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TAX COMPETITION
AND LEVIATHAN

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TAX COMPETITION AND LEVIATHAN

Abstract

Whether one welcomes or regrets the downward pressure on tax rates that increasingly fierce international tax competition seems to be bringing depends on one's view of government. This paper attempts to synthesise the two extremes which, as in other areas of public finance, have dominated the debate, and which have typically been presented as stark alternatives: the view of government as a pure Leviathan (from which tax competition emerges as a useful constraint on policy-makers' exploitation of the citizenry), and the view of government as a benevolent maximiser of their citizens' welfare (from which tax competition emerges as a source of inefficiency calling for international co-ordination). Conditions are derived under which, when policy-makers are neither entirely benevolent nor wholly self-serving, tax co-ordination benefits the representative citizen. It is shown, for example, that the desirability or otherwise of international tax co-ordination turns on a simple comparison between the marginal excess burden from taxation and policy-makers' marginal propensity to waste.

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1 Introduction

In enhancing the mobility of capital, goods and people, increasing international economic integration means, to a large extent, increasing the international mobility of tax bases. This, in turn, raises the prospect of increasingly fierce international tax competition, as national authorities attempt to expand their tax bases by offering more favourable tax treatment than is available elsewhere.¹ Taxes on capital income, in particular, look increasingly vulnerable to international tax competition. Indeed such competition may already be a reality, with the worldwide tax reforms of the 1980s leaving the the average rate of corporate taxation in the OECD about 6 points lower at the end of the decade than at its start (a proportionate reduction of about 12 per cent), and the average top rate on interest income 13 points lower (a proportionate reduction of about 25 per cent).² The recent experience of tax reform in the Nordic countries is even more striking:³ in 1991, Sweden moved to a schedular tax system with a 30% flat rate tax on capital income (far below the previous top marginal rate); in 1992, Norway introduced a similar system but at the lower rate of 28%; Finland followed suit in 1993, but at the still lower rate of 25%. The proper interpretation of these developments is not clear-cut. It is hard to believe, however, that international tax competition is not an important part of the story. The perception that international tax competition is likely to become increasingly cut-throat has, in any event, come to play a major role in tax policy discussions, the question then arising as to whether some form of international tax coordination is appropriate. In the European Union, in particular, such measures have already been adopted in relation to commodity taxation (the abolition, at the start of 1993, of restrictions on the importation for personal use of tax-paid goods being accompanied by the imposition of minimum rates of indirect taxation) and, even more controversially, are under consideration for capital income taxation (with the proposal for a minimum withholding tax on interest income).

This paper addresses the deceptively simple question at the heart of these policy issues: Is international tax competition – or, by the same token, tax competition between lower-level governments in a federal structure – a good thing or a bad thing? Or, to put the point more precisely (and in the form that it will be addressed): Starting from the non-cooperative equilibrium, would the representative citizen benefit from, or be harmed by, some degree of international tax coordination?

Two widely divergent views dominate both the academic literature and the policy debate. In one, tax competition is an essentially straightforward instance of the presumption that non-cooperative behaviour will lead to inefficient outcomes.⁴ Thus Sinn

¹In addition to this 'base-stealing' motive, pointing to excessively low tax rates, there may be a 'tax exportation' motive pointing towards excessively high rates (a point emphasised in the context of commodity taxation by Mintz and Tulkens (1986)). In practice, however, it is the former concern that typically dominates the policy debate (the latter arising only for countries that are, in the relevant sense, 'large').

²The figures, from Owens (1993), are for 18 OECD countries.

³See, for instance, Sørensen (1994) and Tikka (1993).

⁴This is again a sweeping generalisation: there are circumstances in which non-cooperative behaviour by national welfare-maximisers leads to a constrained efficient outcome. With mobile labour, for instance, the Tiebout mechanism can generate an efficient outcome (albeit only under restrictive conditions); and, in a very different context, Kehoe (1989) shows that inter-jurisdiction tax competition can serve a useful purpose in eliminating the problem of time consistency in the taxation of

(1993), for instance, foresees a future for the European Union in which "...fiscal competition will wipe out redistributive taxes on mobile factors and reduce the tax system to one of mere benefit taxation." With this view of the world, attention focusses on the appropriate form of policy coordination: on the imposition of minimum tax rates, for example (analysed in Kanbur and Keen (1993)), or the use of corrective subsidies (analysed in Wildasin (1989)). The second view is radically different. It sees tax competition as serving a valuable purpose in supplementing inadequate constitutional constraints on the intrinsic pressures towards excessively high tax rates implied by policy-makers' pursuit of their own interests. Thus Brennan and Buchanan (1980) argue that "...the intergovernmental competition that a genuinely federal structure offers may be constitutionally 'efficient,' regardless of the more familiar considerations of interunit spillovers examined in the orthodox theory of fiscal federalism" (p.185), and that consequently "...tax competition among separate units ...is an objective to be sought in its own right." (p.186; italics suppressed). This view of the world has become increasingly influential.⁵ The British government, for example, resisted the Commission's initial proposals for indirect tax coordination on the grounds that without them "[t]he pressure on tax rates would in general be downwards, providing an essential antidote to the in-built pressures for increased public expenditure and taxation" (UK Treasury (1988); hyphen added).

These two, sharply contrasting views clearly reflect profoundly different perceptions of policy-making. In the first, governments are benevolent maximisers of their citizens' welfare. In the second, they are intrinsically untrustworthy revenue-maximisers. Perhaps not surprisingly, the conflict between these two views of tax competition has typically reduced to a conflict between these two perceptions of government. But these perceptions, at least in the present state of knowledge, are in turn little more than simple articles of faith. The conflict between the two views of tax competition has, consequently, proved rather sterile, with no clear guidance emerging for the pressing issues of practical policy-making.

The central purpose of this paper is to provide a framework within which these two sharply contrasting views of tax competition can be articulated and compared. For both, clearly, are extreme cases of a more general – and presumably more plausible – formulation in which policy-makers attach some value both to the welfare of their citizens and to the surplus that they are able to extract from the citizenry and put to their own uses. It is the analysis of this more general case that is undertaken here.

Clearly, one cannot hope to find any unambiguous answer to the central question – the desirability or otherwise of unfettered tax competition – from a model that is specifically designed to encompass both the case in which policy-makers are entirely benevolent (towards their own nationals), in which it is almost certainly undesirable, and the case in which they are self-seeking revenue-maximisers, in which the opposite is almost certainly true. (We shall though see that there are interesting intermediate cases in which, surprisingly, one can give a definite answer). One can, however, hope to clarify the deeper economic forces at work, developing some sense, for example, of the conditions under which tax coordination is likely to be desirable even when policy-makers fall short of perfect. Discussion of these issues can then move on to argument

capital income.

⁵It has also spawned a large (and largely inconclusive) empirical literature: see, for example, Oates (1985).

over the likely magnitudes of critical variables, a more productive exercise than the usual exchange of prejudices as to the nature of government. There may, indeed, be circumstances in which those with very different views of the world can nevertheless agree that there is a *prima facie* case for (or against) coordination.

The model we use for this purpose, described in Section 2, is one of tax competition for internationally mobile capital. The bones of the model are standard (being familiar from, for instance, Zodrow and Mieszkowski (1986)); the key departure is in the very general form assumed for the policy-makers' preferences. Section 3 then examines the case for international tax coordination when the tax on mobile capital is the only revenue source available to governments. Section 4 takes up the (more complex) case in which they also have access to an immobile tax base. Section 5 summarises and concludes.

2 The Model

We analyse a model of tax competition among many identical small jurisdictions ('countries'). In each there is a representative consumer, with strictly quasi-concave preferences $U(X, Y, G)$ defined over private goods X and Y and a local public good G . It is further assumed that⁶ $U_{GG} < 0$.⁷ Each consumer is endowed with a quantity $\bar{K}$ of capital, which may be invested at home or abroad (consumers themselves being completely immobile). Denoting by K^i the quantity of capital employed in country i , output in i is given by $F(K^i)$, with $F' > 0$ and $F'' < 0$. Country i imposes a source-based tax on capital employed of T^i per unit. Capital being freely mobile, its after-tax return must, in equilibrium, be the same in all locations. Denoting that common net return by ρ , employment of capital in i is thus determined by the arbitrage condition

$$F'(K^i) - T^i = \rho, \quad (2.1)$$

which implicitly defines $K^i = K(\rho + T^i)$, with

$$K' = 1/F'' < 0. \quad (2.2)$$

In addition to the tax on capital, two further sources of revenue are potentially available. The first is a proportional tax τ on the rents $F - F'K$ to fixed factors (ownership of which is entirely domestic). The second is an indirect tax, levied on a destination basis and at the specific rate t , on good X ; good Y is assumed (without loss of generality, given the presence of the rent tax) to be untaxed. The producer prices of X and Y are assumed to be constant and set, by choice of unit, to unity. Denoting the consumer price of X by $Q = 1 + t$, the consumer thus faces the budget constraint

$$QX + Y = (1 - \tau)\{F - F'K\} + \rho\bar{K} \equiv M. \quad (2.3)$$

⁶Derivatives are indicated by primes for functions of one variable, and by subscripts for functions of several.

⁷As will become clear shortly, the role played in the model by the preferences of the typical policy-maker restricts the representation of those of the representative consumer.

Indirect utility is denoted by $H(Q, G, M)$.

To this point, the model is essentially standard. Our central departure from previous models of tax competition is in the assumed objective function of the policy-maker in each country. To explore the tension between the two views of the world described in the Introduction, we suppose that policy-makers are neither wholly benevolent nor wholly self-serving, but instead have quasi-concave preferences $V(C, U)$ defined over the welfare U of their representative citizen⁸ – reflecting perhaps a genuine empathy, perhaps a favourable impact of U on the policy-maker's chances of re-election – and some item of 'socially unproductive' public expenditure C which, while financed from general revenues, benefits only the policy-maker. For want of a convenient label, we refer to the typical policy-maker – there being one such in each country, each with the same preferences – as a 'Leviathan'.⁹

Though essentially *ad hoc*, this characterisation of policy-makers' preferences is a convenient way of encompassing a wide range of possibilities. It obviously captures as special cases the two extremes on which previous discussions have focussed: with $V(C, U) = U$, the formulation reduces to simple welfare maximisation; with $V(C, U) = C$, it reduces to the maximisation of tax revenue. The particular appeal of the device, however, is that it enables one to explore the implications of less extreme views of the policy process. One obvious possibility to consider – which proves, as we shall see, to have a striking implication – is that $V(C, U) = \alpha C + (1 - \alpha)U$, with $\alpha \in (0, 1)$, so that Leviathan's maximand is simply a weighted average of the expenditure diverted to her own uses and the welfare of the consumer. Another is that in which Leviathan derives benefit $A(C)$ from wasteful public expenditure when in office and is re-elected with probability $p(U)$; normalising the pay-off when out of office to zero, one might then take $V(C, U) = p(U)A(C)$. To focus on cases intermediate to the extremes of welfare and revenue maximisation, and to avoid tedious qualifying statements, it will be assumed throughout the paper – except when indicated otherwise – that both V_C and V_U are strictly positive. This does preclude the polar extremes of revenue and welfare maximisation just mentioned. Encompassing them would be straightforward – it is only necessary to add non-negativity constraints on G and C to the various tax design problems with which the representative Leviathan will be confronted as the analysis proceeds¹⁰ – but would clutter the exposition. The price of neglecting these constraints is small, but should be borne in mind: the various conditions and expressions to be derived do not in general apply unamended to the extreme cases of welfare and revenue maximisation.

The tax and spending decisions of each country are thus taken so as to maximise $V(C, U)$ subject to both optimisation by the representative consumer and the revenue constraint¹¹

⁸They attach no importance to the well-being of citizens abroad.

⁹It should be emphasised, however, that this term is used here only to suggest an element of self-seeking in policy-makers' decision-making, not – a sense in which the term is often used – that such a motive is the only one present.

¹⁰When $V(C, U) = U$, it is the constraint $C \geq 0$ that bites; when $V(C, U) = C$, it is that $G \geq 0$.

¹¹Combining (2.3) and (2.4) gives

$$C + G + X + Y = F + \rho\{\bar{K} - K\},$$

so that the resource constraint for the aggregate economy is satisfied: national expenditure at world prices equals national output plus net property income from abroad.

$$C + G = \tau\{F - F'K\} + TK + tX, \quad (2.4)$$

where we assume the producer prices of C and G to be constant, and normalise both to unity. Each Leviathan perceives its country to be small, and so takes ρ as given in these decisions.

The broad strategy of the analysis that follows is straightforward. Having first characterised the symmetric non-cooperative equilibrium that emerges from uncoordinated decision-making by the many Leviathans, we consider the effects of a small multilateral increase in the tax on mobile capital, the central question being: Bearing in mind the Leviathans' ability to reoptimise their other tax and spending decisions in the face of a collective increase in T , does tax coordination ultimately increase or reduce U , the well-being of the representative citizen?

3 Fully Mobile Tax Base

In this section we address the question just posed for the case in which the tax base facing each Leviathan is entirely mobile between countries. For this, we specialise the model just described by supposing that rents and consumption are untaxed, and so assume throughout this section that

$$\tau = t = 0. \quad (3.1)$$

With $t = 0$, there is no loss of generality in simply supposing that good Y does not exist.

3.1 The Non-Cooperative Equilibrium

In the absence of coordination between them, each Leviathan's problem is simply to choose the amount of wasteful expenditure C , and the tax rate on capital T , so as to maximise $V[C, U(X, G)]$ subject to the constraints represented by equations (2.3), (2.4) and (3.1). It is useful – for both intuition and the later analysis of coordination – to conceive of the representative Leviathan solving this problem in two stages.

In the first stage, Leviathan chooses T and the amount of 'beneficial' public expenditure G so as to maximise the amount of wasteful public expenditure C , subject to the constraint that the representative citizen attains some specified level of utility U . It is convenient to formulate this as an unconstrained problem, for this purpose inverting direct utility $U(X, G)$ to give $G(X, U)$, the quantity of G needed to achieve utility U when private consumption is X . Note, for later use, that¹²

$$G_X = -\frac{U_X}{U_G} \quad (3.2)$$

¹²Equations (3.2) and (3.3) follow on differentiating $U(X, G(X, U)) = U$ with respect to X and U respectively.

$$G_U = \frac{1}{U_G}. \quad (3.3)$$

From the revenue constraint (2.4) and (3.1), and substituting for X from (2.3), the first stage problem of maximising C given ρ and U is then simply to

$$\max_T C(\rho, T, U) \quad (3.4)$$

where

$$C(\rho, T, U) = TK(\rho + T) - G(F[K(\rho + T)] - F'[K(\rho + T)]K(\rho + T) + \rho\bar{K}, U). \quad (3.5)$$

The first order condition for this problem,

$$C_T(\rho, T, U) = 0, \quad (3.6)$$

implies, using (2.2) and (3.2), that

$$\frac{U_G}{U_X} = \frac{K}{K + TK'} > 1. \quad (3.7)$$

It is sufficient for the second order condition to be satisfied that $K'' < 0$.¹³

Condition (3.7) is exactly the condition for a constrained efficient allocation of consumption between public and private goods when only the distorting tax T is available: it is exactly analogous, for instance, to the standard expression for the marginal social cost of public funds when the only tax available is one on elastically supplied labour.¹⁴ The actual levels of provision of G and X , however, are of course liable to be very different. Intuitively, since Leviathan derives some benefit from U she will ensure that any resources she chooses to leave in the private sector are allocated efficiently between G and X ; but her pursuit of C will mean that some resources are taken out of the private sector and diverted to her own use.

Denoting the maximum value function for the first stage problem – the conditionally maximised level of wasteful expenditure – by $C(\rho, U)$, the second stage of Leviathan's problem is then to

$$\max_U V[C(\rho, U), U] \quad (3.8)$$

The solution to this problem is illustrated in Figure 1, which will be a source of simple intuition in much that follows. The first-order condition for (3.8) is

¹³The proof of this is available from the authors on request.

¹⁴Ballard and Fullerton (1992) provide a intuitive rationale of that condition, one that applies equally well here.

$$V_C[C(\rho, U), U]C_U(\rho, U) + V_U[C(\rho, U), U] = 0, \quad (3.9)$$

whilst the assumption that $U_{GG} < 0$ is readily shown¹⁵ to ensure that the feasible set in Figure 1 is strictly convex as drawn, and hence that the second order condition is satisfied.

At the second stage, Leviathan thus simply equates her marginal rate of substitution between wasteful public expenditure on the one hand and the citizen's utility on the other, V_U/V_C , to the marginal price $-C_U$ that she must pay for U in terms of wasteful public expenditure foregone. Differentiating with respect to U in (3.5) and using (3.3) shows that marginal price to be

$$-C_U = G_U = \left(\frac{1}{U_G} \right). \quad (3.10)$$

The reason for this is simply that spending £1 less on C leaves £1 more to spend on G and so increases U by U_G ; conversely, increasing U by one unit means foregoing $1/U_G$ units of C .

We assume the existence of a symmetric non-cooperative equilibrium. Each Leviathan then sets the same tax T , and the net rate of return ρ is such that the amount of capital employed in each country is exactly $\bar{K}$.

3.2 The Effects of Coordination

Suppose now that, starting from the non-cooperative equilibrium, all countries agree to a small increase dT in the tax on mobile capital, whilst retaining their discretion as to the pattern of public expenditure.

¹⁵By differentiating in (3.10) below and using (3.3).

To identify the effect on U , consider the problem that the typical Leviathan now faces. Rather than choosing their T^i in pursuit of their own interests, each Leviathan now agrees to set a common T . The only decision that each Leviathan then has to make is that of G . This leaves only the analogue to the second stage problem of the preceding sub-section:

$$\max_U V[C(\rho, T, U), U] \quad (3.11)$$

which differs from (3.8) in that T is now fixed at some, for the moment arbitrary, level. The first-order condition for (3.11) differs in an analogous way from (3.9), and is written

$$\Omega(\rho, T, U) \equiv V_C[C(\rho, T, U), U]C_U(\rho, T, U) + V_U[C(\rho, T, U), U] = 0, \quad (3.12)$$

which implicitly defines U as a function of the common tax rate T .

To address the consequences of a coordinated increase in T from the non-cooperative equilibrium, the strategy is then to perturb (3.12) and evaluate the effect on U at the non-cooperative equilibrium. The key in doing so is to note that such a coordinated increase in T will leave capital employed in each country unchanged, at $\bar{K}$, and that the arbitrage condition (2.1) consequently implies that

$$d\rho = -dT. \quad (3.13)$$

Proceeding in this way one arrives at:

PROPOSITION 1: *Starting from the non-cooperative equilibrium, a small multilateral increase in the tax rate T on mobile capital leads to an increase in the welfare of the representative consumer if and only if:*

$$\left(1 - \frac{U_G}{U_X}\right) \left\{ V_{CC} - V_{UC} \left(\frac{V_C}{V_U} \right) \right\} + V_U \left\{ U_{GG} - U_{GX} \left(\frac{U_G}{U_X} \right) \right\} > 0. \quad (3.14)$$

Proof: Perturbing (3.12) and using (3.13) gives

$$dU = \left(\frac{\Omega_\rho - \Omega_T}{\Omega_U} \right) dT. \quad (3.15)$$

Since $\Omega_U < 0$ by the second-order condition for the second step of Leviathan's problem (satisfied, recall, by virtue of the assumption that $U_{GG} < 0$), the sign of the effect of a coordinated increase in T on U is thus given by the sign of $\Omega_T - \Omega_\rho$, evaluated at the symmetric non-cooperative equilibrium. To investigate this, note first, from (3.12), that

$$\Omega_\rho = V_{CC}C_\rho C_U + V_C C_{U\rho} + V_{UC}C_\rho \quad (3.16)$$

$$\Omega_T = V_{CC}C_T C_U + V_C C_{UT} + V_{UC}C_T \quad (3.17)$$

From the first order conditions (3.6) and (3.9) for Leviathan's problem in the absence of coordination, evaluating (3.16) and (3.17) at the non-cooperative equilibrium gives

$$\Omega_T - \Omega_\rho = V_C(C_{UT} - C_{U\rho}) + C_\rho \left(V_{CC} \left(\frac{V_U}{V_C} \right) - V_{UC} \right). \quad (3.18)$$

The next step is to evaluate the derivatives of $C(\rho, T, U)$ in (3.18). Differentiating with respect to ρ in (3.5) gives, using (2.2), (3.2) and (3.7),

$$C_\rho = TK' - (K + TK') \left(\frac{K - \bar{K}}{\bar{K}} \right) \quad (3.19)$$

and hence

$$C_{U\rho}(\rho, T, U) = 0. \quad (3.20)$$

Differentiating (3.10) and using (2.2), at the non-cooperative equilibrium

$$C_{UT}(\rho, T, U) = G_{UX}\bar{K} \quad (3.21)$$

$$= \frac{\bar{K}}{U_G^2} \left\{ U_{GG} \left(\frac{U_X}{U_G} \right) - U_{GX} \right\}, \quad (3.22)$$

the second equality following from differentiation of (3.3). Substituting from (3.20) and (3.22) into (3.18), noting from (3.19) and (3.7) that (at the symmetric non-cooperative equilibrium) $C_\rho = \bar{K}((U_X/U_G) - 1)$, one finds

$$\begin{aligned} \Omega_T - \Omega_\rho &= V_C \bar{K} \left(\frac{1}{U_G} \right)^2 \left\{ U_{GG} - U_{GX} \left(\frac{U_G}{U_X} \right) \right\} \\ &+ \left(\frac{U_X}{U_G} - 1 \right) \bar{K} \left(\frac{V_U}{V_C} \right) \left\{ V_{CC} - V_{UC} \left(\frac{V_C}{V_U} \right) \right\}. \end{aligned} \quad (3.23)$$

The result follows from (3.23) on noting from (3.10) and (3.12) that $(1/U_G)^2 = (V_U/V_C)^2$ and dividing by $V_U U_X \bar{K}/V_C U_G$. $\square$

Proposition 1 shows the welfare effect of coordination¹⁶ to turn on the balance between two effects. These look somewhat forbidding, but have straightforward interpretations. We discuss each in turn.

Recalling from (3.7) that $(U_G/U_X) > 1$ in the non-cooperative equilibrium, the first term in (3.14) is strictly positive – that is, is conducive to a welfare gain from coordination – if and only if

¹⁶Leviathan herself, it is straightforward to show, always gains from coordination (by $dV = -V_C TK' dT$): henceforth when we speak simply of 'welfare', we mean that of the representative citizen.

$$V_{CC} - V_{UC}(V_C/V_U) \leq 0. \quad (3.24)$$

This, in turn, is precisely the condition for U to be normal in Leviathan's preferences.¹⁷ One would presumably typically expect this to be so. In the special case $V(C, U) = p(U)A(C)$ mentioned earlier, for instance, normality simply requires that $A(\cdot)$ be strictly concave.

The presumption is thus that the first effect in Proposition 1 will tend to make coordination beneficial. The explanation is straightforward. Since capital employed in each country remains constant at $\bar{K}$, the 'impact' effect of coordination is akin to a lump sum transfer from the citizen to Leviathan of (from (2.3) and (3.13)) $\bar{K}dT = -dX$. If U is normal in Leviathan's preferences, she will spend part of this increase in her lump sum income on raising U . (Note, for later purposes, that the only way in which she can do this is by increasing expenditure on G). Diagrammatically, this shift towards lump-sum taxation implied by coordination leads to an outward shift of the opportunity locus in Figure 1: for any given level of C , for instance, the transfer reduces the representative citizen's welfare by $U_X \bar{K}dT$; but since $U_G > U_X$ at the non-cooperative equilibrium, this is more than offset by the welfare gain from of $U_G \bar{K}dT$ from the additional public expenditure which that transfer finances. Assuming U to be normal, coordination thus exerts an 'income effect' on Leviathan that acts to the advantage of the representative citizen.

The second term in (3.14) takes the same sign as $U_{GG} - U_{GX}(U_G/U_X)$. If, as one would usually presume, the public good G is normal in the preferences of the representative citizen, coordination is therefore on this account detrimental. With the first term in (3.14) naturally thought of as an income effect, this second effect is most usefully interpreted as a 'relative price' effect, the relevant relative price being that of C in terms of U . To develop this interpretation, suppose that Leviathan's income elasticity of demand for U is zero, so that the first term in (3.14) vanishes. In response to the receipt of lump sum revenue associated with the impact effect of coordination, Leviathan will then seek to keep U unchanged. This will involve spending just enough of that additional revenue on G to maintain U unchanged in the face of the reduction in private consumption dX . But this act of compensation will in itself change the relative price, in terms of C , that Leviathan perceives she must pay for U . For recall from (3.10) that this relative price is given by $-C_U = 1/U_G$. With X falling and G rising in such a way as to leave U unchanged, the relative price of U will rise if and only if¹⁸ $U_{GG} - U_{GX}(U_G/U_X) < 0$; which is precisely the condition for this second effect to be harmful. Diagrammatically, the opportunity locus in Figure 1 not only shifts outward: so long as G is normal, it becomes steeper, pushing towards a reduction in U . Put very crudely, the intuition is straightforward. To the extent that Leviathan compensates the representative consumer for the increased tax on capital (or indeed over-compensates him, when U is normal in her preferences) by spending some of the revenue it yields on G , the consequent reduction in the consumer's marginal valuation of G makes it less expensive, in terms of foregone U , for Leviathan to divert revenue away from G and towards her own uses.

¹⁷The result invoked here and used further below can be found, for instance, in Hicks (1939, p.308): in the standard problem of maximising a smooth utility function $u(x, y)$ subject to the budget constraint $p_x x + p_y y = m$, the necessary and sufficient condition for x to be normal (given $u_x, u_y > 0$) is $u_{yy} - u_{xy}(u_y/u_x) > 0$.

¹⁸This follows on differentiating $U_G(X, G(X, U))$ with respect to X and using (3.2).

The overall effect of coordination on the welfare of the representative consumer thus depends on the balance between an income effect that would be presumed advantageous and a (more complex) relative price effect that would be presumed harmful. The income effect is greater (coordination more likely to be beneficial), other things being equal:

- (i) the higher is Leviathan's income elasticity of demand for U , and
- (ii) the higher is the marginal social cost of public funds, U_G/U_X , in the non-cooperative equilibrium (since the greater is then the potential efficiency gain from the element of lump sum taxation implied by coordination).

The relative price effect is more marked (coordination more likely to be harmful), other things equal:

- (i) the more rapidly the (compensated) marginal willingness to pay for the public good decreases with the level enjoyed.

As one would expect, the welfare effect of coordination is, in general, ambiguous. There are, however, two special cases in which, somewhat surprisingly, it can be signed by simple preference restrictions. The first is that, mentioned earlier, in which $V(C, U) = \alpha C + (1 - \alpha)U$. The first term in Proposition 1 then vanishes, and coordination is therefore unambiguously harmful to the representative consumer (so long only as G is normal in his preferences). This is so, it should be emphasised, irrespective of α : so long as Leviathan attaches some positive weight to expenditure diverted to her own use, however small, coordination will be damaging. The second special case is that in which the marginal utility that the representative consumer derives from G is almost¹⁹ independent of G . It is then the second term in Proposition 1 that vanishes: so long only as U is normal in Leviathan's preferences, coordination is in this case unambiguously beneficial, irrespective of the weight that Leviathan attaches to U .

Proposition 1 brings out the fundamental determinants of the final welfare effect of coordination. But there is another useful way of expressing the condition for that effect to be beneficial: one which is in a formal sense more superficial, yet which has appeal as a simple rule of thumb, even though (or perhaps because) it does not make full use of the restrictions of the model. To develop this, note first that the effect of coordination on U is simply

$$dU = U_X dX + U_G dG. \quad (3.25)$$

Since $dX = -\bar{K}dT = -dR$, where $R = TK$ denotes total revenue, and $dG = dR - dC$, (3.25) can be written as

$$dU = \left\{ 1 - \left(\frac{U_X}{U_G} \right) - \frac{dC}{dR} \right\} U_G dR. \quad (3.26)$$

¹⁹Recall that the limiting case in which $U_{GG} = 0$ has been precluded by assumption.

Using (3.7) in (3.26) then gives:

PROPOSITION 2: *Starting from the non-cooperative equilibrium, a small multilateral increase in the tax on mobile capital increases the welfare of the representative citizen if and only if:*

$$-\frac{TK'}{K} > \frac{dC}{dR}. \quad (3.27)$$

Coordination is thus beneficial if and only if the elasticity of the tax base exceeds Leviathan's marginal propensity to waste tax revenue.

The appeal of this kind of condition, as discussed in the Introduction, is in helping to move discussion of the very practical policy issues raised there away from the unproductive exchange of views on the nature of government and on to the evaluation of quantities which, though by no means easy to measure, are at least relatively well-defined. By the same token, it opens up room for consensus even between those with divergent views. Suppose, for instance, that it is agreed that the elasticity of the tax base is 0.4; then it does not matter whether one thinks that Leviathan would waste 5% of any additional revenue or 30%: coordination will in either case benefit the representative citizen.

The rule in Proposition 2 is nevertheless some way from practical applicability. In particular, it is unreasonable to suppose countries' tax bases to be entirely mobile between them; nor, almost by the same token, is it reasonable to conceive of international coordination removing all domestic discretion in tax policy. The question then arises as to how the analysis must be modified when each Leviathan has access to some immobile tax base. It is to this question that we now turn, reverting for this purpose to the general model of Section 2.

4 Partially Immobile Tax Base

Recall that in the general model of Section 2 Leviathan has access not only to the tax T on mobile capital but also to two taxes with immobile bases. One is the tax τ on the rents that accrue to the representative citizen. This is a lump-sum tax, but is subject to the limitation that rents cannot be taxed at more than 100%. The other is the distortionary commodity tax t .

This section deals in turn with the two possible cases: that in which rents are taxed at less than 100% in the non-cooperative equilibrium and that in which they are fully taxed. The second of these cases, as will be seen, is much more complex than the first.

4.1 Rents taxed at less than 100%

The intuition for this case is straightforward (the formalities being in Appendix A).

4.1.1 The Non-cooperative equilibrium

It is routine to show that if Leviathan chooses to set $\tau < 1$ then she will also choose to set $t = 0$: for with $V_U > 0$, Leviathan always prefers to raise taxes in a non-distorting way since – by definition – this imposes the least possible welfare cost on the representative consumer. For the same reason, T will also be zero. Revenue is thus raised entirely by lump sum taxation (and the provision of G follows the Samuelson rule).

4.1.2 The Effects of Coordination

Coordination is in this case irrelevant, in the sense that it ultimately has no effect on U . The reason is simple. As emphasised in Section 3, coordination involves a lump-sum transfer of revenue to Leviathan from the citizen; but in the non-cooperative equilibrium with – as just noted – only rents taxed, Leviathan was already able to raise revenue, at the margin, in a lump-sum manner. Since the level of lump-sum taxation in the non-cooperative equilibrium is chosen by Leviathan to be less than the maximum possible, coordination, which increases the scope for raising lump-sum tax revenue, will simply lead to the replacement of one lump sum tax by another, with Leviathan reducing the tax on rents to offset the effects on both revenue and welfare of the increased taxation of mobile capital.

4.2 Rents fully taxed

We turn now to the case in which, with rents taxed at 100%, Leviathan uses commodity taxation in the non-cooperative equilibrium. As in Section 2, we first characterise the non-cooperative equilibrium and then examine the effects of a multilateral increase in the tax on mobile capital.

4.2.1 The Non-cooperative Equilibrium

The representative Leviathan's problem is now to maximise $V(C, U)$ by choice of t (and hence Q), T , and G , subject to the revenue constraint (2.4), which with $\tau = 1$ (and using (2.1)) is now

$$C = F - \rho K + tX - G, \quad (4.1)$$

and subject also to optimisation by the representative consumer. It is again helpful to conceive of this problem as comprising two steps.

At step one, Leviathan takes T as given and chooses G and t to maximise C , as given in (4.1), subject to the constraint²⁰ that the representative consumer achieves utility of at least U . Recalling that indirect utility is $H(Q, G, M)$ and that now $M = \rho \bar{K}$, the Lagrangean for this problem is

²⁰It is easily seen that this constraint will bite.

$$\mathcal{L} \equiv F[K(\rho + T)] - \rho K(\rho + T) + tX(Q, G, \rho \bar{K}) - G + \lambda \{H(Q, G, \rho \bar{K}) - U\} \quad (4.2)$$

The first order conditions for (an interior solution to) the step one problem thus include

$$\mathcal{L}_t = X + tX_Q + \lambda H_Q = 0 \quad (4.3)$$

$$\mathcal{L}_G = tX_G - 1 + \lambda H_G = 0, \quad (4.4)$$

which imply (making use of Roy's identity, $X = -H_Q/H_M$) that

$$\lambda = \frac{1 - tX_G}{H_G} \quad (4.5)$$

$$\frac{H_G}{H_M} = \frac{(1 - tX_G)X}{X + tX_Q} \quad (4.6)$$

The second order conditions for this problem are problematic: it does not, in general, have convenient concavity properties. This difficulty is familiar from the analysis of optimal commodity taxation (see, for instance, Harris (1975)), and is discussed further in Appendix B. To proceed, we simply assume the second order conditions to hold.

Just as in Section 3, so here too the rule that Leviathan follows for the provision of G (equation (4.6)) is exactly that which a wholly benevolent policy-maker would follow. And for the same reason: it is in Leviathan's interest to make best use of those resources that are made available for the representative consumer.

At the second step, Leviathan chooses T and U to maximise $V[C(\rho, T, U), U]$, where $C(\rho, T, U)$ denotes the maximised value from the first step problem. The first order conditions for this are

$$V_C C_T = 0 \quad (4.7)$$

$$V_C C_U + V_U = 0. \quad (4.8)$$

Consider first the implications of (4.7). Applying the envelope theorem in (4.2) and using (2.1) gives

$$C_T(\rho, T, U) = \mathcal{L}_T = TK'(\rho + T), \quad (4.9)$$

and hence (4.7) implies that $T = 0$ in the non-cooperative equilibrium. This is the production efficiency result of Diamond and Mirrlees (1971) in a somewhat different guise. For a small open economy, the benevolent policy maker who, as here, is able to tax away all rents and is unconstrained in the deployment of other tax instruments, will not wish to tax mobile capital since the burden of doing so will eventually fall on rents, with an additional inefficiency arising from the reduced return to the immobile factor as a consequence of the capital outflow. By the now familiar argument, Leviathan's

interest in the well-being of the representative consumer means that exactly the same concern will apply in the present context.

The first order condition (4.8) implies that

$$\frac{V_U}{V_G} = -C_U \quad (4.10)$$

where, applying the envelope theorem to (4.2) once more and using (4.5),

$$C_U = -\lambda = -\left(\frac{1 - tX_G}{H_G}\right). \quad (4.11)$$

The qualitative features of the solution to the second step of Leviathan's problem are thus just in Section 3, where the tax base was fully mobile, and as illustrated in Figure 1. The marginal cost to Leviathan of wasteful public expenditure again reflects the reciprocal of the marginal utility to the representative consumer of the public good G , but now adjusted in recognition that the indirect effect on commodity tax revenues means that raising G by one unit now costs only $1 - tX_G$. With this small difference, the intuition for the form of C_U is unchanged, though note that in the present context Leviathan, in contemplating an increase in U , has two devices she can use: increasing G (as in Section 3) and/or reducing the indirect tax t . At the optimum, she must be indifferent the two; hence the marginal cost of U in the non-cooperative equilibrium is again simply the revenue foregone by increasing G sufficiently to raise U by one unit.

4.2.2 The Effects of Coordination

The analysis of the effects of a coordinated increase in the tax on mobile capital proceeds in the same way as in Section 3. With T predetermined – and hence each K^i fixed at $\bar{K}$ – (4.8) implicitly defines U as a function of T . Noting that (3.13) again applies, so that a coordinated increase in T implies a lump sum transfer to each Leviathan of $\bar{K}dT$, perturbation of (4.8) leads to:

PROPOSITION 3: *Starting from the non-cooperative equilibrium, a small multilateral increase in the tax on mobile capital increases the welfare of the representative citizen if and only if*

$$C_\rho \left(\frac{V_U}{V_G}\right) \left\{ V_{CC} - V_{UC} \left(\frac{V_C}{V_U}\right) - \right\} - V_C C_{U\rho} > 0 \quad (4.12)$$

where, denoting the compensated demand for X by $X^u(Q, G, U)$,

$$C_\rho = t \left(\frac{X_Q^u}{X}\right) \bar{K} \leq 0 \quad (4.13)$$

at the non-cooperative equilibrium.

Proof: Perturbing (4.8), the same structure of argument as in the proof of Proposition 1 (using (3.13) and the implication of (4.7) that $C_T = 0$) shows dU to have the same sign as the right hand side of (3.18), with $C(\rho, T, U)$ now being the maximised value for the first step problem in (4.2): call this (3.18'). From (4.9), $C_{UT} = 0$; using this in (3.18') gives (4.12).

Equation (4.13) follows on using the envelope theorem to find from (4.2) that

$$C_\rho = (F' - \rho)K' - K + (tX_M + \lambda H_M)\bar{K} \quad (4.14)$$

and simplifying by use of (2.1), the feature of the non-cooperative equilibrium that $T = 0$, (4.3), Roy's identity and the Slutsky equation. $\square$

The first term in (4.12) is directly analogous to the first term in Proposition 1. Except when all substitution effects are zero (in which case it vanishes)²¹, this term is positive – coordination is on this account beneficial – if and only if U is normal in Leviathan's preferences. The strength of this effect depends on C_ρ , which, as is clear from (4.13), is closely related to the marginal deadweight loss from commodity taxation. Thus C_ρ plays a role similar to that of $(U_X/U_G) - 1$ in Proposition 1: the greater the marginal deadweight loss, the greater the potential efficiency gain from the movement towards lump sum taxation implied by coordination.

At least conceptually, the interpretation of the second term in (4.12) is straightforward: if $C_{U\rho} > 0$, the reduction in the net return ρ implied by coordination increases $-C_U$, the marginal cost to Leviathan of the citizen's welfare. The opportunity locus in Figure 1 then becomes steeper, a relative price effect that tends to reduce U : coordination is then, on this account, detrimental.

It is not easy, however, to proceed beyond this generality. The complexity of Leviathan's optimisation problem is such that we have as yet been unable to find a transparent interpretation of $C_{U\rho}$ in terms of the underlying structure of preferences.²² In particular, it does not seem possible to sign $C_{U\rho}$ for the general case. When the tax base is partially immobile, there thus seems to be no general condition for signing the relative price effect as transparent as the normality condition derived in the simpler circumstances of Section 2.

There is, however, one useful special case in which the relative price effect has a simple interpretation, and can be signed. This is that in which preferences are of the form

$$H(Q, G, M) = h[\Gamma(Q, M), G] \quad (4.15)$$

where $h(\Gamma, G)$ is quasi-concave and strictly increasing in both arguments and, further,

$$\Gamma(Q, M) = \gamma(Q) + M \quad (4.16)$$

²¹In this case the commodity tax is lump sum, so that we are effectively back to the case of subsection 4.1: $C_\rho = C_{U\rho} = 0$, and coordination leaves welfare unaffected.

²²To see the complexity, note that in differentiating either C_U in (4.11) with respect to ρ or C_ρ in (4.13) with respect to U , account must also be taken of the induced changes in the solutions $G(\rho, T, U)$ and $Q(\rho, T, U)$ to the first step problem.

where $\gamma(\cdot)$ is decreasing, convex and $\gamma''' \geq 0$. Intuitively, the restriction in (4.15) implies that preferences can be thought of as being defined over the public good G and a composite private good Γ . It implies, in particular, that the Marshallian demand for X is independent of G . The quasi-linear form in (4.16) imposes the further restriction that the demand for X is independent of M (all income effects then attaching to the good Y in the background). The first two restrictions on γ ensure, respectively, that $X > 0$ and $X_Q < 0$; the third implies that $X_{QQ} \leq 0$.

Such preferences give:

PROPOSITION 4: *If the representative citizen's preferences are of the form $H(Q, G, M) = h[\Gamma(Q, M), G]$, as described above, then*

$$C_{U\rho} = \left\{ h_{GG} - h_{G\Gamma} \left(\frac{h_G}{h_\Gamma} \right) \right\} \frac{G_\rho}{(h_G)^2}, \quad (4.17)$$

where $G_\rho(\rho, T, U) < 0$. Thus $C_{U\rho} > 0$ if and only if the composite private good Γ is normal.

Proof: With $X_G = 0$, (4.11) becomes

$$C_U = - \left(\frac{1}{H_G[1 + t(\rho, T, U), G(\rho, T, U), \rho\bar{K}]} \right) \quad (4.18)$$

where $t(\rho, T, U)$ and $G(\rho, T, U)$ denote the solutions to the first step problem (4.2). Hence

$$C_{U\rho} = \left(\frac{1}{H_G} \right)^2 \{ H_{GQ}t_\rho + H_{GG}G_\rho + H_{GM}\bar{K} \}. \quad (4.19)$$

Since $t(\cdot)$ and $G(\cdot)$ meet the constraint of the step one problem in (4.2), $H[1 + t(\rho, T, U), G(\rho, T, U), \rho\bar{K}] = U$, they satisfy

$$H_Q t_\rho + H_G G_\rho + H_M \bar{K} = 0. \quad (4.20)$$

Solving (4.20) for t_ρ and substituting into (4.19) gives

$$C_{U\rho} = \left(\frac{1}{H_G} \right)^2 \left\{ \left(H_{GG} - H_{GQ} \left(\frac{H_G}{H_Q} \right) \right) G_\rho + \left(H_{GM} - H_{GQ} \left(\frac{H_M}{H_Q} \right) \right) \bar{K} \right\}. \quad (4.21)$$

Differentiating Roy's identity with respect to G and using $X_G = 0$ gives

$$H_{GM} = H_{GQ} \left(\frac{H_M}{H_Q} \right), \quad (4.22)$$

so that the final term in (4.21) vanishes. Using in the first term the restrictions implied by (4.15) and (4.16) (that, for example, $H_{GQ} = h_{G\Gamma}\gamma'$), (4.22) gives (4.17).

It remains to show that in this case $G_p < 0$; this is established in Appendix B. $\square$

This result – that the relative price effect is adverse if a normality condition on the representative citizen's preferences is satisfied – is closely analogous to that of Proposition 1 for the situation in which the tax base is entirely mobile, and bears a similar interpretation. To the extent that Leviathan seeks to compensate the representative consumer for the harmful impact effect of reform on U , the act of compensation will in itself shift the terms of trade between C and U that Leviathan faces against U : an increase in G will tend to reduce the marginal utility of further increases, and a reduction in t will tend to reduce the marginal deadweight loss of taxation and so make it more costly to raise U by further tax reductions. Matters are more complex in the more general case in which $X_G \neq 0$: compensating the consumer for an increase in T by raising G , for example, then has further implications for indirect tax revenue; by the same token, compensation by a reduction in t indirectly affects the effective marginal cost of increasing G . These indirect effects, it seems, could in principle be so strong as render the relative price effect beneficial. Nevertheless, the example in Proposition 4, resonant of the argument in Section 2, does tend to create a presumption that the relative price effect will be harmful.

There is again a crude but appealing alternative way of expressing the condition for coordination to benefit the representative consumer, analogous to Proposition 2 for the case in which the tax base is fully mobile. For this we now dispense with the preference restrictions of Proposition 4, and return to the general case. Perturbing $U = H(Q, G, \rho\bar{K})$, using Roy's identity and recalling that $d\rho = -dT$, one finds

$$dU = -XH_M dt + H_G dG - \bar{K}H_M dT \quad (4.23)$$

and, from (4.1) and (2.2),

$$dG = \frac{1}{1 - tX_G} \{ (1 - tX_M)\bar{K}d\rho + (X + tX_Q)dt - dC \} . \quad (4.24)$$

Substituting (4.24) into (4.23) and using (4.6) to evaluate at the non-cooperative equilibrium gives, on simplifying,

$$dU = - \left(\frac{H_G}{(1 - tX_G)H_M} \right) \left\{ \frac{t(X_M X + X_Q)}{X} + \frac{dC}{dR} \right\} \quad (4.25)$$

where $dR = \bar{K}dT$ is the lump sum increase in tax revenue consequent upon coordination. By the Slutsky equation, we then have:

PROPOSITION 5: *Starting from the non-cooperative equilibrium, a small multilateral increase in the tax on mobile capital increases the welfare of the representative citizen if and only if:*

$$-\frac{tX_Q^u}{X} > \frac{dC}{dR} . \quad (4.26)$$

The necessary and sufficient condition for coordination to be desirable is thus that the compensated elasticity of the tax base exceed Leviathan's marginal propensity to waste.

Given the dissimilarity of the underlying assumptions on the tax instruments available to Leviathan, the similarity of the rules in Propositions 2 and 5 is striking. In each case, however, the simple elasticity form of the rule reflects the feature that only one distorting tax instrument is deployed in the non-cooperative equilibrium. This tends to obscure a still deeper underlying similarity, one that provides an encompassing (and, perhaps, generalisable) intuition and is at the same time more easily related to existing empirical knowledge.

To see this, note first that both $-tX_Q^u$ in the numerator on the left of (4.26) and $-TK'$ in the numerator on the left of (3.27) can be interpreted, in their respective contexts, as the additional deadweight loss from a small tax increase. In the former case, the deadweight loss is that from commodity taxation (the only instrument deployed in the non-cooperative equilibrium of Section 4.2), measured as in Kay (1980). In the latter case, it is that from the tax on mobile capital (the only tax deployed in the non-cooperative equilibrium of Section 3), measured as the 'triangle' under the marginal product schedule.²³ By the same token, both $-tX_Q^u/(X + tX_Q)$ and $-TK'/(K + TK')$ can be interpreted as deadweight loss per dollar of revenue, at the margin: as measures, that is, of the marginal excess burden of taxation (MEB).²⁴ Propositions 2 and 5 can thus be re-expressed in the common form:

PROPOSITION 6: *Irrespective of whether the tax base is fully mobile (as in Section 3) or partially mobile (as in the present section), a small multilateral increase in the tax on mobile capital from the non-cooperative equilibrium increases the welfare of the representative citizen if and only if:*

$$\frac{MEB}{1 + MEB} > \frac{dC}{dR} , \quad (4.27)$$

What ultimately matters is thus not so much some notion of the elasticity of the tax base, but rather the marginal excess burden of taxation: the larger it is, the greater is the potential efficiency gain from the element of lump sum taxation implied by coordination, and hence the more likely it is that coordination will prove beneficial.²⁵

Though we have not shown that it applies in circumstances more general than those considered in this paper, it is interesting to confront Proposition 5 with empirical estimates of the deadweight loss from taxation. These vary widely, from about 7 cents

²³That is, as $F[K(\rho)] - F[K(\rho + T)] - \rho\{K(\rho) - K(\rho + T)\}$.

²⁴As Fullerton (1991) emphasises, definitions of the MEB vary quite widely. That adopted here for the commodity tax case – in which the consumer is hypothetically compensated for the tax increase in evaluating its revenue effect – follows, for example, Browning (1987).

²⁵There is another way of seeing and quantifying this idea. For note that $-\frac{1}{2}(t^2 X_Q^u)$ and $-\frac{1}{2}TK'$ are both quadratic approximations to the deadweight loss from taxation, in the tradition of Harberger (1964). So $-\frac{1}{2}(t^2 X_Q^u/tX) = -\frac{1}{2}(tX_Q^u/X)$, for example, is approximately deadweight loss per dollar of revenue. Conditions (3.27) and (4.27) can then both be interpreted as indicating that desirable is desirable if and only if the (approximation to) average deadweight loss exceeds half Leviathan's marginal propensity to waste.

per dollar to about 30 cents (see, for example, Browning (1987), Fullerton (1991) and Hausman (1981)). Taking the higher of these estimates, coordination will be desirable so long as a gift to Leviathan of \$1 of lump sum revenue would not increase socially unproductive public expenditure by more than 23 cents. Taking the lower, it will be desirable so long as unproductive expenditure would not increase by more than about $6\frac{1}{2}$ cents. Such calculations clearly leave room for disagreement as to the wisdom of coordination: there remains considerable uncertainty as to the magnitude of the *MEB*, and consideration of this kind of condition also points to the need to flesh out the concept of 'waste.' The important point for present purposes, however, is that discussion of the case for coordination has acquired a clear structure and, at least to some degree, empirical content.

5 Summary and conclusions

This paper has not set out to provide an unambiguous resolution, in favour of one or the other, of the conflict between the two extreme views of international tax competition and coordination discussed at the outset. By analysing tax competition and coordination in a framework that nests both views, the objective has rather been to identify relatively well-defined conditions upon which, in particular circumstances, the balance of truth between them turns.

It emerges that, when policy-makers are neither wholly benevolent nor wholly unconcerned with the welfare of citizens, the question of whether international tax coordination tends to increase or reduce the well-being of the citizenry – of whether, that is, it is predominantly a desirable response to the inefficiency of non-cooperative behaviour or an undesirable measure of tax 'cartelisation' – hinges on the balance between two effects. The first of these is an 'income effect' that tends to make coordination beneficial. For the impact effect of a multilateral tax increase is akin to a lump sum transfer from the representative citizen to the local Leviathan. While this in itself makes the citizen worse off, Leviathan, now being better off, will generally want to spend part of this additional revenue on raising the citizen's welfare above its initial level. This is achieved by adjusting other tax and spending instruments: increasing expenditure on the local public good or cutting other taxes. The effect is a powerful one, in the sense that the existence of a benefit to the representative consumer through this route does not depend on the relative weight attached to the citizens' welfare in Leviathan's preferences, but merely on an apparently weak normality assumption. The second effect of coordination is on the 'relative price' that Leviathan perceives between tax revenues diverted to her own uses on the one hand and the welfare of the citizen on the other. For the policy adjustments that the income effect suggests Leviathan will tend to make in order to (over-)compensate the citizen for the impact effect of coordination will generally affect the marginal cost to her of buying welfare for the citizen. In the most general of the circumstances examined here, the direction of this effect is ambiguous. But there is some presumption (from special cases) that coordination is on this account damaging to the citizen. Intuitively, the notional compensation would generally be expected to involve, in part, increasing the provision of the local public good; but that in turn will tend to reduce the citizen's valuation of the public good, which means that spending \$1 less on it and \$1 more on herself becomes more attractive to Leviathan, the welfare lost by the citizen if she does so now being rather

smaller.

The net effect, as expected, is in general ambiguous. There is one special case in which a clear-cut answer can be given to the question raised at the outset: if Leviathan simply maximises a weighted average of the citizens' welfare and expenditure put to her own uses, the income effect vanishes and coordination is undesirable (even if only a tiny proportion of the weight in Leviathan's preferences attaches to the expenditure diverted to her use). In other cases, numerical simulation would be needed to reach precise conclusions on the final outcome. We leave this to the future.

It has been shown, however, that in the simple models considered here the central issue can be reduced to the comparison between two numbers for which commentators might reasonably be asked to produce their best guesses. The first is the marginal excess burden of taxation (deadweight loss per dollar of revenue, at the margin); the second is the amount by which unproductive public expenditure would increase if Leviathan were given an additional dollar of lump sum revenue. Some degree of tax coordination is desirable if and only if the former²⁶ exceeds the latter (the efficiency gain then being sufficient to outweigh Leviathan's tendency to waste).

This last conclusion, like the others, can be turned to the pressing policy concerns raised in the Introduction only with considerable caution. The limitations of the framework used here – the neglect of asymmetries between countries, the assumption of a representative consumer, the rather vague notion of 'waste' – are evident enough. It seems, nevertheless, that there may be useful lessons to be learned by synthesising the two perspectives on policy-making rather than, as has often been the case, regarding them as mutually exclusive.

²⁶Expressed in 'inclusive' form.

APPENDICES

Appendix A

The purpose here is to provide the formalities underlying the discussion in Section 4.1 of the case in which rents are taxed at less than 100% in the non-cooperative equilibrium.

Now treating τ as a choice variable, Leviathan's problem can be conceived of as comprising two steps, in much the same way as in section 4.2 of the text. At the first, τ , t and G are chosen so as to maximise C , taking as given both T and U . Imposing the constraint that $\tau \leq 1$, the Lagrangean for this is

$$\mathcal{L} = \tau\{F[K(\rho+T)] - F'[K(\rho+T)]K(\rho+T)\} + TK(\rho+T) + tX(Q, G, M) - G + \lambda\{H(Q, G, M) - U\} + \mu(1 - \tau) \quad (\text{A. 1})$$

where

$$M = (1 - \tau)\{F[K(\rho+T)] - F'[K(\rho+T)]K(\rho+T)\} + \rho\bar{K}. \quad (\text{A. 2})$$

The first order conditions on τ and t are respectively:

$$(1 - tX_M - \lambda H_M)(F - F'K) - \mu = 0 \quad (\text{A. 3})$$

$$X + tX_Q + \lambda H_Q = 0. \quad (\text{A. 4})$$

Suppose then that $\tau < 1$. Then $\mu = 0$ and (by strict concavity of $F(\cdot)$), (A.3) implies that

$$1 - tX_M = \lambda H_M \quad (\text{A. 5})$$

Combining (A.4) and (A.5), use of Roy's identity and the Slutsky equation then gives $tX_Q^s = 0$. Hence (outside the extreme case in which there are no substitution effects, so that the commodity taxation is effectively lump sum), $t = 0$.

Denoting by $C(\rho, T, U)$ the maximum value function for the step one problem, the second step of Leviathan's problem is to choose T and U to maximise $V[C(\rho, T, U), U]$. This implies that

$$C_T = 0 \quad (\text{A. 6})$$

$$V_C C_U + V_U = 0. \quad (\text{A. 7})$$

Applying the envelope theorem to (A.1) gives

$$C_T(\rho, T, U) = TK'(\rho + T) \quad (\text{A. 8})$$

so that, from (A.6), $T = 0$ in the non-cooperative equilibrium.

Turning to the effects of coordination, proceeding exactly as in the proof of Proposition 1 (using (A.6) and assuming the second order condition to be satisfied) shows dU to take the same sign as the right hand side of (3.18), with $C(\cdot)$ now interpreted as just described: call this (3.18''). Applying the envelope theorem to (A.1) gives

$$C_\rho(\rho, T, U) = TK'(\rho + T) + \bar{K} - K(\rho + T). \quad (\text{A. 9})$$

From (A.6), (A.8) and (A.9), $C_\rho = C_{U\rho} = C_{UT} = 0$ at the symmetric non-cooperative equilibrium. Thus all terms in (3.18'') vanish, and hence $dU = 0$. $\square$

Appendix B

We verify here the claim in Proposition 4 that $G_\rho < 0$.

Perturbing the first order conditions (4.3)-(4.4) and the constraint $H(Q, G, \rho\bar{K}) = U$ for the first step of Leviathan's problem, the implication of the assumed preferences that $X_G = X_M = 0$ gives

$$\begin{bmatrix} 2X_Q + tX_{QQ} + \lambda H_{QQ} & \lambda H_{QG} & H_Q \\ \lambda H_{GQ} & \lambda H_{GG} & H_G \\ H_Q & H_G & 0 \end{bmatrix} \begin{bmatrix} dt \\ dG \\ d\lambda \end{bmatrix} = d\rho \begin{bmatrix} -\lambda\bar{K}H_{QM} \\ -\lambda\bar{K}H_{GM} \\ -\bar{K}H_M \end{bmatrix}. \quad (\text{B. 1})$$

Hence, by Cramers' rule,

$$G_\rho = \frac{\text{Det}(\Sigma^*)}{\text{Det}(\Sigma)} \quad (\text{B. 2})$$

where Σ denotes the matrix on the left of (B.1) and

$$\Sigma^* \equiv \begin{bmatrix} 2X_Q + tX_{QQ} + \lambda H_{QQ} & -\lambda\bar{K}H_{QM} & H_Q \\ \lambda H_{GQ} & -\lambda\bar{K}H_{GM} & H_G \\ H_Q & -\bar{K}H_M & 0 \end{bmatrix}. \quad (\text{B. 3})$$

The second order condition for the problem is that $\text{Det}(\Sigma) > 0$. This, however, is not ensured by the preference restrictions of the Proposition. It is straightforward to show that they imply the maximand to be strictly concave in (t, G) . Quasi-concavity of the constraint requires that $\Delta > 0$, where

$$\Delta \equiv H_Q H_G \left\{ 2H_{QG} - H_{GG} \left(\frac{H_Q}{H_G} \right) - H_{QQ} \left(\frac{H_G}{H_Q} \right) \right\} \quad (\text{B. 4})$$

Evaluating (B.4) for preferences of the form in the Proposition gives

$$\frac{\Delta}{h_G} = h_{\Gamma}(\gamma')^2 \left\{ 2h_{\Gamma G} - h_{GG} \left(\frac{h_{\Gamma}}{h_G} \right) - h_{\Gamma\Gamma} \left(\frac{h_G}{h_{\Gamma}} \right) \right\} - \gamma'' . \quad (\text{B.5})$$

The difficulty is that while strict quasi-concavity of $h(\Gamma, G)$ implies that the first term in (B.5) is strictly positive, the second and conceivably dominant term acts in the opposite direction (with $\gamma'' > 0$, it will be recalled, in order that $X_Q < 0$). We shall therefore simply assume that $\text{Det}(\Sigma) > 0$.

It then suffices to show that $\text{Det}(\Sigma^*) < 0$. From (B.4),

$$\begin{aligned} \text{Det}(\Sigma^*) &= H_G \bar{K} \{ \lambda (H_{QQ} H_M - H_{QM} H_Q) + H_M (2X_Q + tX_{QQ}) \} \\ &+ \lambda \bar{K} (H_{GM} H_Q - H_{GQ} H_M) . \end{aligned} \quad (\text{B.6})$$

The final term in (B.6) vanishes by (4.21). Using further the restrictions implied by the preferences of the Proposition gives

$$\frac{\text{Det}(\Sigma^*)}{\bar{K}} = (h_{\Gamma})^2 \gamma'' \left(1 - \frac{H_G}{H_M} \right) - t H_G H_M \gamma''' . \quad (\text{B.7})$$

Noting from (4.6) that (since here $X_G = 0$) $H_G/H_M > 1$ in the non-cooperative equilibrium, and recalling that $\gamma''' \geq 0$ by assumption, it follows from (B.7) that $\text{Det}(\Sigma^*) < 0$ as required. $\square$

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