

OPTIMALITY AND DISTORTIONARY LOBBYING:
CONTROL POLICIES OF CIGARETTE CONSUMPTION

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Abstract

We examine the optimal design of public policies directed at controlling the consumption of tobacco. The public authority uses two types of instruments: an excise tax, that hinders consumption by increasing the price of cigarettes, and (ii) prevention and control programs, that reduce smoking by increasing consumers' awareness about future health harm. On the normative side, the analysis focuses on the optimal mix between the two types of instruments when the objective of the policy maker is to maximize social welfare. On the positive side, the paper investigates how the lobbying activities of the tobacco industry and of anti-tobacco organizations may distort government intervention.

Keywords: Harmful consumption, Pigouvian taxation, Lobbying, Common agency games, Excise taxation in oligopoly

JEL Codes: D72, H21, H23, I18

1 Introduction

We examine the optimal design of public policies directed at controlling the consumption of a harmful good, like tobacco or alcoholic drinks, and we investigate how the lobbying activities of interested parties may distort government intervention.

In our framework, a public authority can use two types of policy instruments to affect the consumption of the harmful good: (i) an excise tax that discourages consumption by increasing the price of the good, and (ii) prevention and control programs that

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lower consumption by making individuals more aware about future health harm. First, we study the optimal mix between the two types of instruments, in the benchmark case in which the objective of the policy maker is to maximize social welfare.

We then investigate the implications of the possibility of lobbying directed at influencing public policy, by allowing for two pressure groups characterized by opposed interests. On the one hand, the producers of the harmful good lobby to obtain weaker control policies. On the other hand, consumers (organized, e.g., in associations of citizens) lobby to advocate stricter regulation of harmful consumption. We thus examine under which conditions one group may prevail over the other one in influencing policy, and we then evaluate the welfare losses (if any) induced by lobbying activity.

We focus our attention on the case of tobacco consumption, by adopting a framework closely related to that developed by O’Donoghue and Rabin (2006) to examine the optimal excise taxation of a harmful good. However, we extend their model along several dimensions. First, we introduce an additional instrument that the regulator may employ to control consumption, namely all forms of prevention and control programs that may help consumers to act more ‘rationally’ by making them more aware about the future harm from current consumption. Second, we assume that cigarettes are traded in an oligopolistic market, instead of a perfectly competitive market, therefore adding inefficiencies due to the presence of market power. Finally, we extend the normative analysis in O’Donoghue and Rabin (2006) by explicitly adding political-economy considerations in the form of lobbying by special interest groups.

The rest of the paper is organized as follows. The model is presented in Section 2, where we derive the market equilibrium and the individual and aggregate welfare. The socially optimal levels of taxation and of prevention and control policies are derived in Section 3, while lobbying is introduced in Section 4. Section 5 concludes the paper and discusses avenues for future research.

2 The model

2.1 Consumers’ behavior and market equilibrium

We build on the model by O’Donoghue and Rabin (2006). Consider an individual that consumes a harmful good, for instance tobacco, and another ‘standard’ consumption

good. The utility function is given by²

$$u^*(x, z) \equiv \left(\rho - \frac{x}{2}\right)x - \beta(\theta)\gamma x + z, \quad \beta = b + k\theta \quad (1)$$

where x is the consumption of the harmful good and z is the consumption of the other consumption goods (quasi-linearity of the utility implies that all income effects fall on the demand for z). The first term of the utility function represents the immediate pleasure from consumption; the parameter $\rho \geq 0$ captures the intensity of preferences for good x . The second term represents the *perceived* present value of future harm that the consumer will suffer from today's consumption; we consider a linear form³ in which the perceived harm per unit of consumption is equal to $\beta\gamma$. The parameter $\gamma \geq 0$ represents the true harm, whereas the term $\beta \in [0, 1]$ captures (in a reduced form) time inconsistency, or bounded rationality, in consumer behavior; in fact, $\beta < 1$ implies overconsumption with respect to the efficient level of consumption (whereas $\beta = 1$ implies rational behavior). O'Donoghue and Rabin (2006) provide a full intertemporal derivation of this model, while Gruber and Kőszegi (2004) present a more articulated model in which the current level of health harm depends on the entire pattern of past consumption levels.

In O'Donoghue and Rabin (2006) the parameter β capturing the degree of time inconsistency is exogenous. We extend their model by assuming that β is endogenously determined by the variable θ , that represents a policy instrument that the regulator can use to affect the consumption of the harmful good. For instance, when the government launches an awareness campaign to inform citizens about the harm from smoking, consumers become more conscious of future harms and thus the time inconsistency problem becomes less serious, because β increases. The parameter $b \leq 1$ represents the exogenous part of time inconsistency (i.e., the component of β that is independent of θ), whereas $k > 0$ is a technical parameter representing the 'productivity' of policy θ on self consciousness.

The population of consumers is therefore characterized by the triplet (ρ, γ, b) of individuals' attributes. For now, we assume that b is single-valued and that the distribution of types is $F(\rho, \gamma)$;⁴ the mass of consumers is also normalized to unity.

²O'Donoghue and Rabin (2006) start their analysis with a general utility function and then consider a specific functional form to make numerical simulations on tax incidence and optimal taxation. Instead, we directly start with a specific functional form of the utility function.

³A quadratic form, with a linearly increasing marginal harm, represents an alternative to the adopted specification.

⁴We plan to consider the more general case of heterogenous agents with respect to b . Following

The consumer's budget constraint is

$$z \leq I + \ell - px, \quad (2)$$

where I is the exogenous income and ℓ is a lump sum transfer from the government, equal for all consumers (see below). Good z is produced in a competitive market and its price is normalized to unity. Good x is instead produced in an oligopolistic market and p is the consumers' price. By considering an oligopolistic market for cigarettes, we extend the current literature on tobacco taxation (e.g., Gruber and Kőszegi, 2004, O'Donoghue and Rabin, 2006), which typically assumes a competitive market, also along another dimension. In fact, in most countries the market for cigarettes is characterized by the presence of a small number of big producers.

The first order condition for maximizing (1) subject to (2) is given by

$$\rho - x - \beta(\theta)\gamma - p = 0,$$

so that the individual demand for good x is equal to (we drop the arguments ρ, b, γ to simplify notation whenever possible)

$$x(p; \theta) = \rho - \beta(\theta)\gamma - p. \quad (3)$$

We assume that $x(p; \theta) > 0$ for all types.⁵ Aggregate demand (that is equal to per capita demand) is then equal to

$$X(p; \theta) = \bar{\rho} - \beta(\theta)\bar{\gamma} - p,$$

while the inverse aggregate demand is

$$p(X; \theta) = \bar{\rho} - \beta(\theta)\bar{\gamma} - X. \quad (4)$$

As for the market of good x , consider a Cournot oligopoly, with a fixed number, $m \geq 1$, of quantity-setting identical firms.⁶ There is a specific (excise) tax at rate t on the consumption of the harmful good, levied on producers. Production costs are linear, with constant marginal costs normalized to unity (there are no fixed costs). Firm j

O'Donoghue and Rabin (2006), we then assume the distribution function $F(\rho, \gamma, b) = G(\rho, \gamma)H(b)$, that implies $\text{cov}(\rho, b) = \text{cov}(\gamma, b) = 0$.

⁵We assume that (ρ, γ, b) are such that all individuals are smokers at all equilibrium prices. Hence we rule out corner solutions in which consumption is zero for some agents.

⁶The Cournot quantity-setting oligopoly model is a standard framework for the analysis of the incidence of indirect taxes under imperfect competition. See Seade (1985) and Stern (1987).

maximizes its profit function with respect to quantity produced, x_j , taking as given the quantities produced by the other firms:

$$\pi_j = (p(X; \theta) - 1 - t)x_j, \quad \text{where } X = \sum_{i=1}^m x_i. \quad (5)$$

By differentiating (5) with respect to x_j , the necessary first order condition for profit maximization by firm j can be written as:⁷

$$\bar{\rho} - \beta(\theta)\bar{\gamma} - 1 - t - \sum_{k \neq j} x_k - 2x_j = 0, \quad j = 1, \dots, m. \quad (6)$$

By summing equation (6) over $j = 1, \dots, m$, one gets:

$$m(\bar{\rho} - \beta(\theta)\bar{\gamma} - 1 - t) - (m - 1)X - 2X = 0.$$

From the latter equation we then obtain the equilibrium aggregate quantity as a function of the relevant tax rates:

$$X^*(t, \theta) = m(1 + m)^{-1} (\bar{\rho} - \beta(\theta)\bar{\gamma} - 1 - t). \quad (7)$$

The market equilibrium is symmetric, since firms are identical. We restrict the analysis to market equilibria such that $t \leq \bar{\rho} - \beta(\theta)\bar{\gamma} - 1$, in order to ensure that $X^*(t, \theta) > 0$.⁸

By substituting $X^*(t, \theta)$ into (4) and then solving for p we get the equilibrium consumers' price:

$$p^*(t, \theta) = \frac{m}{1 + m}(1 + t) + \frac{1}{1 + m} (\bar{\rho} - \beta(\theta)\bar{\gamma}). \quad (8)$$

Notice that aggregate (per capita) consumption (7) is decreasing in both policy parameters t and θ . However, while the tax rate t increases the consumers' price (the more so the higher is the number of firms m , so that the more competitive is the market), anti-tobacco policies θ decrease it because they reduce individual, and thus aggregate, demand.

By substituting p^* from (8) into (3) we get individual consumption as a function of the policy parameters and of individual type:

$$x^*(t, \theta) = \frac{m}{1 + m} (\rho - \beta(\theta)\gamma - 1 - t) + \frac{1}{1 + m} [(\bar{\rho} - \rho) - \beta(\theta)(\gamma - \bar{\gamma})]. \quad (9)$$

⁷Under the given hypotheses (linear demand and linear production costs) the necessary first order conditions for profit maximization are also sufficient. Moreover, Stern's (1987) stability condition of the market equilibrium is also satisfied.

⁸In what follows, we will not return to this existence condition since it is immediate to verify that the equilibrium policies (both in the absence and in the presence of lobbying) are such that $X^* > 0$.

It is then immediate to see that

$$\frac{\partial x^*}{\partial t} = -m(1+m)^{-1} < 0, \quad (10)$$

$$\frac{\partial x^*}{\partial \theta} = -k\gamma + (1+m)^{-1}k\bar{\gamma} \leq 0 \quad \text{iff} \quad \gamma \geq (1+m)^{-1}\bar{\gamma}. \quad (11)$$

These expressions show an interesting result.

Proposition 1 *Taxation reduces individual consumption of all types, because it increases the consumers' price. Control policies, instead, reduce consumption only for those types with harm γ greater than $(1+m)^{-1}\bar{\gamma}$.*

The intuition behind Proposition 1 is simple: an increase in θ reduces aggregate demand and therefore the equilibrium price; however, for those with a low γ the reduction in price causes an increase in demand that outweighs the reduction due to a higher θ .

Aggregate equilibrium profits are equal to

$$\Pi^*(t, \theta) = [p^*(t, \theta) - 1 - t] X^*(t, \theta). \quad (12)$$

2.2 Individual and aggregate welfare

We assume that the revenue from the taxation of tobacco consumption, $tX^*(t, \theta)$, net of the expenditure sustained for direct control policies, $(\phi/2)\theta^2$, $\phi \geq 0$, is given back lump sum, and uniformly in per capita terms, to consumers, so that⁹

$$\ell^*(t, \theta) = tX^*(t, \theta) - \frac{\phi}{2}\theta^2. \quad (13)$$

Using (1) and (2), individual welfare can be defined as

$$w^* \equiv \left(\rho - \frac{x^*}{2} \right) x^* - \gamma x^* - p^* x^* + \ell^* + I,$$

where we suppress the arguments t and θ from all the starred equilibrium variables to simplify the notation. Notice that the true harm, γx^* , enters into the definition of individual welfare, in place of the perceived harm, $\beta(\theta)\gamma x^*$, that instead enters into the decision utility function (1).

By using (13) the above expression can be written as

$$w^*(t, \theta) \equiv \hat{u} + t(X^* - x^*) - (p^* - 1 - t)x^* - \frac{\phi}{2}\theta^2 + I, \quad (14)$$

⁹It is possible to consider a general cost function $\varphi(\theta)$, $\varphi' > 0$, $\varphi'' > 0$. Notice also that we assume that there are no administrative costs for tax collection.

where

$$\hat{u}(t, \theta) \equiv \left(\rho - \gamma - 1 - \frac{x^*(t, \theta)}{2} \right) x^*(t, \theta). \quad (15)$$

Expression (14) shows that individual welfare is composed of several terms. The first is \hat{u} , which is the true gross consumer's surplus net of cigarettes production costs. The second term shows that individuals with levels of consumption below the average level ($X^* > x^*$) are subsidized by individuals with an above the average consumption level ($X^* < x^*$), because for the former the tax paid on consumption is lower than the lump sum payment received from the government (equal to average tax revenue), while for the latter individuals the reverse pattern holds true. The third term shows that individuals' welfare is negatively affected by the price-cost mark-up, $p^* - 1 - t$, and the more so the higher is consumption, x^* . Finally, citizens welfare is negatively affected by the cost of the control policy θ .

Using a Utilitarian social welfare function to aggregate the individual welfare levels (14), per capita (aggregate) welfare of consumers is equal to:

$$W^*(t, \theta) = E_F [w^*(t, \theta)] = E_F [\hat{u}(t, \theta)] - \Pi^*(t, \theta) - \frac{\phi}{2}\theta^2 + I. \quad (16)$$

By adding profits, aggregate social welfare (or aggregate surplus) is then equal to:

$$\Omega(t, \theta) = W^*(t, \theta) + \Pi^*(t, \theta) = E_F [\hat{u}(t, \theta)] - \frac{\phi}{2}\theta^2 + I. \quad (17)$$

3 Efficient tobacco control policy

Suppose that the policy maker sets the policy instruments with the aim of maximizing the aggregate surplus (17). This social objective function implies that optimality is defined in terms of efficiency. Distributional issues (within the group of smokers, between smokers and non-smokers, between consumers and profit earners) are ignored.

The necessary first order conditions for a socially optimal policy are:

$$\frac{\partial \Omega}{\partial t} \equiv E_F \left[\frac{\partial \hat{u}}{\partial t} \right] = E_F \left[(\rho - \gamma - 1 - x^*) \frac{\partial x^*}{\partial t} \right] = 0, \quad (18)$$

$$\frac{\partial \Omega}{\partial \theta} \equiv E_F \left[\frac{\partial \hat{u}}{\partial \theta} \right] - \phi\theta = E_F \left[(\rho - \gamma - 1 - x^*) \frac{\partial x^*}{\partial \theta} \right] - \phi\theta = 0, \quad (19)$$

where, by differentiating equation (15), we use the fact that

$$\frac{\partial \hat{u}}{\partial t} = (\rho - \gamma - 1 - x^*) \frac{\partial x^*}{\partial t}, \quad (20)$$

$$\frac{\partial \hat{u}}{\partial \theta} = (\rho - \gamma - 1 - x^*) \frac{\partial x^*}{\partial \theta}. \quad (21)$$

Using also (10) and (11) equations (18) and (19) become:

$$\frac{\partial \Omega}{\partial t} \equiv -m(1+m)^{-1}(\bar{\rho} - \bar{\gamma} - 1 - X^*) = 0, \quad (22)$$

$$\frac{\partial \Omega}{\partial \theta} \equiv (1+m)^{-1}k\bar{\gamma}(\bar{\rho} - \bar{\gamma} - 1 - X^*) - kE_F[(\rho - \gamma - 1 - x^*)\gamma] - \phi\theta = 0. \quad (23)$$

It is then immediate to see that the second order sufficient conditions for a maximum are satisfied:

$$\begin{aligned} \frac{\partial^2 \Omega}{\partial t^2} &\equiv -\left(\frac{m}{1+m}\right)^2 < 0, \\ \frac{\partial^2 \Omega}{\partial \theta^2} &\equiv -\left(\frac{m}{1+m}k\bar{\gamma}\right)^2 - k^2 \text{var}(\gamma) - \phi < 0, \\ \frac{\partial^2 \Omega}{\partial t \partial \theta} &\equiv -\left(\frac{m}{1+m}\right)^2 k\bar{\gamma} < 0, \\ \frac{\partial^2 \Omega}{\partial t^2} \frac{\partial^2 \Omega}{\partial \theta^2} - \left(\frac{\partial^2 \Omega}{\partial t \partial \theta}\right)^2 &\equiv \left(\frac{m}{1+m}\right)^2 (k^2 \text{var}(\gamma) + \phi) > 0. \end{aligned}$$

After substituting for X^* from (7) into (22), the first order condition for t can be written as

$$\frac{m}{1+m}(1+t) = \bar{\gamma} + 1 - \frac{1}{1+m}\bar{\rho} - \frac{m}{1+m}(b+k\theta)\bar{\gamma}. \quad (24)$$

We can therefore state the following result.

Proposition 2 *For given θ , the optimal tax rate is equal to:*

$$t(\theta) = (1-b-k\theta)\bar{\gamma} - \frac{1}{m}(\bar{\rho} - \bar{\gamma} - 1). \quad (25)$$

Equation (25) is composed of two terms of opposite sign. The first is positive and it is equal to the average harm that consumers do not internalize because of time inconsistent behavior; this is the Pigouvian part of the optimal tax rate. The second term is negative and it corrects for market power, since oligopoly pricing is above marginal cost. Thus, in theory both a tax and a subsidy could be optimal. However, in practice we expect the externality to be more important than market imperfection, so that a positive tax is optimal.

Turning to the control policy θ , since $\bar{\rho} - \bar{\gamma} - 1 - X^* = 0$ by equation (22), the first order condition (23) can be written as:

$$-E_F[(\rho - \gamma - 1 - x^*)\gamma] = \frac{\phi\theta}{k}.$$

Substituting for x^* from (9) we then get

$$-[1 - (b + k\theta)] E_F [\gamma^2] - \bar{\gamma} + \frac{1}{1+m} \bar{\rho} \bar{\gamma} - \frac{1}{1+m} (b + k\theta) (\bar{\gamma})^2 + \frac{m}{1+m} (1+t) \bar{\gamma} = \frac{\phi\theta}{k}.$$

Using (24), after some manipulations, the latter equation simplifies to:

$$-[1 - (b + k\theta)] \{E_F [\gamma^2] - (\bar{\gamma})^2\} = \frac{\phi\theta}{k}.$$

Given that $E_F [\gamma^2] - (\bar{\gamma})^2 \equiv \text{var}(\gamma)$, we finally get the optimal θ and, by substituting for θ^* into (25), we then obtain the optimal tax rate. The expressions for θ^* and t^* are given in the following Proposition.

Proposition 3 *The optimal control policy and tax rate in the absence of lobbying are given by, respectively,*

$$\theta^* = \frac{(1-b)k \text{ var}(\gamma)}{\phi + k^2 \text{ var}(\gamma)}, \quad (26)$$

and

$$t^* = \frac{(1-b)\bar{\gamma}\phi}{\phi + k^2 \text{ var}(\gamma)} - \frac{1}{m}(\bar{\rho} - \bar{\gamma} - 1). \quad (27)$$

It is immediate to see that $\beta^* \equiv \beta(\theta^*) \equiv b + k\theta^* \leq 1$ iff $b \leq 1$, for all $k > 0$, $\phi \geq 0$, as we have assumed above. Observe also that $t^* < \bar{\rho} - \beta^*\bar{\gamma} - 1$ so that $X^* > 0$.

Notice that market structure, represented by the number of firms m , affects only the optimal tax rate t^* and not the optimal level of anti-tobacco control policy θ^* (this outcome may not hold in general, for it could be due to the functional forms used in the model; it is however an interesting result). The first term in (27) is positive and corrects for the average consumption externality; the second term is negative and corrects for oligopoly pricing above marginal cost. Since, in the present specification of the model, the excise tax discourages consumption of all consumer types in an uniform manner (see the partial derivative 10), then the numerator of the first term in (27) depends on the average harm $\bar{\gamma}$. The control policy θ , instead, bears a non-uniform impact on consumption that depends on γ (see the partial derivative 11) and therefore the numerator of (26) depends on the variance of the harm, $\text{var}(\gamma)$. It is interesting to see that although raising taxes is costless while dissuading overconsumption is costly, a non-negative level of both instruments is optimal, provided that $\text{var}(\gamma) > 0$. In the special case in which control policies are also costless ($\phi = 0$), we have that $\theta^* = (1-b)/k$ and $t^* = -(\bar{\rho} - \bar{\gamma} - 1)/m$, so that taxation targets market imperfection while control

policies target the consumption externality.¹⁰ The policy instrument θ is always zero at the optimum when $\text{var}(\gamma) = 0$ and $\phi > 0$, because in this case costless taxation is a sufficient instrument to target both the inefficiency due to market power and that due to the externality. In other terms, if $\text{var}(\gamma) = 0$ then θ becomes a redundant instrument even if $\phi = 0$, so that only t matters.

4 Lobbying

There are two main groups that are affected by tobacco control policies: producers and consumers. However, while producers are identical, and thus are uniformly affected by government policy, consumers are heterogeneous, and therefore each one may hold a different view about the desired levels of policy instruments.¹¹ Formally, the payoff of firms is aggregate profits (12); that of citizens *in the aggregate* is consumers' surplus, net of the externality, plus tax revenue, minus the cost of control policies; that is the expression (16).¹² Recall that we assumed that tax revenue is rebated to consumers, and not to firms.

In a lobbying model with truthful contributions by the two special interest groups,¹³ the policy maker maximizes the objective function:

$$V(t, \theta) = \Omega(t, \theta) + \mu [\Pi^*(t, \theta) + \delta W^*(t, \theta)],$$

where $\mu \geq 0$ is a parameter representing how much the policy maker values contributions relative to aggregate surplus (i.e., the degree of greediness of the policy maker, as in Persson, 1998), while the parameter $\delta \in [0, 1]$ is introduced to capture the fact that citizens are not able (unless $\delta = 1$) to coordinate perfectly to maximize their aggregate surplus, because of the above mentioned heterogeneity of interests within their group, free riding, inability to devise side payments among their members, and so on.

¹⁰An example of a costless (for the government) control policy is the obligation to print warning messages about harm from smoking on cigarette packets.

¹¹To see this, use (14), and (20)-(21) to compute $\frac{\partial w^*}{\partial t}$ and $\frac{\partial w^*}{\partial \theta}$ to show who are the types that support higher t and θ and who are those that support less strict policies.

¹²We assume that profits are concentrated in the hands of a small number of citizens, so that profit earners and consumers constitute two distinct groups with different stakes in public policy.

¹³We use the 'buying influence' model of lobbying with truthful contributions developed by Bernheim and Whinston (1986a, 1986b), Dixit, Grossman and Helpman (1997), Grossman and Helpman (1994, 2001).

From the definition of $\Omega(t, \theta)$ we can express the objective function $V(t, \theta)$ as follows:

$$\begin{aligned} V(t, \theta) &= (1 + \mu)\Pi^*(t, \theta) + (1 + \delta\mu)W^*(t, \theta) = \\ &= \mu(1 - \delta)\Pi^*(t, \theta) + (1 + \delta\mu) \left[E_F [\hat{u}(t, \theta)] - \frac{\phi}{2}\theta^2 + I \right] = \\ &= \mu(1 - \delta)\Pi^*(t, \theta) + (1 + \delta\mu)\Omega(t, \theta). \end{aligned}$$

The expression in the last row clearly shows that the policy maker subject to lobbying maximizes a weighted sum of aggregate surplus Ω (the objective function of a benevolent policy maker) and aggregate profits Π^* . Therefore, it is the extra weight given to profits that distorts tax policy under lobbying with respect to the optimal policy in the absence of lobbying.

Since

$$\begin{aligned} \frac{\partial \Pi^*}{\partial t} &= (p^* - 1 - t) \frac{\partial X^*}{\partial t} + \left(\frac{\partial p^*}{\partial t} - 1 \right) X^* = \\ &= -m(1 + m)^{-1} (p^* - 1 - t) - (1 + m)^{-1} X^* = \\ &= -2m(1 + m)^{-2} [\bar{\rho} - (b + k\theta)\bar{\gamma} - 1 - t] = -2(1 + m)^{-1} X^* < 0, \end{aligned}$$

$$\begin{aligned} \frac{\partial \Pi^*}{\partial \theta} &= (p^* - 1 - t) \frac{\partial X^*}{\partial \theta} + X^* \frac{\partial p^*}{\partial \theta} = \\ &= -(1 + m)^{-1} k\bar{\gamma} [m(p^* - 1 - t) + X^*] = \\ &= -2m(1 + m)^{-2} k\bar{\gamma} [\bar{\rho} - (b + k\theta)\bar{\gamma} - 1 - t] = -2k\bar{\gamma}(1 + m)^{-1} X^* < 0, \end{aligned}$$

it is clear that lobbying aims at making the tobacco control policy less strict than in the absence of it.

Let

$$\pi = \frac{\mu(1 - \delta)}{1 + \delta\mu}.$$

The first order condition for maximizing V with respect to t is:

$$\frac{\partial V}{\partial t} = \mu(1 - \delta) \frac{\partial \Pi^*}{\partial t} + (1 + \delta\mu) \frac{\partial \Omega}{\partial t} = 0,$$

that can be written as

$$\frac{\partial \Omega}{\partial t} + \pi \frac{\partial \Pi^*}{\partial t} = 0. \tag{28}$$

The first order condition for maximizing V with respect to θ can be written as:

$$\frac{\partial \Omega}{\partial \theta} + \pi \frac{\partial \Pi^*}{\partial \theta} = 0. \tag{29}$$

Since $\frac{\partial \Pi^*}{\partial t} < 0$ and $\frac{\partial \Pi^*}{\partial \theta} < 0$ one should expect in equilibrium lower levels of both θ and t than in the absence of lobbying. Moreover, we know that

$$\frac{\partial \pi}{\partial \delta} < 0, \quad \frac{\partial \pi}{\partial \mu} > 0.$$

We need therefore to ask whether if μ increases, it is always true that both t and θ decrease. Solving (28) and (29) we obtain for θ^* the same expression (26) obtained in the absence of lobbying.¹⁴ Somewhat surprisingly, lobbying has no impact on the optimal control policy, which can be rationalized as follows. The lobby of firms is composed of identical members, and firms do not care about the externality or consumers surplus, but only about profits. The lobby of citizens, instead, cares about consumers' surplus and the externality. However, the heterogenous preferences are aggregated linearly and therefore only the average preference parameters matter in the objective function of the lobby. The variance of attitudes does not matter for the lobby, which therefore does not distort θ that depends on variance. The following proposition illustrates the effects of lobbying on the equilibrium tax rate.

Proposition 4 *Lobbying affects only the equilibrium tax rate that is equal to*

$$t^{**} = \frac{(1-b)\bar{\gamma}\phi}{\phi + k^2 \text{var}(\gamma)} - \frac{1}{m}(\bar{\rho} - \bar{\gamma} - 1) + \frac{2(1+m)(\bar{\rho} - \bar{\gamma} - 1)}{m} \left(\frac{\pi}{2\pi - m} \right). \quad (30)$$

The third element accounts for the specific impact of lobbying, since the first two terms are already present in the expression (27) for t^* in the absence of lobbying. If $\delta = 1$ (i.e., consumers are perfectly organized as a lobby group) then $\pi = 0$ and the lobby of producers and the lobby of consumers do not distort policy: they simply neutralize each other. In general, however, $\delta < 1$ and producers are more effective than consumers as a special interest group. Note that the term

$$\frac{\pi}{2\pi - m} = \frac{(1-\delta)\mu}{2(1-\delta)\mu - (1+\delta\mu)m} \quad (31)$$

can take both negative and positive values. If $m \rightarrow \infty$, then profits tend to zero and producers do not lobby; hence the latter term tends to zero and tax policy is not distorted, since the objective functions of the policy maker and of citizens coincide for all δ .

¹⁴The solution is obtained by means of standard algebra in the case of a uniform distribution of γ and with ρ single-valued. However, we conjecture that the same result holds for any distribution function.

The sign of (31) is linked to the second order conditions for a maximum. Considering for notational convenience

$$\tilde{V} = \frac{1}{1 + \delta\mu} V,$$

and differentiating it without loss of generality instead of V , we obtain

$$\begin{aligned} \frac{\partial^2 \tilde{V}}{\partial t^2} &\equiv -\frac{m}{(1+m)^2} (m - 2\pi) < 0 \quad \text{iff } 2\pi - m < 0, \\ \frac{\partial^2 \tilde{V}}{\partial \theta^2} &\equiv -\left(\frac{m}{1+m} k\bar{\gamma}\right)^2 - k^2 \text{var}(\gamma) - \phi + \frac{2m\pi}{(1+m)^2} (k\bar{\gamma})^2 < 0, \\ \frac{\partial^2 \tilde{V}}{\partial t \partial \theta} &\equiv -\left(\frac{m}{1+m}\right)^2 k\bar{\gamma} + \frac{2m\pi}{(1+m)^2} k\bar{\gamma} < 0, \\ \frac{\partial^2 \tilde{V}}{\partial t^2} \frac{\partial^2 \tilde{V}}{\partial \theta^2} - \left(\frac{\partial^2 \tilde{V}}{\partial t \partial \theta}\right)^2 &\equiv \frac{m}{(1+m)^2} (k^2 \text{var}(\gamma) + \phi) (m - 2\pi) > 0 \quad \text{iff } 2\pi - m < 0. \end{aligned}$$

Therefore the second order conditions for a maximum require that

$$2\pi - m < 0,$$

which means that the third term in (30) is negative, so that, unsurprisingly, lobbying distorts downward the tax rate when $\delta < 1$, because producers are more powerful than consumers. If, instead, $2\pi - m > 0$, we get a corner solution for the optimal tax rate: $t^* = 0$ if the tax rate cannot be negative, $t^* < 0$ such that $p^* = 0$ if a negative tax rate is allowed.

5 Concluding remarks

This paper investigates the optimal design of policies controlling the consumption of tobacco based on the joint use of two instruments: an excise tax, limiting consumption by inducing an increase in the price of cigarettes, and prevention and control programs, reducing the consumption of cigarettes by increasing consumers' awareness about future health harm.

We find that both policy instruments are affected by the degree of time inconsistency, but they have different effects: the tax rate reduces consumption of all agents proportionally to the average harm, while the control policy depends on the variance of the harm. Interestingly, although raising taxes is costless while control policies are costly, a non-negative level of both instruments is optimal. This follows from the fact

that market structure influences only the optimal tax rate, but it bears no impact on the optimal level of the control policy. In the special case in which also control policies are costless taxation targets market imperfection while control policies target the consumption externality. Control policies become irrelevant only when the variance of the harm is zero, in which case costless taxation is sufficient to target both the inefficiency due to market power and that due to the externality.

Our analysis of lobbying is quite refined in the sense that it fully accounts for consumers' heterogeneity about the desired level of policy instruments. However, it is somewhat unsatisfactory in another respect, as it neglects that consumers may divide into groups along other relevant dimensions. A partitioning that may have important implications for lobbying is that between smokers and non-smokers. Once one looks at a population as composed by two groups, smokers and non-smokers, it seems reasonable to assume that non smokers do not care about the impact of control policies on consumers' surplus and on the externality. Non-smokers are instead happy to cash the revenue from taxing tobacco consumption: in fact, revenue accrues uniformly to both smokers and non-smokers. Hence non smokers may have tax revenue as their objective function. In reality, non-smokers may also care for the externality, or harm, if they feel worried for smokers; but at least on first approximation one may want to dispose of altruistic behavior. Based on the arguments above, a more refined model of lobbying may arise, in which also non smokers lobby (although free riding is likely to cause incomplete participation to the lobbying activity), having obviously interests sharply contrasting with those of firms. Extending our analysis in this direction is an important goal for future research.

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