Multinationals' capital structures, thin capitalization rules, and corporate tax competition *

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Abstract

We set up a model where two countries compete for internationally mobile firms through statutory tax rates and thin capitalization rules that limit the tax-deductibility of internal debt flows within multinational enterprises. Moreover, both multinational and domestic firms can respond to a higher domestic tax rate by increasing the level of external debt finance. For the case of identical countries we show that tax competition leads to inefficiently low tax rates and inefficiently lax thin capitalization rules. A coordinated tightening of thin capitalization rules will benefit both countries, even though it intensifies competition via statutory tax rates. If countries differ substantially in the number of domestic firms, however, then a coordination of thin capitalization rules may reduce welfare in the country with the larger domestic tax base.

Keywords: thin capitalization, capital structure, tax competition

JEL Classification: H73, H25, F23

1 Introduction

Existing corporate tax systems permit the deduction of interest payments from the corporate tax base, whereas the equity returns to investors are not tax deductible. This asymmetric treatment of alternative means of financing the capital stock offers firms a fundamental incentive to increase the reliance on debt finance. Corporations will thus trade-off the tax advantages of debt against its non-tax costs, where the latter arise primarily from an increased risk of financial distress and the resulting agency costs due to conflicting interests between debt and equity owners (see Myers, 2001).

For a long time, it has proved to be surprisingly difficult to provide empirical support for the theoretical prediction that higher corporate tax rates lead firms to adopt higher debt-equity ratios. In recent years, however, such evidence has been established for nationally operating firms (Gordon and Lee, 2001) and, even more prominently, for multinational enterprises. For example, Desai et al. (2004) show for U.S.-based multi- nationals that a 10% higher tax rate in the host country of a foreign affiliate raises the debt-to-asset ratio of this affiliate by 2.8%. Mintz and Weichenrieder (2005) and Buettner et al. (2006) obtain quantitatively similar results for German multinationals. Finally, Huizinga at al. (2007) provide evidence that the capital structure of European multinationals is systematically adapted in a tax-minimizing way to international dif- ferences in corporate tax systems and corporate tax rates.

The close empirical link between corporate tax rates and multinational firms' financial policies, together with a rapid growth of financial transactions *within* multinational enterprises, has aroused concerns among policy-makers that multinationals use their internal debt policy in order to shift profits from high-tax to low-tax countries. These concerns are supported by independent evidence that multinational firms seem to pay lower taxes, as a share of pre-tax profits, than domestically operating firms. For Europe, Egger et al. (2007) have estimated, using econometric matching techniques, that the tax burden of an otherwise similar manufacturing plant is reduced by more than 50% when the parent firm is foreign-owned, rather than domestically-owned. Hines (2007) finds related evidence that the effective tax payments of U.S. multinationals in their respective host countries have fallen more rapidly than the statutory tax rates in these countries. The results of both studies indicate either that multinationals enjoy specific forms of tax relief, or that they have been able to reduce their tax burden by shifting

profits to low-tax countries and tax havens (or a combination of both).[1] Furthermore, while profit shifting within multinational firms can occur through a variety of channels, there are clear indications that the use of financial policies plays an important role in this process (Grubert, 2003; Mintz, 2004).

In response to these developments, many countries have introduced thin capitalization rules, which limit the amount of interest payments to related entities that is deductible from the corporate tax base. As of today, the majority of OECD countries includes such constraints in their corporate tax codes, and several countries have introduced them during the last decade.[2] As an example, Germany has tightened its thin capitalization rules in its corporate tax reform of 2008 by introducing a strict limitation for the tax deductibility of interest payments equal to 30% of the firm's pre-tax earnings. An escape clause is added to prevent the application of this rule to domestic firms, or to multinational firms with a high overall need for external debt finance. In sum, the new set of thin capitalization rules is thus explicitly targeted at the tax planning strategies of multinational enterprises.

On the other hand, the move to stricter thin capitalization rules is not universal. The U.S., for example, which was one of the first countries to introduce an *earnings' stripping rule* in 1989, has introduced changes in the tax code in 1997 that facilitated the use of internal debt as a tax savings instrument for multinational firms.[3] Ireland and, more recently, Spain have even abolished thin capitalization restrictions completely for loans from EU-based companies, in response to a 2002 ruling by the European Court of Justice that thin capitalization rules must be set up in a non-discriminatory way. In the case of Ireland, it is furthermore noteworthy that the relaxation of thin capitalization

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[1]According to Desai et al. (2006, p. 514), 59% of U.S. firms with significant foreign operations had affiliates in tax haven countries in 1999. The authors provide evidence suggesting that a primary use of affiliates in tax haven countries is to reallocate taxable income to the haven.

[2]See Buettner et al. (2008). In the data set underlying their empirical analysis, 12 out of 24 OECD countries in the sample already had thin capitalization rules by 1996, and a further six countries introduced them during the last decade. For a detailed description of the thin capitalization rules in the EU member states and in several non-EU countries, see Gouthière (2005).

[3]The main element among the 1997 tax changes in the U.S. was the introduction of *hybrid entities*, which are considered as corporations by one country, but as unincorporated branches by another. These rules can be used by U.S. multinationals to circumvent existing rules for controlled foreign corporations (CFC rules), which disallow the deferral of passive business income, including interest payments, for the affiliates of U.S. corporations. See Altshuler and Grubert (2006) for more detail and for empirical evidence on the effects of this regulatory change.

rules directly followed the forced termination of Ireland's split corporate tax rate, which had long been used as an instrument to provide preferential tax treatment to multinationals. This suggests that at least some countries might strategically use thin capitalization rules as a means to grant targeted tax relief to multinational firms.

In general, there are two conflicting considerations in the setting of thin capitalization rules. On the one hand they have the potential to secure the domestic corporate tax base, particularly in high-tax countries, by limiting international profit-shifting via intra-company debt policies of multinationals. On the other hand, binding thin capitalization rules increase the effective tax rate from the perspective of highly mobile multinational firms and this may have a detrimental effect on foreign direct investment. Existing econometric evidence confirms the empirical importance of both of these effects. Buettner et al. (2008) find, for a sample of 24 OECD countries, that thin capitalization rules are effective in reducing firms' debt-to-equity ratio and thus have the potential to reduce international debt shifting. At the same time, the authors also find that the sensitivity of investment with respect to the statutory tax rate increases when thin capitalization restrictions are imposed.

Despite the obvious policy relevance of the subject, and in contrast to the growing body of empirical research, we are not aware of a theoretical analysis that explicitly focuses on the optimal setting of thin capitalization rules from the perspective of countries engaged in international tax competition. This is what we aim to do in this paper. In particular, we set up a model where countries compete for internationally mobile firms using both statutory tax rates and thin capitalization rules that limit the tax-deductibility of internal debt flows within the multinational enterprise. Moreover, both multinational and domestic firms can respond to a higher domestic tax rate by increasing the level of external debt finance. For the case of identical countries we show that tax competition leads to inefficiently low tax rates and inefficiently lax thin capitalization rules, relative to the Pareto efficient solution. A coordinated tightening of thin capitalization rules will intensify tax competition via tax rates but it will nevertheless benefit both countries in the fully symmetric case. We also analyze asymmetries between countries and show that the country with the relatively larger number of domestic firms will choose the more lenient thin capitalization rules in the non-cooperative tax equilibrium. If these differences are substantial, then a coordination of thin capitalization rules may reduce welfare in the country with the larger domestic tax base.

Our analysis builds on two strands in the literature. First, there are partly theoretical

and partly empirical contributions on the interaction between taxes and firms' financial decisions (Mintz and Smart, 2004; Buettner et al., 2008; Schindler and Schjelderup, 2007). These papers derive the response of multinationals' real and financial decisions to exogenously given tax policies, in order to provide testable hypothesis for the ensuing empirical analyses. They do not, however, endogenously derive the optimal set of policies for countries competing for foreign direct investment. A second literature strand focuses on the comparison between discriminatory and non-discriminatory tax competition (Janeba and Peters, 1999; Keen, 2001; Janeba and Smart, 2003; Haupt and Peters, 2005; Peralta et al., 2006; Bucovetsky and Haufler, 2008). This literature shows, in particular, that the abolition of discriminatory tax regimes favoring more mobile tax bases may – but need not – intensify tax competition, in the sense of reducing aggregate tax revenue and welfare in all countries. None of these papers, however, addresses the choice of capital structure within multinationals, and the modeling of tax discrimination in this literature is not well suited to the issue under discussion here. As we will see below these differences have important implications for model results.

The remainder of this paper is set up as follows. Section 2 presents the basic framework for our analysis. Section 3 derives the Pareto efficient set of tax policies in the benchmark case where all tax instruments can be coordinated internationally. Section 4 derives the non-cooperative choice of statutory tax rates and thin capitalization rules when countries instead compete with one another. Section 5 turns to the welfare effects of a partial coordination of thin capitalization rules when each country remains free to set its statutory tax rate in a non-cooperative way. Section 6 concludes.

2   The model

We consider a model of capital tax competition between two countries $i \in \{A, B\}$. There is a representative resident in each country whose exogenous endowment consists of one unit of internationally mobile capital and $d_i > 0$ units of immobile capital. Mobile and immobile units of capital can equivalently be thought of as mobile (multinational) and immobile (domestic) firms. In some parts of the analysis, we suppose a symmetric distribution of capital so that not only the amount of mobile capital is the same in the two countries, but also the amount of immobile capital ($d_A = d_B = d$). Mobile capital can be invested in either country and receives a net return $r_i^m > 0$, whereas domestic capital can only be invested in the home country and receives a return $r_i^d > 0$.

The two types of capital are perfect substitutes in the production of an output good that is produced in both countries.[4] The production function in each country is assumed to be quadratic. In country i, it reads $f(k_i) = ak_i - (b/2)k_i^2$ where $a, b > 0$ and $k_i \in [0, a/b]$ is the total amount of capital used for production in country i. We assume that the source principle of capital taxation is effective and hence capital is taxed in the country where it is employed.[5] Moreover, we model the tax as a unit tax on capital, rather than as a proportional tax on its return. It is well known that, in settings of competitive markets, this specification simplifies the algebra without affecting any of the results.

Central to our analysis is the treatment of the corporate tax base. We denote by $\alpha_i^d \in [0, 1]$ and $\alpha_i^m \in [0, 1]$ the share of *external* debt financing that is chosen by the domestic and the multinational firm in country i, respectively. In all OECD countries this share is fully deductible from the corporate tax base.[6] While the financing of capital via external debt will thus confer tax savings to the firm, it is associated with non-tax costs that are discussed in detail in the corporate finance literature (see Myers, 2001, for a survey). Specifically, a high level of external debt raises the expected costs of financial distress, including the costs associated with possible bankruptcy. On the other hand, the agency literature of the firm stresses that some level of external debt

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[4]This setup has similarities with that in Bucovetsky and Haufler (2008), but there are also important differences. In the present model the internationally immobile tax base responds elastically to statutory tax changes, due to the possibility of external debt finance. On the other hand, the division between mobile and immobile capital is exogenously given.

[5]It is widely agreed that the source principle of taxation is effective in most international capital transactions (see Tanzi, 1995). Source-based taxation applies directly when the residence country of the investor exempts foreign-source income from tax. Even when the tax credit method is used (as in the U.S.), this tax treatment applies only to repatriated income. This offers a tax incentive to defer repatriation when the tax rate in the host country is below that in the residence country (cf. footnote 3). In the reverse case, however, where the tax rate in the source country is the higher one, no tax rebates are paid by the home country of the investor. Hence, source country taxation is again relevant in this case.

[6]At first sight, the new German interest limitation rule seems to contradict this statement, as it specifies an upper limit of 30 % of gross earnings for the *total* amount of deductible interest payments. However, there are several exceptions to this rule. First, the threshold does not apply to domestic (stand-alone) firms. Second, affiliates of multinational firms can fully deduct interest payments as long as their debt-to-equity ratio is not higher than the corresponding company-wide ratio. This 'escape cause' ensures the full deductibility of external debt under normal circumstances, which are assumed in our model. See Homburg (2007) for a more detailed description and a critical evaluation of the German corporate tax reform of 2008.

may be desirable in order to protect the firm from 'empire building' strategies of its managers. We model these different arguments by specifying a target level of external debt, $\bar{\alpha} \in [0,1]$, at which the firm faces no extra costs of its financial structure. Any deviation from this target level will lead to agency costs that are assumed to be convex (for simplicity, quadratic) in the distance to the target level $\bar{\alpha}$. The target level $\bar{\alpha}$ is assumed to be the same for all types of firms.[7]

Let us first analyze the behavior of immobile domestic firms (superscript d). For each domestic firm we can write the net return to capital in country i as

$$r_i^d = f'(k_i) - \tau_i^d - \frac{\beta}{2}\left(\alpha_i^d - \bar{\alpha}\right)^2 = a - bk_i - t_i(1 - \alpha_i^d) - \frac{\beta}{2}\left(\alpha_i^d - \bar{\alpha}\right)^2$$

where $\beta > 0$ is an exogenous parameter for the extra costs of a non-optimal financial structure and $\tau_i^d = t_i(1 - \alpha_i^d)$ is the effective tax rate faced by the domestic firm when the statutory tax rate in country i is $t_i \in [0,1]$ and the financing costs of external debt are fully tax-deductible. In the second step, this relationship has been inserted along with the first derivative of the quadratic production function.

It is then straightforward to derive the optimal debt policy for the domestic firm. In country i, this optimal debt policy is given by

$$\alpha_i^d = \bar{\alpha} + \frac{t_i}{\beta}. \tag{1}$$

In the firm's optimum the tax benefits of a higher level of external debt are traded off against the non-tax costs. As a result the debt ratio chosen by the firm is a falling function of the non-tax costs parameter β and a rising function of country i's tax rate t_i.[8] At this point it should be emphasized that our analysis of the tax advantages of external debt is confined to the level of the corporation and ignores the different tax treatment of equity and debt finance at the shareholder level. There is a general agreement in the literature, however, that a tax advantage of debt is still present, though reduced in size, when personal income taxes are also taken into account.[9]

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[7]This modeling of agency costs is frequently used in the related literature. See e.g. Schindler and Schjelderup (2007).

[8]Empirical tests of this fundamental proposition often face the problem of insufficient variation in tax rates (if they use time-series data) or of uncontrolled heterogeneity in other factors (if cross-country data are used). If these problems can be avoided, however, a statistically significant and positive relationship between the statutory tax rate and the share of external debt is found (Gordon and Lee, 2001).

[9]When the tax treatment at the corporate and the shareholder level is incorporated, the effective

Using (1) the effective tax rate on immobile firms in country i becomes

$$\tau_i^d = t_i \left(1 - \bar{\alpha} - \frac{t_i}{\beta} \right) \tag{2}$$

and the net return to domestic capital in country is

$$r_i^d = a - bk_i - t_i \left(1 - \bar{\alpha} - \frac{t_i}{2\beta} \right). \tag{3}$$

These relations show that the effective tax rate on immobile firms in country i is increasing in the statutory tax rate of country i, while the net return to domestic capital in country i falls when the statutory tax rate t_i goes up.

Let us now turn to the multinational enterprises (MNEs). We employ a set of assumptions that makes our analysis as simple as possible and abstracts from many additional considerations that determine the capital structure within multinationals. It is assumed that external debt finance has the same tax advantages and the same costs for the MNE as for the domestic firm. In addition, however, the multinational firm has the opportunity to engage in financial transactions between its affiliates. A critical assumption for our analysis is that the internal financial transactions serve the sole purpose of minimizing the aggregate tax burden.[10] We thus assume that the multinational firm in each of countries A and B can set up a subsidiary in a tax haven country C, which offers a tax rate of zero. Furthermore, suppose that the multinational firm can freely and costlessly adjust its internal capital structure in a tax-minimizing way. In our setting this implies that the subsidiary in the low-tax country C is endowed with equity and makes an intra-company loan to the parent located in countries A and B, respectively. For each multinational firm, the interest paid for this loan is deductible in the high-tax parent country, whereas the interest income received by the subsidiary in the tax haven is taxed at a zero rate. Hence, the net effect of these intra-firm financial transactions is to remove the share of capital that is financed by internal debt from the corporate tax base in countries A and B.[11]

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tax rate on capital financed by debt equals the personal interest rate of the investor, whereas the tax rate on equity equals the sum of corporation and capital gains taxes (provided that no dividends are paid out). See Auerbach (2002) for more details and Fuest and Hemmelgarn (2005) for an analysis of tax competition when governments can choose both corporate and personal income taxes.

[10]This is clearly an oversimplification, and we will return to this issue in the conclusions.

[11]For empirical evidence on how U.S. multinationals use tax havens to reduce their domestic tax burden, see Desai et al. (2006).

Our assumption that the costs of intra-firm adjustments in the capital structure are zero implies that the tax base of multinational firms would be zero in the parent countries A and B, if no thin capitalization rules were in place. This assumption is clearly a simplification, but it seems plausible that these costs are substantially lower than those for external debt, because there is no increase in the risk of financial distress or even bankruptcy at the aggregate firm level. The relatively low costs of internal debt shifting within multinationals are also confirmed by empirical evidence.[12] Given this assumption, the ratio of internal debt chosen by the multinational firm will always be at the maximum of what is permitted by existing thin capitalization rules.

We thus model a thin capitalization rule as an upper limit on the share of *intra-firm* debt that the multinational firm receives from a subsidiary in a tax haven country and that can be deducted from the multinational's tax base in the home country. In country i, this share is denoted by $\lambda_i \in [0, 1]$ and we restrict it to be non-negative.[13] To link our modeling approach to thin capitalization rules existing in the OECD countries some comments are in order.[14] Our analysis assumes that countries specify thresholds for internal debt only, as the primary purpose of thin capitalization rules is to restrict profit shifting in multinational firms. Instead the thin capitalization rules of many OECD countries specify an upper limit on the *sum* of internal and external debt. In the U.S., for example, the permitted debt-to-equity ratio is 1.5 to 1, corresponding to a 0.6 share of the firm's capital being financed by debt. If a company stays below this threshold, all interest payments will automatically be tax-deductible. The rationale behind this *safe haven approach* is that the distinction between internal and external debt is often difficult to draw in practice and hence it is administratively easier to specify an

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[12]Desai et al. (2004) find that the tax elasticity of internal borrowing for U.S. multinationals is almost twice as high as the tax elasticity of external debt (0.35 versus 0.19). In a setting where firms optimize their capital structure, this finding is consistent with the marginal non-tax costs of external debt being (substantially) higher than those of internal debt.

[13]Allowing negative values for λ_i would imply that the countries could effectively restrict the tax deductibility of *external* debt for multinational firms, but not for domestic firms. This is clearly incompatible with current principles of corporate income taxation, on which the present analysis is based. There are, of course, alternative schemes of taxing corporate income which replace the tax deductibility of debt by various forms of cash-flow taxation (see the proposals by the Meade Committee, 1978). For an analysis of cash-flow taxation in the presence of international profit shifting, see Haufler and Schjelderup (2000).

[14]We thank Thiess Buettner and Michael Overesch for clarifying discussions on this issue.

acceptable share of overall debt for each affiliate.[15] However, when a company's debt-to-equity ratio is above 1.5 to 1 so that it comes to restricting the level of deductible debt, the distinction between internal and external debt is drawn and deductibility is denied only for internal loans. Hence, the final choice parameter of the government is indeed the deductible share of *internal* debt, as specified in our analysis.[16]

With these specifications the net return to a unit of mobile capital (superscript m) in country i is

$$ r_i^m = f'(k_i) - \tau_i^m - \frac{\beta}{2}\left(\alpha_i^m - \bar{\alpha}\right)^2 = a - bk_i - t_i(1 - \alpha_i^m - \lambda_i) - \frac{\beta}{2}\left(\alpha_i^m - \bar{\alpha}\right)^2, $$

where τ_i^m is the effective tax rate on a mobile firm located in country i. Note that the share of external debt, α_i^m, is chosen by the MNE, whereas the maximum permissible share of internal debt, λ_i, is set by the government of country i and fully exploited by the MNE in its financial optimum. The optimal share of external debt chosen by the multinational firm located in country i is

$$ \alpha_i^m = \bar{\alpha} + \frac{t_i}{\beta}. \tag{4} $$

Hence, the multinational firm's optimal choice of the external debt share equals that of domestic firms. The effective tax rate is lower, however, whenever a positive allowance is also made for internal debt, i.e. $\lambda_i > 0$. Using (4) the effective tax rate on mobile firms can be written as

$$ \tau_i^m = t_i\left(1 - \lambda_i - \bar{\alpha} - \frac{t_i}{\beta}\right), \tag{5} $$

yielding a net return to mobile capital equal to

$$ r_i^m = a - bk_i - t_i\left(1 - \lambda_i - \bar{\alpha} - \frac{t_i}{2\beta}\right). \tag{6} $$

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[15]The main problem are back-to-back loans, where one affiliate of a multinational borrows from a local bank (so that the debt is external) but the loan is guaranteed by another affiliate of the same firm.

[16]Another potential difference between our model and existing thin capitalization rules is that, in contrast to our modeling approach, some countries specify a maximum amount of deductible interest payments as a share of the corporation's before-tax profits (for example Germany, see footnote 6). However, this threshold can equivalently be stated as a maximum permissible share of overall debt when both the return to capital and the interest rate charged for the internal loan are fixed at their competitive levels. In practice, restrictions on the amount of interest paid, as a share of before-tax profits, simultaneously control for international profit shifting via interest rates that deviate from their arm's-length levels. Our analysis abstracts from this channel of profit-shifting.

Multinational firms are thus affected by both policy instruments set by the governments. An increase in the statutory tax rate and a tightening of the thin capitalization rule in country i (a reduction in λ_i) both raise the effective tax rate and reduce the net return to mobile capital in this country.

In an international capital market equilibrium, the worldwide supply of capital must equal capital demand. The sum of mobile and immobile capital endowments in countries A and B must therefore equal the worldwide employment of capital, i.e.

$$k_A + k_B = 2 + d_A + d_B. \tag{7}$$

Moreover, international arbitrage has to ensure that the net return to mobile capital is the same in the two countries. Setting $r_A^m = r_B^m$ in (6) and using (7) yields

$$k_i = \frac{2 + d_A + d_B}{2} + \frac{1}{2b}\left[t_j\left(1 - \lambda_j - \bar{\alpha} - \frac{t_j}{2\beta}\right) - t_i\left(1 - \lambda_i - \bar{\alpha} - \frac{t_i}{2\beta}\right)\right], \tag{8}$$

where $i, j \in \{A, B\}$ and $i \neq j$. Equation (8) gives the aggregate amount of capital employed in country i as a function of the exogenous endowments and tax policy parameters.

Our analysis abstracts from distributional considerations and we assume that there is one representative consumer in each country. This representative individual in country i consumes the aggregate output good, whose price is normalized to unity. The consumption of this good, denoted by $x_i > 0$, equals the individual's after-tax income. After-tax income is composed of the net returns from the endowments of mobile and immobile units of capital and the residual remuneration of an exogenously supplied factor of production (e.g. labour). This residual, in turn, equals the value of domestic output, less the competitive payments (based on marginal productivities) to all capital employed in the country. Hence, private consumption in country i is

$$x_i = d_i r_i^d + r_i^m + f(k_i) - f'(k_i)\, k_i = d_i r_i^d + r_i^m + \frac{b}{2}\, k_i^2, \tag{9}$$

where the second step has used the properties of the quadratic production function.

Each government collects taxes from both mobile and immobile capital: Mobile capital employed in each country i is determined as $k_i - d_i$. Aggregate tax revenue in country i can be written as

$$z_i = \tau_i^m(k_i - d_i) + \tau_i^d d_i = \tau_i^m k_i + d_i(\tau_i^d - \tau_i^m). \tag{10}$$

To obtain a measure of national welfare we need to introduce a welfare weight for tax revenue, relative to private consumption. We assume that each Euro of tax revenue is worth $1 + \varepsilon$ Euros of private income with $\varepsilon > 0$. Hence, national welfare in country i is $u_i = x_i + (1 + \varepsilon)z_i$. One possible interpretation for this specification is that there is another distortionary tax (the personal income tax or the value-added tax) available to finance public goods, and this other tax has a marginal excess burden of ε Euros per Euro raised of revenue. Revenue collections from the corporation tax thus allow to reduce the distortions arising from these other taxes while keeping constant the level of public good supply.[17]

Substituting (9) and (10), national welfare in country i becomes

$$u_i = x_i + (1 + \varepsilon)z_i = d_i r_i^d + r_i^m + \frac{b}{2}\, k_i^2 + (1 + \varepsilon)[\tau_i^m k_i + d_i(\tau_i^d - \tau_i^m)] \quad \forall\, i, \qquad (11)$$

where r_i^d and r_i^m must be substituted from (3) and (6), the effective tax rates τ_i^d and τ_i^m are given in (2) and (5) and k_i is given in (8). This welfare function forms the basis for our further analysis.

3   The benchmark: Pareto efficient tax policy

As a benchmark, we derive the Pareto efficient tax policy when the countries can fully coordinate both the tax rates t_A and t_B and the thin capitalization rules λ_A and λ_B. This implies that each country sets its tax policy so as to maximizes the sum of utilities, $u_A + u_B$, of the two countries. Working with a simple utilitarian welfare criterion implies no loss of generality in our analysis, since we will compare the Pareto efficient outcome with the non-cooperative set of tax policies only in the case where the two countries are identical in all respects (i.e. $d_A = d_B = d$).[18]

The optimal tax policies (indicated by the superscript PO for a Pareto optimum) are derived in the appendix. With the constraint that λ has to be non-negative, the Pareto

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[17]The assumption that the marginal excess burden of the overall tax system is exogenous to our analysis can be justified by the empirical observation that corporate tax revenue has accounted for less than 10% of total tax receipts (including social security contributions) in the OECD average during the last decades (see OECD, 2005).

[18]Characterizing Pareto efficient international tax structures is far more difficult when the two countries are heterogeneous and, in particular, have different shadow prices of tax revenue. See Keen and Wildasin (2004) for a detailed discussion of this issue.

optimal tax policies are represented by

$$t^{PO} = \frac{\beta\varepsilon(1-\bar{\alpha})}{1+2\varepsilon} \,, \qquad \lambda^{PO} = 0. \tag{12}$$

If full coordination of tax policies is possible, the optimal policy is to have a thin capitalization rule that does not permit any deductibility of internal debt for tax purposes and a strictly positive statutory tax rate. The rationale of these insights is as follows. In a symmetric situation, the chosen tax policy affects neither the distribution nor the aggregate amount of capital. Relaxing the (common) thin capitalization rule by increasing λ then only has the effect of lowering the tax base. This enhances the net return obtained by mobile capital, but reduces the tax revenues in both countries. The latter effect dominates the former as higher corporate tax revenues would reduce the distortions of the tax system (reflected by the positive value of ε). Hence, it is never optimal to increase λ above zero. The same mechanisms are at work when determining the Pareto efficient statutory tax rate. But there is an additional effect, since for a given tax base an increase in the tax rate raises tax revenues. This is the reason why the efficient statutory tax rate is positive and increasing in ε. Note that t^{PO} is also rising in the cost parameter of a non-optimal capital structure (β), because high costs of financial distress make it unattractive to the firms to pursue a high-debt policy in order to save taxes. This reduces the elasticity with which the (aggregate) capital tax base responds to the statutory tax rate and so raises the efficient effective tax rate on capital.

To further interpret the Pareto optimum, it is helpful to compute the efficient *effective* tax rates. Inserting (12) into (2) and (5) yields

$$\tau^{m,PO} = \tau^{d,PO} = \frac{\varepsilon(1+\varepsilon)\beta(1-\bar{\alpha})^2}{(1+2\varepsilon)^2}. \tag{13}$$

Hence, the (common) effective tax rate is the same for mobile and immobile firms. This is an intuitive result because the international mobility of capital between countries A and B implies no loss in the aggregate capital stock $k_A + k_B = 1 + d_A + d_B$, which is the relevant measure when the two countries can fully coordinate their tax policies. A loss in the *aggregate* tax base of the two countries arises from the possibility to deduct external debt financing from the capital tax base. This possibility is symmetric for the domestic and the multinational firm, however, and therefore does not constitute an argument for discriminatory taxation. Hence, under the assumptions made, it is collectively optimal for the two countries to not offer any deductibility from tax for interest payments to affiliated entities within the MNE.

4 Tax competition

In the previous section we have analyzed the benchmark case where countries can fully coordinate their tax policy. We now assume that the two governments simultaneously and *non-cooperatively* choose both the statutory corporate tax rate and the thin capitalization rule.[19] This will allow us to compare the policies chosen in a situation of tax competition between the two countries with those that are Pareto efficient.

We first stick to the case where both countries are identical ($d_A = d_B = d$). Each country maximizes only the welfare of its own representative resident, but ignores the effects on the neighboring country. The tax policies in the symmetric Nash equilibrium are derived in the appendix and represented by

$$t^* = \frac{\beta \, \varepsilon \, d \, (1 - \bar{\alpha})}{(1 + \varepsilon)(1 + d) + \varepsilon d} \, , \tag{14}$$

$$\lambda^* = \frac{(1 + \varepsilon) \, (1 + d)(1 - \bar{\alpha})}{(1 + \varepsilon)(1 + d) + \varepsilon d} - \frac{2b[(1 + \varepsilon)(1 + d) + \varepsilon d]}{\beta \, d \, (1 + \varepsilon) \, (1 - \bar{\alpha})} \, . \tag{15}$$

Equation (14) shows that the equilibrium tax rate is positive whenever there is a positive excess burden of taxation (ε) and, thus, a need to generate corporate tax revenue. In contrast, the equilibrium level of the thin capitalization rule is composed of a positive and a negative term. Again we constrain λ^* to non-negative values (cf. footnote 13). An interior solution for λ and thus a thin capitalization rule that permits the deduction of a positive share of internal debt for multinationals will only be an equilibrium when the second term in (15) is sufficiently small. This is true, in particular, when the parameter b is low so that mobile capital will respond elastically to the effective tax rate it faces.[20] This leads to strong incentives for each country to underbid the effective tax rate of the other country and hence to a strong pressure to relax the thin capitalization rule (i.e., raising λ_i). On the other side, the permitted share

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[19]A fundamental issue is whether countries do indeed behave strategically when choosing their corporate tax rates and tax bases. Devereux et al. (2008) estimate reaction functions for 21 OECD member states and find evidence that countries compete over both tax rates and tax bases, in line with the theoretical predictions of the tax competition literature.

[20]A low level of b implies that the production function in each country is almost linear so that the marginal productivity of capital rises only slightly when the domestic capital stock is reduced. Hence when one country introduces a source-based capital tax, a large capital outflow will occur until the gross return to capital in this country has risen sufficiently to restore equal net returns to mobile capital in the two countries.

of internal debt is always less than $(1 - \bar{\alpha})$, since the first term in (15) is less than this value, and the second term is negative. This ensures that the tax base of each country's multinational firm is strictly positive in the symmetric Nash equilibrium of the tax competition game.

To further interpret the optimal combination of tax policies it is again helpful to compare the effective tax rates on mobile and immobile firms in the symmetric Nash equilibrium. Substituting (14) and (15) into (2) and (5) yields

$$\tau^{d*} = \frac{\varepsilon \beta d (1 - \bar{\alpha})^2 (1 + \varepsilon)(1 + d)}{[(1 + \varepsilon)(1 + d) + \varepsilon d]^2} \ , \qquad \tau^{m*} = \frac{2b\varepsilon}{1 + \varepsilon} \ . \tag{16}$$

From (16) we can immediately infer how a simultaneous change in the exogenous model parameters in *both* countries affects non-cooperative tax policy in the symmetric equilibrium. A higher elasticity of the mobile tax base in both countries (a fall in b) reduces the effective taxation of mobile firms but leaves the statutory tax rate and thus the effective tax rate on immobile firms unchanged. Hence, this parameter change unambiguously increases the degree of tax discrimination, which can be expressed as $\tau^{d*} - \tau^{m*} = t^* \lambda^*$. An increase in either the costs of financial distress (β) or the number of immobile firms (d) raises the statutory tax rate and, thus, the effective taxation of domestic firms, but it does not affect the effective tax rate on mobile firms. As a consequence, these changes again increase the degree of tax discrimination in favor of mobile capital. Finally, an increase in the valuation of tax revenue (ε) due to a higher excess burden of the tax system unambiguously raises the effective tax rate on both immobile and mobile firms.

We now compare the optimal tax policy in the non-cooperative equilibrium [eqs. (14)–(15)] with those that are Pareto efficient [eq. (12)]. It is easily shown that the statutory tax rate in the non-cooperative tax equilibrium is unambiguously lower than that in the fully coordinated tax equilibrium. Moreover, if tax competition is sufficiently intense (i.e. b is sufficiently low), the non-cooperatively chosen share of tax-deductible internal debt, λ^*, is positive and, thus, larger than the efficient level $\lambda^{PO} = 0$. This highlights the role of the thin capitalization rule as a policy instrument in the competition for mobile capital. In the non-cooperative equilibrium, as in the Pareto optimal case, relaxing the thin capitalization rule (increasing λ_i) reallocates income from the public sector to the private sector. This effect on its own is welfare-reducing for the individual country due to the positive excess burden of the tax system ($\varepsilon > 0$). In contrast to the efficient solution, however, under a non-cooperative choice of policy instruments the increase in

λ_i attracts mobile capital and this gives the individual country an incentive to relax the thin capitalization rule.

The fact that thin capitalization rules are inefficiently lax in the Nash equilibrium immediately implies that the tax base of mobile, multinational firms is also lower in the non-cooperative tax equilibrium, as compared to the Pareto optimum. In this case tax competition thus reduces the effective rate on mobile firms through both a reduction in the statutory tax rate and a smaller tax base. In any event, since the thin capitalization variable λ_i is constrained to be non-negative, the effective tax rates on *both* types of firms are always lower in the non-cooperative tax competition equilibrium as compared to the fully cooperative solution. Formally, this can be seen by comparing (16) with (13) and using $\lambda^* \geq 0$.

So far, we have only considered the case where the two countries are identical in all respects. There are, however, a number of relevant asymmetries across the OECD countries and it is interesting to analyze how such differences affect the equilibrium tax rates and thin capitalization rules. In particular, let us assume that both countries continue to possess one unit of mobile capital, but country A has a higher endowment with immobile capital than country B (i.e., $d_A > d_B$). This difference can also be interpreted as a difference in the size of the two countries when we assume that a larger home market will make it more attractive, other things being equal, to operate in this market only. As an example, country A could stand for Germany, whereas country B could stand for Ireland.

In general such asymmetries are difficult to handle analytically in our framework. Nevertheless, we can gain some important analytical insights when we focus on small difference between the countries. For this, we consider the effects of a marginal increase in d_A on the *difference* between the non-cooperatively chosen effective tax rates in the two countries, starting from an initially symmetric equilibrium. This analysis yields the following results, which are derived in the appendix:

$$\frac{\mathrm{d}(\tau_A^d - \tau_B^d)}{\mathrm{d}d_A} > 0, \qquad \frac{\mathrm{d}(\tau_A^m - \tau_B^m)}{\mathrm{d}d_A} < 0. \tag{17}$$

An increase in the number of domestic firms in country A raises the tax rate chosen in this country, relative to the tax rate change in country B (where no exogenous shock has taken place). This is an intuitive result as an increase in d_A raises the tax base in country A. This makes it attractive for country A's government to raise the statutory capital tax rate and hence also the effective tax rate on domestic capital.

Table 1: Simulation results for asymmetric tax competition

		parameters			endogenous variables							
	d_A	ε	b	β	λ_A	λ_B	t_A	t_B	τ_A^m	τ_B^m	τ_A^d	τ_B^d
(1)	0.5	0.3	0.5	5.0	0.118	0.118	0.321	0.321	0.231	0.231	0.269	0.269
(2)	0.6	0.3	0.5	5.0	0.233	0.062	0.363	0.317	0.216	0.245	0.301	0.265
(3)	0.6	0.5	0.5	5.0	0.172	0.024	0.507	0.444	0.317	0.349	0.405	0.360
(4)	0.6	0.3	0.3	5.0	0.472	0.370	0.364	0.317	0.129	0.148	0.301	0.265
(5)	0.6	0.3	0.5	7.5	0.432	0.319	0.545	0.475	0.216	0.246	0.451	0.397

<u>Note:</u> Parameter values that are held constant in all simulations: $d_B = 0.5$, $\bar{\alpha} = 0.1$, $a = 3$.

The second result in (17) is more surprising, however. Even though the statutory tax rate rises, the effective tax rate on mobile capital falls. The intuition for this result is that the marginal productivity of capital falls in country A when the stock of domestic capital rises. This places country A at a disadvantage vis-à-vis country B in the competition for mobile multinational firms. To partly compensate for the lower gross return to capital, country A thus offers a lower effective tax rate to mobile firms. As the statutory tax rate is simultaneously increased, this can only be brought about by a strong relaxation of the thin capitalization rule, which more than compensates multinational firms for the increase in the statutory tax rate.

Even though we derived these results under the assumption of a small difference between the two countries, the intuition of the results suggests that they remain true for large country asymmetries. This proposition is supported by the numerical simulations given in Table 1. Row (1) gives the simulation results for the symmetric benchmark case. In rows (2)-(5) an asymmetry is introduced by increasing the endowment of domestic capital in country A ($d_A = 0.6$, $d_B = 0.5$). Row (2) shows that the increase in d_A raises the statutory tax rate in country A but at the same time increases λ_A by so much that the effective tax rate on mobile firms in country A actually falls. Moreover, in row (3) of Table 1 the common excess burden parameter ε is raised in both countries. This leads to tighter thin capitalization rules (a reduction in λ) and a higher statutory tax rate in both countries. In line (4) a higher elasticity of the mobile tax base and more aggressive tax competition is analyzed through a reduction in the curvature parameter b of both countries' production functions. This leads to a strong relaxation of the thin capitalization rules while the statutory tax rate stays constant in both countries [as compared to row (2)]. This result confirms our above argument that thin capitalization

rules are the main instruments used by the countries in the competition for mobile capital. In row (5), an increase in the cost of financial distress (a rise in β) causes an increase in the statutory tax rate that is fully compensated for mobile firms by a corresponding increase in λ. Hence the result that τ_i^m is independent of uniform changes in β [see eq. (16)] holds also in the case of asymmetric countries. Finally, observe that in all asymmetric equilibria it holds true that $\tau_A^m < \tau_B^m$ but $\tau_A^d > \tau_B^d$, as stated in our analytical result in eq. (17).

5 Partial coordination of thin capitalization rules

In the last section we have seen that tax competition will lead to inefficiently low tax rates and inefficiently lax thin capitalization rules (i.e., inefficiently high levels of λ_i), relative to the Pareto optimal tax policies. In this section we thus consider the effects of a coordinated tightening of thin capitalization rules in both countries. At the same time we assume that each country is free to adjust its tax rate optimally to the new thin capitalization rules. This is a realistic scenario in both the European Union and worldwide, where tax rate harmonization is not considered to be politically feasible (and perhaps also not economically desirable) at this point. The constraint that not all policy instruments can be chosen in a coordinated fashion opens up the possibility that both countries respond to the coordinated tightening of thin capitalization rules by competing more aggressively via statutory tax rates. Since this will also reduce the taxation of immobile firms, the welfare effects of a partial coordination of thin capitalization rules are theoretically ambiguous a priori.

To carry out this analysis we start again with the case where the two countries are symmetric in all respects. We determine the total change in country j's utility caused by a marginal reduction in both countries' thin capitalization rule parameter. Formally, we set $\mathrm{d}\lambda_i = \mathrm{d}\lambda_j = \mathrm{d}\lambda < 0$. The total change in country j's welfare then reads

$$\frac{\mathrm{d}u_j}{\mathrm{d}\lambda} = \frac{\partial u_j}{\partial \lambda_i} + \frac{\partial u_j}{\partial t_i} \frac{\mathrm{d}t_i}{\mathrm{d}\lambda} \tag{18}$$

for $i, j \in \{A, B\}$ and $i \neq j$. Note that in (18) we used the first order conditions $\partial u_j/\partial t_j = 0$ and $\partial u_j/\partial \lambda_j = 0$ of country j's own policy choice, since both instruments were chosen optimally from country j's perspective before the small, exogenous variation in the thin capitalization rules. The expression $\mathrm{d}t_i/\mathrm{d}\lambda$ in (18) is the response of country i's statutory tax rate to the simultaneous changes in λ_i and λ_j.

It is straightforward to determine the partial derivatives of country j's utility with respect to the two tax variables of country i. Differentiating (11) yields

$$\frac{\partial u_j}{\partial \lambda_i} = -\frac{(1+\varepsilon)\tau^{m,*}\, t^*}{2b} < 0, \tag{19}$$

$$\frac{\partial u_j}{\partial t_i} = \frac{(1+\varepsilon)\tau^{m,*}}{2b}\left(1 - \bar{\alpha} - \lambda^* - \frac{t^*}{\beta}\right) > 0, \tag{20}$$

for $i, j \in \{A, B\}$ and $i \neq j$. Hence, the direct effect of a small reduction in λ_i is beneficial for country j. An isolated tightening of country i's thin capitalization rule increases the effective tax rate on mobile capital in country i and leads to a reallocation of mobile capital to country j. Similar effects arise from a statutory tax increase in country i, which also benefits the neighboring country j.

The remaining question is then how country i's optimal statutory tax rate adjusts to the coordinated change in the thin capitalization rules. This adjustment is derived in the appendix and is given by

$$\frac{\mathrm{d}t_i}{\mathrm{d}\lambda} = \frac{\varepsilon(1+\varepsilon)\beta^2 d^2(1-\bar{\alpha})^2}{\Delta} > 0, \tag{21}$$

where $\quad \Delta \equiv (1 + d + 2\varepsilon d)d^2(1-\bar{\alpha})^2\beta(1+\varepsilon) + 2b(1 + d + \varepsilon + 2\varepsilon d)^2 > 0.$

Equation (21) states that each country responds to the coordinated tightening of the thin capitalization rules ($d\lambda < 0$) by lowering its statutory tax rate. This is just the possibility discussed at the beginning of this section. When each country is forced to increase the tax base and thus, other things equal, raise the effective tax rate on mobile firms, tax competition will shift to a more aggressive lowering of statutory tax rates. Put differently, if a partial coordination restricts the countries' options to use thin capitalization rules in order to attract mobile capital, both countries will more extensively use statutory tax rates in tax competition. From eq. (20) this implies that the indirect effect of a coordinated tightening of thin capitalization rules [the second term in (18)] is negative.

To determine the net effect of a partial coordination of thin capitalization rules we substitute (19)–(21) in (18). With straightforward manipulations this leads to

$$\frac{\mathrm{d}u_j}{\mathrm{d}\lambda} = -\frac{(1+\varepsilon)\tau^{m,*}}{2b\Delta}\frac{\varepsilon d(1-\bar{\alpha})(1 + d + 2\varepsilon d)}{(1 + d + \varepsilon + 2\varepsilon d)} < 0, \tag{22}$$

where $\Delta > 0$ is given in (21). Equation (22) shows that the direct effect of a coordinated tightening of thin capitalization rules dominates the indirect effect and welfare

increases in both countries, despite the simultaneous reduction in statutory tax rates. The intuition for this result can be found in the optimal formulae for t_i and λ_i in the non-cooperative equilibrium [eqs. (14) and (15)]. It is seen there that the parameter b, which characterizes the intensity of international tax competition between the two countries, enters the equilibrium policy rule for λ_i, but not that for t_i. Hence tax competition acts primarily through the choice of thin capitalization rules in the present model. More restrictive rules therefore reduce the overall degree of tax competition and the resulting welfare losses, as formally shown in (22).

Another way to explain this result is to derive the effect of a coordinated change in the thin capitalization rules on the effective tax rate on mobile firms in a given country. Totally differentiating (5), using (21) and substituting in from (14) and (15) yields, after straightforward manipulations

$$\frac{\mathrm{d}\tau_i^m}{\mathrm{d}\lambda} = -\frac{\varepsilon\beta^2 d^3(1-\bar{\alpha})^3(1+\varepsilon)}{\Delta} < 0. \tag{23}$$

Hence, the effective tax rate on mobile capital rises in response to a coordinated tightening of thin capitalization rules, as the fall in the statutory tax rate will not fully offset the effect of the broader tax base for multinational firms. Since the effective tax rate is a summary measure of the two countries' tax policies vis-à-vis mobile firms, an increase in this measures indicates that a coordinated reduction in λ_A and λ_B is an effective way to reduce international tax competition in the present model.

It is interesting to contrast our result on the welfare effects of partial tax coordination, as summarized in equation (22), with the findings of the previous literature on discriminatory tax competition. In our model the coordinated tightening of thin capitalization rules forces both countries to reduce the use of discriminatory tax policies, since only mobile firms benefit from the use of tax-deductible internal debt. Hence, our finding is that restricting the use of discriminatory tax policies is collectively welfare-increasing, even though it leads countries to compete more aggressively via the statutory tax rate. This result is in direct contrast to the analysis of non-discrimination rules in Keen (2001), who shows that forcing two symmetric countries to tax a more and a less mobile tax base at the same rate is unambiguously welfare-*reducing*.[21]

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[21]Keen's results have been qualified in the subsequent literature. Janeba and Smart (2003) show that the result depends on his assumption that both tax bases are fixed in the aggregate. Haupt and Peters (2005) introduce a 'home bias' of investors into Keen's model and show that non-discriminatory policies are more likely to be welfare increasing in this case.

Following Keen (2001), much of the existing literature has modelled tax discrimination as levying different statutory tax rates on two tax bases that vary in their degree of international mobility while tax base effects are ignored. A strict non-discrimination policy forces each country to levy a single tax rate on both mobile and immobile firms, but each country remains free to choose this tax rate in its own best interest. In such a model, all tax instruments are similar in structure and the welfare effects of tax coordination follow from a simple averaging argument. In particular, a non-discrimination rule will lead countries to choose a tax rate that lies in between the two discriminatory tax rates that were chosen prior to the constraint, and hence raises the tax rate on the more mobile tax base while lowering the tax rate on the less mobile base. The intuition for Keen's (2001) result is that, in the non-cooperative tax equilibrium with a non-discrimination rule in place, the higher tax rate on the more mobile base will make it more attractive to compete for this base and hence leads to more aggressive tax competition, on average. In other words, the tax rate on the more mobile base will rise by less than the tax rate on the less mobile base falls, thus reducing tax revenues and welfare in each country.

In the present model, in contrast, the two tax instruments that each country employs in the non-cooperative tax equilibrium play very different roles. As our above analysis has shown, *international* tax competition for mobile firms occurs primarily through the thin capitalization rules, as is seen from the fact that the parameter b, which characterizes the intensity of tax competition, enters only the thin capitalization rule formula. The statutory tax rate instead balances the gains from higher tax revenues against the efficiency losses that arise from both domestic and multinational firms choosing a higher levels of external debt finance. In such a setting a coordinated tightening of thin capitalization rules thus reduces the average intensity of international tax competition, and this is beneficial for both countries in the symmetric equilibrium with partial coordination.

Let us finally turn to partial coordination in the case of asymmetric tax competition. With asymmetries between countries, two different coordination scenarios have to be distinguished. A first variant is that each of the two countries reduces the tax-deductible share of internal debt by the same amount, starting from different initial levels of λ_i. Formally this implies $d\lambda_A = d\lambda_B = d\lambda < 0$. In this case partial coordination acts in a very similar way as in the symmetric case, except that the two countries now start from different values of λ. We were not able to obtain analytical results for this case,

Table 2: Simulation results for partial coordination among asymmetric countries

coord.	endogenous variables								welfare	
$\bar{\lambda}$	t_A	t_B	λ_A	λ_B	τ_A^m	τ_B^m	τ_A^d	τ_B^d	Δu_A	Δu_B
case 1: $d_A = 0.6$, $d_B = 0.5$										
–	0.509	0.443	0.304	0.207	0.172	0.196	0.328	0.289	–	–
0.285	0.494	0.442	0.285	0.202	0.177	0.198	0.318	0.287	> 0	> 0
0.255	0.470	0.441	0.255	0.197	0.184	0.200	0.305	0.287	> 0	> 0
0.207	0.434	0.439	0.207	0.190	0.193	0.202	0.283	0.286	> 0	> 0
case 2: $d_A = 1.0$, $d_B = 0.5$										
–	0.689	0.419	0.442	0.070	0.125	0.244	0.430	0.274	–	–
0.405	0.660	0.415	0.405	0.047	0.146	0.251	0.414	0.271	> 0	> 0
0.350	0.604	0.411	0.350	0.022	0.171	0.260	0.382	0.269	< 0	> 0
0.300	0.544	0.409	0.300	0.006	0.188	0.265	0.348	0.267	< 0	> 0

<u>Note:</u> Parameters held constant in all simulations: $\varepsilon = 0.3$, $b = 0.4$, $\beta = 9$, $\bar{\alpha} = 0.1$, $a = 1$.

but we carried out a comprehensive set of simulations to determine the effects of this policy experiment. As a robust result, these simulations reveal that a simultaneous, small reduction in λ_A and λ_B has the same qualitative effects as those that were derived above for the symmetric case. In particular, the statutory tax rate falls in both countries, but this adjustment only partially offsets the effect of the stricter thin capitalization rule so that the effective tax rate on mobile firms rises in both countries. As a consequence, tax competition becomes less severe and welfare in both countries increases, relative to the level in the non-cooperative Nash equilibrium.

In practice, however, tax coordination is rarely understood as a uniform change in two asymmetric countries' tax instruments. Instead, tax harmonization often takes the form of a minimum requirement imposed on the tax policies of the countries, for example a minimum statutory tax rate. In our case a minimum standard in the setting of thin capitalization rules implies that countries are constrained to allow a maximum value of internal debt, $\bar{\lambda}$, that can be deducted from that corporate tax base. This constraint is assumed to be binding for country A, which is the country with the larger number of domestic firms and hence the more lenient thin capitalization rules in the asymmetric Nash equilibrium [cf. eq. (17) and Table 1]. In contrast, country B is allowed to re-optimize its thin capitalization regulation, as long as it satisfies the constraint $\lambda_B \leq \bar{\lambda}$. The results of our simulation analysis are summarized in Table 2.

Table 2 contains two cases: case 1 where the country asymmetry is only moderate, and case 2 where the number of immobile firms in country A is twice as high as in country B. For small asymmetries between countries (case 1), the minimum thin capitalization standard continues to improve the welfare of both countries, as in the fully symmetric case. The reason is that the increase in country A's effective tax rate on mobile firms induced by the more restrictive thin capitalization rule will also raise country B's effective tax rate on mobile firms. This response benefits country A sufficiently so that both countries gain from the unilateral restriction on country A's thin capitalization policy. The same is not true, however, when the differences between the two countries are large (case 2). In this case, a unilateral restriction that is binding only for country A reduces welfare in this country if the restriction on λ_A is sufficiently tight. Intuitively with large asymmetries between the two countries the effective tax rate on mobile firms in country A increases significantly when a binding constraint on λ_A is imposed. Since country B's effective tax rate on mobile firms increases only moderately, country A loses a substantial amount of mobile capital to country B and this effect is not offset by the lower intensity of tax competition between the two countries. In sum, when countries differ in the number of immobile firms, a minimum standard of thin capitalization regulations may reduce welfare in the country with the larger domestic tax base, provided that countries are sufficiently different and the restriction on thin capitalization rules is sufficiently tight.

6 Conclusions

In this paper we have analyzed a model where countries compete for internationally mobile firms through statutory tax rates and thin capitalization rules that limit the tax-deductibility of internal debt flows within the multinational enterprises. At the same time both multinational and domestic firms will respond to a higher domestic tax rate by increasing the level of external debt finance. In this model we have shown that tax competition leads to inefficiently low tax rates and to inefficiently lax thin capitalization rules, relative to the Pareto efficient solution. A coordinated policy of tightening thin capitalization rules will have the side effect that both countries compete more aggressively via statutory tax rates. Nevertheless, for countries that are identical or at least similar in their relevant characteristics, the overall effect of the partial coordination policy will be mutually beneficial. The reason is that international tax

competition occurs primarily through thin capitalization rules in our model. Hence even a partial coordination of this policy instrument is an effective way to reduce the overall intensity of international corporate tax competition.

The results of our model correspond to some recent developments and empirical findings in the literature. Altshuler and Grubert (2006) provide data for the U.S. showing that the introduction of "hybrid entities" in 1997, which made it easier for U.S. multinationals to avoid taxes on intercompany payments like interest and royalties, induced a large growth in such payments and substantially increased the disparity in the reported profitability of subsidiaries in high-tax and low-tax jurisdictions. At the same time the authors find that the link between host countries' statutory tax rates and foreign direct investment was significantly weakened by this change in tax rules. This is consistent with the implication of our model that tax competition for multinational firms occurs to a large extent through tax rules that apply specifically to this group, whereas statutory corporate tax rates may be of secondary importance in this process. If this evidence is confirmed by more detailed studies, we would expect that countries indeed set their thin capitalization rules less strictly than they otherwise would, for fear of losing foreign direct investment to other regions. A policy case for a coordinated tightening of existing thin capitalization rules can then be made.

At the same time, however, it is obvious that a collective policy of enforcing stricter thin capitalization rules is not an easy undertaking. One well-known problem is identified by our numerical simulations for the case of strongly asymmetric countries. These simulations show that a coordinated tightening of thin capitalization rules may produce winners and losers. Hence, even if the average welfare change of the reform is positive, the countries that lose out from this reform have a strong incentive to vote against the coordination measure. Such a situation seems to be relevant in the EU where members states still differ substantially, and in several respects, from each other. One important distinguishing factor, highlighted in our analysis, is the relative importance of internationally mobile versus internationally immobile tax bases. As we have shown, larger countries with a broader domestic tax base have even stronger incentives than their smaller neighbors to introduce lax thin capitalization rules, as this will give them the opportunity to tax the domestic tax base more heavily via a higher statutory tax rate.

Finally a word on the limitations of our analysis is due. In particular we have assumed that intra-firm financial transactions are exclusively driven by tax considerations while

ignoring any non-tax reasons for such flows. This assumption was made to sharpen the focus of our analysis, but it does not imply that non-tax reasons for intra-firm financial flows are unimportant. Indeed, one of the main findings of the empirical analyses in Desai at al. (2004) and Buettner et al. (2006) is that U.S. multinationals use internal capital markets to overcome market imperfections in the external credit markets of their host countries. Having access to internal sources of financing is thus an important competitive advantage of multinational firms doing business in such countries, in comparison to their local competitors. Any attempt to tighten existing thin capitalization rules must thus carefully distinguish between intra-firm financial transactions that are primarily driven by tax considerations, and those financial flows that serve a productive purpose within the firm.

Appendix

A.1. Fully coordinated tax policy

We focus on the Pareto optimum in the symmetric case where $d_A = d_B = d$, $t_A = t_B = t$ and $\lambda_A = \lambda_B = \lambda$. Equation (8) then implies $k_A = k_B = 1 + d$. Using the effective tax rates (2) and (5) and the net returns (3) and (6), the sum of both countries' welfare can be written as

$$
\begin{aligned}
u_A + u_B = {} & 2(1+d)\left[a - b(1+d) - t\left(1 - \bar{\alpha} - \frac{t}{2\beta}\right)\right] - 2\varepsilon t\lambda \\
& + 2t(1+\varepsilon)(1+d)\left(1 - \bar{\alpha} - \frac{t}{\beta}\right). \quad \text{(A.1)}
\end{aligned}
$$

The derivative of (A.1) with respect to the common level of λ reads

$$
\frac{\partial(u_A + u_B)}{\partial\lambda} = -2\varepsilon t < 0.
$$

Hence, we obtain the corner solution $\lambda^{PO} = 0$ as stated in (12). In order to prove the result for the Pareto efficient tax rate, insert $\lambda^{PO} = 0$ into (A.1) and differentiate with respect to t. This yields the first order condition

$$
\frac{\partial(u_A + u_B)}{\partial t} = 2(1+d)\left[(1+\varepsilon)\left(1 - \bar{\alpha} - \frac{2t}{\beta}\right) - \left(1 - \bar{\alpha} - \frac{t}{\beta}\right)\right] = 0.
$$

Solving this condition with respect to t gives the efficient tax rate t^{PO} in (12).

A.2. Symmetric tax competition

We differentiate the welfare function (11) with respect to t_i. This yields in a first step

$$
\frac{\partial u_i}{\partial t_i} = -\frac{\mu_i}{2}(k_i + 1 + d_i) + \varepsilon d_i\lambda_i + (1+\varepsilon)\left[k_i\left(\mu_i - \frac{t_i}{\beta}\right) - \frac{t_i\mu_i^2}{2b}\right] \quad \text{(A.2)}
$$

where

$$
\mu_i = 1 - \lambda_i - \bar{\alpha} - \frac{t_i}{\beta} \quad \text{(A.3)}
$$

Employing the symmetry assumption $k_i = 1 + d_i$ yields the following first-order condition for the optimal tax rate

$$
\varepsilon\left[(1+d_i)\left(1 - \bar{\alpha} - \frac{t_i}{\beta}\right) - \lambda_i\right] = (1+\varepsilon)t_i\left[\frac{(1+d_i)}{\beta} + \frac{1}{2b}\left(1 - \lambda_i - \bar{\alpha} - \frac{t_i}{\beta}\right)^2\right] = 0. \quad \text{(A.4)}
$$

Analogously differentiating (11) with respect to λ_i yields

$$\frac{\partial u_i}{\partial \lambda_i} = -\frac{t_i}{2}(k_i + 1 - d_i) + (1 + \varepsilon)\left[-(k_i - d_i)t_i + \frac{t_i^2 \mu_i}{2b}\right]. \tag{A.5}$$

Again using symmetry yields the following first-order condition for the optimal thin capitalization rule

$$\frac{(1 + \varepsilon)t_i}{2b}\left(1 - \lambda_i - \bar{\alpha} - \frac{t_i}{\beta}\right) - \varepsilon = 0. \tag{A.6}$$

Equations (A.4) and (A.6) constitute a system of two equations in the two unknowns t_i and λ_i. Solving this equation system yields (14) and (15) in the main text.

A.3. Asymmetric Nash equilibrium

In order to prove (17), we totally differentiate (8), (A.2) and (A.5) and evaluate the resulting expressions at the symmetric equilibrium. This yields

$$\gamma_1 dt_i + \gamma_2 d\lambda_i + \gamma_3 dk_i + \gamma_4 dd_i = 0, \tag{A.7}$$

$$\gamma_5 dt_i + \gamma_6 d\lambda_i - \gamma_7 dk_i + \gamma_7 dd_i = 0, \tag{A.8}$$

$$dk_i = \frac{dd_i + dd_j}{2} + \gamma_8(dt_j - dt_i) + \gamma_9(d\lambda_j - d\lambda_i), \tag{A.9}$$

with $i, j \in \{A, B\}$, $i \neq j$ and

$$\gamma_1 = -\frac{\beta d^2(1 + \varepsilon)(1 - \bar{\alpha})^2(1 + d + 2\varepsilon d) + 2b(1 + d + \varepsilon + 2\varepsilon d)^2}{\beta^2 d^2(1 + \varepsilon)(1 - \bar{\alpha})^2}, \quad \gamma_2 = \varepsilon, \tag{A.10}$$

$$\gamma_3 = \frac{b(1 + d + \varepsilon + 2\varepsilon d)^2(1 + 2\varepsilon) - \beta \varepsilon d^2(1 + \varepsilon)^2(1 - \bar{\alpha})^2}{\beta d(1 + \varepsilon)(1 - \bar{\alpha})(1 + d + \varepsilon + 2\varepsilon d)}, \tag{A.11}$$

$$\gamma_4 = -\frac{b(1 + d + \varepsilon + 2\varepsilon d)^2(1 + 2\varepsilon) - \beta \varepsilon d(1 + d)(1 + \varepsilon)^2(1 - \bar{\alpha})^2}{\beta d(1 + \varepsilon)(1 - \bar{\alpha})(1 + d + \varepsilon + 2\varepsilon d)}, \tag{A.12}$$

$$\gamma_5 = \frac{2b(1 + d + \varepsilon + 2\varepsilon d)^2 - \beta \varepsilon d^2(1 + \varepsilon)(1 - \bar{\alpha})^2}{2b\beta d(1 - \bar{\alpha})(1 + d + \varepsilon + 2\varepsilon d)}, \quad \gamma_6 = -\frac{\beta \varepsilon d(1 + \varepsilon)(1 - \bar{\alpha})}{2b(1 + d + \varepsilon + 2\varepsilon d)}, \tag{A.13}$$

$$\gamma_7 = \frac{1 + 2\varepsilon}{2}, \quad \gamma_8 = \frac{1 + d + \varepsilon + 2\varepsilon d}{\beta d(1 + \varepsilon)(1 - \bar{\alpha})}, \quad \gamma_9 = -\frac{\beta \varepsilon d(1 - \bar{\alpha})}{2b(1 + d + \varepsilon + 2\varepsilon d)}. \tag{A.14}$$

In computing (A.10) - (A.14) we used to equilibrium values (14) and (15). We are interested in the effects of a marginal increase in d_A. Hence, we set $dd_A > 0$ and $dd_B = 0$. Subtracting (A.7) for $i = B$ from (A.7) for $i = A$, using (A.9) and proceeding in the same way with (A.8) yields the matrix equation

$$\underbrace{\begin{pmatrix} \gamma_1 - 2\gamma_3\gamma_8 & \gamma_2 - 2\gamma_3\gamma_9 \\ \gamma_5 + 2\gamma_7\gamma_8 & \gamma_6 + 2\gamma_7\gamma_9 \end{pmatrix}}_{=:J}\begin{pmatrix} d(t_a - t_b) \\ d(\lambda_a - \lambda_b) \end{pmatrix} = \begin{pmatrix} -\gamma_4 \\ -\gamma_7 \end{pmatrix} dd_A. \tag{A.15}$$

26

After some tedious computations, we can calculate the determinant of the matrix J on the LHS of (A.15) as

$$|J| = \frac{\varepsilon d(1-\bar{\alpha})[b(2+3\varepsilon)(1+d+\varepsilon+2\varepsilon d)^3 - \beta\varepsilon^2 d^2(1+\varepsilon)^2(1-\bar{\alpha})^2]}{2b^2(1+d+\varepsilon+2\varepsilon d)^3}. \qquad (A.16)$$

Stability of the Nash equilibrium implies that $|J| > 0$.[22] From (A.15) we then obtain

$$\frac{\mathrm{d}(t_a - t_b)}{\mathrm{d}d_A} = \frac{\beta\varepsilon^2 d(1+\varepsilon)(1-\bar{\alpha})^2[2+d+\varepsilon(3+d)]}{2b(1+d+\varepsilon+2\varepsilon d)^2|J|},$$

$$\frac{\mathrm{d}(\lambda_a - \lambda_b)}{\mathrm{d}d_A} = \frac{b(1+d+\varepsilon+2\varepsilon d)^2[2\varepsilon(2+3\varepsilon)+d(1+\varepsilon)(1+4\varepsilon)+(d+2\varepsilon d)^2]}{2b\beta d(1+d+\varepsilon+2\varepsilon d)^2|J|}$$

$$- \frac{\beta\varepsilon^2 d^2(1+d)(1+\varepsilon)^2(1-\bar{\alpha})^2}{2b\beta d(1+d+\varepsilon+2\varepsilon d)^2|J|}.$$

From these expressions, along with (2) and (5), we can compute the effect on $\tau_A^d - \tau_B^d$ and $\tau_A^m - \tau_B^m$. After several manipulations we obtain

$$\frac{\mathrm{d}(\tau_A^d - \tau_B^d)}{\mathrm{d}d_A} = \frac{b\beta\varepsilon(1+\varepsilon)(1-\bar{\alpha})^2(1+d+\varepsilon)(2+d+\varepsilon(3+d))}{b(2+3\varepsilon)(1+d+\varepsilon+2\varepsilon d)^3 - \beta\varepsilon^2 d^2(1+\varepsilon)^2(1-\bar{\alpha})^2} > 0, \qquad (A.17)$$

$$\frac{\mathrm{d}(\tau_A^m - \tau_B^m)}{\mathrm{d}d_A} = -\frac{b(1+2\varepsilon)[\beta\varepsilon^2 d(1+\varepsilon)(1-\bar{\alpha})^2 + b(1+d+\varepsilon+2\varepsilon d)^3])}{b(2+3\varepsilon)(1+d+\varepsilon+2\varepsilon d)^3 - \beta\varepsilon^2 d^2(1+\varepsilon)^2(1-\bar{\alpha})^2} < 0. \qquad (A.18)$$

This proves (17) since the denominator of both (A.17) and (A.18) is positive due to the stability condition $|J| > 0$.

A.4. Partial tax coordination

We totally differentiate (A.2) and use $\mathrm{d}k_i = 0$ since $\mathrm{d}\lambda_i = \mathrm{d}\lambda_j = \mathrm{d}\lambda$ from the coordinated change in the thin capitalization rules and $\mathrm{d}t_i = \mathrm{d}t_j$ follows from symmetry. This yields in a first step

$$\left[-\varepsilon + \frac{(1+\varepsilon)t^*\mu^*}{b}\right]\mathrm{d}\lambda = \left[\frac{(1+2\varepsilon)(1+d)}{\beta} + \frac{(1+\varepsilon)\mu^*(\beta\mu^* - 2t^*)}{2b\beta}\right]\mathrm{d}t_i \qquad (A.19)$$

where $\mu^* = 1 - \lambda^* - \bar{\alpha} - t^*/\beta$. Substituting the values for t^* and λ^* in the intial equilibrium [eqs. (14) and (15)] yields eq. (21) in the main text.

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[22]Stability requires that the Jacobian determinant of the system of equations consisting of (A.2) and (A.5) for $i \in \{A, B\}$, evaluated at the symmetric Nash equilibrium, has to be negative semidefinte. It can be shown that this stability condition implies $|J| > 0$. Details on the corresponding computations can be obtained upon request.

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