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TAXING A MONOPOLIST[§]

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Abstract
In this paper we consider a simple, self-financing and informational undemanding scheme to reduce the deadweight loss due to a monopolist's market power. In particular, we propose to tax the monopolist and to use the tax revenue to generate a public demand for his output. It turns out that a favorable scenario for the success of the suggested 'tax reform' is an absolute value for the elasticity of market demand of less than 3 (a seemingly realistic assumption in many monopolized markets). We also consider the case for the implementation of the first best, and compare specific and *ad-valorem* taxes as a way to finance the public demand.

Keywords: monopoly, tax reform, first-best implementation.
JEL *Classification*: H20, H42, L13.

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Introduction.

The market mechanism usually fails to generate a Pareto efficient allocation if the involved agents enjoy some market power. The simplest example is of course a monopoly: if perfect price discrimination is not feasible, the monopolist's optimal output is below its efficient level. Can taxation be used to correct the welfare loss generated by the presence of market power? This public finance theme goes back at least to the classical work of Pigou (1920), who noted that the quantity distortion due to the monopoly power (so-called *deadweight loss*) can be reduced by paying the monopolist a subsidy per unit of output (formally, a *negative*, *specific* tax), and that, in principle, in such a way even the efficient quantity could be implemented.[1]

One problem with such a *Pigouvian* (negative) tax is how to pay for it. Unless a (positive) lump-sum tax can be collected to finance the needed amount, or equivalently a tax on the monopolist's *pure* profit is available (this being positive and sufficiently large), any attempt to raise funds by levying a tax on the monopolist's activity should add to the previous distortion the well-known *excess-burden* distortion due to taxation (see e.g., Auerbach (1985), but also our discussion of the work by Myles (1996) in the concluding section). Moreover, a further problem refers to the fact that perfect knowledge of the demand and cost functions is required to design the tax scheme able to implement the first best: indeed, with such an informational endowment, a simpler approach would be just to let the regulator fix the efficient price. Of course similar issues (and others) do arise also in general equilibrium analysis (perhaps a more apt setting), and the question of when the decentralized implementation of Pareto efficient allocations can be achieved through taxation is still under investigation (see, e.g., Guesnerie and Laffont (1978) and Gabzewicz and Grazzini (1999)).

In this paper we will restrict attention to the standard (partial equilibrium) monopolistic setting. We consider an extremely simple, informational undemanding and totally self-financing scheme, which might be able to reduce the deadweight loss. The scheme is the following: on the one hand the productive activity of the monopolist is taxed; on the other hand the tax revenue is used to pay for an additional amount of his output. This modifies the monopolist's revenue function, and might induce him to enlarge the overall production. We will analyse under which conditions this will be the case.

In particular, in Section 1 we will present a simple example with *ad-valorem* taxation, which shows, quite surprisingly, that such an extremely simple 'tax' scheme could implement the efficient level of output. Then, in Section 2 we will discuss the case of *ad-valorem* taxation more generally, investigating the conditions for the previous scheme to deliver a welfare improvement. Section 3 deals with the first-best implementation problem. Section 4 considers the case of specific taxation,

[1] See also Robinson (1933), chapter 13 and Higgins (1959).

and relates our results to the specific vs. *ad-valorem* taxation debate in the public finance literature. Before concluding, a final section discusses some assumptions of our analyses, the implementability of the proposed tax mechanism and a comparison with an alternative tax/subsidy scheme recently proposed by Myles (1996).

1. A simple example with revenue taxation

Consider the case of a so-called *ad-valorem* taxation. The tax revenue is given by $G = g_r(p,\boldsymbol{t}) = \boldsymbol{t}pD^T(p)$, for some $\boldsymbol{t} \in [0,1]$ which represents the tax rate on monopolist's *total* revenues $pD^T(p)$. Suppose that the tax revenue is entirely devoted to pay for a sort of "public" demand for the monopolist's output: i.e., given $\boldsymbol{t}$, define $D^S(p) \equiv G/p$. Total demand is hence given by $D^T(p) \equiv D(p) + D^S(p)$, where $D(p)$ is just "private" demand,[2] and also $D^T(p) \equiv D(p)/(1-\boldsymbol{t})$.[3] Note that the monopolist is asked to pay a tax $\boldsymbol{t}$ on any unit of revenue he collects, but his demand is higher for any chosen price than if $\boldsymbol{t} = 0$. What is the market effect of the mechanism $g_r(p,\boldsymbol{t})$? Let us examine the following linear example: $D(p)=1 - p$, with total costs simply given by $C(q) = q/8$. Given a tax rate $\boldsymbol{t} > 0$, the profit function of the monopolist can then be written:

$$\bar{\boldsymbol{p}}(p,\boldsymbol{t}) = p(1-p) - \frac{1-p}{8(1-\boldsymbol{t})}, \tag{1}$$

i.e., everything is 'as if' the monopolist had experimented an increase (which depends on $\boldsymbol{t}$) in the output (marginal) costs.

Indeed, it is easily computed that:

$$p(\boldsymbol{t}) = \frac{1}{2} + \frac{1}{16(1-\boldsymbol{t})},\ q(\boldsymbol{t}) = \frac{1}{2} - \frac{1}{16(1-\boldsymbol{t})},\ q^T(\boldsymbol{t}) = \frac{1}{2(1-\boldsymbol{t})} - \frac{1}{16(1-\boldsymbol{t})^2}, \tag{2}$$

where $p(\boldsymbol{t})$ is the optimal price chosen by the monopolist under the mechanism, and $q(\boldsymbol{t}) = D(p(\boldsymbol{t}))$ and $q^T(\boldsymbol{t}) = D^T(p(\boldsymbol{t}))$ are the output sold to private consumers and total output, respectively. Thus if $\boldsymbol{t} > 0$, then $p(\boldsymbol{t}) > p(0) = p^m = 9/16$ and $q(\boldsymbol{t}) < q(0) = q^m = 7/16$, but $q^T(\boldsymbol{t}) > q^m$ (if $\boldsymbol{t} < 6/7$). Note that $dq^T(\boldsymbol{t})/d\boldsymbol{t} > 0$ if $0 \le \boldsymbol{t} < 3/4$, and that a simple envelope-theorem argument gives $\hat{\boldsymbol{p}}(\boldsymbol{t}) = \bar{\boldsymbol{p}}(p(\boldsymbol{t});\boldsymbol{t}) <$

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[2] Note that we are assuming: (i) that the monopolist cannot discriminate between private and public demand; (ii) that he must satisfy (total) demand; (iii) for the sake of simplicity, that the acts of taxing and presenting public demand are simultaneous (but on this see Section 2); (iv) that consumers' behavior can be summarized by $D(p)$; (v) that what matters is total monopolist output ((iv) and (v) amount to assume that the output bought by the state can be redistributed at no transaction costs to the consumers, in a way that does not affect their behavior). These assumptions will be discussed in the final section.

[3] Supposing that only revenue coming from private demand is taxed, i.e., $g_r(p,t) = tpD(p)$, makes no relevant difference for the results in this and in the next sections.

$\pi^m = \bar{\pi}(p^m;0)$. We can summarize what happens as follows: a positive level of taxation decreases profit and increases the output price with respect to the case of no intervention (so reducing the private output), but does raise total output (up to a certain tax rate). Figure 1 presents $q^T(\cdot)$, $q(\cdot)$ and $\hat{\pi}(\cdot)$ for our example.

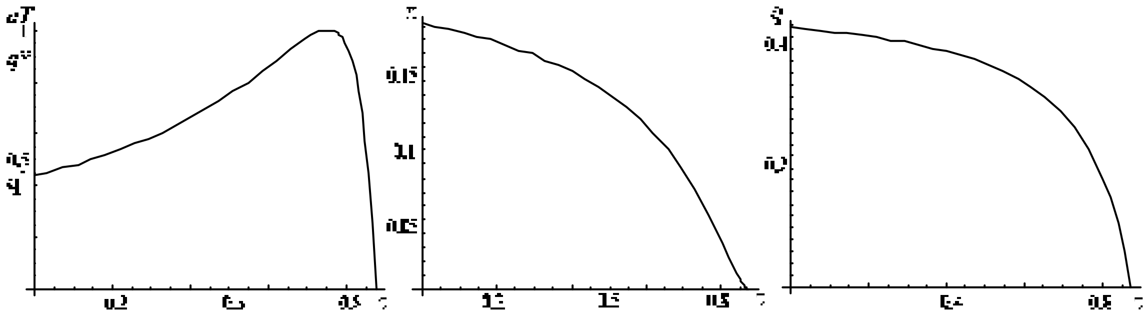

Figure 1. Total output, profit and private output in the linear example

Note that any level of total output $q^T \in [q^m,1]$ can be implemented, in general by two different tax rates: in particular, the first-best output level $q^* = 7/8$ is achievable (but even output larger than q^* could be implemented). Also notice that while the monopolist's profit and private output are monotonically decreasing with respect to τ ($\tau \in (0,7/8)$), the total output function has a global maximum at $\tau = 3/4$. How general are these results, and on which properties of the market fundamentals do they hinge upon?

2. The case of *ad-valorem* taxation

Let us denote inverse demand by $P(q)$: we assume that both $C(q)$ and $D(p)$ are twice continuously differentiable, with $C'(\cdot) \geq 0$, and $D'(p) < 0$ if $D(p) > 0$. To dispense with second-order conditions, we also assume that $C(\cdot)$ is (at least weakly) convex and $D(\cdot)$ is (at least weakly) concave, so that the monopolist profit function is strictly concave.[4] For economic meaningfulness, it is also assumed that $P(0) > C'(0)$, and that (the possibly positive) fixed cost $C(0)$ is not "too high" (so that the 'untaxed' monopolist can achieve a positive profit).

Note that the profit function of the monopolist can always be written as

$$\bar{\pi}(p;\tau) = pD(p) - C\left(D^T(p)\right), \tag{3}$$

thus

$$\frac{dp(\tau)}{d\tau} > 0 \text{ iff } C'\left(q^T(\tau)\right) > 0, \tag{4}$$

and $p(\boldsymbol{t}) > p^m = p(0)$, $q(\boldsymbol{t}) < q^m = q(0)$ and $\hat{\boldsymbol{p}}(\boldsymbol{t}) < \boldsymbol{p}^m = \hat{\boldsymbol{p}}(0)$ are general results if $C'(\cdot) > 0$. Recalling the relationship between total and private output, $q = (1-\boldsymbol{t})q^T$, we can rewrite the profit function in order to study the impact of the mechanism on total output:

$$\boldsymbol{p}\left(q^{T};\boldsymbol{t}\right)=R(q)-C\left(q^{T}\right). \tag{5}$$

Since $\boldsymbol{p}(\cdot)$ is strictly concave with respect to q^T under our assumptions, for a given $\boldsymbol{t}$, the first-order condition:

$$(1-\boldsymbol{t})R'(q)=C'\left(q^{T}\right) \tag{6}$$

does characterize the monopolist's optimal level of output (assuming a positive production). It follows immediately that:

$$\frac{dq^{T}(\boldsymbol{t})}{d\boldsymbol{t}}>0 \text{ iff } \left|\frac{\mathrm{dln}R'(q(\boldsymbol{t}))}{\mathrm{dln}q}\right|>1, \tag{7}$$

i.e., the monopolist's total output is increasing with respect to $\boldsymbol{t}$ if and only if the absolute value of the marginal (private) revenue elasticity is larger than 1.

To get an intuition of what is going on, consider that when $\boldsymbol{t}$ increases everything is 'as if', given marginal cost, the marginal revenue had been affected by two "turns": one downwards due to taxation and one upwards due to the increase in demand. This is so because the relevant 'marginal revenue' (as it can be seen in equation (6)) is $(dR(q)/dq^T) = mr(q^T) = (1-\boldsymbol{t})R'((1-\boldsymbol{t})q^T)$. Note also that $R''(\cdot) < 0$, $mr(0) = (1-\boldsymbol{t})R'(0)$ and $mr^{-1}(0) = R'^{-1}(0)/(1-\boldsymbol{t})$. Thus, in a sense, it is 'as if' when $\boldsymbol{t}$ increases marginal revenue got flatter and moved downwards (see Fig. 2, which refers to the previous linear example with $\boldsymbol{t} < 6/7$). This is exactly what happens if demand is linear, and the favorable case is when an increase in $\boldsymbol{t}$ raises the public demand more than decreases the private demand.

[4] No generalization to these assumptions is attempted here, and we do not discuss why the market is monopolized in the first instance.

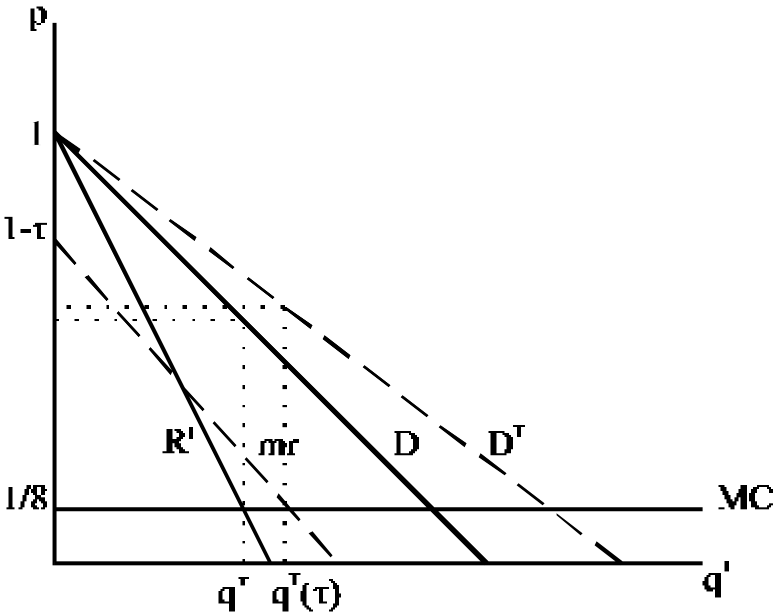

Figure 2. The effect of the tax scheme on the marginal revenue curve in the linear example

The effect of an increase in τ discussed above is obviously related to the demand elasticity. In particular, under our assumptions,

$$|\xi(q)| = \left| \left(\frac{d \ln P(q)}{d \ln q} \right)^{-1} \right| < 3, \tag{8}$$

i.e., the absolute value of the (private) demand elasticity smaller than 3, is a *sufficient* condition for the condition in (7) to be satisfied ((8) is also *necessary* if demand is linear).[5] On the contrary, a more severe constraint should be satisfied by the elasticity of demand if demand were convex. As an example, things go very wrong if demand is so-called *iso-elastic*, i.e., $D(p) = kp^{-\varepsilon}$, k, $\varepsilon > 0$. The condition in (7) then is *never* satisfied when $\varepsilon = |\xi(q)| > 1$.

An interesting policy implication of the previous result is that when the untaxed monopoly price is such the market elasticity is not too large, the introduction of a 'tax reform' in the form of a 'small' tax rate $\tau_r = d\tau_r > 0$ does raise welfare, as stated in the following Proposition.

PROPOSITION 1. *Suppose that demand function is (weakly) concave and the cost function is (weakly) convex, and suppose that* $|\xi(q^m)| < 3$. *Then the* piecemeal policy $d\tau_r > 0$ *generates a welfare improvement*.

Note that, on the one hand, a judgment on the usefulness of the 'tax reform' suggested by Proposition 1 does not require to know (even locally) marginal cost but only to check the market elasticity value, and depends on the empirical question of having the latter under (in absolute value) the threshold value of 3 (a seemingly realistic assumption in many monopolized markets). On the other hand, if the demand elasticity is very high, then roughly speaking the deadweight loss cannot be too large even without any intervention.

Proposition 1 can be extended to the following perhaps more realistic setting (and possibly the less favorable dynamic scenario). Consider a two-period version of the previous monopolistic market, with stable demand and cost functions. Let us use the index $t = 1,2$ to indicate the period, and suppose that the monopolist's revenue is taxed only in the first period, while the tax revenue is used to pay for public demand in the second period. That is, $g_r(p_1;\boldsymbol{t}) = \boldsymbol{t}p_1D(p_1)$, $D_1^T(p_1) = D(p_1)$, and $D_2^T(p_1,p_2) = D^S(p_1,p_2) + D(p_2)$, with $D^S(p_1,p_2) = g_r(p_1;\boldsymbol{t})/p_2$. Define $Q(\boldsymbol{t}) = D_1^T(p_1(\boldsymbol{t})) + D_2^T(p_1(\boldsymbol{t}),p_2(\boldsymbol{t}))$ the overall production as a function of the tax parameter $\boldsymbol{t}$ ($p_t(\boldsymbol{t})$ is the price chosen by the monopolist in period t). It can be trivially shown that $p'_t(0) > 0$ (if marginal cost is positive), but $Q'(0) > 0$ if $|d\ln R'(q^m)/d\ln q| > 1$: i.e., starting from the situation of an untaxed monopolist, if the market marginal revenue elasticity in absolute value is larger than 1 a piecemeal policy $\boldsymbol{t}_r = d\boldsymbol{t}_r > 0$ does raise the overall production, and according welfare if there is no or little (social) discounting. Proposition 2 parallels Proposition 1.

PROPOSITION 2. *Suppose that demand function is stable and (weakly) concave and the cost function is stable and (weakly) convex, and suppose that* $|\boldsymbol{x}(q^m)| < 3$. *Then in the two-period case without discounting the* piecemeal policy $d\boldsymbol{t}_r > 0$ *generates a welfare improvement*.

3. The first-best implementation problem

The previous result has implications not limited to the indicated 'tax reform': for example, one can imagine to raise iteratively the tax rate $\boldsymbol{t}$ till condition (7) remains satisfied, so raising total output.[6] In fact, if the regulator does know the functional forms $D(\cdot)$, and $C(\cdot)$, she might fix the tax rate in order to get the largest possible amount of output, which does not exceed the desired level. The natural question in this context (see e.g. Guesnerie and Laffont (1978), Myles (1996) and Gabzewicz and Grazzini (1999)) is if the first-best level of output q^*, defined by $P(q^*)=C'(q^*)$, can be implemented by the mechanism considered. Our linear example in section 1 (see Fig. 1) does provide an instance of first-best implementability, as we noted. For a second illustration, consider the very special case of null variable cost, i.e., $C'(\cdot) = 0$. In this case $p(\boldsymbol{t}) = p^m$ and $q(\boldsymbol{t}) = q^m$ for any $0 \leq \boldsymbol{t} < 1$, and thus *any* level of total output $q^T > q^m$ can be implemented. The reason of course is that there is no crowding out of private demand by public one in such a special case, since the *ad-*

[5] Note that in our previous linear example $|\boldsymbol{x}(q(\boldsymbol{t}))| = (9-8\boldsymbol{t})/(7-8\boldsymbol{t})$.

valorem taxation is not distortionary. Also note that $\hat{p}(\boldsymbol{t}) = \boldsymbol{p}^m$, since to satisfy public demand has no additional cost for the monopolist, and so he is always willing to participate (indeed, $\boldsymbol{t} > 0$ creates a Pareto improvement).

However, in the opposite polar case of null fixed cost, i.e., $C(0) = 0$, we can show that the first-best level of output cannot always be achieved by our mechanism.[7] In general, the implementation of the first best level of output q^* requires the satisfaction of two conditions (from (6)):

1) *incentive compatibility constraint*: $\exists\ \boldsymbol{t}^*$, $1 > \boldsymbol{t}^* > 0$, such that:

$$f(\boldsymbol{t}^*) \equiv 1 - \frac{C'(q^*)}{R'(q^*(1-\boldsymbol{t}^*))} = \boldsymbol{t}^* \tag{9}$$

2) *participation constraint*: $\boldsymbol{p}(q^*; \boldsymbol{t}^*) \geq 0$. (10)

But note that, if $C(0) = 0$, the participation constraint (10) is equivalent to:

$$\int_0^{q^*} [(1-\boldsymbol{t}^*)R'(x(1-\boldsymbol{t}^*)) - C'(x)]dx \geq 0, \tag{11}$$

which is always satisfied if (9) holds (given the concavity of $\boldsymbol{p}(q^T;\boldsymbol{t})$ with respect to q^T). Thus the only relevant condition is (9), i.e., the existence of a fixed point of $f(\cdot)$ in (0,1). The problem is that the range of the function $f(\cdot)$ is not limited to (0,1). One can show that it is locally increasing and that $1 \geq f(1) > 0$. However, if $q^* > \underline{q}$, where $R'(\underline{q}) = 0$, $f(\cdot)$ is discontinuous at $\underline{\boldsymbol{t}}$, $(1-\underline{\boldsymbol{t}})q^* = \underline{q}$, where it is unbounded: in such a case $f(0) > 1$ (otherwise $f(0) < 0$) and the relevant fixed point, if it exists, must belong to $(\underline{\boldsymbol{t}},1)$ (i.e., the tax rate must be sufficiently large). In general, the indicated fixed point might not exist (even if $q^* < \underline{q}$). However, if it exists it is usually not unique (there should be an even number), as we noted.[8] Some cases are described in Fig. 3a-d.

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[6] However, we should notice that even under our assumptions the elasticity of marginal revenue is not necessarily monotonic.

[7] We do not discuss the general case with both variable and fixed costs: however, in our linear example a positive but sufficiently small fixed cost can be added without any change in the results. Note anyway that the presence of positive fixed cost might introduce the additional problem to guarantee the monopolist participation if the average cost is larger than the marginal cost at q^* (actually, q^* should be redefined to take this technological constraint into account).

[8] This result seems a reminiscence of the well-known fact (which dates back to the work of Dupuit: see e.g. Auerbach, 1995, p. 62) that the same level of revenue can in general be raised by two different tax rates.

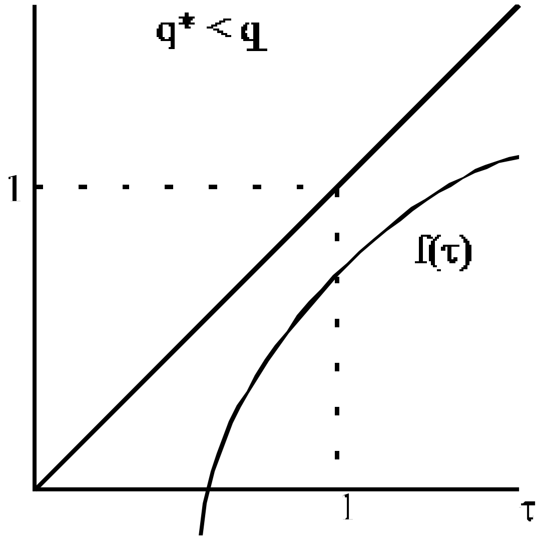

Fig. 3a

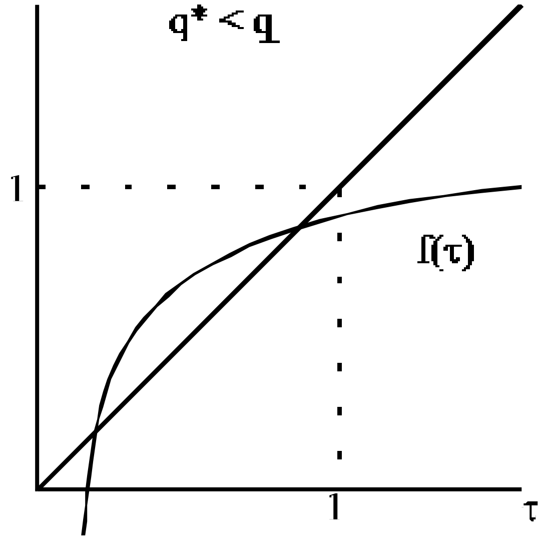

Fig3b

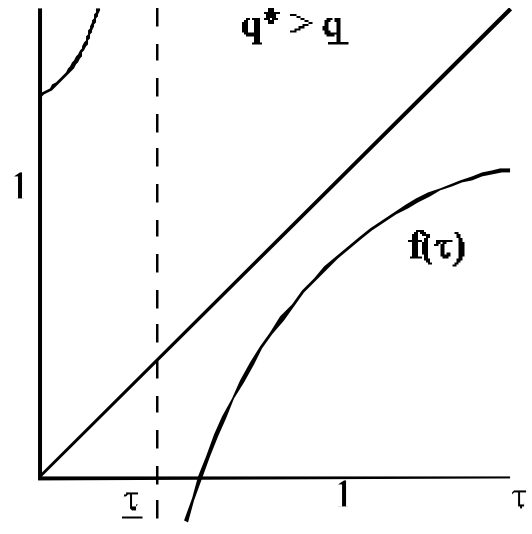

Fig. 3c

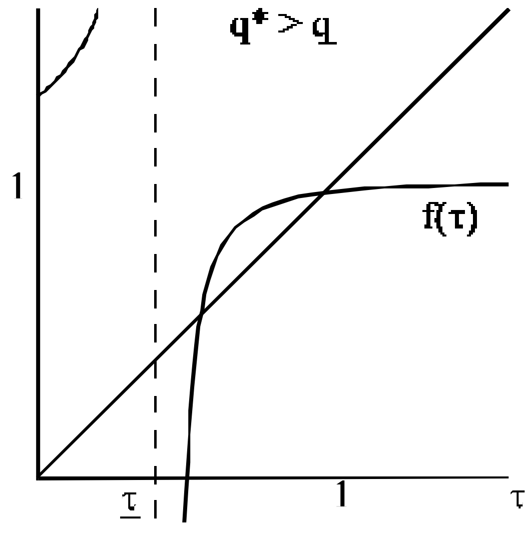

Fig3d

Figure 3. First-best implementability

To illustrate, consider the 'linear' case: $P(q) = 1 - q$, $C(q) = cq$, with $1 > c > 0$ (Section 1 examined the special case of $c = 1/8$). The condition indicate in Proposition 1 ($|x(q^m)| < 3$) is satisfied if $c < 1/2$, since $|x(q^m)| = (1+c)/(1-c)$. When $c \geq 1/2$, the first-best is obviously not implementable (recall that if $|x(q^m)| > 3$ then the scheme would decrease the total quantity produced by the monopolist): this case corresponds to Figure 3a. This somehow disappointing result is anyway not unexpected, since for a large value of c the mechanism is forced to operate upon an elastic (inelastic) part of the demand (marginal revenue) curve, with respect to the price (the quantity). For increasingly smaller values of c, the linear case would correspond first to the case depicted in Figure 3c and then (for $c < 1/3$) to the case illustrated in Fig. 3d. Indeed, note that any quantity $q^T \in [q^m, \bar{q}]$, with $\bar{q} = 1/(8c)$ can be implemented: it is easy to compute that the first-best level of output $q^* = 1 - c$ is implementable if and only if $c \in [0, \underline{c}]$, where $\underline{c} = 1/2 - \sqrt{2}/4$.[9] Note that levels of output larger than q^* are implementable if $c < \underline{c}$.

4. A more general framework: the case of specific taxation

The framework of section 2 can be generalized a little bit by considering other types of financing taxes. Quite generally one might write the tax revenue as a function $\tilde{G} = \tilde{g}(q^T, q; \tau)$, and thus $\tilde{q}^S(q^T, q; \tau) = \tilde{G}/P(\mathrm{q})$ would be the (implicit) public demand function. Suppose that the difference $q = q^T - \tilde{q}^S(q^T, q; \tau)$ well defines a function $q = \tilde{q}(q^T; \tau)$ (this is not necessary the case): then one can refer to a simple analogous to (5), i.e., $\tilde{\pi}(q^T; \tau) = R(\tilde{q}(q^T; \tau)) - C(q^T)$, which is concave with respect to q^T if $\partial^2 \tilde{q}/(\partial q^T)^2 < 0$ (assuming differentiability). In such a case one can easily show that:

$$\frac{dq^T(\tau)}{d\tau} > 0 \text{ iff } \left|\frac{\mathrm{d}\ln R'(q(\tau))}{\mathrm{d}\ln q}\right| \frac{\partial \tilde{q}(q^T(\tau); \tau)}{\partial \tau} \frac{\partial \tilde{q}(q^T(\tau); \tau)}{\partial q^T} < \frac{\partial \tilde{q}(q^T(\tau); \tau)}{\partial q^T \partial \tau} q(\tau), \quad (12)$$

which reduces to (7) in the case of an *ad-valorem* tax on revenue ($q = \tilde{q}_r(q^T; \tau) = q^T/(1-\tau)$).

To illustrate, consider the simple case of specific taxation on (private) output: i.e., $\tilde{g}_o(q^T, q; \tau) = \tau q$. In such a case again $q = \tilde{q}_o(q^T; \tau)$ is well defined with $\partial q/\partial q^T > 0 > \partial^2 q/(\partial q^T)^2, \partial q/\partial \tau$. In particular, it is easy to compute that a tax reform introducing a "small" specific tax rate does increase total output if and only if $|d\ln R'(q^m)/d\ln q| > 1 + 1/|\xi(q^m)|$.[10] Let us indicate with $\tau_o = d\tau_o > 0$ such a piecemeal policy. The previous result is summarized in the following Proposition 3, referring to specific taxation.

PROPOSITION 3. *Suppose that demand function is (weakly) concave and the cost function is (weakly) convex, and suppose that* $|d\ln R'(q^m)/d\ln q| > 1 + 1/|\xi(q^m)|$. *Then the* piecemeal policy $d\tau_o > 0$ *generates a welfare improvement*.

Note that the condition in Proposition 3 is more restrictive than (8): thus a tax reform based on specific taxation is less likely than one based on *ad-valorem* taxation to be welfare improving. The superiority of *ad-valorem* taxation with respect to specific taxation under imperfect competition is a

[9] If $c = \underline{c}$ the first best is uniquely implemented by $\tau^* = (1 + \sqrt{2})/(2 + \sqrt{2})$.

[10] A sufficient condition for this is $|\xi(q^m)| < (1 + \sqrt{3})/2$.

recurrent theme in the public finance literature, which dates back to the work of Cournot and Wicksell: see e.g. Suits and Musgrave (1955), Delipalla and Keen (1992), Skeath and Trandell (1994), Denicolò and Matteuzzi (2000). The basic idea is that *ad-valorem* taxation is better in reducing the monopolist's influence upon marginal revenue. This is confirmed in our setting by the following result, stated as Proposition 4.

PROPOSITION 4. *Suppose that both the piecemeal policy* $\boldsymbol{t}_o = d\boldsymbol{t}_o > 0$ *and the piecemeal policy* $\boldsymbol{t}_r = d\boldsymbol{t}_r > 0$ *are welfare improving. Then, if* $d\boldsymbol{t}_o$ *and* $d\boldsymbol{t}_r$ *are normalized in such a way to have the same effect on total output (i.e., if* $q^T(\boldsymbol{t}_r) = q^T(\boldsymbol{t}_o)$*), it can be shown that* $q(\boldsymbol{t}_r) > q(\boldsymbol{t}_o)$.

5. Discussion and Conclusions

In the previous sections we have investigated a very simple tax mechanism designed to increase welfare, at no cost for the government, by decreasing the deadweight loss due to a monopolist's market power. Two main somewhat related assumptions deserve to be discussed. The first one is our assumption that, as in the tradition of this kind of partial equilibrium analysis, private consumers are in a sense passive: namely, their behavior can be summarized by $D(p)$. The second issue concerns the welfare value to be assigned to total output $q^T = D^T(p)$. That is, which welfare value should be attached to public output $q^S = D^S(p)$? We have assumed that the deadweight loss is decreased as soon as $q^T > q^m$, i.e., that the public output is evaluated as much as the private. Our focus has thus been on the conditions under which the total output is increased by the operation of our tax mechanism.

Both the issues ought to depend on the specific scheme the regulator is going to use to 'redistribute' to consumers the quantity q^S. Theoretically, we can imagine many redistribution schemes for which our hypothesis looks reasonable. For instance, she might organize ex post a competitive context for such a quantity: at least in principle, a well-defined auction should be able to allocate q^S efficiently among consumers, allowing the state to collect a sort of 'tax revenue'. For a second example, she might distribute the quantity somehow randomly for free, leaving the consumers to bargain to reallocate it. In both cases, if the number of consumers is sufficiently large none of them is going to receive (in expected terms) a "large" amount of additional output and hence the mechanisms should (without the monopolist's peculiar bargaining power at work) be able to establish an efficient allocation (the only differences being distributive in nature). The assumption of a sufficiently large number of consumers buys also the passivity of consumers under these redistribution schemes. In fact, it would imply that for each consumer both the probability of receiving such an additional amount and the amount itself are small enough not to influence his consumption behavior. Indeed, the additional quantity one consumer might expect to get ex post should be small with respect to the one he can directly buy in the "primary" market, in order that the ex-post 'redistribution stage' does not challenge the assumption that the private demand is not altered by the mechanism. The problem of the public output welfare value relates to the 'transaction costs' generated by the working of the previous mechanism. We note that such a problem is well known in the "prices-vs.-quantities" regulation literature, since it is implicitly faced by a regulator who directly buys (at least part of) the monopolist output at an imposed price: see e.g. Weitzman (1974) and Chen (1991: footnote 3, p. 524). In this paper we make (similarly to the quoted regulation literature) the most favorable and simplifying assumption that the previous mechanism has *no* specific transaction costs.

A further point regards the fact that the mechanism investigated in this paper is not 'optimal' in the usual sense of the optimal taxation literature, i.e., it has not been derived as the solution of a constrained welfare maximization problem. Indeed, a recent striking result due to Myles (1996) shows that a combination of a positive *ad-valorem* tax and a negative specific tax could be used to eliminate any welfare loss due to imperfect competition (inducing the monopolist to charge the appropriate Ramsey price). The idea is very simple: the well-known (in the public finance literature) problem of finding the optimal combination of *ad-valorem* and specific taxation has a straightforward solution which requires the specific tax to be negative (see Delipalla and Keen (1992)), in order to reduce the excess-burden distortion. In our setting, this implies that an *ad-valorem* tax can be used to finance the Pigouvian subsidy we quoted in the introduction.

Formally, Myles (1996) shows that, for any desired quantity $\hat{q}$,[11] it is possible (under some technical conditions) to find a couple ($\hat{\tau}$, $\hat{s}$), where τ is the *ad-valorem* tax rate and s is the per-unit subsidy, such that when it is announced by the regulator the monopolist produces $\hat{q}$ and the public budget balances. i.e., $\hat{q} \in \operatorname{argmax} \pi = (1-\hat{\tau})R(q) - C(q) + \hat{s}q$, and $\hat{\tau}R(\hat{q}) = \hat{s}\hat{q} + G^0$, where G^0 is a given tax revenue to be financed (in our setting $G^0 = 0$). It thus turns out that through s and τ the revenue function can be sufficiently manipulated to achieve at least the implementation of the second-best level of output, a result that is not limited by the form of the demand function, nor by other fundamentals (but it implies $\hat{\tau} = 1$ with constant returns to scale).

How does our mechanism compare with the optimal one proposed by Myles (1996)? An important point of difference is that the latter mechanism does not balance for *any* behavior of the monopolist, but only for $\hat{q}$.[12] That is, Myles' scheme needs precise market fundamentals information in order for it to deliver a balanced budget, while our mechanism always balances by construction. This suggests the following remarks: in the presence of some realistic residual

[11] With decreasing returns to scale $\hat{q}$ is the appropriate (second-best) Ramsey quantity, otherwise $\hat{q} = q^*$.

uncertainty, Myles' mechanism is not surely self-financing (or is not surely able to get the tax revenue G^0). This would imply that Myles' mechanism could not be applied if the government *is constrained* to balance the public budget.[13] In fact, in such a case, it would be impossible to fix truly exogenously the values of the tax rate and of the subsidy since, given t and q, the value of s would be determined by the condition $s=[R(q)-G^0]/q$. The subsidy would then be a function of the quantity produced by the monopolist, and it is easy to see that a similar mechanism does not affect the monopolist's behavior.

Indeed, the previous remarks raise a subtle problem of credibility: note that ex-post, given production, the regulator is not formally interested in getting a tax revenue larger than G^0. If some renegotiation over the amount of the (gross) subsidy is ex-post possible (or in a somehow 'repeated' version of the game), this opens the possibility of a monopolist's strategic behavior. In other words, the regulator needs a full commitment power to implement Myles's mechanism,[14] while our mechanism does not suffer from this drawback (public demand acts as a credible commitment device). Given these differences, we therefore conclude that the taxing strategy examined in this paper provides a theoretically interesting, simple and informational undemanding alternative approach to the problem of coping with a monopolist.

To summarize, in this paper we have explored once again the theoretical possibility of taxing a monopolist to reduce the negative welfare effects of his market power. A simple scheme, which uses the tax revenue to generate a public demand for the monopolist's output, has been showed to be able to induce the monopolist to enlarge his output under seemingly realistic conditions concerning the demand elasticity (the alleged welfare improvement rests on the assumption that the output received by the regulator can be suitably redistributed to consumers). The scheme is simple, totally self-financing and can be implemented in the form of a piecemeal policy which is informational undemanding. However, since it depends on the 'shape' of the demand function, it might be impossible to use it to achieve the first-best (in any case an informational demanding task).

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[12] A similar point applies to the mechanism examined in Gabzewicz and Grazzini (1999).

[13] This can be justified as an institutional constraint. For example, in many countries public spending rules explicitly decree that public expenditure has to specify the means for financing it. Moreover, in many regulatory regimes the regulator cannot offer transfers to the regulated firms, presumably to reduce the risk of a regulatory capture (under Myles's scheme the monopolist's profit is identically zero).

[14] The assumption that the regulator has full commitment power is standard in the optimal taxation literature, but it is perhaps less compelling in this setting in which fiscal policy is tackling an agent (the monopolist) endowed with both strategic ability and market power.

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