Strategic Tax Competition; Implications of National Ownership*

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Abstract

Two jurisdictions compete to capture the rents of a large multinational enterprise (MNE) which invests locally and which is partly owned by local investors. The MNE contributes to local welfare by tax payments and dividends, and it has private information about the efficiency of the operations in the two localisations. It is shown that the distortions in the MNE's real investment portfolio are determined by a trade-off between fiscal externalities and equity externalities, and that investments in the case of strategic tax competition may be lower than in the co-operative case. Ownership matters, and we show how the firm may reduce its overall tax payments by influencing the distribution of owner shares between investors in the two countries.

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1 Introduction

With enhanced international mobility of the corporate tax base, tax competition is reinforced and national governments experience more problems in raising revenue. Foreign direct investments have been rapidly increasing[1], and recent empirical research shows that effective tax rates are important factors for determining the localisation and investment decisions of multinational enterprises (MNEs).[2] These enterprises tend to be important in industries and firms that are characterized by high levels of R&D relative to sales, a large share of professional and technical workers in their work force, products that are new or technically complex, and high levels of product differentiation and advertising (Markusen 1995). Given these characteristics there is every reason to believe that such a firm is better informed about its operations than are any of the national governments that it relates to. Countries that try to attract investments form such a firm, must then take informational asymmetries into account in their policy design.

In this paper we focus on a case where an MNE has private information about its efficiency and operating profits in two jurisdictions. The international nature of an MNE and the high number of interfirm transactions make it hard for the tax authorities to observe its true income and costs. Complex technology also implies obstacles for the authorities to ascertain the firm's efficiency, and thereby derive its true operating profits. Many of the inputs are not standard commodities with established market prices, making it further difficult to monitor costs or impose norm prices. The inherent flexibility of multinationals not only helps these firms to minimise the costs of taxes and regulations in a given jurisdiction, but it also aids the multinational in pitting one government against the other as countries compete for foreign direct investments; see Gresik (1998).

We analyse this kind of strategic tax competition, where countries try to attract new corporate investments from an MNE. This is modelled as multiple-principal regulation of a firm that divides its real investment portfolio between two jurisdictions, and has an option of redirecting parts of the investments from one of the jurisdictions to the other. As part of a strategy to minimize its tax payments, the firm may have an incentive to behave so as to not completely reveal its earning potential in each individual country. Also, having investment opportunities in two countries, the MNE may try to reduce tax payments in each country by an implicit threat of directing a larger fraction of its investment to the

[1] See Markusen (1995).

[2] See, e.g. Devereux and Freeman (1995), Desai and Hines (1999).

other country.

Apart from its tax payments, the MNE contributes to local welfare by dividend payments to local shareholders. In our context any profits accruing to the MNE are then part of the national welfare to the extent that the country has an equity share in the firm. This assignment of positive welfare weights to profits significantly affects the qualitative results in our (common agency) model, since it implies equity externalities. These externalities arise because each country designs its taxes without taking into account their effects on investors in other countries.[3] They imply that under some owner configurations taxes are higher (and investments are lower) in both countries when the governments compete than when they cooperate. This result is in contrast with tax competition models with symmetric information, in which the competition for attracting real investments causes source taxes to fall and investments to rise, see, e.g., Zodrow and Mieszkowski (1986).[4] We further examine how the MNE's tax payments depend on the ownership structure, in particular on how the MNE's equity is distributed between the two countries. Unlike the symmetric information case and the case of cooperating principals, ownership matters. We analyse the optimal ownership structure seen from the perspective of the MNE and from the governments.

Many countries attempt to secure minimum national ownership stakes in firms that invest locally, e.g. by indigenisation requirements. Tax models or regulation models with symmetric information cannot rationalise such policies, since tax revenues and investment patterns are independent of the national distribution of ownership. We show that in the case of asymmetric information, the national ownership structure may affect the outcome of a tax competition game, which may explain why governments are concerned with local ownership.

The focus of this paper is on private information about productivity in an MNE, i.e. we do not address issues of intra-firm trade and transfer pricing. For an analysis of intra-firm trade in a multi-principal setting, see Bond and Gresik (1996).[5] In that article

[3] An added incentive to tax firms when they have foreign ownership has been noted previously, e.g. by Huizinga and Nielsen (1997). They develop a general equilibrium tax model under symmetric information for a small open economy, with exogenous constraints on the government's ability to capture rents.

[4] It is also in contrast with other common agency models such as Martimort (1992) and Stole (1992), the reason being that their principals do not put any weight on the agent's (firm's) surplus.

[5] In Bond and Gresik a home and a host country use trade taxes to regulate an MNE, which has private information about the cost of an intermediate good that is sold from the parent to a subsidiary in the host

the competing governments control complementary activities, whereas in our model the relevant activities are substitutes. Our economic focus is different from theirs, and by addressing the issues of equity externalities and optimal ownership pattern seen both from the view of the firm and society at large, our analytical perspective is different. We also get different qualitative results. Bond and Gresik find that under asymmetric information the firm's activity level and information rents always are lower when the principals compete than when they cooperate, and that the activity level always is highest in the first-best case. We find that the activity level (investments) and rents under competition may be either higher or lower than under cooperation.[6]

Our model is in some respects an extension of Osmundsen, Hagen and Schjelderup (1998); a partial model where a single principal regulates a continuum of mobile firms which have private information about their mobility costs. That analysis presumes a passive foreign government, which may be unrealistic since it implies a transfer of tax revenue from the foreign country to the home country. We extend the model to take into account strategic interaction between the governments. Our model is also related to Laussel and Lebreton (1995), who analyse taxation of a large investor which possesses an exogenous amount of capital that it may allocate in two locations.[7] We extend this analysis by allowing for national ownership, which affects the qualitative results by introducing equity externalities. Moreover, in our model the level of capital is endogenous, and whereas the firm has private information about the amount of capital it possesses in Laussel and Lebreton, we focus on private information about efficiency.

A different, yet related multiprincipal regulatory problem is analysed by Mezzetti (1997), who considers a case where an agent has private information about his *relative* productivity in the tasks he performs for two principals. In contrast, our focus is on private information about the *absolute* efficiency level. Another difference is that we address a case of substitutes, whereas in Mezzetti's model there is complementarity between the the agent's tasks. The results also differ in important ways. Whereas Mezzetti finds that the

country. Ownership is exogenous, and all the equity of the subsidiary is owned by residents of the home country. This analysis is extended by Calzolari (1998).

[6]For asymmetric countries one can show (Olsen and Osmundsen 1999b) that the activity level under common agency may even exceed the first-best level in one country.

[7]A similar setup is found in Haaparanta (1996), but under perfect information. Haaparanta analyses a subsidy game where two governments, maximising the net wage income, compete to attract investments of a single firm.

agent's information rent is always higher under tax competition than under cooperation, we find that the rent may be lower in come cases. Moreover, Mezzetti's model exhibits countervailing incentives; this is not the case in our model.[8]

2 The model

The particular features of the model are as follows. The MNE invests K_1 in country 1 and K_2 in country 2, yielding operating profits $N_1(K_1, \theta)$ and $N_2(K_2, \theta)$, where θ is an efficiency parameter.[9] The operating profits in each country are given by revenue minus local costs, but before joint costs of the MNE. It is a maintained assumption that the firm will want to invest in both countries, e.g. because the return functions in each of the two countries have sufficiently decreasing marginal returns on capital. Letting $K \equiv K_1 + K_2$, the global profits of the MNE are given by

$$\pi \equiv N_1(K_1, \theta) + N_2(K_2, \theta) - C(K) - r_1 - r_2, \tag{1}$$

where $C(K)$ denotes joint costs for the two affiliates and r_1 and r_2 are the taxes paid to the two countries.[10] We assume that $C'(K) > 0$, $C''(K) > 0$. The convex joint costs, $C(K)$, imply economic interaction effects between the two affiliates; an increase in the investments in one of the countries implies a higher marginal joint cost, which again affects the investments in the other country. Note that if $C''(K) = 0$, e.g. if joint costs were additive separable ($C(K) = C(K_1) + C(K_1)$), there would be no economic interaction effects among the two affiliates. Thus, there would be no strategic interaction effects among the two governments, and we would have two separate single-agency regulation problems.[11] The presence of economic interaction effects in the joint costs $C(K)$ may have different interpretations. First, K may represent scarce human capital, e.g. management resources

[8] In Olsen and Osmundsen (1999a) we extend the present model to include an outside option, and this option is also seen to generate countervailing incentives; i.e. incentive constraints bind 'upwards' as well as 'downwards' on the type interval. The different information structures in the two models have quite different implications, though; whereas Mezzetti obtains equilibria that are unique and exhibit pooling for a range of intermediate types, Olsen and Osmundsen (1999a) obtain non-unique and fully separating equilibria.

[9] In addition there may be sunk investments in both countries.

[10] Nothing substantial would be changed by using a more general (convex) cost function $C(K_1, K_2)$, with $\partial^2 C / \partial K_1 \partial K_2 > 0$.

[11] See Osmundsen et al. (1998).

or technical personnel, where we assume that the MNE faces convex recruitment and training costs. Second, K may represent real investments, where $C(K)$ is management and monitoring costs of the MNE. Economic management and co-ordination often become more demanding as the scale of international operations increases, i.e. $C(K)$ is likely to be convex. Third, instead of interpreting $C(K)$ as joint costs, in the case of imperfect competition it may be perceived as measuring interaction effects in terms of market power. For example, if the two affiliates sell their output on the same market (in a third country), their activities are substitutes: high investments (and output) in affiliate 1 reduce the price obtained by affiliate 2. Another example of a market interaction effect is a case where K_1 and K_2 are investments in R&D; the marginal payoff on R&D-activities of affiliate 1 is lower the higher the R&D activity of affiliate 2, e.g. due to a race for some product or process innovation.[12]

The countries compete to attract scarce real investments from the MNE.[13] The interaction of the principals in the model is through the MNE's joint costs. Note that $\frac{\partial^2 \pi}{\partial K_1 \partial K_2} = -C''(K) < 0$, i.e. we address a case of contracting substitutes; a case where higher investments in one affiliate negatively affects the marginal profitability of the other, e.g. because of an increase in joint marginal monitoring costs. The affiliates of the MNE are separate and independent entities, which means that they are subsidiaries and thus taxed at source. The firm has private information about its operating profits in the two countries, $N_j(K_j, \theta)$, and about its efficiency level, θ, whereas its investment levels are assumed to be observable by both parties.[14] It is presumed that if the firm is efficient in one country it is also an efficient operator in the other country; for reasons of tractability we assume that the firm has perfectly correlated efficiencies in the two countries. It is common knowledge that the efficiency types are distributed according to a cumulative distribution function $F(\theta)$ with density $f(\theta) > 0$ over an interval $[\underline{\theta}, \bar{\theta}]$, where $\underline{\theta}$ denotes the least and $\bar{\theta}$ the most efficient type. The probability distribution satisfies the regularity conditions

[12] Olsen (1993) analyses single-principal regulation of independent R&D units, and emphasizes the role of research activities as substitutes.

[13] The tax literature normally assumes that any one firm is too small to affect tax policy in a jurisdiction. We assume that the MNE is a large and unique firm, or the jurisdictions small, so that the potential tax revenue from the firm is non-negligible relative to the corporate tax bases of the two jurisdictions. An alternative interpretation is that the tax subject is a mobile industry.

[14] We presume that it is prohibitively costly for the government to observe the true efficiency level of the tax subject. Thus, the model deviates from the tax evasion literature, which assumes that the true tax base can be ascertained by (random and costly) extensive audits; see, e.g. Schroyen (1997).

$\frac{d}{d\theta}\left[\left(1-F(\theta)\right)/f(\theta)\right] \leqslant 0$.[15] Efficient types have higher operating profits than less efficient types, both on average and at the margin: $\frac{\partial N_j}{\partial \theta} > 0$ and $\frac{\partial^2 N_j}{\partial \theta \partial K_j} > 0$, $j = 1, 2$; where the latter inequality is a single crossing condition. All types have the same reservation profit, normalised to zero.

The MNE and the governments are risk neutral. For all efficiency types the affiliate's operating profits in each country are sufficiently high so that both governments always want to induce the domestic affiliate to make some investments in its home country. There are potentially three groups in each of the two countries that may benefit from the MNE's activities: consumers, local investors, and other tax payers. However, domestic consumer surpluses in the two countries are unaffected by changes in the MNE's production level, since the firm is assumed to be a price taker; or its market is outside the two countries (in which case the MNE may have market power). Hence, the MNE's contribution to national welfare is in terms of tax payments and the fraction of the producer surplus that accrues to national investors. The governments have utilitarian objective functions: the social domestic welfare generated by an MNE is given by a weighted sum of the domestic taxes paid by the firm and the firm's global profits:

$$W_j = (1 + \lambda_j) r_j + \alpha_j \pi, \quad j = 1, 2, \tag{2}$$

where $(1 + \lambda_j)$ is the general equilibrium shadow cost of public funds in country j, and α_j is the owner share of country j in the MNE, with $\alpha_j < 1$.[16]

3 The second-best cooperative equilibrium

When the agent possesses private information and the principals cooperate, the solution procedure is analogous to the familiar single principal case. The principals seek to maximise the cooperative welfare, subject to incentive and participation constraints. The standard procedure is to analyse this in terms of direct revelation mechanisms. The firm is then asked to report an efficiency type to the governments, in response to which it is instructed to make a certain amount of investments and pay a certain amount of taxes in each of the countries. The mechanism is constructed so that the firm reveals its true

[15] These conditions are satisfied by most usual probability distributions, e.g., the normal, uniform, logistic and exponential distributions.

[16] The shadow costs of public funds are taken as exogenously given in our partial analysis. We have $\lambda_j > 0$ since marginal public expenditure is financed by distortive taxes (positive excess burden).

efficiency.[17] Equivalently (in this case), in a formulation of the tax problem that more closely corresponds to the public economics literature and actual tax systems, the MNE is presented with a non-linear corporate income tax scheme, where net taxes are a function of investment levels. For multinationals, profits are not observable to the tax authorities, due to among other things strategic transfer pricing. Taxes are therefore made contingent on investments, which are assumed here to be the key verifiable variables for such a firm. (Profits may less difficult to verify for purely domestic firms, and different tax schemes may thus be introduced for purely domestic and for multinational firms, reflecting the poorer information available for the latter, as well as the differing national ownership shares). Given the tax scheme, the MNE may have an incentive to misrepresent its tax potential by choosing a tax-investment bundle intended for a less efficient company. However, the scheme is constructed so that the firm indirectly reveals its efficiency type (self selection).

In the direct mechanism approach, the firm is asked to make a report $\hat{\theta}$, in response to which it is asked to invest $K_1(\hat{\theta})$ and $K_2(\hat{\theta})$ and to pay taxes $r_1(\hat{\theta})$ and $r_2(\hat{\theta})$.[18] This yields profits $\pi(\hat{\theta},\theta) = N_1(K_1(\hat{\theta}),\theta) + N_2(K_2(\hat{\theta}),\theta) - C(K_1(\hat{\theta}) + K_2(\hat{\theta})) - r_1(\hat{\theta}) - r_2(\hat{\theta})$. Incentive compatibility requires that the firm's optimal choice of $\hat{\theta}$ is θ, i.e. it requires that[19]

$$\pi'(\theta) = \frac{\partial N_1(K_1(\theta),\theta)}{\partial\theta} + \frac{\partial N_2(K_2(\theta),\theta)}{\partial\theta}, \tag{3}$$

where $\pi(\theta) \equiv \pi(\theta,\theta)$. It can be shown that additional sufficient conditions for incentive compatibility are that $dK_j(\theta)/d\theta \geqslant 0, j = 1,2$. Assuming that $\lambda_1 = \lambda_2 = \lambda$, the optimal

[17] The Revelation Principle (see, e.g. Laffont and Tirole 1993) guarantees that, among all 'contracts' (including non-linear tax schedules) the principal may use, the best result can always be achieved by the use of a direct revelation mechanism.

[18] The tax scheme can be perceived as the *outcome* of a bargaining process. As a bargaining strategy the firm may declare a low tax potential by reporting low efficiency. This is not to be thought of as fraud. Instead it corresponds to selective presentation of data and choice of methodologies, see Baron (1989). Thus, mimicking behaviour can be classified as tax avoidance.

[19] To interpret (3), note that if type $\theta + d\theta$ mimics the less efficient type θ, it obtains additional profits $\frac{\partial N_j}{\partial\theta}d\theta$ relative to type θ in country j. To avoid such behavior the principal must allow for this rent differential in the tax scheme.

investment portfolio is then characterized by the following system of equations[20]:

$$\frac{\partial N_j(K_j,\theta)}{\partial K_j} - C'(K) = \frac{1+\lambda-\alpha_1-\alpha_2}{1+\lambda}\frac{\partial^2 N_j(K_j,\theta)}{\partial\theta\partial K_j}\frac{1-F(\theta)}{f(\theta)},\ j=1,2. \quad (4)$$

Compared with the first-best global optimum[21], the presence of asymmetric information generates the additional right hand sides of (4), which represent marginal information costs. Investment distortions relax the incentive constraints and enable the governments to reduce distortive taxes elsewhere in the economy. The optimal mechanism trades off rent extraction and investment distortions. The investment portfolios are distorted to the point where the resulting marginal deadweight losses equal the marginal deadweight losses in other sectors of the economy.[22] The optimal distortions entail reductions of investment levels in both countries, and the distortions increase with increasing outside ownership $(1-\alpha_1-\alpha_2)$.

The optimal solution in (4) can, under relatively mild conditions, be implemented by a tax schedule $R(K_1, K_2)$ where total tax payments depend only on realized investments. (See e.g. Laffont and Tirole (1986, 1993)). As a second-best response to asymmetric information, the optimal policy deviates from a level playing field (tax neutrality). A basic insight from regulation theory - applied to a tax setting - is to tailor corporate tax payments to firms' characteristics. The flexibility imposed by differential tax enforcement enables the governments to raise welfare, relative to what is obtained with a common proportional effective tax rate. The induced investment distortions improve the governments' ability to capture rent (by reducing the firm's incentives to exploit its information advantage), thus enabling the government to reduce distortive taxes elsewhere in the economy. Note also that this provides another explanation for why the chosen tax structure may discourage capital investments, even when with full information a pure rent tax would be chosen.

[20] To interpret (4), note that if all types in $(\theta, \theta + d\theta)$ increase investments marginally, the production surplus in country j increases by $(\frac{\partial N_j}{\partial K_j} - C')f(\theta)d\theta$, while the rents to type $\theta + d\theta$ increase by $\frac{\partial^2 N_j}{\partial K_j \partial\theta}d\theta$. To preserve incentive compatibility, the same rent increase must be given to all types that are more efficient, i.e to a fraction $1-F(\theta)$ of the possible types. This rent increase is costly, and must be weighted against the production surplus, hence (4) follows.

[21] The first-best allocation is given by $\partial N_1(K_1,\theta)/\partial K_1 = \partial N_2(K_2,\theta)/\partial K_2 = C'(K)$. It can be argued that in the presence of open economies, this reference case is the adequate characterisation of a non-distortive equilibrium.

[22] The latter is determined by the shadow cost of public funds, λ, which is exogenous in our partial analysis. It can be endogenised by a general equilibrium model, see Laffont and Tirole (1993), ch. 3.

4 The second-best non-cooperative equilibrium

Consider now the case where the governments of the two countries compete (to attract the firm's investments) rather than cooperate. The MNE relates to each government separately. The governments cannot credibly share information and they act non-cooperatively, i.e. we seek perfect Bayesian Nash Equilibria. In the present setting it is natural to consider equilibria in tax functions, where the principals offer tax schedules $R_j(K_j)$, implying that the firm's tax payments to country j depends on investments K_j in that country.[23] We first characterize equilibrium investments and taxes, and then consider how these depend on the distribution of the firm's ownership between the countries.

4.1 Equilibrium investments and taxes.

We consider the tax design problem of country 1; the decision problem of country 2 is analogous. Country 1 seeks to maximise expected domestic welfare, subject to incentive compatibility constraints and participation constraints for the firm; and for a given strategy of country 2. The solution procedure in the non-cooperative case is similar to the case of cooperating principals, with two exceptions. First, obviously the relevant objective function in this case is the national welfare. Second, the presence of externalities in contracts imposes an additional constraint on the problem, namely the MNE's optimal choice of investment in the other country. Given the tax function offered by country 2, we can use the Revelation Principle to find the optimal response[24] from country 1. The MNE's profits as a function of its report $\hat{\theta}_1$ to country 1 and its true type are now given by $\pi(\hat{\theta}_1, \theta) = N_1(K_1(\hat{\theta}_1), \theta) + N_2(K_2(\hat{\theta}_1), \theta) - C(K_1(\hat{\theta}_1) + K_2(\hat{\theta}_1)) - r_1(\hat{\theta}_1) - R_2(K_2(\hat{\theta}_1))$, where the firm's investments in country 2 must satisfy $K_2(\hat{\theta}_1) = \arg\max_{K_2}[N_2(K_2, \theta) - C(K_1(\hat{\theta}_1) + K_2) - R_2(K_2)]$. Incentive compatibility requires that the firm reports truthfully ($\hat{\theta}_1 = \theta$), which implies that (3) must hold for equilibrium profits in this non-cooperative case as well. In order for the firm's investments in country 2 to be incentive compatible,

[23] The Revelation Principle in its usual form does not hold for common agency, so a restriction to direct truthtelling mechanisms is not appropriate, see Peters (1999), Martimort and Stole (1999). For a parametric specification of the present model Olsen (1999) shows that the outcome for an equilibrium in (differentiable) revelation mechanisms is also the outcome for an equilibrium in tax functions, but not vice versa.

[24] For a given tax function offered by country 2, it is not restrictive to consider only direct truthtelling mechanisms in country 1's best response problem. Restricting both principals simultaneously to such mechanisms would in general affect the equilibrium.

we must further have

$$\frac{\partial N_2(K_2(\theta),\theta)}{\partial K_2} - C'\left(K_1(\theta)+K_2(\theta)\right) - R_2'(K_2(\theta)) = 0. \tag{5}$$

The decision problem of country 1 can now be seen as maximizing domestic welfare subject to the constraints (3), (5) and the participation constraint $\pi(\theta) \geq 0$.[25] That is, the regulatory problem is similar to the cooperative case, with an additional restriction. Following a procedure similar to Martimort (1992, 1996) - see the Appendix - one can see that, if the system of differential equations below defines a pair of nondecreasing investment schedules $\{K_1(\theta), K_2(\theta)\}$, and those schedules in addition satisfy a set of implementability conditions, they constitute a pure-strategy differentiable Nash equilibrium outcome for the common agency game[26]:

$$\begin{aligned} &\frac{\partial N_j(K_j,\theta)}{\partial K_j} - C'(K) \qquad (6)\\ =\; &\frac{1+\lambda-\alpha_j}{1+\lambda}\left[\frac{\partial^2 N_j(K_j,\theta)}{\partial\theta\partial K_j} + \frac{\frac{\partial^2 N_i(K_i,\theta)}{\partial\theta\partial K_i}C''(K)K_i'(\theta)}{C''(K)K_j'(\theta) - \frac{\partial^2 N_i(K_i,\theta)}{\partial\theta\partial K_i}}\right]\frac{1-F(\theta)}{f(\theta)},\; j=1,2. \end{aligned}$$

Compared with the cooperative solution in Eqs.(4), we see that the marginal information costs contain an additional term, which accounts for the interaction effect of common agency. The added term is negative,[27] so that the effectiveness of investment distortions as a means for relaxing the MNE's incentive constraint is lower when the countries compete than when they cooperate. To interpret the terms in the square brackets of Eqs.(6), we can (a bit loosely) rewrite them as $\frac{d\Delta\pi}{dK_j} = \frac{\partial\Delta\pi}{\partial K_j} + \frac{\partial\Delta\pi}{\partial K_i}\frac{dK_i}{dK_j}$, where $\Delta\pi = \pi'(\theta)d\theta$ is the rent differential between types θ and $\theta + d\theta$. The first term ($\frac{\partial\Delta\pi}{\partial K_j} = \frac{\partial^2 N_j}{\partial\theta\partial K_j}d\theta$) is the direct rent effect[28] which we recognise from the cooperative solution. Seen from the perspective of country j, the direct rent effect calls for *reducing* the investment levels for all firms but the most efficient one, just as in the cooperative case.

[25] The constraints (3,5) are only first-order conditions for the firm's choice of report and investment. Under additional conditions (common implementability conditions) one can check ex post that the first-order conditions are sufficient.

[26] We get the result, traditional for common agency models, that the total tax payments of the MNE are uniquely determined in equilibrium, but not the distribution between the two countries. The latter would be determined outside the model by a bargaining game between the two governments, and will not affect the results of the model.

[27] The numerator is positive and we know from the necessary second-order conditions for common implementability that the denominator is negative, see the appendix.

[28] See (3), which must hold also in common-agency equilibrium.

The second term ($\frac{\partial \Delta\pi}{\partial K_i}\frac{dK_i}{dK_j}$) is an indirect (strategic) rent effect,[29] which calls for *increasing* the investment levels for all firms but the most efficient one. This term is due to the ability of government j (via a strategic tax policy) to affect the MNE's investment K_i in country i. By imposing marginal taxes that induce an increase in the MNE's domestic investments, the government of country j causes investments to fall in country i (for substitutes we have $dK_i/dK_j < 0$), which has the effect, ceteris paribus, of increasing the tax revenue of country j (fiscal externality).[30] If the objectives of the governments were to maximise solely their tax revenues, we would, analogously to Stole (1992), have the following result: compared with the cooperative case, both countries (failing to account for the fiscal externalities they impose on each other) would attempt to extract more rents on the margin, with the consequence that the sum of extracted information rents would be reduced and the investment portfolio would be less distorted.

However, when a government also assigns a positive welfare weight to the part of the MNE's profits that accrues to domestic investors, this result does not necessarily hold. Indeed, for some parameter values the information-induced distortions in the real investment portfolio may be more severe when the countries compete than when they cooperate.[31] To explain this, we compare the different components of the marginal information cost (MIC) in the cooperative and the non-cooperative case. The inverse hazard-rates are the same in the two expressions. The square-bracketed terms in the MIC-expressions of Eqs.(4) and (6) tell us how effective investment distortions are in enhancing the governments' tax potential. As pointed out, due to the fiscal externalities, investment distortions are less effective as a means of rent capture in the case of competition than in the case of cooperation, calling for smaller distortions in the former case. The first term in the respective MIC-expressions reflects the different welfare weights assigned to income that accrues to the government and to the MNE (normalised by the shadow cost of public funds), and tells us how strong a motive the governments have to capture the MNE's rents. In the non-cooperative case, the motive of rent extraction is always the stronger ($1 + \lambda - \alpha_j > 1 + \lambda - \alpha_j - \alpha_i$), since the governments in this case do not internalise the

[29] We have $\frac{dK_i}{dK_j} = C''K_i'(\theta)/\left(C''K_j'(\theta) - \frac{\partial^2 N_i}{\partial\theta\partial K_i}\right)$, see the appendix.

[30] It appears that we cannot generally determine which of the two effects that dominates, i.e. an over-investment result is not precluded. If there is a firm type $\grave{\theta}_j$ for which the direct and indirect rent effects are exactly offsetting, there are two types for which we get investment neutrality; $\bar{\theta}$ and $\grave{\theta}_j$.

[31] See Proposition 1 below.

profits that accrue to the investors in the other country (equity externalities).[32] Ceteris paribus, this calls for higher investment distortions in the non-cooperative than in the cooperative case. Hence, we have two effects that go in different directions, and we cannot generally determine whether investments are higher or lower in common agency than in the cooperative equilibrium.

From the equilibrium conditions it is clear that the pattern of ownership will have implications for the equilibrium allocation of resources. In particular, the equity externalities depend very much on this pattern. In this respect it is of importance both how ownership is distributed between the two countries, and to what extent it is distributed to investors outside the two countries. In the cooperative case only the latter aspect matters for the outcome.

Comparing first the outcomes under tax competition and tax coordination, it is clear that welfare (for the two countries in question) always is higher in the latter case, in a weak sense. Whether coordination is good or bad for the firm is another matter. In much of the present common agency literature (for the case of substitutes), it is the case that the firm (the agent) benefits from competition between the principals.[33] In our context, that would occur if equity externalities were absent, i.e. if the firm is owned entirely by outside investors. We have seen that in the absence of such externalities investments are higher under common agency. And since higher investments are beneficial for the firm (see below), it follows that the firm is better off under tax competition than under tax coordination. On the other hand, we shall show that if the firm has no outside owners, then investment levels may be *lower* with competing than with cooperating principals (this is the case when equity externalities dominate fiscal externalities), making the firm worse off under tax competition compared to tax coordination.

Proposition 1 *Suppose the countries are symmetric, both with respect to technologies and ownership structure, and that a symmetric common-agency equilibrium exists. Then the following holds: (i) if both λ and the outside owner share $(1 - \alpha_1 - \alpha_2)$ are sufficiently small, then tax competition (common agency) leads to lower investments in both countries compared to the case of tax coordination (single agency); (ii) if the outside owner share*

[32] A similar type of externality is present in Martimort (1996), where multiple regulators have biased objectives favoring an interest group. The externality effects are different, however, since the decisions considered there are complements, while ours are subtitutes.

[33] See Stole (1992), Corollary 5.

$(1-\alpha_1-\alpha_2)$ is sufficiently large, then tax competition leads to higher investments in both countries compared to the case of tax coordination. As a consequence, the firm's profits are in case (i) lower and in case (ii) higher under tax competition compared to tax cooperation.

To prove part (i) of this proposition, note that when $\lambda = 0$, and $\alpha_1 + \alpha_2 = 1$, there are no distortions from the first-best under tax coordination, since the governments in this case have no motive for rent extraction. Under tax competition, however, investments are distorted downwards, that is the MIC term is positive: given symmetry we have equal return functions ($N_j = N_i$) and equal investment profiles ($K_j = K_i$), so the derivatives of these functions are also equal (across countries); we then see that the MIC term is positive, since $C''K'_j - \frac{\partial^2 N_i}{\partial\theta\partial K_i}$ is negative by the common implementability conditions (see the Appendix), and $1-\lambda-\alpha_j > 0$. Hence, we have underinvestment in common agency when $\lambda = 0$ and $1-\alpha_1-\alpha_2 = 0$. The same holds when λ and $1-\alpha_1-\alpha_2$ are small[34], and this proves part (i). To prove part (ii) of the proposition, note that when $\alpha_1 = \alpha_2 = 0$, the only difference between the equilibrium conditions for single and common agency is the added strategic term occurring in the latter case. This term is negative, and leads to investments being less distorted (downwards) in common agency compared to single agency. The same will hold when α_1 and α_2 are small, and this proves part (ii). To prove the final statement regarding the firm's profits, note that these profits (rents) satisfy $\pi'(\theta) = \frac{\partial N_1}{\partial\theta} + \frac{\partial N_2}{\partial\theta}$ and $\pi(\underline{\theta}) = 0$ under both regimes. Since $\frac{\partial^2 N_j}{\partial K_j \partial\theta} > 0$, and since investments are for *every* type (but type $\bar{\theta}$) in case (i) lower and in case (ii) higher in common agency compared to single agency, it follows that profits can be ranked the same way. This completes the proof.

So far we have discussed the investments that will be realized in equilibrium. We now turn to the tax schedules $R_j(K_j)$, $j = 1,2$ that constitute the equilibrium strategies for the two competing countries. Being unable to observe the profits of the MNE, national authorities make corporate taxes contingent on local investment levels. Investment distortions designed to enhance rent extraction under asymmetrc information are implemented by investment fees.

Denoting the equilibrium investments determined in (6) by $K_j(\theta)$, the tax schedules must satisfy the first-order conditions $\frac{\partial N_j}{\partial K_j}(K_j,\theta) - C'(K_j+K_i) = R'_j(K_j)$ for $K_j = K_j(\theta)$, $K_i = K_i(\theta)$, and this must hold for every type θ. Assuming that the investment profiles are invertible (e.g. strictly increasing in θ), we define $\theta_j(K)$ to be the inverse of $K_j(\theta)$.

[34] We assume here that the solutions vary continuously with the parameters. This regularity property is fulfilled in the special cases analysed in more detail in Olsen and Osmundsen (1999b).

The type that invests K_j in country j is thus $\theta = \theta_j(K_j)$, and it follows that this type invests $K_i = K_i(\theta_j(K_j))$ in the other country. The first-order condition for the investment K_j then takes the form

$$\frac{\partial N_j}{\partial K_j}(K_j, \theta_j(K_j)) - C'(K_j + K_i(\theta_j(K_j))) = R_j'(K_j) \tag{7}$$

This relation will determine the marginal tax (investment fee) for investments that arise as an equilibrium outcome for some type θ.[35] Even though local taxes in the non-cooperative case are made contingent only on local investments by the firm, we see from the first-order condition that equilibrium tax rates in one country depend on the MNE's investment response to taxes in the other country. Through this link local taxes depend on foreign taxes; and in equilibrium they are mutual best responses.

We know that the equilibrium involves no distortions for the most efficient type, hence it must be the case that the marginal tax rate is zero for $K_j = K_j(\bar{\theta})$. If the countries are not too asymmetric, investments will be distorted downwards in both countries for less efficient types, and marginal tax rates in each country are then positive for $K_j < K_j(\bar{\theta})$. At least in an average sense marginal tax rates are thus decreasing with increasing investment.

The tax rates will depend, among other things, on the ease with which the firm may substitute investments between the two countries. An extreme case is that of perfect substitutes, which arises when the return functions are symmetric and linear in investments. (In that case the firm's gross profits $N_1 + N_2 - C$ depend on investments only via the sum $K_1 + K_2$.) The first-best investment schedules, given by $\frac{\partial N_j}{\partial K_j} = C'$, will then in fact satisfy the equilibrium conditions (6). (Differentiating the first-best conditions with respect to θ, and taking account of $\frac{\partial^2 N_j}{\partial K_j^2} = 0$, we get $\frac{\partial^2 N_j}{\partial \theta \partial K_j} = C''(K)(K_1' + K_2')$, hence we see that the square bracket in (6) vanishes, so that the first-best investment schedules do indeed satisfy the equilibrium conditions.) The equilibrium marginal tax rates in (7) are then identically zero; only lump sum taxes are imposed. This is an equilibrium because, if one country offers a lump sum tax, then any attempt by the other country to introduce positive marginal taxes will induce the firm to substitute investments abroad for investments at home. In the case of perfect substitutes the firm's strategic investment response is $\frac{dK_i}{dK_j} = -1$, and none of the countries can unilaterally extract information rents from the firm. A tax that

[35] To handle unilateral deviations by each principal from the equilibrium investments, the tax functions must be extended outside the equilibrium range. In (Olsen and Osmundsen 1999b) we demonstrate how this can be done for specific functional forms.

reduces domestic investments and thereby the firm's 'domestic' rents ($\frac{\partial^2 N_j}{\partial\theta\partial K_j} dK_j < 0$) will be compensated by the firm by equal increases in foreign investments ($dK_i = -dK_j$) and 'foreign' rents ($\frac{\partial^2 N_i}{\partial\theta\partial K_i} dK_i = -\frac{\partial^2 N_j}{\partial\theta\partial K_j} dK_j$), respectively, such that the firm's net information rents remain unaffected. For technologies with less extreme substitution possibilities the firm cannot escape taxation so easily, and the marginal tax rates will be positive (for all types but the most effcient one) in equilibrium.[36]

4.2 National ownership

The previous section looked into some of the implications of varying degrees of outside ownership. We now shift focus to consider variations in owner shares between the two countries. Keeping the outside owner share fixed (and equal to zero for simplicity), we examine for the non-cooperative tax regime how profits and welfare respond to variations in the distribution of owner shares between the two countries. The analysis shows that for symmetric technologies a balanced ownership structure is optimal for the firm as well as for the two countries at large.[37] This structure protects the firm against highly distortive taxes in the two countries, and thus reduces the costs of asymmetric information, which is beneficial for both the firm and for the governments.[38] The result has a flavor similar to classical results in the public finance literature, in which convex tax collection costs make it advantageous to spread distortions over many tax objects.

Consider first the firm's profits. These are in equilibrium given by $\pi'(\theta) = \frac{\partial N_1}{\partial\theta} + \frac{\partial N_2}{\partial\theta}$ and $\pi(\underline{\theta}) = 0$. An increase of the owner share (α_1) of country 1 will affect marginal profits by $\Sigma_j \frac{\partial^2 N_j}{\partial K_j \partial\theta} \frac{\partial K_j}{\partial\alpha_1}$ (recall that we here assume that $\alpha_2 = 1 - \alpha_1$). Assuming symmetric technologies, we can argue that the investment effects ($\frac{\partial K_j}{\partial\alpha_1}$) will have opposite signs; in fact, if in equilibrium K_1 as a function of θ and α_1 is given by $K_1 = \kappa(\theta; \alpha_1)$, then we

[36] In Olsen and Osmundsen (1999b) we show for a parametric specification of the firm's technology that the equilibrium marginal tax rates are monotonically decreasing in the elastcity of substitution.

[37] For asymmetric technologies one can see that optimal owner shares are asymmetric (and sometimes highly so), and that the firm's preferred share distribution is not the distribution that is optimal for the societies at large, see Olsen and Osmundsen (1999b).

[38] Tax implications of national ownership have also been addressed in analyses of irreversible investments, see Konrad and Lommerud (1998). Local ownership may protect a multinational firm from the hold-up problem in foreign direct investment: since the host country's government cares about its citizens' income from portfolio investment, the government is less willing to use distortive taxes to extract the firm's net revenues.

have $K_2 = \kappa(\theta; 1-\alpha_1)$.[39] The effect of a small change in α_1 on the profit differential can therefore be written as $\frac{\partial^2 N}{\partial K_1 \partial\theta}\frac{\partial\kappa}{\partial\alpha_1} - \frac{\partial^2 N}{\partial K_2 \partial\theta}\frac{\partial\kappa}{\partial\alpha_1}$. The first term captures the additional rents generated by increased investments in country 1, and the second the reduced rents induced by lower investments in country 2.[40] The derivatives in the last expression are evaluated at different points and are therefore generally different. But we see that for $\alpha_1 = \frac{1}{2}$ (symmetric owner shares) we have equal investment levels ($K_1 = K_2$), and we also have investment effects that are equal in magnitude but opposite in signs ($\frac{\partial K_1}{\partial\alpha_1} = -\frac{\partial K_2}{\partial\alpha_1}$). The first-order conditions for an optimum are therefore satisfied at $\alpha_1 = \frac{1}{2}$. Moreover, assuming $\frac{\partial^3 N}{\partial K^2 \partial\theta} \leq 0$ and $\frac{\partial^2 K_1}{\partial\alpha_1^2} \leq 0$ [41], we see that the second-order conditions also hold, so that marginal profits are in fact at a maximum for $\alpha_1 = \frac{1}{2}$. Since this holds for every type θ, it follows that the same holds true for the firm's total profits. Under symmetric technologies the firm therefore prefers a symmetric distribution of ownership between the two countries.

To consider how the two countries' aggregate welfare depends on the distribution of ownership, we are lead to study how variations in owner shares affect the "virtual" aggregate welfare[42] associated with type θ, as given by $N_1 + N_2 - C - \frac{\lambda}{1+\lambda}(\frac{\partial N_1}{\partial\theta} + \frac{\partial N_2}{\partial\theta})\frac{1-F}{f}$. The last term here captures the detrimental effect of having to leave rents to the firm. Assuming as above symmetric technologies, we find that the effect of a marginal change of α_1 on this welfare is $\Sigma_j(\frac{\partial N}{\partial K_j} - C')\frac{\partial K_j}{\partial\alpha_1} - \frac{\lambda}{1+\lambda}\frac{1-F}{f}\Sigma_j \frac{\partial^2 N}{\partial K_j \partial\theta}\frac{\partial K_j}{\partial\alpha_1}$. The last term represents the effect on marginal profits; which was studied above. The first term captures the effect on the total production surplus. Since both of the marginal surpluses are generally nonzero in equilibrium, it is clear that variations in α_1 will indeed affect the total surplus generated in production. By symmetry considerations we also see that the marginal effects on production surpluses and rents are both zero for $\alpha_1 = \frac{1}{2}$. Moreover, maintaining the

[39] For symmetric technologies, the equations that define the equilibrium are entirely symmetric in α_1 and α_2. Let the solutions be $K_j = f_j(\theta; \alpha_1, \alpha_2)$. By symmetry we must then have $K_2 = f_1(\theta; \alpha_2, \alpha_1)$. When $\alpha_2 = 1 - \alpha_1$ and $\kappa(\theta; \alpha_1) = f_1(\theta; \alpha_1, 1-\alpha_1)$, we get $K_2 = \kappa(\theta; 1-\alpha_1)$; as asserted in the text.

[40] For the sake of the argument, we here tacitly assume that K_1 is increasing in α_1. One can verify that this holds true for special cases of the model (see Olsen and Osmundsen 1999b), but this property is not assumed in the subsequent analysis in this section.

[41] The latter condition, i.e., that equilibrium investment K_1 is concave in α_1, is difficult to verify for general functional forms. One can verify that it holds true for special functional forms, see Olsen and Osmundsen (1999b).

[42] Eqs. (1) and (2) yield $\Sigma W_j = (1+\lambda)(\Sigma N_j - C) - \lambda\pi$. By taking expectations, and integrating by parts using (3), one sees that the virtual surplus in the text is the appropriate welfare measure for type θ.

assumption $\frac{\partial^2 K_1}{\partial \alpha_1^2} \leq 0$, we see (from the second-order conditions) that the welfare measure is indeed maximised for this value of α_1, at least for λ not too large.[43] In the case of symmetric technologies, it is thus optimal for the firm as well as for the involved societies to have the ownership equally distributed between the two countries. In summary:

Proposition 2 *Suppose there is tax competition, and that technologies are symmetric between the two countries. Keeping the outside owner share fixed, and assuming* $\frac{\partial^3 N}{\partial K^2 \partial \theta} \leq 0$ *and* $\frac{\partial^2 K_1}{\partial \alpha_1^2} \leq 0$, *the firm's profits are maximised when ownership is equally distributed between the two countries. The aggregate welfare for the two societies is also maximal for this ownership structure if, e.g.* $\frac{\partial^2 K_1}{\partial \alpha_1^2} \leq 0$ *and both* λ *and the outside owner share are not too large.*

The discussion has been confined to symmetric technologies. In Olsen and Osmundsen (1999b) we examine some of these issues when technologies are asymmetric, but for tractability reasons that analysis is confined to special functional forms. The owner shares that are optimal from the firm's point of view are then also asymmetric, and those shares are not generally optimal from the point of view of the two societies at large. In these cases there is thus a conflict of interests between the firm and the societies with repect to how the firm's owner shares should be distributed.

We finally comment here the assumption maintained in this paper that the firm cannot completely escape taxation in one country by moving all of its operations to the other country. To understand some of the ramifications of this assumption, suppose instead that such moves are feasible for the firm. This imposes additional participation constraints on the principals; the firm's (equilibrium) rent must then be at least as large as what the firm can obtain by escaping any one country. It appears that (at least for some functional forms) these additional constraints will only affect the distribution of rents between the parties: except for lump-sum rent transfers, the equilibrium allocation will be the same as before.[44] This means that the countries cannot, when they compete, completely tax

[43] Note that there are general welfare effects that may be ignored in our partial approach. For example, if the total savings of the country is given, equity investments in the MNE must be balanced against other investments that may generate pure rents.

[44] Technically, the new participation constraint facing principal j will apparently bind only for the least efficient type: if $a(\theta)$ is the alternative rent the firm can obtain by escaping country j, and $\pi(\theta)$ is the rent in the 'no-escape' equilibrium, one can see that, at least for the quadratic-uniform case, that we have $\pi'(\theta) \geq a'(\theta)$. Calzolari (1998) also makes this point.

away all rents from the least efficient type of firm; even this type will keep some (mobility) rents. In this case, therefore, types with low efficiency will in general be better off under tax competition compared to tax coordination. More efficient types apparently may or may not be better off in the competitive regime; this seems to depend on how rapidly information rents increase with type.[45] With respect to owner shares, it will still be the case that equal division of ownership maximizes total rents under symmetric technologies. Whether this ownership structure also yields the highest share of those rents to the firm, however, is not evident. We plan to address these issues in future work.

5 Concluding comments

We analyse a case where an MNE allocates investments between two countries, having private information about its efficiency and its operating profits. The countries compete to tax the firm's rents; this competition is modelled as common agency. An advantage of the common agency approach is that it enables the tax systems to be endogenously determined, based on informational considerations. (In contrast, the tax competition literature typically imposes exogenous constraints on the available tax instruments.) Equilibrium tax schedules are shown to trade off fiscal externalities and equity externalities. The latter arise when each country designs its corporate tax schedules without taking into account their effects on investors in the other country. Due to equity externalities we may have equilibria where the introduction of strategic tax competition leads to lower investment levels, i.e. effective marginal capital tax rates increase by imposing tax competition. Marginal tax rates are shown to depend on the ease with which the firm may substitute investments between the two countries. In the exteme case of perfect substitutes, equilibrium marginal tax rates are zero; only lump sum taxes are imposed.

The distribution of ownership between countries matters for the investment allocation and for the sum of tax payments. Given the higher tax rate that will be imposed on a firm with few local shareholders (a more aggressive tax collection of the national governments when the rents of the firm has a low national welfare weight), firms have an incentive to have local owners, and in a symmetric case equal ownership. A joint venture with a

[45] This observation helps us understand the apparent 'discontinuity' between some full-information (e.g., Zodrow and Mieszkowski 1986) and our asymmetric-information model of tax competition: given the escape option it may depend on the extent of uncertainty whether tax competition is advantageous or not for the firm.

local firm is one example of such behaviour. In the case of symmetric technologies the governments also benefit from a balanced ownership structure. This raises some interesting policy issues; the governments and the firm may gain from influencing the ownership pattern.

The ownership structure is most easily affected for non-listed firms. The initial owners may in this case carefully select its investors, which allows them to obtain the preferred national distribution of ownership. The best case for this would be closely held family companies. In the case of a wider dispersion of ownership, a stable ownership structure can be enhanced by initially approaching long term investors. To promote an advantageous national distribution of shares, the firm may undertake direct placement of shares among long term investors in the country holding the lower equity share. As a means to induce an even distribution of ownership among investors in the two countries, the MNE may also want to be listed on the stock exchanges of both countries. As for the governments, the national distribution of equity shares may be affected by regulations, by personal income tax design, or by direct government equity acquisitions or sales. With respect to regulations, some countries have imposed ownership restrictions, e.g. on foreign ownership of financial institutions. Many countries attempt to secure a minimum national ownership stake in firms that invest locally. Some countries partly achieve this by direct government equity acquisitions, whereas other governments attempt to achieve this goal by personal income tax design.[46] More targeted policies in use are indigenisation requirements, meaning that the host government requires an investor to share ownership of an affiliate with residents in the host country (see Katrak (1983)).

Our focus is taxation of internationally mobile firms, where mobility and asymmetric information poses serious challenges to the tax authorities. Hence, similar to other papers in this field, our analytical focus is on source taxes, i.e. corporate income taxes and withholding taxes, or a two-level tax system with full imputation. However, as a means for implementing the optimal investment allocation, both source taxes and residence taxes may be applied. Note, though, that our approach is partial, i.e. we do not account for

[46] National ownership may be affected by changing the rate of the domestic wealth tax or by tax exemptions for share purchases, thus affecting local investor's general willingness to buy shares and thereby benefiting from the home market bias. Other policies in use are dividend imputation schemes available only to domestic shareholders, or differential taxation of foreign versus domestic dividends for domestic shareholders.

issues of equity which are essential to personal income tax design.

An important question is whether the governments can improve the investment allocation by use of a non-integrated two-level tax system. In particular, if dividends were observable and taxable, could the governments simply solve the information problem by taxing the dividends? The MNE's before-tax profits could be derived from the dividend payments if the tax authorities knew the firm's dividend policy (its payout ratio). However, the firm would have an incentive to conceal its true dividend policy, thus maintaining asymmetric information about retained profits. Moreover, corporate income tax and dividend taxes are not equivalent from the pespective of the government, for a number of reasons.[47] It might be an interesting extension of the model to explicitly expand the analysis to allow for two-level taxation.

With respect to ownership we have assumed that the two affiliates of the MNE are fully owned by a holding company. Also, we assume that there are interaction effects through common costs. If we relax these assumptions, we may get different qualitative results. For instance, investors may find that another ownership structure than the holding company can be optimal in a case with no interaction effects between the affiliates. To reduce local distortive taxation, it may now be optimal for the subsidiaries to be fully owned locally.[48] Extensions in this direction seems to be an interesting topic for future research.

Finally, while we have assumed that the firm has private information about its efficiency, its investment levels have been assumed to be subject to symmetric information. Observability of investments may be a reasonable description for physical capital, but not to the same extent for intangible assets. The latter may be important for MNEs, since they typically have high levels of R&D relative to sales.[49] Also, we assume that the MNE's efficiency levels are perfectly correlated in the two countries of operation. Uncorrelated

[47] For instance, since dividends are taxed by the residence principle, this approach would have to presuppose - for each of the governments - that all the owners of the MNE are domestic residents. Moreover, dividend taxes can be avoided by reinvesting. Hinesand Hubbard (1990) found that 84 per cent of all U.S. controlled foreign corporations paid no dividends to their U.S. parents.

[48] This variant of the model may thus also provide an interesting possible explanation for the lack of portfolio diversification internationally, and for the lack of capital flows internationally.

[49] Privately observed investments that are undertaken *after* the tax system is in place (moral hazard) can be accomodated in the model; the profit function can be interpreted as an indirect function where such investments are chosen optimally, conditional on the observable K_j's. Privately observed investments in place *ex ante* would, however, be a part of the firm's private information. The model represents a case where the aggregate effect of sveral such variables can be captured by a one-dimensional parameter.

efficiency parameters may be relevant if firms invest in different countries to diversify portfolios. Asymmetric information about investment levels, or uncorrelated information parameters, may represent interesting extensions of the present model. However, each of these extensions would imply a multidimensional screening problem (i.e. a challenge for the government to reveal a vector of parameters subject to private information), which is not yet fully solved, not even in a single-principal setting; see Rochet and Chone (1998)

Appendix

The non-cooperative (common agency) equilibrium.

Consider the optimisation problem for country 1. Integrating by parts, and using (3), the expected welfare in country 1 may be written

$$EW = \int_{\underline{\theta}}^{\bar{\theta}} \{(1+\lambda)\left(N_1(K_1(\theta),\theta) + N_2(K_2(\theta),\theta) - C\left(K_1(\theta)+K_2(\theta)\right) - R_2(K_2(\theta))\right) \\ -(1+\lambda-\alpha_1)\left(\frac{\partial N_1(K_1(\theta),\theta)}{\partial\theta} + \frac{\partial N_2(K_2(\theta),\theta)}{\partial\theta}\right)\frac{1-F(\theta)}{f(\theta)}\right\} dF(\theta).$$

Maximising the integrand pointwise with respect to K_1 and K_2, subject to (5), we obtain the first-order conditions

$$0 = (1+\lambda)\left(\frac{\partial N_1(K_1,\theta)}{\partial K_1} - C'(K)\right) f(\theta) \\ -(1+\lambda-\alpha_1)\frac{\partial^2 N_1(K_1,\theta)}{\partial\theta\partial K_1}(1-F(\theta)) + \mu(\theta)C''(K), \tag{8}$$

and

$$-(1+\lambda-\alpha_1)\frac{\partial^2 N_2(K_2,\theta)}{\partial\theta\partial K_2}(1-F(\theta)) \\ +\mu(\theta)\left[\frac{\partial^2 N_2(K_2,\theta)}{\partial K_2^2} - C''(K_1+K_2) - R_2''(K_2)\right] = 0. \tag{9}$$

where $\mu(\theta)$ is a multiplier corresponding to the constraint (5). Differentiating Eq.(5) with respect to θ we get

$$\frac{\partial^2 N_2(K_2,\theta)}{\partial K_2^2}K_2'(\theta) + \frac{\partial^2 N_2(K_2,\theta)}{\partial\theta\partial K_2} - C''(K_1+K_2)\left(K_1'(\theta)+K_2'(\theta)\right) - R_2''(K_2)K_2'(\theta) = 0. \tag{10}$$

Combining (9) and (10), we obtain $\mu(\theta) = -\frac{(1+\lambda-\alpha_1)\frac{\partial^2 N_2}{\partial\theta\partial K_2}(1-F)}{\frac{\partial^2 N_2}{\partial\theta\partial K_2} - C''(K)K_1'(\theta)}$, and by inserting for $\mu(\theta)$ in (8) we obtain the condition (6) (with $j=1$ and $i=2$) that characterizes the equilibrium contract for country 1.

It should also be checked that the solution is commonly implementable. Given the associated tax functions, it must indeed be optimal for the agent to report truthfully to both principals (i.e. $\pi(\theta, \theta) \geq \pi(\hat{\theta}_1, \theta)$ for all feasible reports $\hat{\theta}_1$ in principal 1's problem, and similarly for principal 2), and make the targeted investments $K_1(\theta), K_2(\theta)$. The latter requirement is fulfilled if $\Sigma_j N_j(K_j, \theta) - C(K_1 + K_2) - \Sigma_j R_j(K_j)$ is concave.[50] Local concavity is necessary at the point $(K_1, K_2) = (K_1(\theta), K_2(\theta))$. At that point we have from (10) $\frac{\partial^2 N_j}{\partial K_j^2} - C'' - R_j'' = -\frac{1}{K_j'}(\frac{\partial^2 N_j}{\partial\theta\partial K_j} - C'' K_i')$, and the necessary local concavity conditions can then be written as
$-K_1' K_2' C'' + \frac{\partial^2 N_i}{\partial\theta\partial K_i} K_i' \geq 0, i = 1, 2,$ and $K_1' K_2' \left(\frac{\partial^2 N_1}{\partial\theta\partial K_1} \frac{\partial^2 N_2}{\partial\theta\partial K_2} - C'' \left[\frac{\partial^2 N_1}{\partial\theta\partial K_1} K_1' + \frac{\partial^2 N_2}{\partial\theta\partial K_2} K_2' \right] \right) \geq 0$. These conditions are also sufficient in the case of quadratic functions and contract substitutes, provided both investment schedules are nondecreasing (cf. Stole (1992), Thm. 11, p. 22).

Finally, to derive the firm's strategic investment response $\frac{dK_i}{dK_j}$, consider its choice of investment (K_i) in the other country. Its optimal investment there is given by $\frac{\partial N_i}{\partial K_i} - C'(K) = R_i'(K_i)$, and it follows that $\frac{dK_i}{dK_j} = \frac{-C''}{R_i'' + C'' - \frac{\partial^2 N_i}{\partial K_i^2}}$. In equilibrium we will have $K_i = K_i(\theta)$, $K_j = K_j(\theta)$, and we can use (10) to substitute for the denominator $R_i'' + C'' - \frac{\partial^2 N_i}{\partial K_i^2}$. We then obtain $\frac{dK_i}{dK_j} = \frac{C'' K_i'(\theta)}{C'' K_j'(\theta) - \frac{\partial^2 N_i}{\partial\theta\partial K_i}}$, which is the formula referred to in the main text.

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[50] Concavity holds if $\frac{\partial^2 N_j}{\partial K_j^2} - C'' - R_j'' \leq 0$ and $(\frac{\partial^2 N_1}{\partial K_1^2} - C'' - R_1'')(\frac{\partial^2 N_2}{\partial K_2^2} - C'' - R_2'') - (C'')^2 \geq 0$.

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