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The Dilemma of Tax Competition: How (Not) to Attract (Inefficient) Firms?*

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Abstract

We consider a tax competition game between asymmetrically un-informed governments. Two governments simultaneously propose tax arrangements to attract a multinational firm (MNF) which has an ex-ante preference to operate in both countries, and governments anticipate that once the MNF accepts their offer, each host will know the marginal cost of local production, but not the marginal cost in the other country. We show that when the multinational prefers to operate in both countries or not operate at all, then the tax competition game features two equilibria. In one equilibrium, efficient MNFs are attracted in the two countries, while in the other equilibrium, inefficient MNFs are attracted. The equilibrium in which only efficient firms are attracted may occur as the unique outcome if the MNFs can ultimately decide to settle in one country only. Our results suggest that, the existence of (small) countries who are aggressive in attracting MNFs by offering substantial tax advantages allows competing governments to keep inefficient firms away from their territories.

Keywords: Common Agency, Adverse Selection, tax competition, Multinationals.

*JEL(s):*D82; L51; H21

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1 Introduction

Within the last years, tax competition has received a lot of attention by politicians, especially in the EU. For whom pays attention to medias, the concept of tax “race to the bottom”, which portrays the phenomenon by which tax rates (and hence public good provision) converge to very low levels because of competition for foreign investment¹, is certainly not new. Within the tax competition literature (see Wilson, 1999 for a survey), it is usually assumed that governments are solely interested in attracting capital. In other words, what type of capital they attract is irrelevant. However, if firms are differentiated on the basis of their efficiency, it should make a difference for a country depending on whether its tax policy attracts the most efficient or the most inefficient firms.

This paper shows that when governments compete in taxes to attract firms, then two equilibria may emerge: either the most efficient firms are attracted, or the most inefficient firms are attracted. However, if one of the two governments is more aggressive than the other, in that it is willing to provide a lot more advantages to the firm, then the “efficient” equilibrium may be sustained as the unique equilibrium.

Our model borrows from the recent trend that uses common agency as a tool to describe the relation between MNCs and governments (see the last paragraph for more). However, a main difference with the existing literature is that the MNC’s information set which is bi-dimensional in our paper, and the fact that governments are asymmetrically informed. These two differences are to capture the following facts: if an MNC is to operate in two countries, there are country specific parameters affecting local profit, which the local government may know better than the other government. We therefore assume that the MNC’s subsidiaries in the two countries have different cost-efficiency parameters and that each government while knowing the cost efficiency of the subsidiary in its country, ignores the cost-efficiency of the subsidiary in the other country.

The firms that we consider are multinational firms in the sense that they prefer to operate in both countries. However, we shall analyze two situations. In the first case, the multinational’s operations are worth pursuing only if they are carried on in both countries. This means that either the MNC settle in both countries, or it settles in none of the two countries. This type of common agency model is known as intrinsic common agency². Under the second scenario, the MNC prefers to settle in both countries, but may accept to settle in one country only if by doing so, it gets a higher (global) after tax profit than it would get by being active in both countries. This is the so called delegated common agency model. These two scenari

¹See Zodrow and Mieszkowsky (1986) and Wilson (1986).

²Bernheim and Winston coined this expression

may arise, depending on the project or product of the MNF. For instance the first one (settle in both or none) is more likely when there exists strong spillovers, or cost complementarities between the operations in the two countries, while the latter scenario is more likely when these spillovers are low.

The governments compete in non-linear taxes. On a theoretical ground, this is due to the fact that the MNF has private information. On a practical level, although corporate taxes are usually proportional, other tax advantages that are offered, especially by those countries which are aggressive in attracting capital, render corporate taxes non-linear. Knowing that the MNF prefers to be active in both countries, each government has to ensure that the MNF gets at least its outside opportunity when the MNF operates in both countries. In particular, none of the two governments will try to ensure that the MNF operates in its country only. Such an attempt may be interpreted as a harmful tax practice³. Therefore, even in the case of low spillovers in which an MNF may choose only one country in equilibrium, we assume that governments will nevertheless choose to ensure that the firm is better off when picking both countries, than trying to ensure that the MNF picks their country exclusively.

We find that in the case where the firm settles in both countries or none, there exists two equilibria with the following features. In one equilibrium, the tax offered by the two governments are such that the MNF's surplus is decreasing in its cost efficiency. This means that MNFs with the lowest marginal cost of production in both countries receives the highest after-tax profit, while those with the highest marginal cost get a zero after-tax profit. With such taxes, both governments are sure that tax competition will attract the most efficient MNFs. The other equilibrium has reversed features: tax competition attracts the most inefficient firms. The features of this latter equilibrium are unusual in standard adverse selection models, where typically, the most inefficient firm would get zero surplus.

Our paper follows the trend of incentive regulation of multinational firms that uses the common agency approach; see Bond and Gresik (1997, 1998), Olsen and Osmundsen (2002), Calzolari (2001, 2004). It is also related to the common agency literature in general. However, it is most closely related to Ivaldi and Martimort (1994), Bond and Gresik (1997, 1998), and Diaw and Pouyet (2004a) in that these papers either consider a bi-dimensional information set for the agent (as in Ivaldi-Martimort, 1994), or asymmetrically informed/uninformed principals (Bond and Gresik, 1997, 1998). Diaw and Pouyet (2004a) are the first to consider simultaneously bi-dimensional information set and asymmetrically informed/uninformed principals, but they analyze oligopoly competition with substitute products and obtain different equilibria than those obtained here. Ivaldi and Martimort analyze

³In a recent report for the European Commission, a group lead by the British Paymaster General Dawn Primarolo established a list of harmful tax practices in the EU.

competition in non-linear pricing (with data from the French energy sector). They have a bi-dimensional adverse selection model which ultimately boils down to a uni-dimensional screening problem after finding a sufficient statistic for the information (symmetrically) unknown to both governments. Bond and Gresik (1997) analyze an (intrinsic) common agency model with unidimensional information, but assume that one of the two principals is perfectly informed about the agent's private characteristic. However, they restrict attention to games in which (i) principals compete in linear transfers (lump-sum plus piece rate), and more importantly, (ii) neither principal attempts to elicit information from the agent, which introduces an important difference with our paper. Bond and Gresik (1998) consider the same model as in (1997) but with two-type adverse selection and principals trying to elicit information from the agent. The endogeneity problem also arises in their model. However, in our paper, when a principal has a preference over a low type agent, so does the other principal, while in their paper, it may only occur to the uninformed principal. Hence our results can in a sense be viewed as a "generalization" of their results to the case of two (asymmetrically) uninformed principals competing in non-linear transfers⁴.

2 The Model

We consider a multinational firm (the agent) which can operate in two countries. When producing quantity q_1 and q_2 in countries 1 and 2 respectively, the MNF incurs a total cost of production equal to

$$C_T(\theta, q_1, q_2) = C_1(\theta_1, q_1) + C_2(\theta_2, q_2) + C(q_1, q_2), \quad (1)$$

with $\frac{\partial C_T}{\partial \theta_i} = \frac{\partial C_i}{\partial \theta_i} \geq 0$. Notice that: $\frac{\partial^2 C_T}{\partial \theta_i \partial q_i} = \frac{\partial^2 C_i}{\partial \theta_i \partial q_i} \geq 0$. However, the common cost $C(\cdot, \cdot)$ creates a link between the production decisions, which are considered to be complements (as in Bond and Gresik, 97, 98), hence ($\frac{\partial^2 C_T}{\partial q_i \partial q_j} \leq 0$). The adverse selection parameters are independently distributed, and it is common knowledge that θ_i is distributed on $\Theta_i \equiv [\underline{\theta}_i, \bar{\theta}_i]$ according to the density $f_i(\cdot)$ with cumulative distribution $F_i(\cdot)$. We assume that \mathcal{P}_i (or equivalently government i , or Principal i) is informed about θ_i , but remains uninformed on θ_j . Therefore, principals are asymmetrically informed, and uninformed.

⁴This is taken in a loose sense since they use a two-type model, while we use a continuous type model. However, except for that difference, our model is more general, as we have two (asymmetrically) uninformed principals and non-linear transfers, instead of one uninformed principal and linear transfers in their paper.

In country i , the MNF sells its production in the local market, getting Revenue $R(q_i)$. In exchange for doing business in \mathcal{P}_i 's country, the MNF must pay a (non-linear) tax $T_i(q_i)$ contingent on local production. In particular, to avoid being classified as harmful practice, a firm's tax offer to the MNF cannot be contingent on other subsidiaries's production.⁵ The MNF's after tax profit is therefore

$$\pi(\theta, q_i, q_j) = R_1(q_1) - T_1(\theta_1, q_1) + R_2(q_2) - T_2(\theta_2, q_j) - C_T(\theta, q_1, q_2),$$

where $\theta \equiv (\theta_i, \theta_j)$. To save on notation, let $t_i(q_i) \equiv R_i(q_i) - T_i(\theta_i, q_i)$ denote the revenue net of taxes. The choice of an appropriate tax for the government is therefore equivalent to choosing how much net revenues to leave to the firm. The firm's profit can therefore be more simply written as

$$\pi(\theta, q_i, q_j) = t_1(\theta_1, q_1) + t_2(\theta_2, q_j) - C_T(\theta, q_1, q_2),$$

Each government designs its tax by maximizing the following welfare function composed of consumer's net surplus plus tax revenues⁶:

$$SW_i = S_i(q_i) - R_i(q_i) + T_i(\theta_i, q_i) = S_i(q_i) - t_i(\theta_i, q_i).$$

The timing goes as follows: first, the principals offer simultaneously and non cooperatively their tax to the MNF; second, the MNF decides to participate or not; if it chose to participate, the MNF chooses its production level in each country, and receives the corresponding transfers t_1 and t_2 .

In a first time, we consider the intrinsic common agency case (*ica*), i.e., either the MNF accepts both contracts or does not produce at all. Therefore, to ensure the participation of the MNF, each principal must ensure that the following participation constraint is satisfied:

$$\pi(\theta) \equiv \max_{\{q_i > 0, q_j > 0\}} \pi(\theta, q_i, q_j) \geq 0. \quad (PC^{ica})$$

In a final section, we will consider the delegated common agency setting (*dca*), in which the MNF can be active for only one principal at equilibrium. From the viewpoint of \mathcal{P}_i , the participation constraint becomes:

$$\pi(\theta) \geq \max \left\{ 0; \pi_i^{out}(\theta_j) \equiv \max_{q_j > 0} \pi(\theta, q_i = 0, q_j) \right\}, \quad (PC^{dca})$$

where $\pi_i^{out}(\theta_j)$ is the MNF's outside opportunity with respect to \mathcal{P}_i if it decides to be active only with \mathcal{P}_j .

⁵On a theoretical ground, it is usual in the common agency under adverse selection literature, to exclude the possibility for one principal to contract on the activity undertaken by the agent for the other principal.

⁶Note that both principals do not value the MNF's rent. Laffont and Pouyet (2002) and Olsen and Osmundsen (2001) study the role such valuations in common agency models.

Full cooperation between governments

If both governments decide to fully cooperate by exchanging their information, then they will both be under full information since each government knows a ‘piece of the puzzle’. Once fully informed, it is a simple exercise to show that whether the two governments set their taxes non cooperatively, or whether they maximize joint welfare will yield the same outcome: each government would implement a tax such that ⁷

$$S'_i(q_i^*(\theta)) = \frac{\partial C_T}{\partial q_i}(\theta, q_i^*(\theta), q_j^*(\theta)). \quad (2)$$

However, a usual feature of the intrinsic common agency setting is that only the sum of the transfers provided to the MNF is defined at equilibrium. In this setting, the (non) cooperative aspect of the game will likely affect the rent sharing between the two governments. By contrast, in the delegated common agency setting, if one of the outside opportunities is strictly positive, then each transfer is uniquely defined (both under complete and incomplete information).

It is clear that, given the generality of our model, it can apply to other settings than tax competition between governments. Therefore, we interchangeably use the terms government and principal.

3 Information Revelation

3.1 The first-order approach in a differentiable equilibrium

Consider that principals offer the MNF twice differentiable deterministic transfers. For a given contract offered to the MNF by \mathcal{P}_j , there is no loss of generality in using the Revelation Principle⁸ to find \mathcal{P}_i ’s best-response. However, different contracts offered by \mathcal{P}_j affect differently the MNF’s incentive to behave with respect to \mathcal{P}_i . To account for this effect, Martimort and Stole (1998) propose the following methodology (called the ‘first-order approach’) to compute the best-response of the principals in a differentiable equilibrium.

First, define:

$$\hat{\pi}_i(\theta_j, q_i) = \max_{q_j > 0} \{t_j(\theta_j, q_j) - C_T(\theta, q_i, q_j)\}, \quad (3)$$

$$\hat{q}_j(\theta_j, q_i) = \arg \max_{q_j > 0} \{t_j(\theta_j, q_j) - C_T(\theta, q_i, q_j)\}. \quad (4)$$

⁷This FOC of the government’s maximization program relies on the concavity of $S_i(q_i) - C_T(\theta, q_i, q_j)$ in q_i for any production level q_j , which we assume to hold.

⁸See Green and Laffont (1977) or Myerson (1979).

$\hat{\pi}_i(\theta_j, q_i)$ gives the maximal gain of the MNF with type θ_j for a given production level q_i when it chooses optimally the production level for \mathcal{P}_j . $\hat{q}_j(\theta_j, q_i)$ is defined through the first-order condition⁹:

$$\frac{\partial t_j}{\partial q_j}(\theta_j, \hat{q}_j) - \frac{\partial C_T}{\partial q_j}(\theta, q_i, \hat{q}_j) = 0. \quad (5)$$

Now, from the viewpoint of \mathcal{P}_i , everything happens as if he were facing an MNF with total rent given by:

$$\pi(\theta) \equiv \max_{q_i > 0} \{t_i(\theta_i, q_i) + \hat{\pi}_i(\theta_j, q_i)\}.$$

We can thus apply the standard methodology to find the conditions for local incentive compatibility from the viewpoint of \mathcal{P}_i , which are given in the next lemma.

Lemma 1 *A pair $\{\pi(\theta_i, \cdot), q_i(\theta_i, \cdot)\}$ is implementable by \mathcal{P}_i if and only if, for all $(\theta_i, \theta_j) \in \Theta_i \times \Theta_j$, the following conditions are satisfied:*

$$\frac{\partial \pi}{\partial \theta_j}(\theta) = \frac{\partial \hat{\pi}_i}{\partial \theta_j}(\theta_i, q_i(\theta)), \quad (FOIC_i)$$

$$\frac{\partial^2 \hat{\pi}_i}{\partial q_i \partial \theta_j}(\theta_j, q_i(\theta)) \frac{\partial q_i}{\partial \theta_j}(\theta) \geq 0. \quad (SOIC_i)$$

To validate this approach, it must be the case that, at equilibrium, it is indeed a global maximum for the MNF to accept both contracts. We shall assume that this holds for all activity profiles $\{q_i, q_j\}$, or:

$$(SOC_A) \begin{cases} \frac{\partial^2 t_i}{\partial q_i^2}(\theta_i, q_i) - \frac{\partial^2 C_T}{\partial q_i^2}(\theta, q_i, q_j) \leq 0 & i, j = 1, 2 \quad i \neq j, \\ \left[\frac{\partial^2 t_i}{\partial q_i^2}(\theta_i, q_i) - \frac{\partial^2 C_T}{\partial q_i^2}(\theta, q_i, q_j) \right] \left[\frac{\partial^2 t_j}{\partial q_j^2}(\theta_j, q_j) - \frac{\partial^2 C_T}{\partial q_j^2}(\theta, q_i, q_j) \right] \geq \left[\frac{\partial^2 C_T}{\partial q_i \partial q_j}(\theta, q_i, q_j) \right]^2. \end{cases}$$

3.2 Information revelation

Let us look at the way \mathcal{P}_i provides the MNF with the incentive to reveal its private information θ_j . Using (1) and (3), $(FOIC_i)$ can be rewritten as follows:

$$\frac{\partial \pi}{\partial \theta_j}(\theta) = \frac{\partial t_j}{\partial \theta_j}(\theta_j, \hat{q}_j(\theta_j, q_i(\theta))) - \frac{\partial C_j}{\partial \theta_j}(\theta_j, \hat{q}_j(\theta_j, q_i(\theta))). \quad (6)$$

⁹Martimort and Stole (1998) show that such characterization is always possible through an adequate extension of the equilibrium transfers (to account for possible out-of-equilibrium reports which would generate out-of-equilibrium production levels).

As a consequence of (6), \mathcal{P}_i can affect the MNF's rent only in an *indirect* way since the slope of the rent only depends directly on \hat{q}_j . In this sense, information revelation operates only in an indirect way: by distorting the production profile $q_i(\theta_i, \cdot)$, \mathcal{P}_i provides the MNF with an incentive to reallocate both production levels (since quantities are linked through the common cost); this reallocation of production affects in turn the MNF's rent.

The Spence-Mirrlees condition¹⁰ (\mathcal{SM}) becomes in our model: for all q_i ,

$$(\mathcal{SM}) \quad \frac{\partial^2 \hat{\pi}_i}{\partial \theta_j \partial q_i}(\theta_j, q_i) \leq 0$$

Under (\mathcal{SM}), the second-order condition for incentive compatibility reduces to a monotonicity condition.

3.3 Limits of the analysis

As explained previously, we will need to ascertain that the different optimality conditions are satisfied at equilibrium. The MNF's and the principals' problems must be locally but also globally concave. Similarly, the Spence-Mirrlees condition must be satisfied for every equilibrium quantity profiles.

These conditions typically depend endogeneously on the transfers implemented by the principals, which make them difficult to check *ex post*, as opposed to the one principal-one agent model. Therefore, the literature on common agency under adverse selection has followed two paths: in asymmetric settings, postulate the existence of a differentiable equilibrium characterized by a first-order approach (as in Olsen and Osmundsen, 2001, or Laffont and Pouyet, 2002); in symmetric settings, verify *ex post* those conditions by imposing more structure on the model (e.g., Martimort and Stole, 1998, show that with a quadratic cost function those conditions are satisfied). Notice also that the verification of these conditions typically strongly relies on a comparison between the quantity profiles under perfect cooperation between principals with the ones under non cooperation.

Given the inherent asymmetry of our model, we will mainly consider the existence of a differentiable equilibrium as granted, implying that (SOC_A) and (\mathcal{SM}) are assumed to be satisfied¹¹

¹⁰It should also be noted that this condition is endogenous and cannot be postulated *priori*. Throughout the analysis, we shall assume that this property emerges in both indirect utility functions vis-à-vis either principal.

¹¹We are able to prove the existence of such equilibrium if we assume a quadratic cost function and uniform distributions (see also Ivaldi and Martimort, 1994)

4 Tax competition with static multinationals

We first consider \mathcal{P}_i 's problem under incomplete information. The slope of the MNF's rent is:

$$\frac{\partial \pi}{\partial \theta_j}(\theta) = \frac{\partial \hat{\pi}_i}{\partial \theta_j} = \frac{\partial t_j}{\partial \theta_j}(\theta_j, \hat{q}_j) - \frac{\partial C_T}{\partial \theta_j}(\theta, q_i, \hat{q}_j),$$

which cannot be signed a priori. To ensure that the problem is well-behaved, we assume that $\text{Sign}[\frac{\partial \pi}{\partial \theta_j}(\theta)]$ is constant. This implies that there exists θ_j^* , with $\theta_j^* \in \{\underline{\theta}_j, \bar{\theta}_j\}$ such that if the participation constraint is satisfied in $\theta_j = \theta_j^*$, it will be satisfied for all θ_j . Let define by $\tilde{\theta}_j$ the bound of Θ_j different from θ_j^* .

The problem of \mathcal{P}_i can be restated as follows:

$$\begin{aligned} \max_{\{q_i(\theta), \pi(\theta)\}} \mathbf{E}_{\theta_j} \{S_i(q_i(\theta)) + \hat{\pi}_i(\theta_j, q_i(\theta)) - \pi(\theta)\} \\ \text{s.t. } \pi(\theta_i, \theta_j^*) \geq 0, \\ \forall \theta_j \in \Theta_j : (FOIC_i), (SOIC_i). \end{aligned}$$

Since leaving a rent to the MNF is costly for \mathcal{P}_i , the participation constraint will be binding at θ_j^* : $\pi(\theta_i, \theta_j^*) = 0$. The Hamiltonian associated to \mathcal{P}_i 's problem is:

$$H = f_j(\theta_j) [S_i(q_i(\theta)) + \hat{\pi}_i(\theta_j, q_i(\theta)) - \pi(\theta)] + \mu_i(\theta_j) \frac{\partial \hat{\pi}_i}{\partial \theta_j}(\theta_i, q_i(\theta)).$$

The Maximum Principle gives $\dot{\mu}_i(\theta_j) = -\frac{\partial H}{\partial \pi} = f_j(\theta_j)$. Since there is no transversality condition in $\tilde{\theta}_j$, we have $\mu_i(\theta_j) = \int_{\tilde{\theta}_j}^{\theta_j} f_j(x) dx$. Then, optimizing with respect to $q_i(\theta)$ yields:

$$S'_i(q_i) - \frac{\partial C_T}{\partial q_i}(\theta, q_i, \hat{q}_j) = -\frac{\mu_i(\theta_j)}{f_j(\theta_j)} \frac{\frac{\partial^2 t_j}{\partial \theta_j \partial q_j}(\theta_j, \hat{q}_j) - \frac{\partial^2 C_T}{\partial \theta_j \partial q_j}(\theta, q_i, \hat{q}_j)}{\frac{\partial^2 t_j}{\partial q_j^2}(\theta_j, \hat{q}_j) - \frac{\partial^2 C_T}{\partial q_j^2}(\theta, q_i, \hat{q}_j)} \frac{\partial^2 C_T}{\partial q_i \partial q_j}(\theta, q_i, \hat{q}_j). \quad (7)$$

In Appendix A, we show that $\frac{\partial^2 t_j}{\partial \theta_j \partial q_j}(\theta_j, \hat{q}_j) - \frac{\partial^2 C_T}{\partial \theta_j \partial q_j}(\theta, q_i, \hat{q}_j) \leq 0$, implying that the sign of the right-hand-side of (7) is given the sign of $\mu_i(\theta_j)$ and the nature of the interaction between activities.

At equilibrium, we will have

$$\hat{q}_j(\theta_j, q_i(\theta)) = q_j(\theta) \quad (8)$$

and the first-order condition associated to $\hat{q}_j(\theta_j, q_i(\theta))$ becomes

$$\frac{\partial t_j}{\partial q_j}(\theta_j, q_j(\theta)) - \frac{\partial C_T}{\partial q_j}(\theta, q_i(\theta), q_j(\theta)) = 0. \quad (9)$$

Totally differentiating (9) with respect to θ_i and θ_j and rearranging yields (we omit arguments for simplicity):

$$\frac{\partial^2 t_j}{\partial q_j^2} - \frac{\partial^2 C_T}{\partial q_j^2} = \frac{\partial^2 C_T}{\partial q_i \partial q_j} \frac{\frac{\partial q_i}{\partial \theta_i}}{\frac{\partial q_j}{\partial \theta_i}} \quad (10)$$

$$\frac{\partial^2 t_j}{\partial \theta_j \partial q_j} - \frac{\partial^2 C_T}{\partial \theta_j \partial q_j} = \frac{\partial^2 C_T}{\partial q_i \partial q_j} \frac{\frac{\partial q_i}{\partial \theta_j} \frac{\partial q_j}{\partial \theta_i} - \frac{\partial q_i}{\partial \theta_i} \frac{\partial q_j}{\partial \theta_j}}{\frac{\partial q_j}{\partial \theta_i}}. \quad (11)$$

Equations (10) and (11) enable to simplify (7); proceeding to similar computations for \mathcal{P}_j leads to a system of partial differential equations that characterize the equilibrium quantity profiles in a informative equilibrium of the common agency game under incomplete information.

Using then the concavity of $S_i - C_T$ (respectively $S_j - C_T$) with respect to q_i (respectively q_j), we are then able to analyze the equilibrium distortions with respect to the first-best solution.

We shall now determine θ_j^* and θ_i^* . Consider that $\frac{\partial \pi}{\partial \theta_j}(\theta) \leq 0 \forall \theta_j$. Then, $\theta_j^* = \bar{\theta}_j$, $\tilde{\theta}_j = \underline{\theta}_j$ and $\mu_i(\theta_j) = F_j(\theta_j)$. Using (*FOIC*_{*i*}), the MNF's rent can be rewritten as follows:

$$\pi(\theta) = - \int_{\theta_j}^{\bar{\theta}_j} \left[\frac{\partial t_j}{\partial \theta_j}(\theta_j, \hat{q}_j) - \frac{\partial C_T}{\partial \theta_j}(\theta, q_i, \hat{q}_j) \right] d\theta_j. \quad (12)$$

Using (12) and the fact that $\frac{\partial C_T}{\partial \theta_j}(\theta, q_i, q_j) = \frac{\partial C_j}{\partial \theta_j}(\theta_j, q_j)$, we obtain (see Appendix A):

$$\frac{\partial \pi}{\partial \theta_i}(\theta) = - \int_{\theta_j}^{\bar{\theta}_j} \left[\frac{\partial^2 t_j}{\partial \theta_j \partial q_j}(\theta_j, \hat{q}_j) - \frac{\partial^2 C_T}{\partial \theta_j \partial q_j}(\theta, q_i, \hat{q}_j) \right] \frac{\partial \hat{q}_j}{\partial q_i} \frac{\partial q_i}{\partial \theta_i} d\theta_j \leq 0.$$

This implies that, from \mathcal{P}_j 's viewpoint, the MNF's rent is decreasing in the unknown adverse selection parameter θ_i : therefore, $\theta_i^* = \bar{\theta}_i$ and $\mu_j(\theta_i) = F_i(\theta_i)$.

Similarly, we can show that had we assumed that $\frac{\partial \pi}{\partial \theta_j}(\theta) \geq 0 \forall \theta_j$ (implying that $\theta_j^* = \underline{\theta}_j$), we would have obtained that $\theta_i^* = \underline{\theta}_i$; in that case, we would have obtained that $\mu_i(\theta_j) = -(1 - F_j(\theta_j))$ and $\mu_j(\theta_i) = -(1 - F_i(\theta_i))$.

The next proposition summarizes these results

Proposition 1 *In the tax competition game with static multinationals, two equilibria emerge. The first equilibrium features the most efficient MNF ($\underline{\theta}_1, \underline{\theta}_2$) getting zero after-tax profits, while the most inefficient MNF ($\bar{\theta}_1, \bar{\theta}_2$) gets the highest after-tax profit, and there is overproduction in both countries with respect to full cooperation. The second equilibrium has (the standard) reversed features.*

A potentially damaging aspect of tax competition that has often been put forward is the tax race to the bottom, i.e. the fact that tax revenues are pushed downward. The above proposition points at another potential damage of tax competition: attracting the most inefficient firms. Indeed, if the tax policies toward foreign investment are such that the most inefficient firms make the highest profit, then they will be inevitably attracted by such policies, while efficient firms may want to stay away from these countries. However, a key aspect for the emergence of such an unusual equilibrium is the information asymmetry not only between the MNF and the governments, but between the government themselves. With asymmetrically uninformed governments, the government's preference over the agent's type becomes endogenous. This endogeneity effect is present in Bond and Gresik (97, 98), and in Diaw and Pouyet (2004a). However, as we shall see next, if the synergy between subsidiaries's operation are small enough so that the MNF can credibly decide to settle in one country only when the other country's offer is uninteresting, then both governments *may* escape the dilemma of attracting capital without attracting bad firms.

5 Effect of relocation threat

We now focus on the analysis of the case in which the MNF prefers to operate in both countries, but may decide, once governments make their offers, to be active in one country only. An alternative formulation is to assume that the MNF is already doing operations in both countries, but can credibly threaten to move all its operation in one country to the other country (hence the title of the section), if it is more profitable than being in both countries. This is likely to happen if the other country offers more tax advantages. Despite this threat, we analyze a game in which none of the two governments tries deliberately to exclude the other government. In equilibrium, the MNF settles in both countries. The effect of the relocation threat is to affect the outside opportunity of the MNF in its relation with a government, such outside option being endogenous. Hence each government faces an MNF with type-dependant participation constraints. Before proceeding, we present the following result, due to Calzolari and Scarpa (2001)

Lemma 2 *Both outside opportunities cannot be simultaneously positive*

Therefore, either both outside opportunities are negative, and the governments have to ensure the firm at least zero profit, in which case we are back to the equilibria under static multinationals; Or, one at most of the outside opportunities is positive.

We first consider the relation between the MNF and principal i , and assume that the outside opportunity of the MNF, if it accepts principal j 's offer only, is positive (by lemma 2, this implies that in the MNF's relation with principal j , the outside opportunity of the MNF is negative). We analyze how this possibility for the MNF to threaten principal i to be active only for principal j does alter the principals' behavior.

We define

$$\begin{aligned}\pi_i^{out}(\theta_j) &\equiv \max_{q_j} \{t_j(\theta_j, q_j) - C_T(\theta, q_i = 0, q_j)\}, \\ q_j^{out}(\theta_j) &\equiv \arg \max_{q_j} \{t_j(\theta_j, q_j) - C_T(\theta, q_i = 0, q_j)\}.\end{aligned}$$

We also assume that $q_j^{out}(\theta_j)$ is defined through the first-order condition (we omit argument for simplicity):

$$\frac{\partial t_j}{\partial q_j}(\theta_j, q_j^{out}) - \frac{\partial C_j}{\partial q_j}(\theta_j, q_j^{out}) - \frac{\partial C}{\partial q_j}(\theta, q_j^{out}) = 0, \quad (13)$$

which can be rewritten as follows:

$$\frac{\partial t_j}{\partial q_j}(\theta_j, q_j^{out}) - \frac{\partial C_T}{\partial q_j}(\theta, q_i, q_j^{out}) = \frac{\partial C_T}{\partial q_j}(\theta, 0, q_j^{out}) - \frac{\partial C_T}{\partial q_j}(\theta, q_i, q_j^{out}) \quad (14)$$

$$= - \int_0^{q_i} \frac{\partial^2 C_T}{\partial q_j \partial q_i}(\theta, x, q_j^{out}) dx. \quad (15)$$

Remember that by definition, $\hat{q}_j(\theta_i, q_i)$ is defined by (we omit argument for simplicity):

$$\frac{\partial t_j}{\partial q_j}(\theta_j, \hat{q}_j) - \frac{\partial C_T}{\partial q_j}(\theta_j, \hat{q}_j) = 0. \quad (16)$$

Define, for all $q_j \geq 0$, the following function:

$$\phi(q_j) = \frac{\partial t_j}{\partial q_j}(\theta_j, q_j) - \frac{\partial C_T}{\partial q_j}(\theta, q_i, q_j).$$

We have¹²:

$$\phi'(q_j) = \frac{\partial^2 t_j}{\partial q_j^2}(\theta_j, q_j) - \frac{\partial^2 C_T}{\partial q_j}(\theta, q_i, q_j) \leq 0,$$

¹²As argued in Martimort and Stole (1998), the transfer schedules must be extended (over the real line for instance) to account for possible out-of-equilibrium report, which would generate quantity levels outside the equilibrium intervals. Martimort (1992) shows that it is always possible to extend the transfer schedules in a linear way.

under $(SOC_{\mathcal{A}})$. Therefore, $(\phi^{-1})' = \frac{1}{\phi'} \leq 0$, implying that ϕ^{-1} is a decreasing function.

As a consequence, using (15) and (16), we obtain that $q_j^{out}(\theta_j) \leq \hat{q}_j(\theta_j, q_i)$. Simple manipulations show that:

$$\begin{aligned}\frac{\partial \pi}{\partial \theta_j}(\theta) &= \frac{\partial \hat{\pi}_i}{\partial \theta_j}(\theta_j, \hat{q}_j) = \frac{\partial t_j}{\partial \theta_j}(\theta_j, \hat{q}_j) - \frac{\partial C_T}{\partial \theta_j}(\theta, q_i, \hat{q}_j), \\ \frac{\partial \pi_i^{out}}{\partial \theta_j}(\theta_j) &= \frac{\partial t_j}{\partial \theta_j}(\theta_j, q_j^{out}) - \frac{\partial C_T}{\partial \theta_j}(\theta, 0, q_j^{out}).\end{aligned}$$

Using the last two equations and our definition of the cost function, we obtain:

$$\frac{\partial}{\partial \theta_j} [\pi(\theta) - \pi_i^{out}(\theta_j)] = - \int_{\hat{q}_j}^{q_j^{out}} \left[\frac{\partial^2 t_j}{\partial \theta_j \partial q_j}(\theta_j, x) - \frac{\partial^2 C_T}{\partial \theta_j \partial q_j}(\theta_j, q_i, x) \right] dx. \quad (17)$$

Therefore, the net rent $\pi(\theta) - \pi_i^{out}(\theta_j)$ is decreasing in θ_j .

Given that the outside opportunity is positive, this implies that if the participation constraint is satisfied in $\theta_j^* = \bar{\theta}_j$, then it will be satisfied for all θ_j .

Now, let us analyze the relation between principal j and the MNF. Recall that, by the fact that the MNF's outside opportunity in its relation with principal i is positive, the MNF's outside opportunity in its relation with principal j is negative by lemma 2. Hence it equals zero. The problem faced by principal j is therefore the same as the one he faces in the case of a static multinational. Recall that in that case, if the rent of the MNF with the other principal (e.g., principal i) is decreasing, so will be the rent of the MNF with respect to principal j (see analysis right before proposition 1). Therefore, for both principals, the participation constraints of the firm are binding at $(\bar{\theta}_1, \bar{\theta}_2)$.

Proposition 2 *In the tax competition game, the following equilibria may emerge*

- *If both outside opportunities are negative, the equilibria are the same as in the static case*
- *If one outside opportunity is positive then there exists a unique equilibrium in which the most efficient MNFs $(\underline{\theta}_1, \underline{\theta}_2)$ are attracted*

Technically, one cannot identify the conditions under which one government's outside opportunity is positive. However, intuitively, if one of the governments is strongly committed to attract the MNF, then it will be less aggressive in the rent extraction game between principals. Hence, the MNF's equilibrium profit with that government, if it decides to settle only in its country, is likely to be positive. In

Europe, for example, some big countries stick to tax policies with relatively high tax rates (France, Germany, England), while other smaller countries offer large tax advantages to MNF (Ireland and, to a lesser extent, The Netherlands). Based on the remark above about outside opportunities, one may conclude that the existence of such countries offering low tax rates is not so bad after all, because it may allow to ‘escape’ the equilibrium in which inefficient firms are attracted. This does not mean that the second equilibrium in proposition 2 dominates the equilibrium in which inefficient firms are attracted with a static multinational. Indeed, with a relocation threat, one government has to offer the MNF at least the value of its (positive) outside option, on top of the informational rents, while these latter are the only surplus collected by the static MNF.

6 Conclusions

In this paper, we have derived the (differentiable) equilibria of a common agency game in which the agent has a bidimensional information set, each principal being perfectly informed about one dimension, imperfectly informed about the other, and asymmetrically informed between them. With complementary productions, there exists two equilibria under the intrinsic common agency case: one in which the principals prefer the socially inefficient firm, and another with reverse feature. In the delegated common agency, the odd equilibrium (in which the most inefficient firm gets the highest surplus) *may* disappear.

A Appendix

Differentiating (5), we obtain:

$$\left[\frac{\partial^2 t_j}{\partial q_j^2}(\theta_j, \hat{q}_j) - \frac{\partial^2 C_T}{\partial q_j^2}(\theta, q_i, \hat{q}_j) \right] \frac{\partial \hat{q}_j}{\partial q_i} = \frac{\partial^2 C_T}{\partial q_i \partial q_j}(\theta, q_i, q_j). \quad (18)$$

Using (SOC_A) and (18) we get:

$$\text{Sign} \left[\frac{\partial \hat{q}_j}{\partial q_i} \right] = + \quad (19)$$

Finally, notice that:

$$\frac{\partial^2 \hat{\pi}_i}{\partial \theta_j \partial q_i}(\theta_j, q_i) = \left[\frac{\partial^2 t_j}{\partial \theta_j \partial q_j}(\theta_j, \hat{q}_j) - \frac{\partial^2 C_T}{\partial \theta_j \partial q_j}(\theta, q_i, \hat{q}_j) \right] \frac{\partial \hat{q}_j}{\partial q_i}. \quad (20)$$

(SM) and (20) yield:

$$\text{Sign} \left[\frac{\partial^2 t_j}{\partial \theta_j \partial q_j}(\theta_j, \hat{q}_j) - \frac{\partial^2 C_T}{\partial \theta_j \partial q_j}(\theta, q_i, \hat{q}_j) \right] = - \quad (21)$$

Finally, under (SM) and (SOC_A) it must be the case that $\frac{\partial q_i}{\partial \theta_i}(\theta) \geq 0$ at equilibrium.

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