac{1+t}{p\beta}-1\right)+(1-\alpha)\beta\left(\ln\frac{\beta(1+t)}{p}-1\right)+\overline{w}-\frac{pt}{1+t}\overline{h}^{t}(t)+b\overline{h}^{t}(t). \end{aligned}$$

The problem of the government is to choose t to maximize aggregate welfare. The first-order condition for welfare maximization is[7]

$$\frac{\partial W^{t}}{\partial t}=\left(\frac{b}{p}-\frac{t}{1+t}\right)\left(\frac{\alpha}{\beta}+(1-\alpha)\beta\right)=0,$$

[7] Again $\frac{\partial^{2}W^{t}}{\partial t\partial t}<0$ for all t.

whereby the socially optimal tax rate is

$$t^o = \frac{b}{p-b}$$

where again superscript o refers to social optimum.

3.3 Comparison of the two regimes

We are now ready to compare the two regimes. It should be noted here that neither the socially optimal tax nor subsidy depends on the preference heterogeneity in the economy: the public good is valued in the same manner by all consumers and the preference heterogeneity is related only to the private benefit derived from the consumption of the organic product. As the optimal policies are designed to internalize the positive externality associated with organic production, the heterogeneity does not affect them.

We also have that

Proposition 1 *Both instruments can be used to achieve first-best level of consumption of the organic product.*

Proof. Implementation of t^o or s^o leads to

$$\overline{h}^s\left(s^o\right) = \overline{h}^t\left(t^o\right) = \frac{\frac{\alpha}{\beta} + (1-\alpha)\,\beta}{(p-b)}.$$

If the government were to impose a level of consumption on both consumer groups that maximizes aggregate welfare, it would choose h_α and $h_{1-\alpha}$ that maximize

$$\alpha\left[w_\alpha - ph_\alpha + \frac{\ln h_\alpha}{\beta} + b\overline{h}\right] + (1-\alpha)\left[w_{1-\alpha} - ph_{1-\alpha} + \beta \ln h_{1-\alpha} + b\overline{h}\right].$$

Solving for the optimal demands leads directly to the same result. ■

This is a usual Pigouvian result establishing that both a tax and a subsidy can yield an environmentally optimal outcome. The policy instruments are not equivalent,

however, as they have dissimilar impacts on the distribution of income. Using the indirect utility functions and optimal policies we obtain

Proposition 2 *With no income differences, the consumers are indifferent between the instruments. With income differences, the rich prefer a subsidy for the organic product and the poor prefer a tax on the conventional product.*

Proof. By inserting the socially optimal subsidy and tax rate into the indirect utility functions (6), (7), (12) and (13), we establish that

$$v_{\alpha}^{t}(t^{o}) - v_{\alpha}^{s}(s^{o}) = \frac{b}{p}(\frac{w_{\alpha}}{\bar{w}} - 1)\left(p\overline{h}^{o} - \overline{w}\right)$$

and

$$v_{1-\alpha}^{t}(t^{o}) - v_{1-\alpha}^{s}(s^{o}) = \frac{b}{p}(\frac{w_{1-\alpha}}{\bar{w}} - 1)\left(p\overline{h}^{o} - \overline{w}\right).$$

Clearly, when $\frac{w_{\alpha}}{\bar{w}} = \frac{w_{1-\alpha}}{\bar{w}} = 1$,

$$v_{\alpha}^{t}(t^{o}) - v_{\alpha}^{s}(s^{o}) = v_{1-\alpha}^{t}(t^{o}) - v_{1-\alpha}^{s}(s^{o}) = 0.$$

Note that we must have $\overline{w} - p\overline{h}^{o} > 0$. Hence, $v_{\alpha}^{t}(t^{o}) - v_{\alpha}^{s}(s^{o}) < 0$ and $v_{1-\alpha}^{t}(t^{o}) - v_{1-\alpha}^{s}(s^{o}) > 0$ when $\frac{w_{\alpha}}{\bar{w}} > 1$ and $\frac{w_{1-\alpha}}{\bar{w}} < 1$. ■

When there is no income heterogeneity, the choice of policy instrument is not of a concern for the consumer. The reason for this is that both the subsidy and the tax correct the consumption of organic food to the socially optimal level.

Since the demand for the organic product is the same with a socially optimal subsidy and a socially optimal tax, any preference for one instrument over the other must result from differences in the consumption levels of the conventional product. Let us consider first the rich. Their consumption levels of the conventional product under a socially optimal tax and subsidy are

$$c_{\alpha}^{t}(t^{o}) = \frac{w_{\alpha}(p-b)}{p} - \frac{1}{\beta} + \frac{b}{p}\left(\overline{w} - p\overline{h}^{o}\right)$$

and

$$c_{\alpha}^{s}(s^{o}) = w_{\alpha} - \frac{1}{\beta} - \frac{b\overline{h}^{o} w_{\alpha}}{\bar{w}},$$

respectively.

A straightforward comparison of these equations shows that $c_{\alpha}^{s}(s^{o}) > c_{\alpha}^{t}(t^{o})$. That is, under the subsidy scheme, the consumption of the conventional product is always higher than under the tax scheme. In contrast, for the poor we have

$$\begin{aligned} c_{1-\alpha}^{t}(t^{o}) &= \frac{w_{1-\alpha}(p-b)}{p} - \beta + \frac{b}{p}\left(\overline{w} - p\overline{h}^{o}\right) \\ c_{1-\alpha}^{s}(s^{o}) &= w_{1-\alpha} - \beta - \frac{b\overline{h}^{o} w_{1-\alpha}}{\bar{w}}. \end{aligned}$$

These two equations may be used to show that $c_{1-\alpha}^{t}(t^{o}) > c_{1-\alpha}^{s}(s^{o})$. That is, the consumption of the conventional product by the poor is higher under the tax scheme.

It is important to notice that preference heterogeneity, determined by β, only matters for the absolute level of consumption in these two groups; it does not affect the optimal policy. The key is the transfer mechanism: when the tax is set at the socially optimal level and the revenue from taxing the conventional product is returned to the consumer in a lump-sum manner, the poor always gain more than if a socially optimal subsidy is paid on the organic product.

All the results derived above apply to socially optimal policies. However, if the consumers prefer one instrument to the other when the subsidy or tax is chosen optimally, it is certainly plausible that they prefer some other tax rate or subsidy to the socially optimal ones. Accordingly, in the following section we consider what kind of outcome a democratic voting process would generate.

4 Politically determined environmental policy

The mechanism of collective decision-making we consider here is direct voting. Since we only have two different consumer groups, the voting problem is very easy to characterize: the politically determined subsidy and tax rate will coincide with the preferred policy of the larger group. As we assume that the poor are more numerous than the rich, it follows that the poor are decisive in the political process. We therefore have a unique solution to the voting problem if the policy preferences of the poor have the properties $\frac{\partial^2 v^t_{1-\alpha}(t)}{\partial t \partial t} < 0$ and $\frac{\partial^2 v^s_{1-\alpha}(s)}{\partial s \partial s} < 0$. It is straightforward to show that $\frac{\partial^2 v^t_{1-\alpha}(t)}{\partial t \partial t} < 0$. However, in order to guarantee that $\frac{\partial^2 v^s_{1-\alpha}(s)}{\partial s \partial s} < 0$, we must assume that $\frac{b}{p} < \frac{w_{1-\alpha}}{\overline{w}}$. Note that since $\frac{b}{p} < 1$, this inequality is satisfied provided that the income difference is not too large relative to the social value of the organic product.

4.1 Subsidy for the organic product

In order to determine the equilibrium subsidy, we must first describe the policy preferences of the two consumer groups. The policy preferences are given by the indirect utilities of the two consumer groups determined in equations (6) and (7). Solving for the majority preferred subsidy level gives:

Proposition 3 *If the rich value the organic product substantially more than the poor relative to the difference in their incomes, the subsidy will be lower than is socially optimal. Otherwise, the subsidy will be higher than is socially optimal.*

Proof. Let us denote by s^* the subsidy preferred by the majority. Then s^* is implicitly determined by

$$\frac{\partial v^s_{1-\alpha}(s)}{\partial s} = h^s_{1-\alpha}(s) - \frac{w_{1-\alpha}}{\overline{w}}\left(\overline{h}^s(s) + s\frac{\partial \overline{h}^s(s)}{\partial s}\right) + b\frac{\partial \overline{h}^s(s)}{\partial s} = 0,$$

where $\overline{h}^s(s) = \frac{\frac{\alpha}{\beta}+(1-\alpha)\beta}{(p-s)}$. Taking into account (4), we obtain

$$s^* = p(1-\gamma\theta) + b\theta,$$

where $\gamma = \frac{w_{1-\alpha}}{\overline{w}}$ and $\theta = \frac{\frac{\alpha}{\beta}+(1-\alpha)\beta}{\beta}$. If $\beta < 1$ ($\beta > 1$), then $\theta > 1$ ($\theta < 1$). Clearly, when either $\gamma < 1$ or $\theta \neq 1$, we have $s^* \neq s^o$. Note that

$$s^* > s^o \Leftrightarrow p(1-\gamma\theta) + b\theta > b.$$

Since $p > b$, this holds true when $\beta > 1$.

When $\beta < 1$, an increase in preference heterogeneity increases θ. Rearranging the terms yields

$$s^* < s^o \Leftrightarrow \frac{1-\gamma\theta}{1-\theta} > \frac{b}{p}.$$

Hence, if β is low enough, $s^* < s^o$. ■

Let us first discuss in more detail the situation where there are no differences in preferences but income inequality prevails ($\gamma < 1$). In such a case, it directly follows that

$$s^*_{\beta=1} > s^o.$$

With no preference heterogeneity, the groups consume the same amount of the organic product. A subsidy for the organic product therefore benefits both groups equally. However, most of the tax burden falls on the rich, and the subsidy level differs from the social optimum solely due to the redistributional objective of the poor. The more unequal the distribution of income is, the higher will be the politically determined subsidy.

If, in turn, there is no income heterogeneity ($\gamma = 1$) but different consumers value the organic product differently ($\beta \neq 1$), the politically determined subsidy will be lower than the socially optimal subsidy if the rich value the organic product more than the

poor. The rationale for this claim is the following. Since all consumers have the same income level, the tax burden involved in financing the subsidy for the organic product is equally distributed. The main beneficiaries of the intervention would be consumers in group α ('the rich') because they consume the organic product more than those in group $(1-\alpha)$ ('the poor'). As a result, the majority, consisting of the poor, will vote for a lower subsidy. For the very same reason, the politically determined subsidy will also be higher than the social optimum if the poor value the organic product more than the rich do.

When both types of heterogeneities are present, the outcome depends on the relative importance of the two. In particular, only if the rich value the organic product sufficiently more than the poor relative to the differences in income between the groups will the majority prefer a suboptimally low subsidy.

4.2 Tax on the conventional product

The policy preferences are given by the indirect utilities of the two consumer groups determined in equations (12) and (13). Solving again for the tax level preferred by the majority yields:

Proposition 4 *The politically determined tax rate will be lower than is socially optimal if the rich value the organic product substantially more than the poor relative to the difference in their incomes. Otherwise, the tax rate will be higher than is socially optimal.*

Proof. The tax level preferred by the majority is determined by

$$\frac{\partial v_{1-\alpha}^{t}(t)}{\partial t} = \frac{\overline{w} - w_{1-\alpha}}{(1+t)^2} + \frac{\beta}{(1+t)} - (\frac{\alpha}{\beta} + (1-\alpha)\,\beta)(1-\frac{b}{p}) = 0.$$

Solving for the tax rate yields

$$t^* = \frac{-\beta \pm \sqrt{\beta^2 + 4(\frac{\alpha}{\beta} + (1-\alpha)\,\beta)(1-\frac{b}{p})(\overline{w} - w_{1-\alpha})}}{-2(\frac{\alpha}{\beta} + (1-\alpha)\,\beta)(1-\frac{b}{p})} - 1.$$

Let $\varphi = 4(\frac{\alpha}{\beta} + (1-\alpha)\,\beta)(1-\frac{b}{p})(\overline{w} - w_{1-\alpha}) \geq 0$. Since $\sqrt{\beta^2+\varphi} \geq \beta$, we must rule out one of the solutions as we wish to concentrate on positive tax rates. Hence,

$$t^* = \frac{\beta + \sqrt{\beta^2+\varphi}}{2(\frac{\alpha}{\beta} + (1-\alpha)\,\beta)(1-\frac{b}{p})} - 1 \tag{14}$$

Since $\frac{\partial \varphi}{\partial(\overline{w}-w_{1-\alpha})} > 0$, increasing income differences tend to increase the politically determined tax on the conventional product. Recall that $t^o = \frac{b}{p-b}$. If $\beta = 1$ but $\gamma < 1$, (14) becomes

$$t^*_{\beta=1} = \frac{1 + \sqrt{1+\varphi}}{2(1-\frac{b}{p})} - 1$$

and we have

$$\begin{aligned} t^*_{\beta=1} &> t^o \Leftrightarrow \\ \frac{1+\sqrt{1+\varphi}}{2(1-\frac{b}{p})} &> \frac{p}{p-b} \Leftrightarrow \\ \sqrt{1+\varphi} &> 1. \end{aligned}$$

When there are no income differences, $\varphi = 0$. The tax rate is then

$$t^*_{\gamma=1} = \frac{p - \theta\,(p-b)}{\theta\,(p-b)}$$

and we have that

$$t^*_{\gamma=1} > t^o \Leftrightarrow p - \theta\,(p-b) > \theta b.$$

Therefore, $t^*_{\gamma=1} > t^o$ if $\beta > 1$ $(\theta < 1)$ and vice versa. ■

Consider again the situation where there is no preference heterogeneity but the distribution of income is not equal. It follows directly that the tax rate on the conventional product is too high relative to the socially optimal tax rate. Again, this happens

because of the distributional objective of the poor: the rich consume more the conventional product than the poor because of their larger budget; the tax burden falls mostly on the rich but the tax revenue is equally distributed to all consumers.

When there are no income differences, the politically determined tax rate will be lower (higher) than the socially optimal tax rate if $\beta < 1$ ($\beta > 1$). The reason is the same as under the subsidy scheme: when the majority of consumers consume the conventional product more (less) than the minority, they prefer a lower (higher) tax rate on the consumption of the conventional product.

Again the relative importance of the two types of heterogeneities determines how much the politically determined tax differs from the socially optimal one. Large income differences tend to increase the equilibrium tax. The effect of large differences in preferences depends on whether it is the poor or the rich who value the organic product more.

5 Discussion

We have investigated the political desirability of using economic instruments in environmental policy in a setting where heterogeneity of both income and preferences for the consumptive characteristics of green products are taken into account. As an example of a green product we used organic products, whose promotion may have important distributional implications given that consumers with low income spend relatively more of their income on agricultural products than those with high income.

Although both subsidies and taxes can be used to reach a socially optimal outcome in consumption, in the presence of income inequality consumers are not indifferent with regard to the two instruments. Those with high income prefer a subsidy for organic products to a tax on conventional products while those with a low income prefer a

tax on conventional products to a subsidy for organic products. This result does not depend on preferences for organic products.

To gain more understanding of the distributional impacts of the environmental policies, we examined how the preference heterogeneity affects policies preferred by the majority. Large income disparities tend to increase both the equilibrium subsidy level and the equilibrium tax rate. The effect of the preference heterogeneity on the level of policy instruments naturally depends on which group values the organic product more.

If the high-income consumers are main consumers of organic products and income differences are large, the majority preferred tax and subsidy may be lower than is socially optimal. Otherwise, that is, if the consumers with low income value the organic product more or if the differences in preferences are relatively small compared to income differences, both the majority preferred tax and the subsidy are unambiguously higher than is socially optimal. This result runs counter to the common finding in earlier studies that low-income consumers prefer laxer environmental policies than high-income consumers. The explanation here is that environmental policy is used as a method for redistributing income from those with high income to those with low income.

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