Tax competition when firms choose their organizational form: Should tax loopholes for multinationals be closed? *

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Abstract

We analyze a sequential game between two symmetric countries when firms can invest in a multinational structure that confers tax savings. Governments are able to commit to long-run tax discrimination policies before firms’ decisions are made and before statutory capital tax rates are chosen non-cooperatively. Whether a coordinated reduction in the tax preferences granted to mobile firms is beneficial or harmful for the competing countries depends critically on the elasticity with which the firms’ organizational structure responds to tax discrimination incentives. A model extension with countries of different size shows that small countries are likely to grant more tax preferences than larger ones, along with having lower effective tax rates.

Keywords: tax competition, multinational firms, preferential treatment

JEL-Classification: H73, F23

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1 Introduction

The issue of why firms choose a multinational structure has received much attention in the modern theory of international trade. According to this theory, savings in transportation costs and tariff-jumping arguments are among the core reasons for firms investing in more than a single country (Horstmann and Markusen, 1992). Tax savings, on the other hand, have so far played hardly any role in this literature. This is surprising, because 70% of FDI inflows and more than 90% of FDI outflows occur between the developed countries (Markusen, 2002, Table 1.2) which are characterized, on average, by high corporate taxes, but relatively low tariffs and transportation costs.¹ There is by now substantial empirical evidence that multinational firms are able to significantly reduce their corporate tax burden by transfer pricing and other profit shifting strategies (Hines, 1999; Bartelsman and Beetsma, 2003). Moreover, a rising share of FDI occurs in knowledge-based industries where a large part of earnings consists of royalties and license fees that can easily be shifted internationally.² While precise quantifications remain difficult, these tax savings are arguably at least as important from the perspective of multinational firms as the reduction of transportation costs or tariffs. Nevertheless, the extensive literature on taxation and foreign direct investment (see Gresik, 2001 for a survey) has so far not considered taxes as a potential cause for the choice of a multinational form, but has instead focused almost exclusively on the consequences for tax policy of the existence of multinational firms.³

In this paper we present a model where firms endogenously choose a national or a multinational form, in response to the tax advantages accorded to a multinational status. These tax advantages may come in several forms. In Europe, for example, governments

¹Using revenue collections as an indicator, tariff revenue was only about 10% of corporate tax revenue in the United States in 2003 (§ 21 billion vs. § 200 billion). In the European Union, the share of tariff collections over corporate tax revenue is even lower, due to the high volume of tariff-free intra-European trade. See OECD (2005).

²As an example, Microsoft has moved some of its R&D operations to a subsidiary in Dublin, allowing the company to channel a disproportionate share of its profits from European sales to low-tax Ireland (12.5% corporation tax). See Wall Street Journal, November 7, 2005.

³One exception is Janeba (2000), who analyzes the incentives for a monopolist to install capacities in each of two countries, in order to induce tax competition between them.
increasingly grant special tax preferences to multinational enterprises (MNEs) that are not extended to domestic firms. The EU’s Primarolo Report (1999) lists a total of 66 examples of discriminatory tax preferences in favour of MNEs. A typical case are Belgium’s special tax rules for large, foreign-based corporations that establish a coordination center in the country. Under this law, the normal statutory tax rate is applied to a very narrow ‘notional’ tax base, leading to effective tax rates that are close to zero for most of the benefitting firms (Primarolo Report, 1999, A 001).

While special tax laws favouring MNEs are a particularly visible kind of tax discrimination, they are not the only one. Some MNEs can shift profits elsewhere, for instance to the 35 offshore tax havens identified by the OECD (1998, 2000). A weak enforcement of transfer pricing rules equally grants MNEs a tax advantage over domestic firms, and thus acts as a discriminatory device. These examples demonstrate that discriminatory tax reductions in favour of mobile, multinational firms have become widespread. Moreover, tax discrimination can be actively influenced or controlled by national governments, and can therefore itself be viewed as a strategic policy variable.

In the political debate, the current consensus in both the OECD and the European Union seems to be that tax discrimination in favour of mobile firms is both ‘unfair’ and ‘harmful’. The EU has adopted a Code of Conduct for business taxation (European Communities, 1998) under which member states have committed themselves to phase out existing tax preferences, and a similar policy goal is pursued by the OECD. From a theoretical perspective it is by no means obvious, however, that discriminatory tax policies are harmful in a world where national or sub-national jurisdictions are free to choose corporate tax rates independently. Instead, tax rate competition may well be intensified when the possibility to tax-discriminate between internationally mobile and immobile firms is reduced.

To capture the central features of the resulting interaction between countries and firms, two model elements are important in our view. As mentioned above, the first element is that tax concessions offer an incentive for firms to invest in a multinational structure,

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4Bartelsman and Beetsma (2003, Table 1) give details – based on information collected by Ernst & Young – on the formal enforcement of transfer pricing rules in 16 OECD countries. This comparison documents substantial international differences in the enforcement of transfer pricing rules and their econometric results indicate that a stricter control of these rules does indeed reduce profit shifting.
in order to benefit from these tax advantages. The second element is the long-term nature of most tax concessions, which are changed far less frequently than statutory tax rates. This observation applies to both the formal enforcement of transfer pricing rules, codified in national tax laws, and to many of the special tax preference schemes that explicitly aim at organizational adjustments within the tax-favoured multinational group. In the example of the Belgian coordination centers mentioned above, the tax preferences implied by the narrow tax base have been in effect continuously since 1983. Given the long-term commitment to maintain its tax preference, a large number of multinational groups have been attracted to Belgium, despite the uncertainty about the development of statutory tax rates, which were changed five times since the beginning of the preferential tax rule.\(^5\)

In this paper we set up a model that incorporates these elements and analyze the effects that the firms’ endogenous choice of organizational form has on optimal corporate tax policy. Specifically, we model a sequential game between two symmetric countries in which governments decide in a first stage on the degree of tax preferences for internationally mobile firms. Firms then decide on whether to invest a fixed cost and set up a foreign division, in order to qualify for these tax reductions. In the third stage, governments compete for mobile capital by means of statutory corporate tax rates, before firms make their investment decisions.

Our analysis yields the following results. When the firms’ choice of organizational form responds inelastically to tax advantages, then countries will choose a high level of tax preferences in the first stage of the game, and set the statutory tax rate on immobile firms at the maximum possible level. In this regime, the optimal coordinated policy is indeed to reduce the number of tax loopholes for multinationals. If, however, the response of firms’ organizational form to tax preferences is elastic, then non-cooperative policies will consist of a moderate level of tax discrimination chosen in the first stage of the game, and an interior level of the statutory tax rate in the third. A coordinated policy should then increase, rather than reduce, the degree of tax discrimination, in order to soften the competition via corporate tax rates. A further, positive result is obtained when we extend the model to account for differences in country size. Our

\(^5\)See Weichenrieder (1996) for an account of the response of German firms to this and other special tax schemes in the EU.
numerical results show that small countries are likely to grant more tax preferences than larger ones, in addition to having lower effective tax rates.

Our analysis relates to two different strands in the literature. A first group of papers explicitly compares inter-jurisdictional tax competition under discriminatory vs. non-discriminatory tax regimes. Janeba and Peters (1999) show that a mutual agreement to refrain from tax discrimination is Pareto improving in a setting where two countries compete for a tax base that is perfectly mobile internationally, but at the same time are able to tax a completely inelastic domestic tax base. Keen (2001), in contrast, reaches the opposite conclusion in a model where both tax bases are internationally mobile, albeit to a different degree, and the aggregate size of each tax base is fixed. Janeba and Smart (2003) generalize Keen’s model and provide a synthesis of the conditions under which a preferential tax treatment of the more mobile base is beneficial or harmful for the competing countries. Finally, Haupt and Peters (2005) show that the policy case for a ban on preferential tax regimes is strengthened when investors have a ‘home bias’. All these contributions model tax discrimination as a single-stage game and assume that capital tax bases differ exogenously in the degree of international mobility.\(^6\)

A second, recent strand in the literature focuses on the strategic use of tax enforcement policies. Peralta et al. (2006) analyse a two-stage game between asymmetric countries which compete for the profits of a single multinational firm by means of the corporation tax rate and a tax enforcement variable. In their analysis, tax enforcement is used as a strategic instrument to influence the rival country’s subsequent choice of tax rate. A direct precursor to our work is Hong and Smart (2005) who consider a small open economy which chooses both its statutory tax rate and the degree of tax sheltering given to multinationals. They find that an increase in income shifting allows the government of the small country to increase its tax rate. The final objective of their analysis is to evaluate the effects that the presence of tax havens has on global welfare. The same question is also asked by Slemrod and Wilson (2006), with different conclusions being reached in the two analyses. None of these papers, however, endogenizes the decision of firms to invest in a multinational organizational form.

\(^{6}\)Osmundsen et al. (1998) consider a problem that is related to this literature. In their model the government is unable to observe the degree of international mobility of firms and the optimal tax policy is to tax mobile firms more, and immobile firms less, than under perfect information.
The remainder of this paper is organized as follows. Section 2 describes the basic model. Section 3 analyzes tax rate competition in the third stage of the game. Section 4 describes the choice of organizational form by firms. Section 5 analyzes non-cooperative discrimination policies in the first stage. Section 6 turns to the welfare effects of coordinated changes in discrimination policies. Section 7 extends the analysis to allow for size asymmetries between countries and Section 8 concludes.

2 The model

We analyze a model of two countries that compete in capital tax rates and in the tax advantages granted to MNEs, taking account of the firms’ endogenous choice of organizational form.7 We consider a four-stage game with the following sequence of events. In the first stage, governments decide on the degree of tax discrimination between mobile and immobile firms. In the second stage, firm owners decide on whether to invest a lump sum to open up a foreign division and become a mobile, multinational firm, or remain an immobile, domestic firm. In the third stage, governments choose statutory capital tax rates. In the fourth stage, mobile firms decide where to produce and production and consumption plans are realized. All agents perfectly anticipate future decisions and the model is solved by backward induction. Hence in this section and in the following one we treat the decision of firms to be mobile or immobile as exogenous, and derive the sub-game perfect solution for the non-cooperative choice of tax rates.

In the benchmark model we assume that there are two identical countries $i \in \{1, 2\}$, which form a federation.8 The (representative) resident of each of countries 1 and 2 owns $e$ units of capital. Let $k_i^j$ be the investment in country $i$ of an investor from country $j$. Then the total amount of capital invested in country $i$ is $k_i = k_i^1 + k_i^2$. The production function $f(k_i)$ exhibits the usual properties of a positive but decreasing marginal product of capital, $f'(k_i) > 0, f''(k_i) < 0$. Moreover the Inada conditions hold, i.e., $f'(0) \to \infty$ and $f'(\infty) \to 0$. Full employment of the fixed aggregate supply of capital implies

$$k_1 + k_2 = 2e.$$  

7Throughout our analysis, the terms capital and firms are used interchangeably.
8The assumption of identical countries will be relaxed in section 7.
The investment of each individual is divided between \( h_i \) units of immobile capital and \( \kappa_i = k^i_i + k^j_i - h_i \) units of mobile capital. Hence \( e = h_i + \kappa_i, \; i \in \{1, 2\} \), where \( h_i \) and \( \kappa_i \) are predetermined at this stage of the game. Internationally mobile and immobile capital are perfect substitutes in the production of output. Mobile capital can locate anywhere in the federation costlessly, whereas immobile capital cannot be moved at all.

The amount of mobile capital employed in country \( i \) is endogenous, and denoted \( m_i \).

The total quantity of capital (mobile and immobile) invested in country \( i \) is thus

\[
k_i = k^i_i + k^j_i = h_i + m_i \quad \forall \; i, j, \; i \neq j \; ; \quad h_i, m_i \geq 0.
\]

We assume that all capital employed in country \( i \) is taxed at source, i.e., country \( i \) taxes all capital invested locally \( (k^i_i + k^j_i) \), but exempts the foreign investment of domestic residents \( (k^j_i) \) from tax. This follows a widespread perception in the literature that worldwide company taxation in practice follows closely the source principle of taxation (e.g. Tanzi 1995, Ch. 6-7).\(^9\) Nevertheless, as is true for much of the tax competition literature, our treatment simplifies international tax relations by not endogenizing the optimal tax response of the residence country.\(^10\)

Mobile and immobile capital must be taxed at the same statutory rate \( t_i \). However, mobile capital may face a lower effective rate, since it can shelter income. Let \( 1 - \phi_i \) be the share of capital income which can be sheltered from tax so that \( \phi_i \) measures to

\(^9\)Host countries generally tax the profits of multinational firms that operate within its jurisdiction. Hence the source principle applies directly when the residence country of the investor exempts foreign-earned profits from tax, to avoid international double taxation. This exemption method is employed by the majority of OECD countries. However, several countries – notably the United States, the United Kingdom and Japan – use instead the credit method, which taxes residents on their worldwide income, but grants a credit for taxes paid abroad (see Gresik 2001, Table 1). Even in this case, however, source taxation of corporate profits often remains effective. A first reason is that the tax credit granted by the residence country is typically limited to the amount of tax that would have been owed domestically. This implies that the source country’s tax rate is relevant, if it exceeds the tax rate in the residence country. Secondly, foreign-earned profits are not taxed in the residence country until they are repatriated. This offers firms an incentive to defer the repatriation of profits whenever the tax rate in the residence country exceeds that in the source country.

\(^10\)See Gresik (2001) for a survey of the literature on this issue and Davies and Gresik (2003) for a recent analysis which shows that tax competition between the host and the home countries of a multinational is affected by the mode of financing the subsidiary’s operations.
which extent the two countries enforce taxes on mobile capital.¹¹ To keep our model as simple as possible we do not incorporate any costs of this tax sheltering, and hence do not model an optimal tax avoidance decision taken by mobile firms.

With tax sheltering the effective tax rate on mobile capital in country \(i\) is

\[
\tau_i \equiv \phi_i t_i, \quad 0 \leq \phi_i \leq 1. \tag{3}
\]

The gross return to capital in country \(i\) is \(f'(k_i)\). Taxes are imposed per unit of capital so that the net return for a unit of mobile capital is \(f'(k_i) - \tau_i\). As we will discuss in more detail in section 4, the distribution of costs to become a multinational firm is specified such that some firms will always want to choose a multinational structure, even in the absence of any tax advantages. This ensures that, in our model, there will always be some mobile capital employed in each country.

Even in the presence of mobile firms, each country must find it attractive to compete for mobile capital, rather than switch to a high-tax strategy where it fully expropriates the return to immobile capital while allowing all mobile capital to leave the country. This possibility is analyzed extensively in Janeba and Peters (1999), in a model where any tax differential induces all the mobile capital to move to the lower–tax jurisdiction. In the present model, which features decreasing marginal productivities of capital, it can be ruled out that countries find it optimal to let all the mobile capital locate elsewhere, if the number of mobile firms is not too low, relative to the marginal costs of public funds.¹² Assuming that this condition holds and invoking the Inada conditions, tax competition will equalize the net return to mobile capital between countries

\[
r = f'(k_i) - \tau_i = f'(k_j) - \tau_j \quad \forall \ i, j, \ i \neq j, \tag{4}
\]

where \(r\) is the endogenous net return to mobile capital in the federation. Together with the capital market clearing condition (1), this determines the allocation of capital as a function of the effective tax rates \(\tau_i\) in each country. The response of the capital

¹¹One example of this sort of sheltering is thin capitalization, whereby the firm borrows money from an affiliate in a tax haven located outside the federation. Here \(1 - \phi_i\) would indicate the fraction of its capital costs which can be deducted in country \(i\). See Mintz and Smart (2004).

¹²This is shown in Appendix 1. All appendices to this paper can be found on our homepages at http://dept.econ.yorku.ca/˜ sam and www.vwl.uni-muenchen.de/ls_haufler.
tax base to a change in each country’s effective tax rate is determined by implicitly differentiating (4). This yields the conventional result that the capital tax base in each country is falling in its own tax rate, but rising in the tax rate of the other country, $\partial k_i / \partial \tau_i < 0$ and $\partial k_i / \partial \tau_j > 0$, $i \neq j$.

Immobile capital faces the full statutory tax rate. Hence, while mobile and immobile capital receive the same gross return, immobile capital bears a higher tax burden and receives a lower net return:

$$r_i^h = f'(k_i) - t_i = r - \frac{1 - \phi_i}{\phi_i} \tau_i \quad \forall \ i.$$  

(5)

In the following, it proves convenient to define a measure for the degree of tax discrimination in favour of mobile capital. This measure is

$$\rho_i \equiv \frac{1 - \phi_i}{\phi_i}, \quad \infty > \rho_i \geq 0.$$  

(6)

If taxes on mobile capital are fully enforced ($\phi_i = 1$) there is no discrimination and $\rho_i = 0$. In contrast, in the absence of any enforcement of taxes on mobile capital ($\phi_i \to 0$), the tax preference for MNEs becomes arbitrarily large and $\rho_i \to \infty$. From the definition of $\rho_i$ and (5) the tax advantage of a unit of mobile capital over a unit of immobile capital is given by $t_i - \tau_i = \rho_i \tau_i$.

Even though capital stocks are fixed, the net return to immobile capital cannot be negative. Since $k_i = e$ in any symmetric equilibrium, we assume an exogenous ceiling for the statutory tax rate equal to $\bar{t} = f'(e)$. This ceiling will in turn constrain the (lower) effective tax rate on mobile capital, if the discrimination parameter $\rho_i$ is sufficiently large. From (3) and (6) the maximum effective tax rate $\tau^M$ is

$$\tau^M = \frac{\bar{t}}{1 + \rho_i} = \frac{f'(e)}{1 + \rho_i} \quad \forall \ i.$$  

(7)

There is a representative individual in each jurisdiction, who owns the region’s capital endowment and receives residual labour income $f(k_i) - f'(.) k_i$, which remains untaxed. Using (4) and (5), private consumption of the representative individual is

$$x_i = f(k_i) - f'(.) k_i + e r - \rho_i \tau_i h_i \quad \forall \ i,$$  

(8)

whereas the total tax revenue collected by the source-based capital tax is

$$z_i = \tau_i (k_i + \rho_i h_i) \quad \forall \ i.$$  

(9)
The government maximizes the utility of the representative agent, given by

\[ u_i = x_i + (1 + \varepsilon) z_i = f(k_i) + (e - k_i) r + \varepsilon \tau_i (k_i + \rho_i h_i) \quad \forall \quad i, \quad (10) \]

where (4), (8) and (9) have been used in the second step. The utility function (10) exhibits a constant marginal rate of substitution between the public and the private good, where \(1 + \varepsilon\) is the marginal cost of public funds and \(\varepsilon\) represents the exogenous excess burden of the tax system.\textsuperscript{13} For any \(\varepsilon > 0\), countries would like to coordinate on high effective tax rates on capital, since - with symmetric countries - this provides a non-distortionary source of funding for the public sector.

3 Third stage: Tax rates

In the third stage of the game, governments choose capital tax rates. Since the discrimination parameter \(\rho_i\) is already fixed at this stage, it does not matter whether the statutory tax rate or the effective tax rate is considered as choice variable: equation (3) shows the relation between \(t_i\) and \(\tau_i\) for any given level of \(\phi_i\). In the following it will prove more convenient to treat the effective tax rates \(\tau_i\) as strategic variables.

Differentiating (10) with respect to \(\tau_i\) determines each country’s optimal effective tax

\[ \varepsilon (k_i + \rho_i h_i) + (1 + \varepsilon) \tau_i \frac{\partial k_i}{\partial \tau_i} + (e - k_i) \frac{\partial r}{\partial \tau_i} = 0 \quad \forall \quad i = 1, 2. \quad (11) \]

We assume that each country’s maximand (10) is a quasi-concave function of its own effective tax rate\textsuperscript{14} as long as \(h_i < k_i\), so that the solution to (11) defines country \(i\)’s best response to the tax rate chosen by country \(j\). Given the symmetry of our benchmark model it is natural to focus on a symmetric equilibrium in which \(\tau_1 = \tau_2\).\textsuperscript{15}

\textsuperscript{13}The assumption of an exogenous excess burden \(\varepsilon\) implies that the bulk of each country’s revenue is raised by taxes other than the one considered here. This is supported by the empirical observation that corporate income tax revenue has accounted for less than 10% of total tax receipts (including social security contributions) in the OECD average during the last decades (OECD, 2005).

\textsuperscript{14}This will be the case if the production function is quadratic. However, as is well-known in the tax competition literature, it is difficult to find weaker restrictions on the primitives of the model which ensure that this assumption holds.

\textsuperscript{15}A symmetric equilibrium in tax rates will arise only when both countries have chosen the same
The best response function implicitly defined by (11) shows how tax preferences to multinationals can alter the incentives to set taxes. The first term measures the marginal benefit of raising $\tau_i$. The effective tax rate is applied to the tax base $k_i$, but immobile capital $h_i$ carries the additional tax burden $\rho_i \tau_i$. The second term describes the marginal loss from an increase in $\tau$, due to a reduced capital tax base. Finally, the last term represents an intertemporal terms of trade effect, which disappears in a symmetric equilibrium where $k_i = e$.

The effective tax pair $\tau_1 = \tau_2 = \tau^I$ will be a symmetric interior Nash equilibrium if $\tau_i = \tau^I$ is a best response of country $i$ to $\tau_j = \tau^I$. Equation (11) implies that there is at most one symmetric Nash equilibrium tax rate, given by\(^{16}\)

$$\tau^I = \frac{\varepsilon}{1 + \varepsilon} \left[ -2f''(e) \right] (e + \rho h).$$

Equation (12) shows that the equilibrium tax rate $\tau^I$ is rising in the excess burden parameter $\varepsilon$, and it is positive for any positive value of $\varepsilon$. Recall, however, that there is an upper bound on $\tau$ given by (7), which will bind for sufficiently high levels of $\rho$. Therefore, there will be an interior symmetric Nash equilibrium at $\tau_1 = \tau_2 = \tau^I$ if and only if $\tau^I < \tau^M$. Otherwise, there will be a corner solution with $\tau_1 = \tau_2 = \tau^M$.\(^ {17}\)

In the following we will refer to the interior Nash equilibrium with $\tau_1 = \tau_2 = \tau^I$ as 

*Regime I*, and to the corner Nash equilibrium with $\tau_1 = \tau_2 = \tau^M$ as 

*Regime II*. If incentives to compete in tax rates were extremely low, the Nash equilibrium would be

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\(^{16}\)Without any further assumptions, it can be shown that the second–order conditions for optimality are satisfied in both countries when $\tau_1 = \tau_2 = \tau^I$. This result, proved by Bayindir–Upmann and Ziad (2005), implies that $\tau_1 = \tau_2 = \tau^I$ must be a second–order locally consistent equilibrium.

\(^{17}\)Note that there cannot be an interior Nash equilibrium with tax rates that exceed $\tau^M$. To see this, assume that such a pair of tax rates exists and denote them by $\tau^H_1 = \tau^H_2 > \tau^M$. In this case immobile firms would not produce so that $h_i = 0$. Since the tax rates $t^H$ are derived from the best response function (11), it can then be inferred from (12) that $\tau^H_i < \tau^I_i$ for all positive levels of $\rho$. But this leads to a contradiction since $\tau^I < \tau^M$. Intuitively, the existence of immobile capital moderates tax competition and allows each country to set a higher effective tax rate than if all capital were mobile internationally [as will be seen from (15) below]. Therefore, tax competition does not allow governments to raise effective tax rates beyond $\tau^M$. 

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in Regime II for any value of $\rho$. This does not seem a realistic possibility. To ensure that an interior Nash equilibrium exists for some levels of $\rho$, it must be true that $\tau^I < \tau^M$ when $\rho = 0$. From the definition of $\tau^M$ in (7) and (12) this condition is

$$\frac{\varepsilon}{1 + \varepsilon} \frac{-f''(e)e}{f'(e)} \leq \frac{1}{2}. \quad (13)$$

Condition (13) implies that neither the excess burden of the tax system nor the elasticity of the marginal product of capital $-f''(e)e/f'(e)$ are too large. In what follows we assume that this condition is indeed met.\(^\text{18}\) Equilibrium to this tax-setting stage can then be summarized by

**Proposition 1** There exists a unique symmetric Nash equilibrium to the tax setting sub-game, in which

$$\tau^*_1 = \tau^*_2 = \min\left\{\tau^I = \frac{\varepsilon}{(1 + \varepsilon)} \left[-2f''(e)\right] (e + \rho h), \quad \tau^M = \frac{f'(e)}{(1 + \rho)}\right\}. \quad (14)$$

Either there is an interior Nash equilibrium with $\tau^* = \tau^I$ (Regime I), or a corner Nash equilibrium with $\tau^* = \tau^M$ (Regime II).

In the interior Nash equilibrium of Regime I, implicit differentiation of (11) implies that best response functions are upward-sloping and have a slope less than 1 in the neighbourhood of the equilibrium. In the symmetric equilibrium, the slope is

$$\frac{\partial \tau^I_i}{\partial \tau^j} = \frac{1 + 2\varepsilon}{3 + 4\varepsilon} < 1. \quad (14)$$

Our main interest lies in the response of $\tau^I_i$ to a change in the discrimination parameter $\rho_i$. Holding constant the number of immobile firms $h_i$, equation (12) implies that

$$\frac{\partial \tau^I_i}{\partial \rho_i} = \frac{\varepsilon}{1 + \varepsilon} \left[-2f''(e)\right] h > 0 \quad \forall \ i. \quad (15)$$

Equation (15) holds a central result for our analysis. As long as some immobile firms exist in each country ($h > 0$), increasing the tax preferences for mobile firms will lead

\(^{18}\)A similar condition is needed to ensure that the equilibrium in the standard Wilson–Zodrow–Mieszkowski model does not involve tax rates greater than 100%. For example, Assumption 3 in Bayindir–Upmann and Ziad (2005) generalizes this condition to a variable cost of public funds, and an arbitrary number of identical countries.
to a higher effective tax rate on these firms. This implies that the statutory tax rate $t_i$ must rise by so much that it overcompensates for the effect of the narrower tax base.

Intuitively, the problem faced by the two countries in this stage of the game is that they are legally constrained to levy the same statutory tax rate $t_i$ on both mobile and immobile capital. Each country would like to increase the effective tax rate on immobile capital, but this tax rise will simultaneously drive mobile capital to the other country. The larger is $\rho_i$, the higher is the extra gain in tax revenue from immobile firms for any given level of $\tau_i$ and the more attractive is it for each country to raise the effective rate of capital taxation. Therefore, increases in $\rho_i$ shift up each country’s best response function, implying higher equilibrium tax rates in Regime I.

In Regime II both countries impose the maximum effective tax $\tau^M_i = \bar{t}/(1 + \rho_i)$, given the pre-determined choice of $\rho_i$. Hence there is no interaction between the effective tax rates in the two countries ($\partial \tau^M_i / \partial \tau_j = 0$). Furthermore, the relationship between $\rho_i$ and $\tau_i$ is negative in this regime, as a higher discrimination parameter reinforces the exogenous constraint on the effective tax rate

$$\frac{\partial \tau^M_i}{\partial \rho_i} = \frac{-\tau^M_i}{(1 + \rho_i)} = \frac{-\bar{t}}{(1 + \rho_i)^2} < 0.$$  

These comparative static results are summarized in:

**Proposition 2** In an interior (corner) Nash equilibrium, the effective tax rate on mobile capital is rising (falling) in the degree of tax discrimination.

4 Second stage: Firms’ organizational form

In the tax setting stage of the game, the distribution of firms between internationally mobile and immobile types is exogenous. We now endogenize the decision of firms to choose their organizational form. This decision is driven by two conflicting considerations. On the one hand mobile capital faces a lower effective tax rate and thus receives a higher net return, as analyzed above. On the other hand, it is well-known from the literature on foreign direct investment that becoming “mobile” involves choosing a multinational organizational structure, which may be costly (see Horstmann and Markusen, 1992; Markusen, 2002).
In our setting we assume that there are fixed costs associated with setting up a division in the other country. These costs, denoted $c$, are firm-specific and are distributed continuously in the interval $(c, \bar{c})$ with density function $g(c)$. Owners of capital compare these firm-specific fixed costs with the tax advantages of mobility. From (5) and (6), the latter are given by $\rho_i \tau_i$. Hence there is a critical level of fixed costs $c^*$, for which

$$\rho_i \tau_i - c^* = 0. \quad (17)$$

All firms with $c \leq c^*$ choose to become mobile multinational firms ($m_i$), whereas firms with $c > c^*$ prefer to stay immobile ($h_i$) and operate only in the residence country of the capital owner. We assume that $c < 0$ and $\bar{c} > \bar{t}$. The first of these assumptions incorporates the fact – extensively discussed in the trade literature – that there are also non-tax reasons for choosing a multinational structure. The second assumption postulates that the costs of setting up a subsidiary in the other country are sufficiently high for some firms to exceed the maximum possible tax advantage. Together these assumptions imply that there will always be some mobile and some immobile firms, for any set of tax policies chosen by the two governments.\(^{19}\)

The continued presence of mobile firms, even when there are no tax preferences, is crucial for some of the results below. Elimination of all tax preferences would be a very attractive policy for governments, if this resulted in the complete elimination of multinationals. Then countries would have no incentive to cut taxes below their statutory maximum rates in the subsequent stage: the corporate income tax would be a lump-sum tax on domestic capital. But if some mobile firms remain, even in the absence of tax preferences, then countries will want to attract these firms. In fact, with tax preferences absent, tax rate competition in the third stage will be very similar to the standard model where all capital is interregionally mobile, as a cut in effective tax rates will cause no extra revenue leakage from domestic firms in this case.

In general equilibrium the number of immobile firms in each country is determined by the tax preferences and the tax rates chosen by both countries. However, from the

\(^{19}\)An alternative assumption that ensures a positive number of mobile firms in equilibrium would have been to introduce convex costs to the government of preventing international tax shifting. In this case, it is too costly for each government to prevent profit shifting completely, giving firms with positive, yet small, fixed costs an incentive to choose the mobile type.
arbitrage condition (4), the net return to a mobile firm is always equal to \( r \), independent of where it locates. Hence to determine the effect of an increase in \( \rho_i \) on the number of immobile firms in country \( i \), it is sufficient to look at the tax advantage to becoming multinational, which from (5) equals \( \rho_i \tau_i \). Holding tax rates constant, an increase in \( \rho_i \) directly increases the benefit to a multinational form. But holding \( \rho_i \) constant, the induced change in \( \tau_i \) will also affect the benefits of being mobile, and capital owners anticipate this additional (indirect) effect. In Regime I, the direct and the indirect effect work in the same direction, whereas in Regime II they work in opposite directions. Substituting the equilibrium tax rate in Regime II shows that the tax advantage \( \rho_i \tau_i \) equals \( \frac{\tau_i \rho_i}{1 + \rho_i} \), which is an increasing function of \( \rho_i \). Hence an increase in \( \rho_i \) unambiguously reduces the number of immobile domestic firms in both regimes:

\[
h_i = e \left[ 1 - \int_0^{\rho_i} g(c) dc \right] : \frac{dh_i}{d\rho_i} = \frac{dh_i}{d\tau_i} \frac{d\tau_i}{d\rho_i} < 0. \tag{18}
\]

### 5 First stage: Discrimination policies

We now set up each government’s problem of choosing the optimal non-cooperative discrimination policy \( \rho_i \). In this initial stage of the game, the private consumption term in the utility function (10) must account for the aggregate costs that firms pay in equilibrium in order to become multinationals. These costs are treated as a pure waste of resources in the present model because, at the margin, tax savings are the reason for choosing a multinational structure. The government objective is then

\[
u_i = f(k_i) + (e - k_i) r + \varepsilon \tau_i(k_i + \rho_i h_i) - \int_0^c c g(c) dc.
\tag{19}
\]

We differentiate with respect to \( \rho_i \) and employ symmetry and the arbitrage condition (17) for the last mobile firm. Expressing capital stocks as \( k_i[\tau_i(\rho_i), \tau_j[\tau_i(\rho_i)]] \) to indicate that \( \rho_i \) shifts country \( i \)'s reaction function in the third stage along country \( j \)'s reaction function gives

\[
\frac{\partial u_i}{\partial \rho_i} = \left[ \varepsilon (k_i + \rho_i h_i) + (1 + \varepsilon) \tau_i \frac{dk_i}{d\tau_i} \frac{d\tau_i}{d\rho_i} + (1 + \varepsilon) \tau_i \frac{dk_j}{d\tau_j} \frac{d\tau_j}{d\tau_i} \frac{d\tau_i}{d\rho_i} \right. \\
+ \left. \tau_i [\varepsilon h_i + (1 + \varepsilon) \rho_i \frac{dh_i}{d\rho_i}] \right] = 0. \tag{20}
\]
Equation (20) is valid for both regimes discussed above, but we restrict attention in this section to Regime I. The first term in equation (20) is zero in this regime, since countries choose tax rates optimally in the third stage [see eq. (11)]. The second term describes the effect that the choice of $\rho_i$ has on the intensity of tax competition in the third stage. We will show below that this effect must be positive in Regime I. Finally, the third term incorporates the ability to tax immobile firms more heavily when $\rho_i$ rises, and the negative effect that this has on the number of immobile firms.

Note next that when deciding upon the level of $\rho_i$ in the first stage of the game, each government will take account of both the direct effect and the indirect effect (via the induced change in $h_i$) that this will have on the optimal level of $\tau_i$ in the third stage.

Differentiating (12) and allowing for a variable level of $h_i$ gives

\[
\left. \frac{d\tau_i}{d\rho_i} \right|_I = \frac{\partial \tau_i}{\partial \rho_i} + \frac{\partial \tau_i}{\partial h_i} \frac{dh_i}{d\rho_i} = \frac{\varepsilon}{1 + \varepsilon} (-2f''(e)) h (1 - \mu_i).
\]

(21)

Here we have defined

\[
\mu_i \equiv \left. \frac{\partial h_i}{\partial \rho_i} \right|_I > 0
\]

(22)

as the absolute value of the elasticity with which the number of immobile firms responds to tax preferences. Note that this is a total elasticity, taking account of the direct and indirect effects in eq. (18). If $\mu_i < 1$, then $d\tau_i/d\rho_i|_I > 0$.

Equation (4) implies that $\partial k_i/\partial \tau_j = -1/[2f''(e)]$ when $\tau_1 = \tau_2$. Using this fact, along with (21) and (14), equation (20) reduces to (in Regime I)

\[
\left. \frac{\partial u_i}{\partial \rho_i} \right|_I = \tau_i h_i \left[ \frac{1 + 2\varepsilon}{3 + 4\varepsilon} \varepsilon (1 - \mu_i) + \varepsilon (1 + \varepsilon)\mu_i \right].
\]

(23)

It is easily checked that (23) can equal zero only if $\mu_i < 1$. But this implies that $d\tau_i/d\rho_i$ in (21) must be positive at any Nash equilibrium in Regime I. Hence the optimal level of $\rho_i$ trades off the advantage of being able to set higher taxes on both mobile and immobile firms in the third stage, against the fact that some firms will choose a multinational organizational form in response to these tax preferences.

We first evaluate (23) at $\rho_1 = \rho_2 = 0$. In this case definition (22) implies that $\mu_i = 0$ so that (23) must be strictly positive. This indicates that some tax discrimination between mobile and immobile firms will always be introduced by optimizing governments.

\[\text{Outcomes that are not within Regime I are analyzed in Appendix 2.}\]

\[\text{In contrast, eq. (15) has included only the direct effect of } \rho_i \text{ on } \tau_i.\]
Intuitively, a small tax advantage for mobile firms allows to raise the effective tax rate and hence increase tax revenues in the third stage, whereas the induced reduction in $h_i$ causes no first-order revenue losses when the initial level of tax discrimination is zero.

To analyze the conditions under which an interior Nash equilibrium in Regime I exists in the third stage, we denote by $\bar{\rho}$ the level of tax preferences that forms the boundary between the two regimes: that is $\rho_1 = \rho_2 = \bar{\rho}$ leads to a third-stage outcome in which $\tau^I = \tau^M$. If the elasticity $\mu_i$ with which firms respond to tax preferences, evaluated at $\rho_1 = \rho_2 = \bar{\rho}$, is sufficiently high so that $\partial u_i / \partial \rho_i |^I < 0$, then there must be some $0 < \rho < \bar{\rho}$ for which $\partial u_i / \partial \rho_i |^I = 0$. The condition for (23) to be negative at $\rho = \bar{\rho}$ is

$$\mu_i > \mu^c = 1 - \frac{3 + 4\varepsilon}{3 + 8\varepsilon + 6\varepsilon^2}. \quad (24)$$

If instead $\mu_i$ is below this critical value, then each country will find it optimal to choose a high degree of tax discrimination $\rho_i \geq \bar{\rho}$ in the first stage, and tax immobile firms at the maximum rate $\tau^M$ in the third stage (see Appendix 2). This gives:

**Proposition 3** If the elasticity with which firms respond to tax preferences is sufficiently high so that condition (24) holds at $\rho_1 = \rho_2 = \bar{\rho}$, then non-cooperative choice of tax discrimination policies leads to a symmetric Nash equilibrium with effective tax rates in the third stage in the interior of Regime I.

Note that the assumption that countries can commit to a long-term discrimination policy is critical for the results derived here. To see this assume instead that countries cannot commit and choose tax preferences and tax rates simultaneously and non-cooperatively after firms have decided on their organizational structure. Choosing $\rho_i$ and $t_i$ simultaneously effectively decouples the taxation of mobile and immobile firms. Each country would thus tax immobile firms at the highest rate possible, and compete for mobile firms as in the standard tax competition model. Hence in this case the equilibrium would always be in Regime II.

### 6 Coordinating discrimination policies

We now determine whether the non-cooperative choice of discrimination policies is efficient from a global welfare perspective. Suppose then that countries could coordinate
the tax discrimination parameter $\rho$ in the first stage, knowing that they will still set effective tax rates non-cooperatively in the third stage. This setting is at the core of current policy debates in both the EU and the OECD, where an international coordination of tax discrimination policies is actively pursued, but countries remain free to set corporate tax rates autonomously.

Starting from a symmetric, non-cooperative equilibrium in either Regime I or Regime II, the joint welfare effects of a marginal, coordinated increase in $\rho$ can be determined solely by evaluating the spillover effects that a small increase in country $i$’s discrimination policy $\rho_i$ has on welfare in country $j$ ($j \neq i$). The (first-order) effect on country $i$’s own welfare must be zero from the optimality of the initial equilibrium, and the simultaneous increase in $\rho_j$ has identical effects due to the symmetry of the model. Hence, we differentiate $u_j$ in equation (19) with respect to $\rho_i$ and note that country $j$’s tax rate is affected only via the induced change in $\tau_i$. This gives

$$\frac{\partial u_j}{\partial \rho_i} = \left[ \varepsilon (k_j + \rho_j h_j) + (1 + \varepsilon) \tau_j \frac{\partial k_j}{\partial \tau_j} \frac{d \tau_i}{d \rho_i} \right] \frac{\partial k_j}{\partial \tau_i} \frac{d \tau_i}{d \rho_i} + \left[ \varepsilon + \frac{d \tau_j}{d \rho_i} \frac{d h_i}{d \rho_i} \right] \frac{\partial k_j}{\partial \tau_i} \frac{d \tau_i}{d \rho_i} \quad \forall i \neq j. \quad (25a)$$

The first of these terms is now zero in both regimes: in Regime I, the term in the squared bracket is zero from (11), whereas $\partial \tau_j / \partial \tau_i = 0$ holds in Regime II. Moreover, in Regime II we also have $dh_j / d\rho_i = 0$, as a change in country $i$’s discrimination parameter has neither a direct nor an indirect effect (because there is no induced change in $\tau_j$) on firms’ choices in country $j$. Therefore, the effects on country $j$’s welfare in the two regimes are

$$\frac{\partial u_j}{\partial \rho_i} \bigg|_I = (1 + \varepsilon) \tau_j \left( \frac{\partial k_j}{\partial \tau_i} \frac{d \tau_i}{d \rho_i} \right) \quad \forall i \neq j, \quad (25a)$$

$$\frac{\partial u_j}{\partial \rho_i} \bigg|_{II} = (1 + \varepsilon) \tau_j \left( \frac{\partial k_j}{\partial \tau_i} \frac{d \tau_i}{d \rho_i} \right) < 0 \quad \forall i \neq j. \quad (25b)$$

In Regime II the spillover effect can be readily signed from $\partial k_j / \partial \tau_i > 0$ and (16). An increase in $\rho_i$ will induce a reduction in country $i$’s effective tax rate in this regime, thus harming country $j$ in the third stage of the game. In Regime I, the corresponding first effect is positive, as $d \tau_i / d \rho_i > 0$ must hold in this regime [cf. (21)], and the rise in $\tau_i$ allows country $j$ to also raise its tax in the third stage [from (14)]. However, anticipating the tax increase in the third stage, some additional firms in country $j$ will choose a multinational form $(dh_j / d\rho_i < 0)$ so that the second term in (25a) is negative.
Nonetheless it can be shown that the first effect in the bracket must dominate in this regime, and a small increase in country $i$’s discrimination policy raises welfare in country $j$. The proof requires a detailed calculation of comparative static effects and is relegated to Appendix 3. We can then state:

**Proposition 4** If the elasticity with which firms change their organizational form is sufficiently high (low), so that an interior (corner) equilibrium results in the tax-setting stage, then a small coordinated increase (reduction) in the tax preferences given to mobile firms must be jointly welfare increasing.

Proposition 4 shows that the implications for welfare-improving changes in coordination policies are exactly opposed in the two regimes. In Regime I, a higher level of $\rho_i$ will lead to less aggressive tax competition (that is, a higher effective tax rate) by country $i$ in the third stage of the game, thus relaxing the constraint for country $j$’s choice of capital tax rate. In this regime, non-cooperative discrimination policies thus lead to a Nash equilibrium with too few tax advantages granted to internationally mobile firms. In Regime II, in contrast, a coordinated increase in the discrimination parameters aggravates the exogenous constraint on statutory tax rates. This reduces the effective taxation of mobile firms in the third stage of the game, lowering welfare in both countries. In this case the non-cooperative Nash equilibrium in Regime II thus features too many tax advantages granted to multinational firms.\(^{22}\)

The two scenarios in Proposition 4 incorporate both benchmark cases from previous work on corporate tax discrimination. Janeba and Peters (1999) distinguish exogenously between a tax base that is costlessly mobile internationally and an immobile domestic tax base in each country. This setting corresponds to our model in the special case where the elasticity with which firms adjust their organizational form is zero. In line with the results of Janeba and Peters, this case is associated in our analysis with maximum taxation of the immobile factor (Regime II) and excessive tax preferences granted to MNEs. In contrast, Keen (2001) assumes that both tax bases are

\(^{22}\)These results for small coordinated changes in $\rho$ suggest that the optimal coordinated discrimination policy is to set $\rho = \tilde{\rho}$, thus maximizing the effective tax rate that countries will non-cooperatively set in the third stage. This argument neglects the role of firms’ fixed costs, however. Incorporating these, it is shown in Appendix 4 that the optimal coordinated level of tax preferences cannot lie in the interior of Regime II, but it may be either at $\tilde{\rho}$ or in the interior of Regime I.
internationally mobile to some degree. In this setting, coordinated restrictions on tax preferences are globally welfare-reducing, as they will make tax competition more aggressive. While the set-up of our model is different, its implications are similar to Keen’s when an interior Nash equilibrium in taxes occurs in the third stage (Regime I).

There is, however, an important difference. In the analyses of Janeba and Peters (1999) and Keen (2001), the trade-off for tax policy arises at the tax-setting stage: the constraint to impose equal tax rates on both bases increases the equilibrium tax on the mobile base, but simultaneously lowers the tax rate on the less mobile base. In the present model, in contrast, an increase in the tax preferences granted to mobile firms increases, in a Regime I equilibrium, the effective tax rate levied on the immobile and on the mobile base. However, the mix between the mobile and the immobile tax base changes in our analysis, whereas this has been held fixed in previous work.

7 Differences in country size

In this section we relax the assumption that the two competing countries are identical in all respects. A well-established model is that of two countries which differ in size, but have identical preferences and per-capita endowments (see Bucovetsky, 1991; Wilson, 1991; Kanbur and Keen 1993). In this model the capital market clearing condition (1) changes to $s_1k_1 + s_2k_2 = e$, where $s_1$ and $s_2$ are the shares of each country in the world population (with $s_1 + s_2 = 1$) and all variables are expressed in per-capita form.

To obtain some analytical results for this asymmetric model, it is necessary to work with simple functional forms for the production function and for the distribution of the costs of establishing a foreign division. Hence the analysis in this section assumes a quadratic production function $f(k_i) = ak_i - bk_i^2$, $i \in \{1, 2\}$. Moreover, we assume that the fixed costs $c$ are uniformly distributed over some interval $(0, A)$, i.e. $g(c) = \beta > 0$ where $0 \leq c \leq A$. We ignore negative levels of $c$ but assume instead that there is a positive fraction of firms $\alpha$ that chooses a multinational form, even in the absence of any tax preferences. Finally, the restriction $\alpha + \beta A < 1$ ensures that there will always be some immobile firms in each country in equilibrium. Together these assumptions imply that the (per-capita) number of immobile firms is given by $h_i = e \left[1 - \alpha - \beta \rho_i \tau_i \right] \forall i$. 

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With these specifications it is possible to obtain closed-form solutions for each country’s choice of effective tax rate and for the equilibrium number of immobile firms, both as functions of the exogenous parameters and of the tax preferences chosen in the first stage of the game. These solutions are derived in Appendix 5. Still, these expressions are so complex that they permit only to derive local results, starting from an initial equilibrium in which both countries have no tax preferences ($\rho_1 = \rho_2 = 0$). These results can be summarized as follows:

**Proposition 5** If countries differ only in population size, the following holds when tax preferences are zero in the initial equilibrium ($\rho_1 = \rho_2 = 0$):

(i) The larger country levies the higher effective tax rate.

(ii) A small increase in each country’s tax preferences increases the effective tax rate in both countries in the subsequent tax-setting equilibrium.

(iii) Each country gains from a small increase in its own tax preferences.

(iv) A small increase in the tax preferences of either country benefits the other country.

Part (i) of the proposition is well-known from the literature on asymmetric tax competition when all capital is mobile internationally (Bucovetsky 1991, Wilson 1991). Parts (ii) and (iii) confirm that the local results at $\rho_i = 0$ incorporated in Propositions 2 and 3 above carry over to the case of asymmetric countries. Finally, part (iv) shows that a zero level of tax preferences in either country is unambiguously ‘too low’ from a global welfare perspective.

To gain more insights into the interaction between country size, tax preferences and effective tax rates and determine more generally the welfare implications of coordinated changes in tax preferences, we have to rely on simulation analyses. All simulations focus on Regime I equilibria, since the interesting strategic interactions arise in this regime.

Table 1 shows a consistent pattern of results for various changes in the exogenous parameters. The large country (country 1) sets the higher tax rate in all the Nash equilibria computed, but at the same time also chooses fewer tax preferences. This reciprocal relationship can be explained by the fact that the tax incentives for firms to choose a multinational structure are given by the product $\rho_i \tau_i$. Hence a high level of $\rho_i$ imposes high marginal costs on the setting of $\tau_i$ (in terms of revenue lost due to
Table 1: Simulation results for countries of different size

<table>
<thead>
<tr>
<th>exogenous parameters</th>
<th>endogenous variables</th>
<th>( \partial u_1 )</th>
<th>( \partial u_2 )</th>
<th>( \partial \rho_1 )</th>
<th>( \partial \rho_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( s_1 ) 0.5</td>
<td>( s_2 ) 0.5</td>
<td>( \varepsilon ) 0.5</td>
<td>( b ) 1</td>
<td>( \beta ) 1</td>
<td>( \rho_1 ) 0.300</td>
</tr>
<tr>
<td>(1) 0.7</td>
<td>0.3</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td>0.226</td>
</tr>
<tr>
<td>(2) 0.9</td>
<td>0.1</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td>0.102</td>
</tr>
<tr>
<td>(3) 0.9</td>
<td>0.1</td>
<td>0.5</td>
<td>1</td>
<td>1</td>
<td>0.114</td>
</tr>
<tr>
<td>(4) 0.9</td>
<td>0.1</td>
<td>0.2</td>
<td>1</td>
<td>1</td>
<td>0.090</td>
</tr>
<tr>
<td>(5) 0.9</td>
<td>0.1</td>
<td>1.0</td>
<td>1</td>
<td>1</td>
<td>0.036</td>
</tr>
<tr>
<td>(6) 0.9</td>
<td>0.1</td>
<td>0.5</td>
<td>0.2</td>
<td>1</td>
<td>0.397</td>
</tr>
<tr>
<td>(7) 0.9</td>
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<td>0.5</td>
<td>1</td>
<td>5</td>
<td>0.022</td>
</tr>
<tr>
<td>(8) 0.9</td>
<td>0.1</td>
<td>0.5</td>
<td>1</td>
<td>0.2</td>
<td>0.397</td>
</tr>
<tr>
<td>(9) 0.9</td>
<td>0.1</td>
<td>0.5</td>
<td>1</td>
<td>0.2</td>
<td>0.397</td>
</tr>
</tbody>
</table>

Note: Parameter values that are held constant in all simulations: \( e = 1 \), \( \alpha = 0.1 \), \( a = 10 \).

additional firms choosing a multinational structure), and vice versa. The same reasoning also underlies the finding that a higher excess burden of taxation \( \varepsilon \) raises effective tax rates, but simultaneously lowers tax preferences. Moreover, a strong curvature of the production function (a high level of \( b \)) reduces the elasticity of the mobile capital tax base and increases effective tax rates, whereas a higher tax elasticity of the choice of organizational structure (an increase in \( \beta \)) reduces the level of tax preferences. Finally, in all simulations that we have carried out a small increase in tax preferences of either country, starting from the non-cooperative equilibrium values, raises the welfare of the other country. Hence Proposition 4 is not overturned by the introduction of size asymmetries between countries, at least for the specific example analyzed here.

8 Conclusions

This paper has analyzed a sequential game between two symmetric countries when firms can invest in a multinational structure that confers tax savings and governments are able to commit to long-run tax discrimination policies. The fundamental trade-off for governments in this setting is that granting tax breaks to MNEs softens tax rate
competition, but a preferential tax policy also provides incentives for firms to choose a multinational structure with the sole purpose of benefitting from tax breaks. The non-cooperative equilibrium in tax discrimination strategies and corporate tax rates can be in one of two regimes. If the firms’ choice of organizational structure is rather insensitive to tax preferences, then countries will choose a high degree of tax discrimination and maximum taxation of immobile firms. If, however, the firms’ organizational structure responds elastically to tax preferences, then countries will choose moderate tax preferences for mobile firms and levy tax rates that do not confiscate the return to immobile capital.

These results offer one possible reason why tax breaks for multinational firms are limited in practice, despite the high mobility of this tax base. In setting their discrimination policy, governments take into account the incentives given to firms to invest in a multinational structure, in order to reduce tax payments in subsequent periods. Moreover, extending our model to account for countries of different size, our simulation results indicate that small countries tend to grant more tax preferences than their larger neighbours while at the same time levying lower effective tax rates. This result is consistent with the observation that the vast majority of all reported cases of discriminatory tax regimes occurs in small countries. The explanation for this phenomenon given by our model is that substantial tax preferences reinforce the effects of low effective tax rates in the international competition for mobile capital, whereas the domestic revenue costs caused by tax preferences are mitigated when the overall tax level is low.

Our analysis can be applied to the recent policy moves in both the European Union and the OECD, which aim at abolishing preferential tax regimes in favour of multinational firms, but leave national governments full autonomy over capital tax rates. The EU’s Code of Conduct and the OECD’s guidelines against ‘harmful tax competition’ address practices in which individual countries try to ring-fence their domestic tax bases by tailoring tax breaks to foreign-based firms without granting domestic firms (even domestic multinationals) the same benefits. Hence countries need not fear that domestic firms respond to tax preferences by changing their organizational form. In this setting the costs of granting generous tax preferences are thus small, and the non-cooperative equilibrium may well be characterized by excessive tax preferences for multinational firms. Hence, according to our model, a coordinated reduction in these tax preferences
is indeed likely to raise tax revenue and welfare in each country. However, our analysis has also shown that results may be very different in other policy settings when the firms’ choice of organizational form responds elastically to tax preferences. Coordinated efforts at reducing tax discrimination then have the potential to render tax rate competition more aggressive, and hence be welfare-reducing.

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**References**


Hong, Q. and M. Smart (2005), In praise of tax havens: International tax planning and foreign direct investment. Mimeo, University of Toronto.


OECD (2000), Towards global tax co-operation. Progress in identifying and eliminating harmful tax practices (Paris)


Appendix (not for publication)

Appendix 1: Avoiding Discrete Jumps in Tax Rates

Suppose that country 2 chooses the effective tax rate $\tau^I < f'(e)/(1 + \rho)$. As country 1 increases $\tau^1$ above $\tau^I$, it will lose mobile capital. The assumption that the country’s payoff function is quasi-concave (when $h_i < k_i$) implies that country 1’s payoff decreases as it increases $\tau^1$ further, if $\tau^1$ is already greater than its best response to $\tau^2 = \tau^I$.

However, if $\tau^1$ gets high enough, all mobile capital may move to country 2. This will be the case, at a tax rate $\tau^1$ less than the maximum possible rate $\tilde{t}/(1 + \rho)$, if the following condition holds

$$f'(2e - h) - \tau^I > f'(h) - \frac{f'(e)}{1 + \rho}. \quad (A.1)$$

If (A.1) holds, then there is some $\tau^0 \in [\tau^I, f'(e)/(1 + \rho)]$ such that $h_1 = k_1$ at $\tau_1 = \tau^0$.

In this case further increases in $\tau_1$ above $\tau^0$ have no impact on $k_1$, as $k_1 = h_1$. Raising $\tau_1$ above $\tau^0$ must then increase the payoff to country 1, as aggregate income of its residents is unchanged, but more income will be diverted to the public sector.

Therefore, country 1’s optimal policy, given that the other country has set an effective tax rate of $\tau^I$, is either to choose its interior best response $\tau_1 = \tau^I$, or to choose the maximal possible effective tax rate $f'(e)/(1 + \rho)$, and lose all mobile capital. The payoff to the first policy is

$$f(e) + \varepsilon \tau^I(e + \rho h) \quad (A.2)$$

and the payoff from the second policy is

$$f(h) + \varepsilon f'(e)h + \left[f'(2e - h) - \tau^I\right](e - h) \quad (A.3)$$

Thus, given that (A.1) holds, the country will wish to ‘deviate’ by specializing in immobile capital only if

$$\Delta \equiv \varepsilon[f'(e)h - \tau^I(e + \rho h)] - [f(e) - f(h)] + [f'(2e - h) - \tau^I](e - h) > 0. \quad (A.4)$$

If there were no firms with negative fixed costs of multinational form, so that $h$ equaled 0 for very low values of $\rho$, then condition (A.4) would have to hold when $h = e$. But our assumption on the cost of multinational form ensures that $h$ is bounded below $e$, for all values of $\rho$.
Concavity of the production function $f(\cdot)$ implies that $f'(2e - h) < f'(e)$, so that $\Delta$ is bounded above by

$$\varepsilon[f'(e)h - \tau^I(e + \rho h)] - [f(e) - f(h)] + [f'(e) - \tau^I](e - h) > 0.$$  

From concavity we also have that $f(e) - f(h) > f'(e)(e - h)$, implying

$$\Delta < \varepsilon f'(e)h - \tau^I[(1 + \varepsilon)e - h] \quad (A.5)$$

From equation (12)

$$\tau^I \geq \frac{2\varepsilon f'(e)}{1 + \varepsilon} \sigma, \quad (A.6)$$

where $\sigma$ is the elasticity of capital supply with respect to its net return

$$\sigma \equiv -\frac{f'(e)}{f''(e)e}.$$  

Equation (A.6) then implies that a sufficient condition for $\Delta$ to be negative is that

$$\varepsilon h < \frac{2}{\sigma} \frac{\varepsilon}{1 + \varepsilon} [(1 + \varepsilon)e - h].$$

This condition is equivalent to

$$\frac{h}{e} < \frac{2(1 + \varepsilon)}{(1 + \varepsilon)\sigma + 2} \quad (A.7)$$

Condition (A.7) is a sufficient condition (but not a necessary one) for $\tau_1 = \tau_2 = \tau^I$ to be a Nash equilibrium to the tax-setting stage when $\tau^I < \tau^M$: it implies that a deviation by either country to a maximal statutory tax rate would reduce its payoff. The condition must hold if $\varepsilon$ is sufficiently large, or $\sigma$ sufficiently small.\(^1\)

Condition (A.7) implies fairly weak restrictions on the parameters. For example, Chirinko et al (1999) estimate a value of about 0.25 for the elasticity $\sigma$. If this is the case, as long as at least 12 percent of capital were mobile, then condition (A.7) would have to hold for any positive value of for $\varepsilon$.

Chirinko, R., S. Fazzari, and A. Meyer (1999), How responsive is business capital formation to its user cost? An exploration with micro data. *Journal of Public Economics* 74, 53-80

\(^1\)Whenever $\sigma (1 + \varepsilon)/\varepsilon < 2$, the right side of condition (A.7) must exceed 1. This implies $\tau^I > \tau^M$, so that the tax-setting equilibrium must be in Regime II.
Appendix 2: Extending Proposition 3

Equation (20) defines the first–order condition for a country’s choice of tax preferences in the first stage, whatever regime results in stage 3. However, the right side of the equation changes discontinuously at $\rho_1 = \rho_2 = \tilde{\rho}$, the boundary between regimes.

In Regime II, the first term on the right side of (20) does not equal zero, as it does in Regime I. The second term, however, is zero, since the two countries’ tax rates are independent of each other when the constraints $\tau_i \leq \tau^M$ bind.

At $\rho_1 = \rho_2 = \tilde{\rho}$, the first term on the right side of (20) will be zero, since there $\tau^I = \tau^M$.

Therefore,

$$\frac{\partial u_i}{\partial \rho_i} \bigg|_{\rho=\tilde{\rho}} = (1 + \varepsilon) \tau_i \left( \frac{\varepsilon}{1 + \varepsilon} - \mu_i \right). \quad (A.8)$$

If condition (24) holds, then it must be the case that $\mu_i > \varepsilon/(1 + \varepsilon)$; otherwise the right side of (23) would be positive. So (24) implies that both $\partial u_i/\partial \rho_i|^I$ and $\partial u_i/\partial \rho_i|^II$ are negative at $\rho_1 = \rho_2 = \tilde{\rho}$.

On the other hand, if firms are so unresponsive to tax preferences that $\mu_i < \varepsilon/(1 + \varepsilon)$ at $\rho_1 = \rho_2 = \tilde{\rho}$, then both $\partial u_i/\partial \rho_i|^I$ and $\partial u_i/\partial \rho_i|^II$ are positive at $\rho_1 = \rho_2 = \tilde{\rho}$.

Finally, if condition (24) does not hold, but $\mu_i \geq \varepsilon/(1 + \varepsilon)$, then $\partial u_i/\partial \rho_i|^I \geq 0$ and $\partial u_i/\partial \rho_i|^II \leq 0$ at $\rho_1 = \rho_2 = \tilde{\rho}$, so that $\rho_1 = \rho_2 = \tilde{\rho}$ is a Nash equilibrium for the countries’ tax preferences.

Summarizing, we get the following extended version of Proposition 3:

**Proposition 3** If $\tilde{\mu}$ denotes the value of $\mu_i(= \mu_j)$ when $\rho_1 = \rho_2 = \tilde{\rho}$ and

$$\mu^c = 1 - \frac{3 + 4\varepsilon}{3 + 8\varepsilon + 6\varepsilon^2}$$

then the following holds:

(i) If $\tilde{\mu} > \mu^c$ then there is a symmetric Nash equilibrium in which $\rho_1 = \rho_2 < \tilde{\rho}$ and in which the resulting third–stage tax rates are in Regime I;

(ii) If $\mu^c \geq \tilde{\mu} \geq \varepsilon/(1 + \varepsilon)$ then there is a symmetric Nash equilibrium in which $\rho_1 = \rho_2 = \tilde{\rho}$ and in which the resulting third stage tax rates are $\tau^I = \tau^M$;

(iii) If $\varepsilon/(1 + \varepsilon) > \tilde{\mu}$ then there is a symmetric Nash equilibrium in which $\rho_1 = \rho_2 > \tilde{\rho}$ and in which the resulting third stage tax rates are in Regime II.
Appendix 3: Proof of Proposition 4

If $\rho_1 = \rho_2$ initially, and if the symmetric third–stage tax–setting equilibrium is in Regime I, then the equilibrium values of $\tau_1$, $\tau_2$, $h_1$ and $h_2$ can be defined as the solution to the system of four equations

\begin{equation}
(\varepsilon - k_i) \frac{\partial r_i}{\partial \tau_i} + \varepsilon (k_i + \rho_i h_i) + (1 + \varepsilon) \tau_i \frac{\partial k_i}{\partial \tau_i} = 0 \quad \forall \ i \in \{1, 2\}, \tag{A.9}
\end{equation}

\begin{equation}
h_i - \int_{\rho_i \tau_i}^{\infty} g(c) dc = 0 \quad \forall \ i \in \{1, 2\}. \tag{A.10}
\end{equation}

A symmetric equilibrium is further characterized by

\begin{equation}
\frac{\partial k_i}{\partial \tau_i} = \frac{1}{2 f''(e)}, \quad \frac{\partial r_i}{\partial \tau_i} = -\frac{1}{2}, \quad \frac{\partial^2 k_i}{\partial \tau_i^2} = 0. \tag{A.11}
\end{equation}

Equation (A.9) defines the reaction curve for a country in the third, tax-setting stage. From equation set (A.11), the slope of a reaction curve, in a symmetric equilibrium is

\begin{equation}
\frac{\partial \tau_i}{\partial \tau_j} = \frac{1 + 2 \varepsilon}{3 + 4 \varepsilon}, \quad i \neq j. \tag{A.12}
\end{equation}

Also using the results (A.11), the differential of the equation system (A.9)–(A.10) can be written

\begin{equation}
\begin{pmatrix}
\frac{3 + 4 \varepsilon}{4 f''(e)} & -\frac{1 + 2 \varepsilon}{4 f''(e)} & \varepsilon \rho & 0 \\
-\frac{1 + 2 \varepsilon}{4 f''(e)} & \frac{3 + 4 \varepsilon}{4 f''(e)} & 0 & \varepsilon \rho \\
\rho g(\rho \tau) & 0 & 1 & 0 \\
0 & \rho g(\rho \tau) & 0 & 1
\end{pmatrix}
\begin{pmatrix}
d\tau_1 \\
d\tau_2 \\
dh_1 \\
dh_2
\end{pmatrix}
= \begin{pmatrix}
-\varepsilon h \\
0 \\
-\tau g(\rho \tau) \\
0
\end{pmatrix} d\rho_i \tag{A.13}
\end{equation}

The determinant of the matrix on the left side of equation (A.13) is

\begin{equation}
\Delta = A + B
\end{equation}

where

\begin{equation}
A = \frac{(3 + 4 \varepsilon)^2 - (1 + 2 \varepsilon)^2}{16[f''(e)]^2} - \varepsilon \rho^2 g(\rho \tau) \frac{3 + 4 \varepsilon}{4 f''(e)} > 0, \tag{A.14}
\end{equation}

\begin{equation}
B = \varepsilon^2 \rho^4 [g(\rho \tau)]^2 - \varepsilon \rho^2 g(\rho \tau) \frac{3 + 4 \varepsilon}{4 f''(e)} > 0. \tag{A.15}
\end{equation}

Cramer’s Rule then shows the effects on the subsequent stages of a unilateral change in one country’s tax preferences

\begin{equation}
\frac{dh_i}{d\rho_i} = \frac{-\tau g(\rho \tau) A + (h_i / \rho) B}{A + B}. \tag{A.16}
\end{equation}
From the definition of the elasticity of firm structure with respect to the tax advantages of MNE form [see eq. (A.27)] and (A.10)

\[ \eta \equiv - \frac{dh}{d(\rho \tau)} \frac{\rho \tau}{h} = g(\rho \tau) \frac{\rho \tau}{h}, \]

so that equation (A.16) becomes

\[ \frac{dh_i}{d\rho_i} = -\frac{h}{\rho} \left[ 1 + (\eta - 1) \frac{A}{A+B} \right] \iff 1 - \mu_i = \frac{A}{A+B} (1 - \eta), \quad (\text{A.17}) \]

where the definition of \( \mu_i \) in the main text [eq. (22)] has been used. It follows that at a symmetric equilibrium in Regime I:

**Lemma A.1** If \( \eta < 1 \) (\( \eta > 1 \)) then \( \eta < \mu < 1 \) (\( \eta > \mu > 1 \)).

Further, equation (A.13) implies that

\[ \frac{dh_j}{d\rho_i} = (1 - \eta) \frac{\varepsilon h \rho g(\rho \tau)}{(A+B) 4f''(e)} \quad j \neq i, \quad (\text{A.18}) \]

so that an increase in one country’s tax preferences will decrease the number of immobile firms in the other country if \( \eta < 1 \).

For the response of a country’s effective tax rate with respect to its own tax preference parameter, Cramer’s Rule gives

\[ \frac{d\tau_i}{d\rho_i} = (1 - \eta) \frac{\varepsilon h \rho g(\rho \tau)}{(A+B) 4f''(e)} \left[ \varepsilon \rho^2 g'(\tau \rho) - \frac{3}{4} + \frac{4\varepsilon}{4f''(e)} \right], \quad (\text{A.19}) \]

so that \( d\tau_i/d\rho_i > 0 \) if and only if \( \eta < 1 \). Moreover, if \( \eta < 1 \), then \( d\tau_j/d\rho_i > 0 \) also holds from the fact that reaction curves slope up near a symmetric equilibrium.

**Lemma A.2** If \( 0 \leq \varepsilon \leq 1 \), then a coordinated increase in the tax preference parameter \( \rho \) must increase the payoff to each country, starting from a non–cooperative equilibrium which implies an outcome in Regime I.

**Proof:** It is necessary to show that an increase in \( \rho_i \) must raise country \( j \)'s payoff, starting from a symmetric Nash equilibrium (for which the stage 3 tax rates are in Regime I).

The effect of \( \rho_i \) on \( u_j \) was defined by equation (25a) of the text, repeated here

\[ \left. \frac{\partial u_j}{\partial \rho_i} \right|_I = (1 + \varepsilon) \tau_j \left( \frac{\partial k_j}{\partial \tau_i} \left. \frac{d\tau_i}{d\rho_i} \right|_I + \rho_j \frac{dh_j}{d\rho_i} \right) \quad \forall i \neq j \]
Equation (11) of the text implies that

\[ \varepsilon (e + \rho h) = - (1 + \varepsilon) \tau \frac{\partial k_i}{\partial \tau_i} \iff \varepsilon (e + \rho h) = (1 + \varepsilon) \tau \frac{\partial k_j}{\partial \tau_i} \quad j \neq i \]

At a symmetric non-cooperative equilibrium, equation (20) can be written

\[
\frac{\partial u_i}{\partial \rho_i} \bigg|_I = \varepsilon (e + \rho h) \frac{d\tau_i}{d\rho_i} + \tau_i \left[ \varepsilon h_i + (1 + \varepsilon) \rho_i \frac{d\rho_i}{d\rho_i} \right] = 0,
\]

if the third-stage equilibrium is in Regime I. From the definition of \( \mu \), and equation (A.12), this becomes

\[
\varepsilon (e + \rho h) \frac{d\tau_i}{d\rho_i} = - \tau h \left[ \varepsilon - (1 + \varepsilon \mu) \right] \frac{3 + 4\varepsilon}{1 + 2\varepsilon}.
\]

(A.20)

so that

\[
\frac{\partial u_j}{\partial \rho_i} \bigg|_I = \tau h \left[ \frac{3 + 4\varepsilon}{1 + 2\varepsilon} (1 - \varepsilon (1 - \mu)) + \rho_j (1 + \varepsilon) \tau \frac{d\rho_j}{d\rho_i} \right] \quad \forall i \neq j
\]

Using (A.18), this becomes

\[
\frac{\partial u_j}{\partial \rho_i} \bigg|_I = \tau h \left[ \frac{3 + 4\varepsilon}{1 + 2\varepsilon} (1 - \varepsilon (1 - \mu)) \right] - \frac{(1 + \varepsilon)\rho^2 g(\rho \tau)\varepsilon (1 - \eta) (1 + 2\varepsilon)}{-4f''(e)} (A + B) \]

(A.21)

From the definition (A.14)

\[
\varepsilon \rho^2 g(\rho \tau) \frac{1 + 2\varepsilon}{-4f''(e)} < \frac{A}{2}
\]

so that

\[
\frac{\partial u_j}{\partial \rho_i} \bigg|_I > \tau h \left[ \frac{3 + 4\varepsilon}{1 + 2\varepsilon} (1 - \varepsilon (1 - \mu)) \right] - \frac{1}{2} (1 + \varepsilon) \frac{A}{A + B}.
\]

This implies that \( \frac{\partial u_j}{\partial \rho_i} \bigg|_I > 0 \) when

\[
(3 + 4\varepsilon) [1 - \varepsilon (1 - \mu)] - \frac{1}{2} (1 + \varepsilon) (1 + 2\varepsilon) \frac{A}{A + B} > 0. \tag{A.22}
\]

Since \( \mu \geq \varepsilon / (1 + \varepsilon) \) if the non-cooperative equilibrium leads to an outcome in Regime I, the left side of equation (A.22) is greater than or equal to

\[
(3 + 4\varepsilon)(1 - \varepsilon) + \varepsilon^2 \frac{3 + 4\varepsilon}{1 + \varepsilon} - \frac{1}{2} (1 + \varepsilon) (1 + 2\varepsilon) \frac{A}{A + B} \tag{A.23}
\]

Since \( 3 + 4\varepsilon > 3(1 + \varepsilon) \), and since \( A \) and \( B \) are positive, so that \( A/(A + B) < 1 \), expression (A.23) is strictly greater than

\[
(3 + 4\varepsilon)(1 - \varepsilon) + 3\varepsilon^2 - \frac{1}{2} (1 + \varepsilon) (1 + 2\varepsilon) \tag{A.24}
\]
which in turn can be simplified to
\[
\frac{1}{2} [5 - \varepsilon - 4\varepsilon^2] \quad \text{(A.25)}
\]

Expression (A.25) must be non-negative for all \(0 \leq \varepsilon \leq 1\). Therefore, (A.23) must be strictly positive whenever \(0 \leq \varepsilon \leq 1\), so that inequality (A.22) must hold whenever there is a Nash equilibrium leading to an outcome in Regime I when \(\varepsilon \leq 1\).  

\[ \bullet \]

When \(\varepsilon > 1\), a similar result can be shown:

**Lemma A.3** If \(\varepsilon \geq 1\), then a coordinated increase in the tax preference parameter \(\rho\) must increase the payoff to each country, starting from a non-cooperative equilibrium which implies an outcome in Regime I.

**Proof.** From equations (25a), (A.18), and (A.19), we have
\[
\frac{\partial u_j}{\partial \rho_i} \bigg|_{\text{I}} = \frac{(1 - \eta) \varepsilon^2 h (e + \rho h)}{A + B} \left[ \varepsilon \rho^2 g(\rho \tau) + \frac{3 + 4\varepsilon}{-4f''(e)} \right] - \frac{(1 - \eta) (1 + \varepsilon) \rho \eta \varepsilon h^2 (1 + 2\varepsilon)}{(A + B) [-4f''(e)]} \quad \text{A.26}
\]

Since \(\eta < 1\) at any non-cooperative equilibrium leading to an outcome in Regime I, and since \(A\) and \(B\) are both positive, this effect will be positive iff
\[
\varepsilon (e + \rho h) \left[ \varepsilon \rho^2 g(\rho \tau) + \frac{3 + 4\varepsilon}{-4f''(e)} \right] - \frac{\eta \rho \varepsilon h (1 + \varepsilon) (1 + 2\varepsilon)}{[4f''(e)]} > 0.
\]

But since \(e + \rho h > \rho h\), and \(3 + 4\varepsilon > 2(1 + 2\varepsilon)\), this will be positive whenever
\[
\eta \leq \frac{2\varepsilon}{1 + \varepsilon} \quad \text{(A.26)}
\]

At the non-cooperative equilibrium \(\eta < 1\). The right side of inequality (A.26) equals 1 when \(\varepsilon = 1\), and is an increasing function of \(\varepsilon\). \[ \bullet \]

Lemma A.2 and Lemma A.3 together complete the proof of Proposition 4, if the third-stage equilibrium is in Regime I. \[ \square \]
Appendix 4: Optimal coordinated discrimination policies

The analysis of coordinated discrimination policies in the main text has been confined to small coordinated changes in discrimination policies, starting from a non-cooperative equilibrium. In this appendix we determine the degree of tax discrimination that maximizes joint welfare. Within Regime II, equation (25b) shows that welfare must monotonously decline with the degree of tax preferences. In Regime I our analysis has shown that the net effect in (25a) is positive for a small increase in \( \rho \) above the non–cooperative level. It is not clear, however, that \( \rho \) should be increased all the way to the boundary between the two regimes, given by \( \tilde{\rho} \). The reason for this ambiguity is that the benefits of decreased tax competition may be offset by the increases in total fixed costs incurred by firms.

Whether discrimination should be increased or decreased within Regime I is determined by the elasticity of firm structure with respect to the coordinated tax advantage \( \rho \tau \) of multinational form. This elasticity is defined by

\[
\eta \equiv -\frac{dh}{d\rho \tau} \frac{\rho \tau}{h} = \frac{g(\rho \tau)\rho \tau}{\int_{\rho \tau}^{\infty} g(c)dc} > 0, \tag{A.27}
\]

where the second step uses (18). We can state the following condition for \( \eta \) which ensures that coordinated increases \( \rho \) are welfare-enhancing throughout Regime I:

**Proposition A.1** The optimal coordinated discrimination policy cannot exceed \( \tilde{\rho} \). If \( \eta \leq \varepsilon/(1 + \varepsilon) \), then the optimal coordinated discrimination policy equals \( \tilde{\rho} \), and maximizes the effective tax rate set in the last stage of the game.

**Proof:** Equation (25b) establishes that a reduction in \( \rho_i \) must increase \( u_j \) throughout Regime II. In Regime I, consider the effect of a coordinated change in \( \rho \). Equations (17) and (12) imply that

\[
h - \int_{\rho \tau}^{\infty} g(c)dc = 0 \tag{A.28}
\]

where \( C \equiv [\varepsilon/(1 + \varepsilon)][-2f''(e)] > 0 \). Differentiation of (A.28) yields

\[
\left. \frac{dh}{d\rho} \right|_c = -\frac{h(e + 2\rho h) \eta}{\rho[e + (1 + \eta)\rho h]} \tag{A.29}
\]
where the superscript \( c \) is used to denote a simultaneous (coordinated) policy change in both countries. Also, since \( \tau = C(e + \rho h) \),

\[
\frac{d\tau}{d\rho} \bigg|_c = Ch \left( 1 + \frac{\rho dh}{h d\rho} \right). \tag{A.30}
\]

In a symmetric equilibrium, where each country employs a level of capital \( k_i = e \), the payoff \( u \) to each country’s government can thus be written as

\[
u = f(e) - \int_{-\infty}^{\rho\tau} cg(c)dc + \varepsilon\tau (e + \rho h) = f(e) - \int_{-\infty}^{\rho\tau} cg(c)dc + \varepsilon \frac{\tau^2}{C} \tag{A.31}
\]

Note that a coordinated increase in \( \rho \) must increase the number of mobile firms in each country [from equation (A.29)]. Thus a necessary condition for this increase to be welfare-improving is that total tax revenue rises. If \( \eta \geq 1 \), then equation (A.30) shows that \( \tau \), and hence tax revenue falls. Therefore \( \eta < 1 \) is a necessary condition for an increase in \( \rho \) to increase utility in each country.

But using (A.30) and (A.31), \( du/d\rho \) can be shown to be proportional to

\[
2\varepsilon(e + \rho h) - \eta \left[ 2\varepsilon (e + \rho h) + e + 2\rho h \right]
\]

so that, if \( du/d\rho = 0 \), then

\[
\frac{\varepsilon}{1 + \varepsilon} < \eta < \frac{2\varepsilon}{1 + 2\varepsilon}
\]

holds in Regime I. From this follows that \( u \) will be monotonously increasing in \( \rho \) throughout Regime I when \( \eta < \varepsilon/(1 + \varepsilon) \).

Hence, if \( \eta \) is sufficiently low, then the gain in tax revenues resulting from a joint increase in \( \rho \) dominates the induced increase in firms’ fixed costs throughout Regime I.

In this case countries will jointly choose the discrimination policy that induces each one of them to levy the highest possible level of \( \tau \) in the non-cooperative third stage of the game. But this level is reached just at the boundary between the two regimes, as \( \tau \) is rising in \( \rho \) in Regime I, but falling in \( \rho \) in Regime II.
Appendix 5: Differences in country size

Assumptions

The two countries may differ in population, but are otherwise identical. In particular, each country has the same excess burden $\varepsilon$ of the tax system, and the same per capita endowment of capital $e$. Let $s_i$ denote the share of the total (immobile) population which resides in country $i$, so that $s_1 + s_2 = 1$. We adopt the convention that country 1 has the larger population, $s_1 \geq s_2$.

In order to obtain analytic results, two strong restrictions will be imposed upon the forms for the production function and the density function for firms’ fixed costs of multinational form.

(i) the production function is: $f(k_i) \equiv ak_i - (b/2)k_i^2 \quad \forall \quad i = 1, 2, \quad a > 0, \quad b > 0$.

(ii) the distribution of fixed costs is: $g(c) = \beta > 0, \quad 0 \leq c \leq A$.

Let $\alpha$ denote the fraction of firms which choose multinational form, even when there are no tax preferences

$$\alpha = \int_0^A g(c)dc$$

Then it must be the case that

$$\alpha + \beta A < 1$$

so that some firms choose not to become multinationals when the tax advantage of multinational form is sufficiently small.

It will be assumed that

$$\frac{as_1s_2}{be} > \frac{2s_1s_2 + \varepsilon(5s_1s_2 - 1) - \varepsilon^2(s_1 - s_2)^2}{3\varepsilon^2 + 5\varepsilon + 2}.$$  \hspace{1cm} (A.32)

Restriction (A.32) ensures a positive net return to capital in the Nash equilibrium to the tax–setting game played by countries in the third stage, if each country does not have any tax preferences ($\rho_1 = \rho_2 = 0$). Since all the results obtained in this appendix will hold only in a neighbourhood of $\rho_1 = \rho_2 = 0$, this restriction is needed to ensure that the third–stage outcome is in Regime I, if tax preferences in each country are small enough. Note that restriction (A.32) requires that, for given excess burden parameter $\varepsilon$, the ratio $a/be$ be sufficiently large, if size asymmetries are large ($s_2 \to 0$).
For a Nash equilibrium in Regime I, it is also required that neither country prefers to set its own tax rate so high that all mobile firms move to the other country, leaving the deviating country free to confiscate all the return to domestic immobile capital and use it for public expenditure. Such deviations to a high–tax, no–mobile–capital policy are not possible (i.e., tax increases in country \( i \) drive capital’s net return down to zero before they drive out all mobile capital), if the following condition is fulfilled

\[
beb[s_i(1 + \varepsilon) + 2s_i(1 - s_i) + \varepsilon] > (1 - s_i)(3\varepsilon^2 + 5\varepsilon + 2)[as_i - be(1 - \alpha(1 - s_i))]. \tag{A.33}
\]

Even if condition (A.33) does not hold, countries still might not want to deviate to this high–tax policy. We do not provide a further closed–form condition for these deviations not to be beneficial. However, in every one of the calculated examples provided below, it was confirmed that neither country did want to deviate, and that the outcomes presented as (stage 3) tax–setting Nash equilibria in Regime I are indeed global best responses for each country.

That is, even though each country places a premium on public sector expenditure, and even though (in the examples) most of the capital is immobile, countries will not choose simply to confiscate the rents to the immobile capital; they each have an incentive to try and attract some of the mobile capital.

### The Effect of One Country’s Tax Rate on the Other Country

Proposition A.4 below uses the following characterization of the effect of one country’s tax rate on the other country’s well–being:

**Lemma A.4** **Holding constant tax preferences, and the number of multinational firms, the effect on one country’s effective tax rate on the other country’s payoff is**

\[
\frac{\partial u_i}{\partial \tau_j} = (1 + \varepsilon)k_i - e \tag{A.34}
\]

**Proof:** In general, even when the production function is not quadratic, the first–order condition for optimality of country \( i \)’s tax rate can be written

\[
(1 + \varepsilon)\tau_i \frac{\partial k_i}{\partial \tau_i} + (e - k_i)\frac{\partial r}{\partial \tau_i} + \varepsilon k_i = 0 . \tag{A.35}
\]
The effect of country \( j \)'s tax rate on utility in country \( i \) is
\[
\frac{\partial u_i}{\partial \tau_j} = (1 + \varepsilon) \tau_i \frac{\partial k_i}{\partial \tau_j} + (e - k_i) \frac{\partial r}{\partial \tau_j} .
\] (A.36)

With fixed aggregate endowments, it must be the case that
\[
\frac{\partial k_i}{\partial \tau_j} = -\frac{\partial k_i}{\partial \tau_j}
\] (A.37)

and that
\[
\frac{\partial r}{\partial \tau_i} + \frac{\partial r}{\partial \tau_j} = -1.
\] (A.38)

Substitution of (A.37), (A.38) and (A.35) into (A.36) implies (A.34).

**Deriving closed-form solutions for \( \tau_i \) and \( h_i \)**

The quadratic production function implies that
\[
f'(k_i) = a - bk_i
\]
so that the equation defining the net return to capital in each region is
\[
r = a - bk_1 - \tau_1 = a - bk_2 - \tau_2 .
\] (A.39)

When regions differ in size, full employment of the total endowment of capital implies
\[
s_1 k_1 + s_2 k_2 = e \equiv \bar{e}
\] (A.40)

Equations (A.39) and (A.40) imply per-capita capital stocks
\[
k_1 = e - \frac{s_2}{b} (\tau_1 - \tau_2), \quad k_2 = e - \frac{s_1}{b} (\tau_2 - \tau_1),
\] (A.41)

which in turn determine the net return to mobile capital as
\[
r = \bar{r} - s_1 \tau_1 - s_2 \tau_2, \quad \bar{r} \equiv a - be.
\] (A.42)

From equations (A.41)–(A.42),
\[
\frac{\partial k_i}{\partial \tau_i} = -\frac{1 - s_i}{b}, \quad \frac{\partial k_i}{\partial \tau_j} = \frac{s_i}{b} \forall j \neq i, \quad \frac{\partial r}{\partial \tau_i} = -s_i .
\] (A.43)

The first–order condition for country \( i \)'s choice of its own effective tax rate \( \tau_i \) in the third stage of the game is therefore
\[
\varepsilon (k_i + \rho_i h_i) + (1 + \varepsilon) \tau_i \frac{\partial k_i}{\partial \tau_i} + (e - k_i) \frac{\partial r}{\partial \tau_i} = 0.
\] (A.44)
Substituting into (A.44) from (A.41) and (A.43), country 1’s optimal choice of effective tax rate obeys
\[
\varepsilon \left[ e - \frac{s_2}{b} (\tau_1 - \tau_2) + \rho_1 h_1 \right] - \tau_1 (1 + \varepsilon) \frac{s_2}{b} - \frac{s_2}{b} (\tau_1 - \tau_2) s_1 = 0
\]
which in turn can be written
\[
b \varepsilon + b \varepsilon \rho_1 h_1 - s_2 [1 + s_1 + 2 \varepsilon] \tau_1 + s_2 [s_1 + \varepsilon] \tau_2 = 0. \tag{A.45}
\]

The analogous first–order condition for country 2 is
\[
b \varepsilon + b \varepsilon \rho_2 h_2 - s_1 [1 + s_2 + 2 \varepsilon] \tau_2 + s_1 [s_2 + \varepsilon] \tau_1 = 0 \tag{A.46}
\]

The effective tax rates in the two countries (if the outcome is in Regime I) are defined by the equation
\[
A \begin{pmatrix} \tau_1 \\ \tau_2 \end{pmatrix} = \begin{pmatrix} b \varepsilon e \\ b \varepsilon e \end{pmatrix} + \begin{pmatrix} b \varepsilon_1 \\ 0 \end{pmatrix} \rho_1 h_1 + \begin{pmatrix} 0 \\ b \varepsilon_2 \end{pmatrix} \rho_2 h_2 \tag{A.47}
\]
where the elements of the matrix \( A \) are defined by
\[
A_{ii} = s_j (1 + s_i + 2 \varepsilon), \quad A_{ij} = -s_j (s_i + \varepsilon) \quad j \neq i
\]
The determinant \( \Delta_A \) of the matrix \( A \) is
\[
\Delta_A = s_1 s_2 (3 \varepsilon^2 + 5 \varepsilon + 2) > 0.
\]
Solving the linear equation system (A.47) implies that
\[
\tau_i = B_{ii} \rho_i h_i + B_{ij} \rho_j h_j + [B_{ii} + B_{ij}] \varepsilon \quad j \neq i \tag{A.48}
\]
where
\[
B_{ii} = \frac{b}{\Delta_A} (s_i (1 + s_j + 2 \varepsilon)) \varepsilon > 0,
\]
\[
B_{ij} = \frac{b}{\Delta_A} (s_j (s_i + \varepsilon)) \varepsilon > 0, \quad j \neq i.
\]
Equation (A.48) gives a closed–form expression for the third–stage effective tax rates, in terms of the tax preferences chosen in the initial stage, and the number of immobile firms in each country chosen in the second stage.
Turning to the second stage, from the assumption on the density function for fixed costs follows

\[ h_i = [\alpha - \beta \rho_i] e \quad i = 1, 2 \] (A.49)

which, from (A.48), gives

\[ h_i = \alpha e_i - \beta [B_{ii} \rho_i h_i + B_{ij} \rho_j h_j + (B_{ii} + B_{ij})] \rho_i e_i. \] (A.50)

Hence

\[
\begin{pmatrix}
D_{h_1} \\
D_{h_2}
\end{pmatrix} =
\begin{pmatrix}
\frac{\alpha e_1 - \beta (B_{11} + B_{12}) \rho_1 e^2}{\Delta_D} \\
\frac{\alpha e_2 - \beta (B_{21} + B_{22}) \rho_2 e^2}{\Delta_D}
\end{pmatrix}
\] (A.51)

where the elements of the matrix \( D \) are defined as

\[ D_{ii} = 1 + \beta B_{ii} \rho_i^2, \]

\[ D_{ij} = \beta B_{ij} \rho_i \rho_j e, \quad j \neq i. \]

Equation (A.51) provides closed-form expressions for the number of immobile firms in each country, as a function of the countries' tax preferences:

\[ h_1 = \frac{e}{\Delta_D} [\alpha e_1 - \beta (B_{11} + B_{12}) \rho_1 e^2 - \beta B_{22} \rho_2 e^2] D_{22} - (\alpha - \beta B_{21} \rho_2 e - \beta B_{12} \rho_1 e) D_{12}] \] (A.52)

\[ h_2 = \frac{e}{\Delta_D} [\alpha e_2 - \beta (B_{21} + B_{22}) \rho_2 e^2 - \beta B_{11} \rho_1 e^2] D_{11} - (\alpha - \beta B_{11} \rho_1 e - \beta B_{12} \rho_1 e) D_{21}] \] (A.53)

where

\[ \Delta_D = 1 + \beta (B_{11} \rho_1^2 + B_{22} \rho_2^2) e + \beta^2 \rho_1^2 \rho_2^2 e^2 (B_{11} B_{22} - B_{12} B_{21}). \]

**Local results when tax preferences are zero initially**

Suppose that we start from an initial situation in which one of the countries, country \( i \), has no preferences for multinationals. The other country, \( j \), has non-negative preferences. If \( \rho_i = 0 \), then

\[ D_{ii} = 1; \]

\[ D_{ij} = D_{ji} = 0, \quad j \neq i; \]

\[ D_{jj} = 1 + B_{jj} \rho_j^2 e, \quad j \neq i; \]

\[ \Delta_D = 1 + B_{jj} \rho_j^2 e, \quad j \neq i. \]
Further, 
\[ \frac{\partial D_{ii}}{\partial \rho_i} = \frac{\partial D_{jj}}{\partial \rho_i} = \frac{\partial \Delta D_{ii}}{\partial \rho_i} = 0, \]
\[ \frac{\partial D_{ij}}{\partial \rho_i} = \beta B_{ij} \rho_j e \geq 0, \quad \frac{\partial D_{ji}}{\partial \rho_i} = \beta B_{ji} \rho_j e \geq 0. \]

From equations (A.52) and (A.53) this implies
\[ \frac{dh_j}{d\rho_i} = \frac{\alpha e \Delta D_{ii}}{\beta B_{ji} \rho_j e} \geq 0, \quad j \neq i \quad (A.54) \]

It then can be shown that

**Proposition A.2** Under the assumptions of this appendix, starting from \( \rho_i = 0 \), a small increase in country \( i \)'s tax preference \( \rho_i \) must increase its own effective tax rate \( \tau_i \) in the subsequent tax-setting equilibrium, as well as the effective tax rate \( \tau_j \) in the other country.

**Proof:** Equation (A.48) implies that, when \( \rho_i = 0 \),
\[ \frac{d\tau_i}{d\rho_i} = B_{ii} h_i + B_{ij} \rho_j \frac{dh_j}{d\rho_i} \quad (A.55) \]
and that
\[ \frac{d\tau_j}{d\rho_i} = B_{jj} h_j + B_{ji} \rho_j \frac{dh_j}{d\rho_i}, \quad j \neq i \quad (A.56) \]

From equation (A.54), the assumption that the number of immobile firms in each region is strictly positive, and the fact that all the \( B_{mn} \)'s are positive, expressions (A.55) and (A.56) both must be strictly positive. \( \square \)

**Lemma A.5** If \( \rho_i = 0 \), then in the third-stage tax-setting equilibrium
\[ (1 + \varepsilon)k_i > e \quad (A.57) \]

**Proof:** Suppose first that both \( \rho_1 \) and \( \rho_2 \) equal 0. Then \( h_1 = h_2 = \alpha e \), and equation (A.48) implies that the third-stage effective tax rates \((\tau_1^0, \tau_2^0)\) in the two countries are
\[ \tau_1^0 = \frac{be}{s_1s_2} \frac{\varepsilon}{(3\varepsilon^2 + 5\varepsilon + 2)} \left[ s_1(1 + \varepsilon) + 2s_1s_2 + \varepsilon \right], \quad (A.58) \]
\[ \tau_2^0 = \frac{be}{s_1s_2} \frac{\varepsilon}{(3\varepsilon^2 + 5\varepsilon + 2)} \left[ s_2(1 + \varepsilon) + 2s_1s_2 + \varepsilon \right]. \quad (A.59) \]
From the definition (A.42) of the net return $r$, and equations (A.58) and (A.59), condition (A.32) implies that $\tau_1$ and $\tau_2$ are sufficiently small at $\rho_1 = \rho_2 = 0$ so that the resulting net return to investment $r$ must be strictly positive.

Equations (A.58) and (A.59) imply that

$$\tau_1^0 - \tau_2^0 = \frac{be}{s_1 s_2} \frac{\varepsilon(1 + \varepsilon)}{(3\varepsilon^2 + 5\varepsilon + 2)(s_1 - s_2)}. \quad (A.60)$$

Moreover, from equations (A.41), in Nash equilibrium

$$k_i^0 = \frac{2(1 + \varepsilon)^2 e}{3\varepsilon^2 + 5\varepsilon + 2} + \frac{s_2}{s_1} \frac{\varepsilon(1 + \varepsilon) e}{(3\varepsilon^2 + 5\varepsilon + 2)} \quad (A.61)$$

$$k_j^0 = \frac{2(1 + \varepsilon)^2 e}{3\varepsilon^2 + 5\varepsilon + 2} + \frac{s_1}{s_2} \frac{\varepsilon(1 + \varepsilon) e}{(3\varepsilon^2 + 5\varepsilon + 2)} \quad (A.62)$$

Equations (A.61) and (A.62) imply that

$$k_i^0 > \frac{2(1 + \varepsilon)^2 e}{3\varepsilon^2 + 5\varepsilon + 2}$$

Therefore, condition (A.57) will hold if

$$\frac{2(1 + \varepsilon)^3}{3\varepsilon^2 + 5\varepsilon + 2} > 1 \quad (A.63)$$

for all $\varepsilon > 0$.

But condition (A.63) is equivalent to

$$\Phi(\varepsilon) > 0 \text{ for all } \varepsilon > 0 \quad (A.64)$$

where

$$\Phi(\varepsilon) \equiv 2(1 + \varepsilon)^3 - (3\varepsilon^2 + 5\varepsilon + 2)$$

Since $\Phi(0) = 0$, and

$$\Phi'(\varepsilon) = 1 + 6\varepsilon + 6\varepsilon^2$$

condition (A.64) must hold. This proves the lemma for the case that $\rho_1 = \rho_2 = 0$.

Now assume that $\rho_i = 0$ and that $\rho_j > 0$ $(j \neq i)$. When $\rho_i = 0$, equation (A.48) implies that

$$\tau_j - \tau_i = \tau_j^0 - \tau_i^0 + (B_{jj} - B_{ij})\rho_j h_j$$

Since $B_{jj} > B_{ij}$, $\tau_j - \tau_i$ must be strictly larger than $\tau_j^0 - \tau_i^0$ when $\rho_i = 0$ and $\rho_j > 0$.

Since $k_i$ is an increasing function of $\tau_j - \tau_i$, therefore $k_i$ must be strictly larger than $k_i^0$, completing the proof of the lemma.

•
The proof of the lemma incorporates the following result, which follows directly from equation (A.60):

**Proposition A.3** If \( \rho_1 = \rho_2 = 0 \), then the larger country (country 1 by convention) levies the higher effective tax rate in the third-stage tax-setting equilibrium.

We can now move on to:

**Proposition A.4** Starting from a situation in which \( \rho_i = 0 \), a slight increase in \( \rho_i \) must benefit country \( j \).

**Proof:** The payoff to country \( j \) is \( f(k_j) + r(e - k_j) + \varepsilon \tau_j(k_j + \rho_j h_j) \). The effect of a change in the other country’s tax preference level \( \rho_i \) on this payoff can be written

\[
\frac{\partial u_j}{\partial \rho_i} = \frac{\partial u_j}{\partial \tau_j} \frac{d\tau_j}{d\rho_i} + \frac{\partial u_j}{\partial \tau_i} \frac{d\tau_i}{d\rho_i} + \frac{\partial u_j}{\partial h_j} \frac{dh_j}{d\rho_i} + \frac{\partial u_j}{\partial \rho_i} \tag{A.65}
\]

where \( d\tau_j/d\rho_i \), \( d\tau_i/d\rho_i \) and \( dh_j/d\rho_i \) refer to the effects of first-stage changes in tax preferences on the equilibrium tax rates and number of multinational firms, as defined by equations (A.52) and (A.53), and substitution of those equations in (A.48).

Since country \( j \) chooses its own tax rate \( \tau_i \) in the third stage so as to maximize its own payoff, \( \partial u_j/\partial \tau_j = 0 \), when the third-stage equilibrium is in Regime I, so that the first term on the right side of expression (A.65) is zero.

Since \( \partial u_j/\partial h_j = \varepsilon \tau_j \rho_j \), equation (A.54) implies that the third term on the right side of expression (A.65) is also positive, if \( \rho_i = 0 \) initially. Lemmas A.4 and A.5 imply that \( \partial u_j/\partial \tau_i > 0 \) when \( j \neq i \); at \( \rho_i = 0 \). Finally, Proposition A.2 implies that \( d\tau_i/d\rho_i > 0 \) at \( \rho_i = 0 \), completing the proof of the proposition.

Our final result is:

**Proposition A.5** Both countries must have some tax preferences (\( \rho_1 \) and \( \rho_2 \) must be strictly positive) in any Nash equilibrium.

**Proof:** The effect of a change in a country’s own tax preference level \( \rho_i \) on its payoff can be written

\[
\frac{du_i}{d\rho_i} = \frac{\partial u_i}{\partial \tau_i} \frac{d\tau_i}{d\rho_i} + \frac{\partial u_i}{\partial \tau_j} \frac{d\tau_j}{d\rho_i} + \frac{\partial u_i}{\partial h_i} \frac{dh_i}{d\rho_i} + \frac{\partial u_i}{\partial \rho_i} \tag{A.66}
\]
Again, the first term on the right side of expression (A.66) must be zero because of the optimality of the country’s own third–stage choice of $\tau_i$; the third term must be zero at $\rho_i = 0$ since $\partial u_i / \partial h_i = \varepsilon \tau_i \rho_i$. That means that, if $\rho_i = 0$,

$$\frac{\partial u_i}{\partial \rho_i} = (\varepsilon k_i - e) \frac{d \tau_j}{d \rho_i} + \varepsilon \tau_i h_i.$$  \hspace{1cm} (A.67)

Lemmas A.4 and A.5 and Proposition A.2 show that the first term on the right side of (A.67) must be positive. The second term must also be positive, proving the proposition.

□

An immediate corollary to these two propositions is:

**Corollary 1** Starting at $\rho_1 = \rho_2 = 0$, any coordinated small increase in tax preferences in both countries will benefit both countries.