International Tax Competition and Tax Incentives in Developing Countries

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1. Introduction

Tax policy advisers often counsel the governments of developing countries against using investment incentives under their income taxes.[1] A wide variety of arguments have been offered in support of this position. Investment tax incentives can be costly in revenue terms, generating relatively little new investment per dollar of revenue cost and requiring increases in other distortionary taxes; this is especially problematic if the incentives are general (untargeted), so that they benefit a great deal of inframarginal investments, including those that generate significant economic rents. Non-uniform investment incentives that apply only to certain types of capital assets or firms and thus only to certain business sectors may inefficiently distort the allocation of productive

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[1] For reviews of the arguments for and against the use of investment incentives, see Hulten and Klayman (1988), Boadway and Shah (1995) and Zee, Stotsky and Ley (2002).

resources. Moreover, the econometric evidence on the effectiveness of investment incentives in attracting investment is mixed. The current consensus appears to be that, holding other factors constant, investment does in fact respond positively to reductions in the cost of capital, such as those associated with tax incentives (Cummins, Hassett and Hubbard, 1997; Hassett and Hubbard, 1997). In particular, in their reviews of empirical studies of the effects on taxes on foreign direct investment, Gordon and Hines (2002) and deMooij and Ederveen (2001) conclude that the empirical evidence suggests an elasticity of aggregate foreign direct investment with respect to effective host country tax rates of roughly 0.6-0.7 in absolute value, with the most recent research characterized by substantially larger elasticities. Nevertheless, other observers argue that macroeconomic factors are by far the primary determinant of investment and that tax factors such as investment incentives play a relatively minor role (Chirinko, 1987), with investment much less sensitive to cost of capital factors than suggested above (Chirinko, Fazzari and Meyer, 1999).

Another problem is that investment incentives — especially those that are targeted to minimize revenue cost — can be difficult to administer, as the tax authorities must inevitably draw fine lines in determining which investments meet the specified criteria. Such targeted incentives also create the potential for corruption and for the waste of resources in the form of rent-seeking behavior. Under many incentive schemes, tax administrators must also devote resources to ensuring that firms do not use incentives to facilitate tax avoidance and evasion – e.g., using transfer pricing between related or unrelated firms to shift revenues to a tax-favored activity or entity and deductible costs to fully taxed activities or entities.

Effective tax incentive schemes can be difficult to design and not especially transparent, again especially if they are highly targeted and/or apply only to incremental investment. For example, it may be difficult to determine the stimulative effects of an incremental investment credit that applies only to investment in excess of, say, an average of investment over the previous three years, because current investment will raise average investment in future years and thus lower future credits (Eisner, Albert and Sullivan, 1984). Similarly, the stimulative effects of tax holidays that do not provide for carryforward of depreciation deductions that would normally be taken during the tax

holiday period may be relatively small; indeed, tax holidays can actually increase the cost of capital for longer-lived investments that are subject to sufficiently front-loaded deductions for depreciation and other investment allowances (Mintz, 1995).

Finally, in the developing country context, the effects of investment incentives on the cost of capital may be muted for firms based in countries, such as the United States, that tax their multinationals on a residence basis, subject to a foreign tax credit for taxes paid abroad.[2] In the limiting case in which foreign tax credits are granted contemporaneously and used immediately in the home country, reductions in the effective tax rate in the host country have no effect on investment since any taxes foregone in the host country are fully offset with home country taxes – the so-called "Treasury transfer" effect. The importance of this effect, however, is quite limited in many cases. Many capital-exporting countries tax their multinationals on a "territorial" basis and thus impose no home country tax on foreign source earnings, or have entered into treaties that allow "tax sparing" under which fictitious foreign tax credits offset the home country tax liability that would otherwise arise when the host country offers investment incentives. Moreover, given existing home country limitations on the use of foreign tax credits, many multinationals already have more foreign tax credits than they can use (they are in an "excess foreign tax credit position"), so that host country tax incentives are beneficial since host country taxes are reduced while home country taxes are offset using the existing stock of foreign tax credits. Finally, the Treasury transfer argument assumes equal and contemporaneous host country taxes and home country credits. In actuality, the present value of host country taxes, which are paid contemporaneously, typically exceeds the present value of home country tax credits, which are deferred until earnings are repatriated to the parent company. Indeed, under certain circumstances, the home country repatriation tax is irrelevant to investments financed with the retained earnings of the subsidiary, which are affected only by the host country tax (Hartman, 1985). Although the net effect of all these factors will depend on the specific circumstances in a country, these qualifications suggest that in many if not

[2] For elaboration of this argument, with an application to Colombia, see Echavarría and Zodrow (forthcoming).

most cases the possibility of foregoing a treasury transfer effect does not constitute an important argument against the use of tax incentives (Gordon and Hines, 2002).

In any case, despite the various arguments against their use, investment tax incentives are widespread in developing countries. Some of this may simply be attributable to the fact that politicians face tremendous pressure to increase investment and create jobs, and tax incentives are a highly visible and relatively flexible means of concrete action toward achieving these goals, regardless of their effectiveness. However, a wide variety of more substantive arguments, with different degrees of validity, have been offered in support of the use of investment tax incentives.

For example, within the context of an income tax, the standard argument for uniform treatment of all types of business assets and all business sectors (and thus against the use of (non-uniform) investment incentives) hinges on a number of assumptions that are unlikely to be fully satisfied in practice. The case for uniformity is strongest within the context of a dynamic model in which labor is taxed optimally over time; if these conditions are not obtained, differential taxation of capital inputs can be desirable (Auerbach, 1989), similar to the exceptions that arise to the Diamond and Mirrlees (1971) production efficiency theorem (which precludes taxation of production inputs) when all commodity taxes are not available or not set optimally. Similarly, uniformity requires perfect competition; otherwise, differential taxation designed to offset the effects of market imperfections and capture economic rents — especially those attributable to foreign owners of capital — will be desirable. However, the likelihood that investment incentives could and would be designed to accurately correct for these market imperfections may be small. Given the administrative convenience of uniform rates and the likelihood that any tax differentials enacted will reflect political power rather than optimal tax considerations, the case for using investment incentives to introduce the tax differentials required by optimal taxation must be applied with great caution.

Externalities also potentially provide a rationale for differential capital income taxation. In many cases, such as the generation of pollution, externalities are negative so that, in the absence of the appropriate effluent fees, properly designed investment incentives could encourage activities that do not generate negative externalities. Alternatively, some activities, such as investment in research and development, may

generate positive externalities, which would be underprovided in the absence of investment incentives. These arguments provide a rationale for highly targeted incentives that attempt to correct for the externality, but do not support general tax incentives or targeted incentives that are not explicitly tied to the generation of externalities.[3]

Another rationale for investment incentives that is often cited in the developing world is the need to attract highly mobile international capital to increase the returns to local factors and stimulate growth and technological innovation. The basic line of reasoning is as follows. As is well known (Gordon, 1986; Sadka and Razin, 1991), a country that faces a perfectly elastic supply of internationally mobile capital should avoid using source-based taxes on capital income. In the long run, imposing such a tax will merely drive capital out of the taxing country until the after-tax rate of return returns to the internationally determined level. This migration of capital lowers the productivity of the factors in the taxing jurisdiction that are immobile – land and labor that is relatively immobile. As a result, local factors bear not only the entire burden of the tax but also its "excess burden" – the efficiency cost imposed by the tax-induced out-migration of capital from the taxing jurisdiction.

This efficiency cost or excess burden of taxing mobile capital arises from three sources. First, as noted above, the tax-induced capital outflow lowers the productivity of local factors. Second, use of the capital income tax creates a tax bias favoring production of labor-intensive goods; this effect arises because the tax-induced reduction in wages that occurs as the capital income tax is shifted to labor is less pronounced for goods with a relatively large labor income share, causing an inefficient reallocation of labor to the labor-intensive sector (Gordon and Hines, 2002). Third, as stressed in the tax competition literature (Zodrow and Mieszkowski, 1986; Wilson, 1986), governmental

[3] Investment incentives are also often advocated on macroeconomic grounds as a means of providing short-run stimulus to an economy that is suffering from excessive unemployment or inadequate growth. The validity of the case for incentives on these grounds depends on the reasons for unemployment or inadequate growth. However, the effectiveness of investment incentives in stimulating an economy that is already at excess capacity, as well as the ability of governments to time the use of investment incentives to effectively offset cyclical factors, is open to serious question. The current consensus seems to favor the use of monetary policy over the use of fiscal policy (such as changes in investment incentives) as a stabilization tool. Yet another rationale for investment incentives arises if economies of scale are important in the production of tradable goods, so that investment incentives will increase the scale of operation of local firms, lower their costs, and increase their competitiveness on imperfectly competitive international markets.

concern about the negative effects of taxing mobile capital may lead to under-provision of public services.[4] These factors imply that, from the viewpoint of the taxing jurisdiction, it is preferable simply to tax the local factors directly, and thus avoid at least the excess burden of the tax on mobile capital.

On the other hand, not all capital is perfectly mobile, at least not in the medium term that is likely to be the focus of most governments. For example, some capital may earn location-specific rents and, once capital is in place, adjustment costs for moving capital in response to a tax increase may preclude either rapid or any adjustment. Under these circumstances (and abstracting from anticipation effects on future capital accumulation), some source-based taxation of such imperfectly mobile may be desirable, especially if some of this imperfectly mobile capital is owned by foreigners so that the tax burden can be exported. Moreover, some form of taxation of business capital is necessary as a backstop to the individual income tax. Otherwise, individuals could incorporate as businesses in order to defer paying tax on their labor income, perhaps indefinitely if income can be withdrawn from the corporation as capital gains that are tax exempt or taxed very lightly (Gordon and Mackie-Mason, 1995). Taxation of domestic capital income at rates approximating those applied to labor income is desirable to limit this form of tax avoidance. In addition, taxation of foreign source corporate income at the same nominal tax rate as that applied to domestic corporate income is likely to be a political necessity, and may even be constitutionally required.

This discussion suggests that the problem of capital income taxation facing a developing country that utilizes an income tax can be loosely outlined as follows. Concerns about tax avoidance and the desire to appropriate some economic rents from imperfectly mobile capital (especially if it is foreign owned), perhaps coupled with the political necessity of creating at least the appearance of taxing internationally mobile capital, require that a uniform tax rate be applied to all capital income. However, the small open economy argument outlined above, including the tendency for under-provision of critical public services due to concerns about the economic effects of taxing

[4] Of course, tax competition has many other effects, some of which are also efficiency reducing and others that are efficiency enhancing (Wilson, 1999; Zodrow, 2003a). Nevertheless, a central message of this literature is that to the extent that capital is internationally mobile, tax competition puts downward pressure on both capital income tax rates and the public services financed with the associated revenues.

highly mobile capital, suggests that source-based taxation of internationally mobile capital should be reduced or eliminated, a result that can be achieved in the context of uniform rates by providing only such highly mobile capital with the appropriate investment incentives. This is the approach analyzed in this paper, which builds on Zodrow (2003) and Gugl and Zodrow (forthcoming), as it examines the use of investment incentives in the context of differentiating the tax treatment of perfectly mobile and imperfectly mobile capital when both types of capital are nominally taxed at the same tax rate and international tax competition leads to underprovision of public services financed with taxes on mobile capital. (Although the two types of capital could be defined in any reasonable way, one paradigm would be that imperfectly mobile capital includes capital already in place in the host country or capital that earns location-specific economic rents, while all other capital, including potential new foreign direct investment, is perfectly mobile.)

In order to focus on this question of the use of tax incentives to provide differential tax treatment to perfectly and imperfectly mobile capital, the model abstracts from many other important issues. Most obviously, the analysis focuses solely on the perspective of a single country, and does not consider the general equilibrium implications that would arise if some or all of world's economies acted in a similar fashion. For recent discussions of the general equilibrium effects of both tax incentives as well as constraints on their use, see Janeba and Peters (1999), Keen (2001) and Janeba and Smart (2003).[5] Three additional issues are of special importance. First, the tax system is modeled very simply as the tax rate applied to capital income, neglecting all the complex issues associated with measuring capital income accurately. Second, no attempt is made to model potentially beneficial aspects of international tax competition, including the limitations such competition may place on tendencies toward overprovision of public services attributable to Leviathan-type tendencies of national politicians and bureaucrats (McLure, 1986; Edwards and Keen, 1996). Third, it is assumed that tax incentives can be

[5] These results are mixed, as Janeba and Peters (1999) conclude that tax coordination in the form of eliminating tax preferences for mobile capital are beneficial, Keen (2001) reaches the opposite conclusion, and Janeba and Smart (2003) construct a more in general model in which both results can be obtained. Note also that these models also generally assume that governments act to maximize revenues, while the approach utilized in this paper assumes that the government acts to maximize the welfare of local residents, taking into account the potential under-provision of public services attributable to concerns about taxing mobile capital.

accurately targeted to perfectly mobile capital, reducing its effective tax rate. Although this might be difficult to achieve in practice, there are many examples of attempts to do so, including tax preferences, such as rate reductions, tax holidays or investment credits/deductions that are available only to certain types of capital (e.g., preferences that are "ring-fenced" or not available to domestic taxpayers); such preferences could also be approximated with similar provisions designed to favor only assets that are used disproportionately by internationally mobile capital. The model is thus constructed to analyze in a fairly stylized way the implications of differentially mobile capital for the use of investment incentives when the government is concerned about the underprovision of public services associated with financing such services with source-based taxes on capital income in the presence of international tax competition for perfectly mobile capital.

2. The Model

The model, which assumes competitive product and factor markets, is constructed as follows. A country is small relative to the international economy and therefore takes the rental rate r of perfectly mobile capital K as given. There is also, however, a second type of capital, C, which is less than perfectly mobile over the relevant time horizon, and whose inverse supply is given by $w(C)$ with $w'>0$. The country also has one immobile factor, inelastically supplied labor (or the combination of labor and land), L. Output is produced with the two types of capital and labor using a constant returns to scale technology and a production function that is strictly concave in both types of capital,

$$F(L,C,K) = F_L L + F_C C + F_K K;$$
$$F_L > 0, F_C > 0, F_K > 0;$$
$$F_{ii} < 0, F_{ij} > 0 \text{ for all } i, j = L, C, K \text{ and } i \neq j.$$

Since the production function is homogeneous of degree 1, the marginal products are homogenous of degree zero and, due to strict concavity of $F(\ )$ in C and K, the determinant of the second order derivative matrix of $F(\ )$ with respect to C and K is strictly positive.[6] Thus,

[6] For example, the commonly used Cobb-Douglas and CES production functions satisfy these properties.

$$\begin{aligned} &F_{KC}C + F_{KK}K = -F_{KL}L < 0; \\ &F_{CK}K + F_{CC}C = -F_{CL}L < 0; \\ &F_{CC}F_{KK} - F_{KC}^{\,2} > 0. \end{aligned} \qquad (1)$$

Each unit of output is either used as a unit of a numeraire consumption good (X) or is transformed into a unit of a pure public good, denoted as G, that the government provides to its residents. The government finances G with taxes on both types of capital at a uniform tax rate, t, and head taxes on residents, which in the aggregate are denoted as H. In addition, the government can enact tax incentives for perfectly mobile capital, which result in an effective tax rate on perfectly mobile capital of θt, $0 \leq \theta \leq 1$, with values of $\theta < 1$ indicating the presence of such incentives. The government budget constraint is thus

$$G = H + t(C + \theta K). \qquad (2)$$

With this tax structure, profit maximization by private firms implies

$$\begin{aligned} F_K &= r + \theta t, \\ F_C &= w + t. \end{aligned} \qquad (3)$$

There are n identical residents of the country, each of whom owns the same share of perfectly mobile capital, which can be invested anywhere in the world economy including the country of residence. Each resident thus has an exogenous amount of income $y \geq 0$ from ownership of a share of perfectly mobile capital. To simplify the analysis while still allowing for the possibility of expropriating rents from foreign owners of imperfectly mobile capital, we assume that such capital is owned entirely by foreigners.[7]

Each resident's utility is assumed to depend on the amount of private consumption and the consumption of the public good, $U(X/n, G)$, where the utility function is well behaved (strictly quasi-concave, continuous and twice differentiable). The government is assumed to choose its tax instruments t, H and θ to maximize the aggregate utility of its residents, subject to its balanced budget constraint.

[7] This implies the government can ignore the income effects on its residents of taxing imperfectly mobile capital. The appendix discusses the derivation of the inverse supply function $w(C)$ and the implications of domestic ownership of a share of the imperfectly mobile capital.

As in Zodrow and Mieszkowski (1986), the government recognizes in choosing its tax parameters that an increase in the tax on capital will, in equilibrium, cause an outflow of both types of capital. Specifically, differentiating the private firms' profit maximization conditions yields the reactions of the two types of capital K and C to an increase in the tax rate t

$$\begin{aligned} \frac{dK}{dt} &= \frac{\theta\left(F_{CC} - w'\right) - F_{KC}}{D} < 0, \\ \frac{dC}{dt} &= \frac{F_{KK} - \theta F_{KC}}{D} < 0, \end{aligned} \tag{4}$$

where $D = F_{KK}\left(F_{CC} - w'\right) - F_{KC}^{\ 2} > 0$. The reaction of the two types of capital to a reduction in tax incentives (an increase in θ) is also unambiguously negative

$$\begin{aligned} \frac{dK}{d\theta} &= \frac{\left(F_{CC} - w'\right)t}{D} < 0, \\ \frac{dC}{d\theta} &= \frac{-F_{KC}t}{D} < 0. \end{aligned} \tag{5}$$

As expected, a reduction in incentives for perfectly mobile capital drives out perfectly mobile capital. In addition, reducing such incentives also drives out imperfectly mobile capital, as the tax-induced reduction in perfectly mobile capital reduces the productivity of, and hence demand for, complementary imperfectly mobile capital.

The government's optimization problem is thus

$$\max_{t,\theta,H} nU\left(\frac{F\left(L,C,K\right) - \left(r + t\theta\right)K - (w + t)C - H}{n} + y,\ H + t\left(C + \theta K\right)\right) \tag{6}$$

$$s.t. \quad F_C = w(C) + t, \qquad F_K = r + \theta t \ ,$$

and the first order conditions are

$$t: \qquad U_X\left(-\left(C + \theta K\right) - w'C\frac{dC}{dt}\right) + nU_G\left(\left(C + \theta K\right) + t\frac{dC}{dt} + t\theta\frac{dK}{dt}\right) = 0 \ ; \tag{7}$$

$$\theta: \qquad U_X\left(-tK - w'C\frac{dC}{d\theta}\right) + nU_G\left(tK + t\frac{dC}{d\theta} + t\theta\frac{dK}{d\theta}\right) = 0 \ ; \tag{8}$$

$$H: \qquad -U_X + nU_G = 0 \ . \tag{9}$$

The following sections discuss solutions to various versions of this problem. We consider first the efficient equilibrium, then the situation in which the government can tax both types of capital but is constrained to tax them at the same rate t (incentives are

precluded), and finally the case in which the government is constrained in its use of head taxes but can utilize tax incentives.

The Unconstrained Optimum

If head taxes can be imposed and tax incentives are available, then the three first order conditions are satisfied if $t = w'C$, $\theta = 0$, and H is set so that the Samuelson condition for the efficient provision of public goods $nU_G/U_X = 1$ is satisfied. The tax on imperfectly mobile capital is imposed following a standard inverse elasticity rule; that is, since the elasticity of imperfectly mobile capital is given by $\varepsilon = w/(w'C)$, the tax t can be written as $t = w'C = w/\varepsilon$. Thus, the tax on imperfectly mobile capital t will be positive, as the government extracts some rents from foreign owners of imperfectly mobile capital, balancing this benefit against the cost of lower productivity of the immobile factor due to the outflow of imperfectly mobile capital that arises from the imposition of the tax. On the other hand, the standard small open economy result holds for perfectly mobile capital – tax incentives should be used to eliminate all taxation of such capital. This result obtains because the price of perfectly mobile capital is fixed internationally so that any positive taxation counterproductively reduces the stock of such capital without capturing any of its returns, while lowering the productivity of local factors by the full amount of both the tax and its excess burden (Zodrow and Mieszkowski, 1983; Gordon, 1986; Razin and Sadka, 1991).

Note for future reference that

$$(C + \theta K) + (w/\varepsilon)\frac{dC}{dt} > 0,$$

$$tK + (w/\varepsilon)\frac{dC}{d\theta} > 0.$$

since, from (1),

$$(C + \theta K)(F_{CC}F_{KK} - F_{KC}^{\ 2}) - \theta w'(F_{KK}K + F_{KC}C) > 0,$$

$$K(F_{CC}F_{KK} - F_{KC}^{\ 2}) - w'(F_{KK}K + F_{KC}C) > 0.$$

This implies that an interior solution guarantees that

$$\begin{aligned} &(C+\theta K)+t\left(\frac{dC}{dt}+\theta\frac{dC}{dt}\right)>0, \\ &tK+t\left(\frac{dC}{d\theta}+\theta\frac{dC}{d\theta}\right)>0. \end{aligned} \tag{10}$$

That is, in equilibrium an increase in the tax on capital or a reduction in tax incentives increases capital tax revenues.

Ban on Tax Incentives with Head Taxes Unconstrained

Suppose that the government is precluded by law or political considerations from using tax incentives for perfectly mobile capital (θ=1); that is, the tax rates on imperfectly and perfectly mobile capital are constrained to be the same. Denote this uniform tax rate, which will be termed the benchmark rate, as t_B. Assume that head taxes H are still unconstrained. Evaluating (7-9) at θ=1 implies

$$\begin{aligned} &\frac{nU_G}{U_X}=1, \\ &t_B=(w/\varepsilon)\frac{\frac{dC}{dt}}{\frac{dC}{dt}+\frac{dK}{dt}}<w/\varepsilon \\ &0<t_B<w/\varepsilon. \end{aligned} \tag{11}$$

Thus, the tax rate applied to both types of capital is positive but unambiguously below the rate of w/ε that obtains in the unconstrained case, as the government reduces the extent of capital taxation because it must be applied to perfectly mobile capital as well as imperfectly mobile capital. However, as long as the government of the small open economy is unconstrained in its use of head taxes, there is no underprovision of public services.

Since the results for the unconstrained case established that taxing both types of capital at the same rate is not optimal, using incentives is clearly desirable in this case. To prove this, note that when the first order condition for t (7) is evaluated at θ=1, the first order condition for θ (8) is strictly negative; that is a marginal reduction in θ (the

introduction of tax incentives) unambiguously increases the utility of all residents. This result obtains if

$$-U_X\left(tK + w'C\frac{dC}{d\theta}\right) + nU_G\left(tK + t\left(\frac{dC}{d\theta} + \frac{dK}{d\theta}\right)\right) < 0$$

$$\frac{tK + (w/\varepsilon)\dfrac{dC}{d\theta}}{tK + t\left(\dfrac{dC}{d\theta} + \dfrac{dK}{d\theta}\right)} > \frac{nU_G}{U_X} = 1$$

which requires

$$t > (w/\varepsilon)\frac{\dfrac{dC}{d\theta}}{\dfrac{dC}{d\theta} + \dfrac{dK}{d\theta}},$$

which is satisfied at $\theta = 1$ as long as

$$\frac{\dfrac{dC}{dt}}{\dfrac{dC}{dt} + \dfrac{dK}{dt}} > \frac{\dfrac{dC}{d\theta}}{\dfrac{dC}{d\theta} + \dfrac{dK}{d\theta}}.$$

Substituting from (4) and evaluating at $\theta = 1$, this condition is met as long as $D>0$, which is unambiguously true. Thus, with head taxes unconstrained, the introduction of tax incentives from the equilibrium where $\theta=1$ unambiguously increases welfare for residents.

Constraint on the Use of Head Taxes, with and without Tax Incentives

Suppose now that head taxes cannot be imposed at the efficient level and the government is instead constrained to $H' < H^*$, where H^* denotes the efficient amount of head taxes. As in Zodrow and Mieszkowski (1986), the constraint on head taxes and the resulting use of capital taxation leads to the underprovision of public services as the government reduces services because it is concerned about driving out mobile capital. Thus, in contrast to the efficient equilibrium, the marginal rate of transformation between the private good and the public good is no longer equal to one, and the government can no longer simply maximize residents' income and then choose the level of public goods such that the Samuelson efficiency condition holds. Instead, as soon as the head tax

constraint becomes binding and the marginal unit of the public good is financed by capital taxation, an increase in the public good of one unit implies a decrease of the private good by more than one unit.

To demonstrate this formally, recall that, given H and θ, (7) specifies the optimal tax rate t and (10) implies that an increase in the tax rate increases tax revenues. If $H<H^*$ and t were lower than in the unconstrained case, then the equilibrium would have to be characterized by underprovision, since both head taxes and property tax revenues would be lower than in the efficient equilibrium. On the other hand, if the tax rate increases, as expected, relative to the optimal tax rate in the unconstrained equilibrium, then the equilibrium is again characterized by underprovision of public services. To see this, note that (7) can be solved for the marginal rate of substitution between public and private goods

$$\frac{nU_G}{U_X} = \frac{(C+\theta K)+(w/\varepsilon)\dfrac{dC}{dt}}{(C+\theta K)+t\left(\dfrac{dC}{dt}+\theta\dfrac{dK}{dt}\right)} \qquad (12)$$

and recall that t_B, the optimal tax rate with unconstrained H but θ=1, is given by (11). Thus, if it is true that $t > t_B$, then

$$t' = \beta t_B = \beta(w/\varepsilon)\frac{\dfrac{dC}{dt}}{\dfrac{dC}{dt}+\theta\dfrac{dK}{dt}}, \quad \beta > 1 ,$$

and it must be true that

$$\frac{nU_G}{U_X} = \frac{(C+\theta K)+(w/\varepsilon)\dfrac{dC}{dt}}{(C+\theta K)+\beta(w/\varepsilon)\dfrac{dC}{dt}} > 1 ; \qquad (13)$$

that is, the equilibrium is unambiguously characterized by underprovision of public services.

Given underprovision of public services in the presence of the constraint on head taxes, (7) implies that the change in residents' utility with an increase in the tax on capital is proportional to

$$U_X\left[\left(\frac{nU_G}{U_X}-1\right)(C+\theta K)-\left((w/\varepsilon)\frac{dC}{dt}\right)+\frac{nU_G}{U_X}t\left(\frac{dC}{dt}+\theta\frac{dK}{dt}\right)\right]. \qquad (14)$$

This expression is in general theoretically ambiguous in sign. The first term is positive and indicates that an increase in t increases residents' welfare because it increases revenues and thus mitigates the problem of underprovision of public services. The second term is also positive and reflects the benefit of expropriating rent from foreign owners of imperfectly mobile capital (even though some of the benefits of a larger stock of perfectly mobile capital are captured by the owners of imperfectly mobile capital, which becomes more productive). However, the third term is negative and captures the loss in residents' welfare due to the tax-induced outflow of both types of capital. Similarly, with underprovision, (8) implies that the change in residents' utility with a reduction in tax incentives for mobile capital (an increase in θ) is proportional to

$$U_X\left[\left(\frac{nU_G}{U_X}-1\right)tK-\left((w/\varepsilon)\frac{dC}{d\theta}\right)+\frac{nU_G}{U_X}t\left(\frac{dC}{d\theta}+\theta\frac{dK}{d\theta}\right)\right], \qquad (15)$$

with the interpretations of the three terms analogous to those for an increase in t. Finally, note that (7-8) with a constraint on the use of head taxes can be used to solve for t and θ as functions of each other

$$t=\frac{(nU_G-U_X)(C+\theta K)-U_X(w/\varepsilon)\dfrac{dC}{dt}}{-nU_G\left(\dfrac{dC}{dt}+\theta\dfrac{dK}{dt}\right)} \qquad (16)$$

$$\theta=\frac{U_X(w/\varepsilon)\dfrac{dC}{d\theta}-nU_Gt\dfrac{dC}{d\theta}-(nU_G-U_X)tK}{nU_Gt\dfrac{dK}{d\theta}}. \qquad (17)$$

No Tax Incentives. Suppose initially that no tax incentives for perfectly mobile capital are allowed (θ=1). Then (7) implies

$$\frac{(C+K)+(w/\varepsilon)\dfrac{dC}{dt}}{(C+K)+t\left(\dfrac{dC}{dt}+\dfrac{dK}{dt}\right)}=\frac{nU_G}{U_X}>1$$

which yields

$$t>(w/\varepsilon)\frac{\dfrac{dC}{dt}}{\left(\dfrac{dC}{dt}+\dfrac{dK}{dt}\right)}=t_B\ . \tag{18}$$

Thus, relative to the case in which head taxes are set optimally, the tax rate, applied uniformly to both types of capital, must increase. Indeed, if the constraint is sufficiently binding, t may exceed w/ε, the maximum tax rate applied to imperfectly mobile capital in the unconstrained equilibrium.

Nevertheless, the case for introducing tax incentives in this case is theoretically ambiguous, even in the complete absence of such incentives (θ=1). Solving (16) using (4) evaluated at θ=1 and recalling that $D=F_{KK}\left(F_{CC}-w'\right)-F_{KC}{}^2>0$ yields

$$t=\frac{(nU_G-U_X)(K+C)D-U_X(w/\varepsilon)(F_{KK}-F_{KC})}{-nU_G(F_{CC}-w'-2F_{KC}+F_{KK})}\ . \tag{19}$$

At this tax rate, the introduction of incentives is desirable if (8) is negative when evaluated at $\theta=1$, or if

$$-U_X\left(tK+(w/\varepsilon)\frac{dC}{d\theta}\right)+nU_G\left(tK+t\left(\frac{dC}{d\theta}+\frac{dK}{d\theta}\right)\right)<0\ . \tag{20}$$

Substituting from (5) yields

$$-U_X\left(KD-w'CF_{KC}\right)+nU_G\left(KD+t\left(F_{CC}-w'-F_{KC}\right)\right)<0$$

which implies

$$t>\frac{(nU_G-U_X)KD+U_Xw'CF_{KC}}{-nU_G\left(F_{CC}-w'-F_{KC}\right)}\ . \tag{21}$$

Substituting from (19), this condition becomes

$$-U_X\left(KD - w'CF_{KC}\right) + nU_G\left(KD + t(F_{CC} - w' - F_{KC})\right) < 0$$

$$\frac{\left(nU_G - U_X\right)(K + C)D - U_X(w/\varepsilon)\left(F_{KK} - F_{KC}\right)}{-nU_G\left(F_{CC} - w' - 2F_{KC} + F_{KK}\right)} > \frac{\left(nU_G - U_X\right)KD + U_X(w/\varepsilon)F_{KC}}{-nU_G\left(F_{CC} - w' - F_{KC}\right)}$$

Simplifying yields

$$U_X w'C > \left(nU_G - U_X\right)\left(F_{CC}C + F_{KC}K - w'C - F_{KC}C - F_{KK}K\right) .$$

Thus, when θ=1, introducing tax incentives for perfectly mobile capital will be desirable if

$$nU_G(w/\varepsilon) > \left(nU_G - U_X\right)\left[-(F_{KK}K + F_{KC}C) + (F_{CC}C + F_{CK}K)\right]$$

or, using (1), when

$$(nU_G/U_X)(w/\varepsilon) > \left(nU_G/U_X - 1\right)\left[L(F_{KL} - F_{CL})\right] . \qquad (22)$$

This condition holds unambiguously when $F_{CL} > F_{KL}$, that is, when imperfectly mobile capital is more complementary with the untaxed factor, labor, since the right side of the expression is negative, while the left side is positive. In this case, optimal tax considerations in the presence of heterogeneous capital (independent of supply elasticities) do not prescribe uniform taxation and instead call for differentially higher taxation of imperfectly mobile capital (Auerbach, 1979), which is achieved with the introduction of tax incentives for perfectly mobile capital. Note that this effect is amplified if underprovision of public services due to international tax competition is relatively severe, that is, if nU_G/U_X is large relative to one. In addition, incentives are relatively more desirable if ε is small, as a relatively inelastic supply of imperfectly mobile capital implies that differentially high taxation of such capital is especially desirable in order to capture the rents enjoyed by foreign capital owners. This factor is also amplified if underprovision of public services due to international tax competition is relatively important. (If tax-induced underprovision of public goods attributable did not arise ($nU_G = U_X$), this effect would be the only relevant one, and tax incentives for perfectly mobile capital would unambiguously be desirable.)

On the other hand, if $F_{CL} < F_{KL}$, then optimal tax considerations in the presence of heterogeneous capital call for differentially higher taxation of perfectly mobile capital. If this factor is sufficiently important, incentives for perfectly mobile capital can be

undesirable even at θ=1, since they create a tax differential in the "wrong direction" from an optimal heterogeneous capital taxation standpoint, even though such incentives will be desirable to tax imperfectly mobile capital at a relatively higher rate. Indeed, it is theoretically possible that differentially higher taxation of perfectly mobile capital (which has been precluded by assumption since $\theta \leq 1$) is desirable in this case.

More generally, as noted in the introduction, the case for incentives may be tempered by concerns regarding resource misallocations attributable to advantageous tax treatment of specific types of capital. Any such inefficiencies must be weighed against the benefits of lowering the taxation of perfectly mobile capital and reducing the underprovision of public services attributable to the taxation of mobile capital.

Full Tax Incentives. Although the case for tax incentives is theoretically ambiguous, it is possible to show that, in contrast to the case with unconstrained head taxation, full use of tax incentives to completely relieve the tax burden on perfectly mobile capital (θ=0) is never optimal if the government cannot impose head taxes in the efficient amount. Substituting into (7) at θ=0 and using (4) yields

$$t = \frac{(nU_G - U_X)CD + U_X(w/\varepsilon)F_{KK}}{-nU_G F_{KK}}. \tag{23}$$

From (8), reducing tax incentives (increasing θ from θ=0) is desirable if

$$t < \frac{(nU_G - U_X)KD - U_X w' C F_{KC}}{nU_G F_{KC}} \quad . \tag{24}$$

Substituting from (23) and using (1) implies that this condition is satisfied if

$$\frac{(nU_G - U_X)(C + \theta K)D - U_X w' C(F_{KK} - \theta F_{KC})}{-nU_G(\theta^2(F_{CC} - w') - 2\theta F_{KC} + F_{KK})} < \frac{(nU_G - U_X)KD + U_X w' C F_{KC}}{-nU_G(\theta(F_{CC} - w') - F_{KC})}$$

$$\frac{(nU_G - U_X)CD - U_X w' C F_{KK}}{-nU_G F_{KK}} < \frac{(nU_G - U_X)KD + U_X w' C F_{KC}}{nU_G F_{KC}}$$

$$(nU_G - U_X)D(F_{KC}C + F_{KK}K) < 0$$

$$(nU_G - U_X)D(F_{KL}L) > 0, \tag{25}$$

which is always satisfied since $F_{KL}>0$. Thus, if head taxes are not available in the efficient amount, the second-best optimum requires a strictly positive θ – that is, less tax incentives than in the first best optimum. The intuition behind this result is an extension of the results regarding the optimal taxation of heterogeneous capital noted above. Specifically, if head taxes are constrained and taxes on labor are not used, the public good will be partially financed with distortionary taxes on the two factors that are complementary to labor, including both perfectly mobile as well as imperfectly mobile capital. Of course, as noted above, uniform taxation of the two types of capital will not be desirable unless they are equally complementary to labor.

These results are sufficiently ambiguous from a theoretical standpoint that some simple simulations of the model may be illustrative in determining the extent to which tax incentives in the presence of international tax competition are desirable in the model. Several such simulations are provided in the following section.

3. Some Simple Simulation Results

As an illustration of the nature of the interaction between the tax rate on capital and investment tax incentives, consider the following example. Suppose the production function is Cobb-Douglas and is given by $F = AC^{\alpha}K^{\beta}$, where A = 10, $\alpha = .25$, $\beta = .426$. Suppose the supply curve for imperfectly mobile capital is linear $w(C) = \gamma C$ with $\gamma = .1$, which implies that the supply elasticity is unitary (ε=1). The return on capital is set as r = 1, the capital owned by residents is 34.09 and the number of residents is 100.[8] The utility function of residents is given by $U = X^{.75}G^{.25}$, where X denotes the amount of private good and G the amount of public good consumed by the representative resident. Given these parameter values, the price of imperfectly mobile capital in the country if head taxes and tax incentives are set optimally is also equal to one.

Table 1 reports the equilibrium values for perfectly mobile capital (K), imperfectly mobile capital (C), the tax rate on capital ($t/(w+t)$), the tax incentives for perfectly mobile capital (θ), head taxes (H), the amount of public goods (G) and the

[8] We have chosen the capital share of the country to be the same as the amount of perfectly mobile capital in the country if tax incentives and head taxes can be used.

aggregate amount of private goods (X), as well as "Loss," the amount of private good that would be required to compensate the residents for the decrease in the public good as a percentage of $X+G$ (the total amount of goods and public services consumed by the residents). The last column shows the sum of the marginal rates of substitution of the residents (nU_G/U_X) which equals one in an efficient equilibrium.

TABLE 1: SOME SIMULATION RESULTS

	K	C	t/(w+t) (%)	θ	H	G	X	Loss	ΣMRS
H unconstrained	34.090	10.000	50.000	0.000	7.500	17.500	0.525	0.000	1.000
H unconstrained, θ=1	25.566	12.497	16.510	1.000	7.526	16.933	0.508	3.369	1.000
H constrained, θ=1	25.541	12.491	16.545	1.000	7.500	16.918	0.508	3.370	1.001
H constrained, θ=1	25.095	12.380	17.218	1.000	7.000	16.649	0.511	3.397	1.023
H constrained, θ=1	24.656	12.269	17.897	1.000	6.500	16.376	0.513	3.441	1.045
H constrained	33.565	9.923	50.346	0.007	7.000	17.216	0.528	0.008	1.022
H constrained	33.045	9.846	50.692	0.014	6.500	16.931	0.531	0.032	1.045

The first row of results in this table indicates that when head taxes are unconstrained the optimal tax rate on imperfectly mobile capital, expressed as a percentage of the total price of imperfectly mobile capital, is 50%. We first compare two cases in which head taxes are set optimally – in the first case, the country can enact tax incentives while in the second case the government has to tax both types of capital uniformly. Since the government has more choice in the first case than in the latter case, it is not surprising that the residents are better off with tax incentives than without them, especially since the model requires full tax incentives in the first best optimum. Note that the amount of head taxes is higher if θ=1 than when θ=0, while the amount of public good is higher with θ=0 than with θ=1. The interpretation of this result is that if the country has to tax both types of capital uniformly, it will always lose mobile capital and will therefore set a tax rate that is below the tax rate $t=w/\varepsilon$. On the other hand, if incentives are available so that the government can tax imperfectly mobile capital only, it can maximize the income of residents. Since both X and G are normal goods, as income goes down, less of both goods will be consumed. Taxing both types of capital at the

same rate has a negative income effect. On the other hand there will also be a substitution effect between the tax instruments, because the tax structure that maximizes residents' income can no longer be imposed (i.e. $t = w/\varepsilon$, $\theta = 0$). As perfectly mobile capital is taxed and therefore is driven out of the country, the productivity of the fixed factor decreases, while by taxing imperfectly mobile capital the productivity of labor also decreases but at the same time the price paid to owners of imperfectly mobile capital decreases as well. On the other hand, using head taxes does not change the income of residents. This makes the use of head taxes even more attractive than in the case where $\theta=0$. If on the other hand, the country relied only on head taxes, the utility of residents would be lower and so is the amount of private consumption (49.1 as opposed to 50.8). Thus, the country increases the amount of head taxes if $\theta = 1$ compared to $\theta = 0$, but at the same time it uses some capital taxation, because capital taxation still incorporates the benefit of expropriating rents from foreign capital owners.

Once head taxes are constrained, underprovision of public goods results. However, while the amount of public good goes down, the revenues raised from taxing both types of capital go up.

Next, compare row 2 to rows 3, 4 and 5. In all of these cases, the country needs to impose a uniform tax rate on both types of capital, but in rows 3-5, the country is constrained in its use of head taxes. As expected, the country increases the tax rate to compensate for the loss in revenue from head taxes, but any increase in the capital tax rate decreases the amount of both types of capital in the jurisdiction and results in underprovision of public services.

Underprovision also occurs when the country is constrained in its use of head taxes but can enact tax incentives. If head taxes are constrained but can still finance a large portion of the public good, tax incentives help mitigate the negative effect of taxing perfectly mobile capital and the underprovision is less pronounced than in the case of uniform taxation of both types of capital. Once head taxes are constrained, the tax rate rises modestly, but the optimal amount of incentives is very close to full incentives ($\theta=0$). Recall from the previous section that the complementarity of the two factors with respect to labor was one of the determining factors for the size of the tax incentive. In the table below we report the values of $\left(F_{KL} - \theta F_{CL}\right)$.

	F_{CL}	F_{KL}	$F_{KL}-\theta*F_{CL}$
H unconstrained	0.648	0.324	0.324
H constrained	0.647	0.326	0.322
H constrained	0.647	0.328	0.319
H unconstrained, θ=1	0.485	0.404	-0.081
H constrained, θ=1	0.485	0.404	-0.081
H constrained, θ=1	0.484	0.407	-0.077
H constrained, θ=1	0.484	0.411	-0.073

The last four values of $(F_{KL}-\theta F_{CL})$ indicate that θ=1 is not optimal and that a decrease in θ (increase in tax incentives) would be beneficial. If θ is set optimally, $(F_{KL}-\theta F_{CL})$>0, as indicated in the first three reported values, since $(nU_G-U_X)L(F_{KL}-\theta F_{CL})=nU_G w'C\theta$ describes the optimal solution for θ and the right hand side of this equation is unambiguously positive for $\theta>0$. Note also that while tax incentives in this example should be substantial, they decrease as the country faces a more severe restriction on head taxes; indeed, tax incentives decrease much more as a percentage of the previous value than the capital tax rate increases. This is consistent with the result that jurisdictions will be less generous with tax incentives as underprovision is more severe.

4. Conclusion

This paper has examined the case for investment tax incentives from the perspective of a developing country in the context of differentiating the tax treatment of perfectly mobile and imperfectly mobile capital when both types of capital are nominally taxed at the same tax rate and international tax competition leads to underprovision of public services financed with taxes on mobile capital. The results of the model utilized in the paper are clear cut when head taxes are available and unconstrained, as head taxes are used to ensure efficient provision of public services and the tax rate on imperfectly mobile capital is set following an inverse elasticity rule while incentives are used to eliminate the tax burden on perfectly mobile capital. Once head taxes are constrained

and capital taxes are used to replace the lost revenues, underprovision of public services results. Under these circumstances, the case for using investment tax incentives is no longer theoretically unambiguous since, following the literature on the optimal taxation of heterogeneous capital, the efficient tax structure depends on the complementarity of perfectly and imperfectly mobile capital with labor, and tax incentives may move the tax system toward greater inefficiency in the taxation of the two types of capital. Nevertheless, some simulations of the model suggest that investment tax incentives can be quite beneficial in reducing the inefficiency attributable to underprovision of public services in the presence of international tax competition, although these results are still tentative.

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Appendix

This appendix investigates the implications of domestic ownership of a fraction of imperfectly mobile capital amd discusses the supply function for imperfectly mobile capital. Suppose that a fraction μ of C^*, the amount of imperfectly mobile capital initially in the initial equilibrium, is owned by residents. (The income from any ownership of imperfectly mobile capital in other countries is assumed to be unaffected by any changes in domestic tax policy and is included in y.) In this case, tax changes will affect the country's residents through income effects related to their ownership of imperfectly mobile capital. Suppose further that there are M owners of imperfectly mobile capital in the country (that is, there are n owners who are residents and M-n foreign owners) and every owner has an equal share. Suppose that in response to a tax increase, a firm in the country decides to move capital abroad. By withdrawing capital from the taxing country and transferring it to a different country, this firm incurs adjustment costs given by the strictly convex function $\phi(C^*\text{-}C)$; that is, investment is assumed to be characterized by increasing marginal adjustment costs. The firm then sells the capital for W per unit on the world market. In order to get capital from the investors, the firm must offer the investors in the country at least w. The firm's optimization problem then becomes

$$\max_C (W - w)(C^* - C) - \phi(C^* - C)$$

where C denotes the amount of capital the firm chooses to leave in the country after the price for capital goes down in the home country compared to the world price of this capital, W. The first order condition is given by

$$w - W + \phi'(C^* - C) = 0$$

or $\phi' = W\text{-}w$, that is, the tax increase causes emigration of capital until the marginal adjustment cost equals the increase in the rate of return that can be obtained by moving imperfectly mobile capital abroad. The inverse supply of imperfectly mobile capital is thus given explicitly by

$$w(C) = W - \phi'(C^* - C)$$

and, with convex adjustment costs, $w'(C) = \phi' > 0$ as assumed above.

In this case, the country's optimization problem (6) becomes

$$\max_{t,\theta,H} nU\left(\frac{F(L,C,K)-(r+t\theta)K-(w+t)C-H+\mu\left[\frac{wC^*+(W-w)(C^*-C)-\phi(C^*-C)}{M}\right]}{H+t(C+\theta K)}+y,\right)$$

$$s.t. \quad F_C = w(C)+t,\ F_K = r+\theta t \quad and \quad w = W-\phi'(C^*-C).$$

and the first order conditions are

$$t: \quad U_X\left(-(C+\theta K)-(1-\mu)w'C\frac{dC}{dt}\right)+nU_G\left((C+\theta K)+t\frac{dC}{dt}+t\theta\frac{dK}{dt}\right)=0;$$

$$\theta: \quad U_X\left(-tK-(1-\mu)w'C\frac{dC}{d\theta}\right)+nU_G\left(tK+t\frac{dC}{d\theta}+t\theta\frac{dK}{d\theta}\right)=0;$$

$$H: \quad -U_X+nU_G=0.$$

If the government is unconstrained in its use of head taxes, $t = (1 - \mu)w'C$ or $t = (1 - \mu)w/\varepsilon$; $\theta = 0$, and $nU_G/U_X = 1$. Thus, as more of the imperfectly mobile capital is owned domestically, the tax on imperfectly mobile capital decreases.

If the government is constrained in its use of head taxes, then for any value of θ the optimal t is given by

$$t=\frac{(nU_G-U_X)(C+\theta K)-(1-\mu)U_X w'C\frac{dC}{dt}}{-nU_G\left(\frac{dC}{dt}+\theta\frac{dK}{dt}\right)}.$$

In this case, the condition under which tax incentives are desirable (a decrease of θ from $\theta = 1$) is given by

$$\frac{(nU_G-U_X)(C+K)D-(1-\mu)U_X w'C(F_{KK}-\theta F_{KC})}{-nU_G((F_{CC}-w')-2F_{KC}+F_{KK})} > \frac{(nU_G-U_X)KD+(1-\mu)U_X w'CF_{KC}}{-nU_G((F_{CC}-w')-F_{KC})}$$

$$(nU_G-U_X)L(F_{CL}-F_{KL})>(-nU_G+\mu U_X)w'C$$

In the extreme case in which all imperfectly mobile capital is owned domestically, we obtain the condition

$$w/\varepsilon > L(F_{KL}-F_{CL}).$$

That is, to a greater extent than in the case of foreign ownership, the use of tax incentives will depend on optimal taxation conditions in the presence of heterogeneous capital. It is straightforward to show that full incentives are still never optimal in this case.