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ON MONOPOLISTIC TAX EVASION UNDER
DIRECT AND INDIRECT TAXATION

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Abstract:

The purpose of this paper is to shed light on the question of how various policies of changing the tax structure and 'progression' affect production, tax shifting and tax evasion. Under the policy of keeping the expected utility of monopolistic firm constant the ad valorem tax dominates the unit tax and the profit tax dominates both the ad valorem and unit tax in the sense that shifting the tax base towards the dominating one will increase both production and tax declaration. This results is not, however, robust. Under the policy of keeping the expected tax revenue of government constant the ranking may actually be reserve, particularly in terms of tax declaration effects. Finally, and perhaps a bit surprisingly, while changes in pure 'progression' tend to affect production negatively, the tax declaration effects seem to be a priori ambiguous under both policies.

1. INTRODUCTION

Since the seminal paper by Allingham and Sandmo (1972), who analyzed individual income tax evading behaviour with exogenous income and proportional taxation, quite a lot of attention has been paid to problems arising from tax evasion. While the analyses of tax compliance have mostly dealt with consumer behaviour, the recent paper by Marrelli (1984) entered a new ground by providing a preliminary analysis of the incentives of the monopolistic firm to evade taxes. More specifically, Marrelli showed in a linear proportional tax scheme with the penalty rate being charged from the evaded taxes that the production and tax declaration decisions display a sort of one-way separation if the probability of detection from tax evasion is exogenous; the production decision is not affected by the tax declaration decision, but vice versa is not true. Moreover, Marreli (1984) demonstrated how under certain assumptions the (indirect) ad valorem tax will lead to a higher tax declaration than the (direct) profit tax if the tax rates are set so as to yield an equal amount of tax revenues from both sources ex ante when the possibility of tax evasion is not taken into account.

There is no particular reason, however, why government should aim to get an equal amount of tax revenue from each tax source and neglect the possibility of tax evasion. After all changing the tax base from the "equal amount ex ante"-rule might either increase the expected utility of taxpayers and/or tax compliance behaviour and/or the expected tax revenues of government. In what follows we develop the implications for production and tax declaration decisions of various other and more appealing (in the sense that the possibility of tax evasion is not neglected) policies of changing the tax structure.

In the presence of tax evasion government tax revenues are uncertain so that it is not immediately evident what is meant by a change in the structure of taxation. One possibility is to consider changes in the structure of taxation with the same expected tax revenue, which is particularly appealing when private risks are independently distributed.[1)] This approach emphasizes the financial restrictions faced by government. This restriction is less important in the second route I follow where government is assumed to be free to consider changes in the structure of taxation, which maintain the expected utility of the monopolistic firm constant. More specifically, we first analyze the relative effectiveness of ad valorem and unit taxes in fighting against tax evasion and compare them with the profit taxation under the above mentioned criteria. Second we explore how changes in the 'progression' of those taxes influence production and tax compliance.

To anticipate results it turns out that the tax decleration effects of changing the tax structure may be sensitive to the question of whether the tax structure is changed so as to keep the expected utility of the monopolistic firm or the expected tax revenues of government constant. In particular, while under the criterium of keeping the expected utility of the monopolistic firm constant shifting the tax base in indirect taxation towards the ad valorem tax will increase tax compliance as will do a shift in the tax base towards the (direct) profit taxation, it is possible that under the criterium of keeping the expected tax revenues of government constant tax compliance may go down under those policies! Finally, and perhaps a bit surprisingly, while changes in pure 'progression' tend to effect production negatively, the tax declaration effects seem to be a priori ambiguous under both policies.

Section 2 presents of model of monopolistic firm with production, tax shifting and tax declaration in the presence of ad valorem, unit and profit taxation and section 3 is devoted to develop its implications for the policies mentioned above.

2. A MODEL OF PRODUCTION, TAX SHIFTING AND TAX EVASION

Following Marrelli (1984) consider a monopolistic firm, whose behaviour is assumed to satisfy the axioms permitting the construction of a von Neumann-Morgenstern utility function defined over post-tax profits. The marginal utility is assumed to be positive and decreasing and the following notation is adopted:

$R(Q)-C(Q)$ = the before-tax profit, where the total revenue R and the total cost C depend on production Q (= quantity purchased),

$xT(Q)$ = the actual tax revenues, where x is the tax rate and T is the tax base,

Θ = the fraction of the tax revenues reported,

$g(>1)$ = the penalty rate on the evaded taxes,

r = the lump-sum transfer from government to firm,

π = the (exogenous) probability of detection from tax evasion (if caught from tax evasion, the firm is assumed to be convicted of it with certainty).[2)]

In the following the partial derivatives are denoted by subscripts for functions with many variables and by primes for one variable functions. Use if also made of the Arrow-Pratt absolute risk aversion measure, defined by $A(k) = -U''(k)/U'(k)$, which is assumed to be decreasing in k.

The monopolistic firm selects production Q (and thereby price) and tax declaration θ so as to maximize the expected utility of the prospect $EU = (1-\pi)U(Y) + \pi U(Z)$, where $Y = R(Q) - C(Q) + r - \theta xT(Q)$ = the post-tax income when tax evasion is not detected and $Z = Y - g(1-\theta)xT(Q)$ = the post-tax income when tax evasion is detected.

The first-order conditions for the maximization of the expected utility at the interior solution are $EU_Q = 0 = (1-\pi)U'(Y)Y_Q + \pi U'(Z)Z_Q$ and $EU_\theta = 0 = (1-\pi)U'(Y)Y_\theta + \pi U'(Z)Z_\theta$, which can be transformed into the following form

$$(1) \qquad \begin{cases} (i) & R'-C'-xT' = 0 \\ (ii) & -(1-\pi)U'(Y) + \pi(g-1)U'(Z) = 0 \end{cases}$$

The production and tax declaration decisions display a sort of one-way separability; the production decision equates the post-tax marginal revenues and marginal costs like in the case of no evasion and is thus not affected by the tax declaration decision, but vice versa is not true since Y and Z depend on the production decision. Thus also tax shifting and tax evasion display a sort of one-way separability.

In the presence of ad valorem tax τ, unit tax t and profit tax v the actual tax revenues are

$$(2) \qquad xT(Q) = v(R(Q) - C(Q)) + (\tau R(Q) + tQ)(1-v)$$

so that (1i) can be expressed as $R'(1-\tau) - C' - t = 0$. Turning to the comparative statics of production and tax shifting when $R = p(Q)Q$ with downward-sloping demand function ($p'(Q) < 0$) it is evident that they are

not affected by g,p,r and v. In the case of ad valorem and unit tax we have $Q_\tau = D^{-1}R' < 0$ and $Q_t = D^{-1} < 0$, where $D = R'' - C'' - xT'' = R''(1-\tau) - C'' < 0$ because of the second-order condition.[3)]

As for the comparative statics of the tax declaration the second order condition is $\Delta = -(1-\pi)U''(Y)Y_\theta + \pi(g-1)U''(Z)Z_\theta = -xTe(A(Y) + (g-1)A(Z)) < 0$ where the latter expression has been obtained by utilizing the first-order condition (1ii) and where $e = (1-\pi)U'(Y) > 0$. Here we have to take into account that parameters may affect tax declaration both directly and indirectly via production changes. Utilizing the first-order condition (1ii) the effect on tax declaration of production can be expressed $\theta_Q = -(A(Y)Y_Q - A(Z)Z_Q)/[xT(A(Y)+(g-1)A(Z))]$. Utilizing (1i) we get $Y_Q = (1-\theta)xT'$ and $Z_Q = (1-\theta)xT'(1-g)$, where $xT' = \tau R' + t + v(R'(1-\tau) - C' - t) = \tau R' + t$ so that

$$(3) \qquad \theta_Q = (1-\theta)(\tau R' + t)/xT > 0$$

i.e. the direct production effect on tax declaration is positive at the interior solution $0 < \theta < 1$. Since the indirect effect of the parameter η on tax declaration ($\theta_Q Q_\eta$) is negative for τ and t and zero for π,g,r and v, the 'total' effect

$$(4) \qquad d\theta/d_\eta = \theta_\eta + \theta_Q Q_\eta$$

depends on the sign of the direct effect θ_η. This direct effect can be shown to be positive for the probability of detection π, and the penalty rate g while negative for the lump-sum transfer r, which latter results from decreasing absolute risk aversion.

Finally, after some manipulations the direct tax declaration effects of τ, t and v can be expressed as follows

$$(5)\quad \begin{cases} \text{(i)} & \theta_\tau = R(1-v)\theta\{\theta_Q/(\tau R' + t) - \theta_r\} > 0 \\ \text{(ii)} & \theta_t = Q(1-v)\theta\{\theta_Q/(\tau R' + t) - \theta_r\} > 0 \\ \text{(iii)} & \theta_v = (R(1-\tau) - C - tQ)\theta\{\theta_Q/(\tau R' + t) - \theta_r\} > 0 \end{cases}$$

The direct effects of taxes are like the scaled effect of production, which is reinforced by the fact that e.g. a rise in taxes decreases profits, ceteris paribus, and thus increases tax declaration because of decreasing absolute risk aversion. Thus the 'total' tax declaration effect is positive for profit taxation and ambiguous for ad valorem and unit taxation with the direct and indirect effects running counter to each other. Given the production effects, the tax shifting effects are of opposite sign. For convenience the comparative statics has been collected in Table 1.

Table 1. Comparative statics of production, tax shifting and tax evasion.

	τ	t	v	g	r	π
Q	-	-	0	0	0	0
p	+	+	0	0	0	0
θ	?	?	+	+	-	+

3. ON RELATIVE EFFECTIVENESS OF AD VALOREM, UNIT AND PROFIT TAXES AS DETERRENTS TO NON-COMPLIANCE BEHAVIOUR

Let us now turn to our major focus of interest, to the evaluation of relative performance of various policies mentioned earlier in fighting

against tax evasion. The relative effectiveness here means a sort of Mundellian assignment of instruments to targets in the following sense: the instrument A is said to be more effective than the instrument B as a deterrent to noncompliance behaviour, if a rise in the use of A compensated by a change in the use of B so as to keep either the expected utility of the monopolistic firm or the expected tax revenues of government constant will increase tax compliance.

3.1. The ad valorem, unit and profit taxation

Let us first look at the implications of changing in various ways the tax structure so as to keep the expected utility of the monopolistic firm constant. Changing the ad valorem tax and the unit tax with the given expected utility defines the following tax switch

$$(6) \qquad d\tau = -(Q/R)dt \qquad \text{as } EU = EU^{*}$$

where the first-order conditions (1i) and (1ii) have been utilized. The production and tax declaration effects associated with changes in τ and t are $dQ = Q_{\tau}d\tau + Q_t dt$ and $d\theta = \theta_{\tau}d\tau + \theta_t dt + \theta_Q dQ$ and substituting the right hand side of (6) for $d\tau$ in the dQ- and $d\theta$-expressions yield

$$(7) \qquad (dQ/dt)_{EU=EU^{*}} = Q_t - (Q/R)Q_{\tau} = D^{-1}(-p'Q/p) < 0$$

and

$$(8) \qquad (d\theta/dt)_{EU=EU^{*}} = \underbrace{\theta_t - (Q/R)\theta_{\tau}}_{=0} + \underbrace{\theta_Q(dQ/dt)_{EU=EU^{*}}}_{(-)} < 0$$

Shifting the tax base in indirect taxation towards the ad valorem tax and away from the unit tax so as to keep the expected utility constant will increase both production and tax declaration. Thus also the final price will be lower under the ad valorem than under the unit taxation.[4] Under the ad valorem taxation the production changes are partially mitigated by changes in the marginal revenue which explains (7). Because the tax switch is conducted so that EU does not change, the 'income effects' associated with changes in τ and t will cancel each other so that the effect of the policy switch on tax declaration operates only via the production in (8).

Next we compare the ad valorem tax and the (direct) profit tax under the expected utility criterium. Changing the profit tax and the ad valorem tax with the given utility defines the following tax switch

$$(9) \qquad dv = -(R(1-v)/(R(1-\tau) - C - tQ))d\tau \qquad \text{as } EU = EU^*$$

where again the first-order conditions (1i) and (1ii) have been used.

Substituting the right hand side of (9) for dv in $dQ = Q_\tau d\tau + Q_v dv$ and in $d\theta = \theta_\tau d\tau + \theta_v dv + \theta_Q dQ$ will wind up with

$$(10) \qquad (dQ/d\tau)_{EU=EU^*} = Q_\tau < 0 \qquad \text{because } Q_v = 0$$

and

$$(11) \qquad (d\theta/d\tau)_{EU=EU^*} = \underbrace{\theta_\tau - (R(1-v)/(R(1-\tau) - C - tQ))\theta_v}_{=0} + \underbrace{\theta_Q (dQ/d\tau)_{EU=EU^*}}_{(-)} < 0$$

Thus shifting the tax base towards the profit taxation and away from the ad valorem taxation with increase both production and tax declaration so that the final price will also decrease. The profit tax has no production effect, while the 'income effects' of changing τ and v under the expected utility criterium cancel each other out with a consequence that the tax declaration effect of the policy switch (9) again operates solely via the production changes in (11).[5)]

Concludingly, under the policy of changing the tax structure so as to keep the expected utility of the monopolistic firm constant the results are clearcut; the profit tax dominates the ad valorem tax, which in turn dominates the unit tax in the sense that if government wants to increase tax compliance behaviour it shoud shift taxation towards the ad valorem tax in indirect taxation and towards the profit tax when the indirect taxes serves as the compensating taxes. These policies, while decreasing tax evasion, may be regarded as undesirable for the reason that government tax revenue will change. Therefore, it is of interest to scrutinize the effects of changes in the tax structure which keep the expected tax revenues of government constant.

In the presence of ad valorem, unit and profit taxation the expected tax revenues of government are

$$(12) \qquad ET = xT\beta - r$$

where $\beta = \theta + \pi g(1-\theta)$ and where the actual tax revenues xT have been defined in the expression (2). Now if τ and t are changed to keep ET constant, then the shifts in τ and t are defined from (12) by

$$(13) \qquad d\tau = -(Q/R)dt - ((\tau R' + t)/(R(1-v))dQ - (xT(1-\pi g)/(R(1-v)\beta))d\theta$$

where we have utilized the first-order condition (1i), and where $1-\pi g > 0$ because of the interior solution for θ. Substituting the right-hand side of (13) for $d\tau$ in the expressions $dQ = Q_\tau d\tau + Q_t dt$ and $d\theta = \theta_\tau d\tau + \theta_t dt + \theta_Q dQ$ yields after some manipulations

$$(14) \qquad (dQ/dt)_{ET=ET^*} = B^{-1} \underbrace{[\,1 + (\theta(1-\pi g)/\beta)\,](1-\theta-xT\theta_r)}_{(?)\qquad\qquad(+)} \underbrace{(dQ/dt)_{EU=EU^*}}_{(-)}$$

and

$$(15) \qquad (d\theta/dt)_{ET=ET^*} = B^{-1} \underbrace{[\,(1-\theta)\theta_Q + (\tau R' + t)\theta\theta_r\,]}_{(?)\qquad\qquad(?)} \underbrace{(dQ/dt)_{EU=EU^*}}_{(-)}$$

where $B = 1 + (\theta(1-\pi g)/\beta)(1-\theta-xT\theta_r) + (\tau R' + t)/(R(1-v)\beta)Q_\tau = ?$

Now we are unable determine the production, tax shifting and tax evasion effects of changing the tax base between the ad valorem and unit tax in indirect taxation. Basically this ambiguity results from the fact that the tax switch defined by the expression (13) does not specify an unambiguous relationship between changes in τ and t. Hence, the result obtained earlier according to which shifting the tax base in indirect taxation towards the ad valorem tax will increase tax compliance may no longer hold; it is possible that raising the ad valorem tax and compensating the unit tax will give rise to increased tax evasion.

What about the relative effectiveness of the direct profit tax and the indirect taxation under the expected tax revenue criterium? If τ and v are changed to keep ET constant, then the shifts in τ and v are defined from (12) by

$$(16) \qquad dv = -(R(1-v)/F)d\tau - ((\tau R' + t)/F)dQ - (xT(1-\pi g)/F\beta)d\theta$$

where $F = R(1-\tau) - C - tQ$ and where we have utilized the first-order condition (1i). Substituting again the right-hand side of (16) for dv in $dQ = Q_v dv + Q_\tau d\tau$ and in $d\theta = \theta_v dv + \theta_\tau d\tau + \theta_Q dQ$ implies $(dQ/d\tau)_{ET=ET^*} = Q_\tau < 0$ because $Q_v = 0$ and

$$(17) \qquad (d\theta/d\tau)_{ET=ET^*} = \underbrace{[1 + (\theta(1-\pi g)/\beta)(1-\theta-xT\theta_r)]^{-1}}_{(+)} \underbrace{[(1-\theta)\theta_Q + (\tau R' + t)\theta\theta_r)]}_{(?)} \cdot$$

$$(dQ/d\tau)_{ET=ET^*}$$

$$(-)$$

Thus changing the tax base towards the profit tax and away from the ad valorem tax induces a rise in production, while leaves the tax declaration effect ambiguous a priori. The reason for the ambiguity lies in the fact that on the one hand a rise in production tends to raise the tax declaration via the production effect (3), but on the other hand a rise in production tends to lead to a fall in the profit tax according to (13), which in turn decreases tax declaration (see (5iii)) so that the total tax declaration is ambiguous. It is clearly possible that in sharp contrast to the expected utility criterium tax declaration goes down with the expected tax revenue criterium. If this happens, then shifting the tax

base towards the profit taxation will increase both production and tax evasion and decrease the final price. It is easy to see that analogous considerations are operative in the comparison between the profit tax and the unit tax.

3.2. Changes in 'progression'

In the analyses presented thus far changes in the tax rates have represented simultaneous changes in the marginal as well as the average rate of tax because the lump-sum transfer been kept fixed. In the following we study the effect of changes in pure 'progression' when the average rate of tax is kept constant either in the expected utility or in the expected tax revenue sense. To put it in a slightly different way, we are interested in the relative performance of proportional and linear progressive taxes.

Differentiating the expected utility function with respect to the tax rate x and the lump-sum transfer r and taking the first-order conditions (1i) and (1ii) into account defines the switch, which keeps EU constant

$$(18) \qquad dr = T^{Q} \left[\theta + g(1-\theta)h \right] dx \qquad \text{as } EU=EU^{*}$$

where $1 > h = U'(Z)/((1-\pi)U'(Y) + \pi U'(Z)) > 0$ and where T^{Q} is $R(1-v)$, $Q(1-v)$ and $R(1-\tau) - C - tQ = F$ for $x = \tau$, t and v respectively. Thus r and x are positively related in the tax schedule $xT(Q)-r$.[6] Since the lump-sum transfer does not affect production, a rise in 'progression' - a rise in x associated with a rise in r - will decrease production and increase

the final price under the ad valorem and unit taxation while having no effect under the profit taxation. Substituting the right-hand side of (18) for dr in $d\theta = \theta_x dx + \theta_r dr + \theta_Q dQ$ leads up to

$$(19) \qquad (d\theta/dx)_{EU=EU^*} = \underbrace{(T^o(1-\theta)/xT)(\theta + gh\theta_r xT)}_{(?)} + \underbrace{\theta_Q Q_x}_{(\leq 0)}$$

where T^o is $R(1-v)$, $Q(1-v)$ and F for $x = \tau$, t and v respectively. The effects of changes in 'progression', when the tax rates are compensated so as to keep EU constant, thus remain ambiguous in terms of tax declaration. This ambiguity is "guaranteed" by the direct offsetting effects of changes in x and r. Finally, if r is compensated so as to keep ET constant the switch between x and r is defined by

$$(20) \qquad dr = T^o dx + (\tau R' + t)dQ + (xT(1-\pi g)/\beta)d\theta \qquad \text{as } ET=ET^*$$

Again a rise in x associated with a compensating change in r will decrease production under the ad valorem and unit taxation while leaves it unchanged under the profit taxation for the same reason than earlier. Substituting the right-hand side of (20) for dr in the $d\theta$-expression yields

$$(21) \qquad (d\theta/dx)_{ET=ET^*} = G^{-1} \underbrace{((1-\theta)T^o/xT)(\theta + xT\theta_r)}_{(+)\qquad(?)} + \underbrace{(\tau R' + t)\theta_r Q_x}_{(\geq 0)}$$

where $G = 1 - \theta_r(1-\pi g)xT/\beta > 0$. Roughly for similar reasons than in the earlier case the direct tax declaration effect of the policy switch (20) is ambiguous. In contrast with the expected utility case the indirect

effect of the policy switch is now positive for the ad valorem and unit taxes; a rise in those taxes gives rise to a fall in production and government tax revenues so that in order to keep ET unchanged r has to decrease, which increases tax declaration, ceteris paribus. But the total effect of the policy of raising 'progression', however, remains ambiguous.

All in all, if we keep to the widely accepted hypothesis of decreasing absolute risk aversion changes in 'progression' under both policies cannot be unambiguously signed in terms of their tax declaration effects for the ad valorem, unit and profit taxation. But changes in 'progression' do affect production negatively and final price positively for the ad valorem and unit taxation.

4. CONCLUDING REMARKS

In this paper we have analyzed in a simple model of monopolistic firm the production, tax shifting and tax evasion effects of various policies under two alternative criteria: the policy changes have been developed both for the case when the expected utility of monopolistic firm and for the case when the expected tax revenues of government remain constant.

Results can be briefly summarized as follows: Under the policy of keeping the expected utility unchanged the ad valorem tax dominates the unit tax and the profit tax dominates both the ad valorem and unit taxes in the sense that shifting the tax base towards the tax which dominates will increase tax compliance and production and thus decrease the final price. This is not necessarily true, however, under the policy of keeping the expected tax revenues of government unchanged; particularly in terms of

tax evasion effects the ranking of policies may well be reverse from that obtained under the policy of keeping the expected utility unchanged. Finally, while a rise in 'progression' tends to decrease production and increase the final price, its tax evasion effects turn out to be a priori ambiguous under both policies.

In this paper we have used a simplest possible model of imperfect competition. An obvious area for further research is to look at these questions in more sophisticated frameworks of monopolistic and oligopolistic competition.

FOOTNOTES

1) This need not imply that government is risk neutral. To the extent that risks are independent across firms and the number of firms is large, the law of large numbers will guarantee government a constant total revenue despite uncertainty at the private level. Under these circumstances government is simply a more efficient risk-pooler than firms. To the extent that the law of large numbers does not operate e.g. because of 'business cycle risks', the assumption that government is risk neutral is presupposed.

2) For an analysis of the endogenous probability of detection case, see Marrelli (1984), from which this section draws.

3) Here we assume that neither the demand curve nor the 'supply curve' is completely inelastic. For a treatment of the comparative effects of the unit and ad valorem taxes under competition and monopoly, see Bishop (1968).

4) It is interesting to note that this price effect was already pointed out by Wicksell (1896), who called it "somewhat peculiar relationship".

5) In the light of the results presented above it is obvious (and can be shown) that shifting the tax base towards the profit taxation with the expected utility criterium will increase both production and tax declaration, when the unit tax serves as the compensating tax.

6) This linear tax schedule is progressive under the following definitions of progressivity, suggested by Musgrave and Thin (1948): (1) the average tax is increasing with income before tax, (2) the elasticity of the tax function with respect to income before tax is greater than one, (3) the elasticity of income after tax with respect to income before tax is less than one. The implications of their fourth possible definition of progressivity as the increasing marginal tax rate is not considered here. If a more progressive taxation should be unambiguously more redistributive according to the so-called Lorenz domination - which can be given some welfare justification - then the "residual progression" (3) is the only acceptable measure of progressivity (see Jakobsson (1976) and Eichhorn and Funke and Richter (1984), who provide some generalizations). In the case of the tax function $xT(Q)-r$ it is easy to see that the elasticity of the after tax income with respect to the before tax income decreases, when both x and r are increased. This happens in the case of the expected utility criterium and most likely also in the case of the expected tax revenue criterium. Undoubtedly, the most natural context to think about progression is in the case of many economic agents.

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