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## Strategic Business Taxation when Finance and Portfolio Decisions are Endogenous

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**Volkswirtschaftliche  
Diskussionsbeiträge**



**Strategic Business Taxation**  
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# **Strategic Business Taxation**

## **when Finance and Portfolio Decisions are Endogenous**

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**Abstract:** The paper analyzes the impact of personal income taxes on strategic business taxation. It sets up a model of tax competition between small jurisdictions whose governments are revenue maximizers and use business taxes on the capital stock and on corporate profits as their policy instruments. Personal income taxes, which are parametrically fixed, discriminate between dividends and interest incomes and determine portfolio choices of households and finance decisions of firms. It turns out that the strategic incentives in business taxation are strongly influenced by personal income tax parameters. In the case of profit taxation this influence is non-monotonic and discontinuous. Generally, Leviathan governments prefer fully equity financed firms. It can be shown that from a government viewpoint profit and capital taxes are perfect substitutes as they create identical strategic incentives.

**JEL classification:** H25, H71, H77

## 1. Introduction

In many real-world tax systems, capital and its returns are not subject to a single and uniform tax only, but rather to several taxes with different rates and/or tax bases. This holds especially (i) for federal tax structures, where different levels of government exploit the same or overlapping tax bases, and (ii) for the field of international taxation when the source country of earnings and the residence country of their final claimant do not coincide. In both the federal and the international setting, governments nowadays face a high mobility of capital, including a greater tax sensitivity of this factor.<sup>1</sup> High mobility creates pressures on tax policies and governments compete with each other for scarce capital which is a very elastic tax base. This kind of fiscal competition has been on the research agenda of public finance theorists for several years and, in principle, is well-understood.<sup>2</sup> However, these analyses have so far not taken into account the high complexity of real-world capital income tax systems which discriminate between different kinds of capital income (e.g., dividends, interest income, capital gains), between different tax payers (corporate vs. personal taxes, foreigners vs. residents) and between different ways of using capital income (e.g., retentions or distributed profits). Neither has the theoretical literature so far considered the strategic interrelationships between different taxes. These might occur due to partial overlaps in the tax bases of different capital related taxes which imply that the reallocation of capital due to a change in one tax may alter the strategic incentives for governments with respect to another tax.

This paper investigates into the strategic effects for capital taxation in a moderately complex capital tax system which includes both business and personal taxation. We set up a model with two small jurisdictions whose governments have at their disposal two business taxes: a tax on profits and a tax on the capital stock invested within their jurisdiction. Governments are revenue maximizers and, as capital is assumed to be costlessly mobile in the economy, engage in tax competition. Each jurisdiction hosts one corporate firm which makes its investment and finance decisions as to maximize its dividend payouts. Households, who are capital suppliers, make up their portfolio choices between bond and equity shares of the firms. Household's dividend and interest earnings are subject to differential personal taxation. These personal taxes

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<sup>1</sup> See Razin/Sadka/Yuen (1996) for a critical assessment of this view and its implications for taxation.

<sup>2</sup> To name but a few contributions to this area, see Zodrow/Mieszkowski (1986), Wildasin (1989), Razin/Sadka (1991) Bucovetsky/Wilson (1991), Mirtz/Tulkens (1996) or Braid (1996).

are levied by a tax authority other than those two engaged in the tax competition game. Throughout the analysis personal tax rates are assumed to be parametrically fixed. This structure allows for two more specific interpretations:

- (i) *Interregional tax competition in a federation*: First, the jurisdictions may be interpreted as the lower, "local" level of a federation (states, regions, communities). Then profit and capital taxes are instruments of local governments, which is in harmony with the current practice of a number of OECD countries (see OECD (1991)). For lower levels of government such taxes often constitute important sources of finance. Furthermore, in order to make the own jurisdiction an attractive location for investors, local taxes are amongst the first-place policy instruments of local governments. Personal income taxes are set by the upper (central) level in the federation.
- (ii) *International tax competition*: Second, the jurisdictions may be interpreted as countries in an integrated economic environment with free capital mobility. The national governments' tax instruments are source-based taxes on the capital stock and on corporate income.<sup>3</sup> Households live outside the two countries such that both countries import capital. Personal taxes are levied according to the residence principle at the residence of the capital supplier.

In order to avoid abstract terminology we will in the sequel only use the first ("federal") of these interpretations and thus speak of local governments etc. Our results can, however, be readily transferred to the "international" setting.

The paper deals with the following issues:

- In our model only taxes at the firm level are set strategically whereas personal taxes are parametrically fixed. It will nevertheless turn out that the personal tax parameters strongly influence the governments' strategic decisions on corporate taxation. Thus, the results of a tax competition game cannot be attributed exclusively to the players of the game, but also to those agents who set the stage for the play. This calls for an integrated treatment of tax competition both on the levels of corporate and personal taxation.<sup>4</sup>

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<sup>3</sup> The profit tax in our model allows for the interpretations both as a tax on business profits and as a corporate income tax.

<sup>4</sup> The focus of our analysis is not on the question whether tax decisions should be centralized on the central level of government or whether they should be delegated to local authorities. It is well known

- In our model, the financial decisions of firms and portfolio choices of households endogenously depend on taxation. This yields new insights on two levels: first, we can analyse the impacts of local, source-based taxes on finance and investment decisions quite precisely. Second, we can show the strong repercussions of variable corporate capital structures on the strategic incentives governments.
- We analyse the strategic use both of profit and of capital taxes. This corresponds to the German system of local business taxation before 1998. Although at first sight it looks like a fiscal game with two strategy variables (such as in Bucovetsky/Wilson (1991) or Braid (1996)), we will show that profit and capital taxes are perfect substitutes in the sense that they offer identical strategic incentives and tax revenues to governments. I.e., one of the instruments is redundant. This has strong implications for a recent German policy debate on the abolition of one of the local business taxes (namely, the *Gewerbekapitalsteuer*).

The rest of the paper is organized as follows: Section 2 presents the model. Sections 3 and 4 examine the tax competition game with the capital tax and the profit tax, respectively. Section 5 shows that both taxes are perfect strategic substitutes for each other. Section 6 concludes.

The discussion in the main text will only deal with the case of small jurisdictions, i.e. with jurisdictions which do not influence the net rate of return on capital markets. In the Appendix we provide a brief survey on the case of non-price-taking jurisdictions where the equilibrium rate of return is formed endogenously on the capital market.

## **2. The model**

### **2.1 General structure**

We use a simple two-period-two-jurisdiction model of a capital market. The first period consists of two stages: in stage I, governments non-cooperatively choose their tax rates such as to maximize their tax revenues (this is the tax competition game). Given the tax rates, in stage II the capital market equilibrium (CME) is determined: consumers make their portfolio

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(see Gordon (1983) or Hansson/Stuart (1987)) that in the presence of externalities centralization is superior to decentralization. Our perspective is not that of allocational efficiency, but rather that of strategic incentives. For a combination of both issues see Kotsogiannis/Makris (1997).

decisions and firms decide on investment and capital structure. The financial instruments available to the firms are debt and equity. Consumers' portfolio choices are to be made between bonds and shares. In a CME, supply and demand must balance.

All events in period 2 are predetermined by period 1. Production takes place with capital as the only input. Firms sell their output, pay taxes, interests and dividends. Debt is repaid to creditors and the rest of the firms' value accrues to shareholders via liquidation. Governments collect taxes.

The two jurisdictions are labelled by  $A$  and  $B$ . The business sector in each jurisdiction is represented by a single corporate firm, also called  $A$  and  $B$ , respectively. There is a single representative consumer in the economy. We assume that neither of the jurisdictions can levy personal income taxes on the consumer; hence the consumer's place of residence is irrelevant for our considerations.

## 2.2 Production and capital structure

The business sector of each jurisdiction can be aggregated to one single-output firm. Output serves as the numéraire. The only input in each jurisdiction is capital  $K^i$  ( $i = A, B$ ). Technologies are represented by production functions  $F^i(K^i)$  which are thrice differentiable and exhibit strictly positive, but decreasing marginal returns  $F'_k(K^i)$ . Furthermore,  $F^i(0) = 0$  and  $\lim_{K^i \downarrow 0} F'_k(K^i) = +\infty$ . Capital can either be equity or debt financed. We assume that the physical stock results in a simple additive manner from the monetary terms equity  $E^i$  and bonds  $B^i$ :  $K^i = E^i + B^i$ .

- Each unit of debt bears an interest cost of  $r^i \geq 0$  ( $i = A, B$ ). In period 2 firm  $i$ 's bondholders receive an amount of  $(1+r^i) \cdot B^i$  in exchange for lending  $B^i$  in period 1. Debtholders do not exert any influence on corporate policy.
- Shareowners are claimants to the firms' net wealth, which depends on the profitability of the enterprise. We assume that equityholders are repaid their invested capital plus a

dividend  $d^i \in \mathfrak{R}$  per unit of stock. Hence, shareholders obtain a total amount of  $(1+d^i) \cdot E^i$  at the end of period 2. It is the corporation's policy to maximize dividends  $d^i$ .

### 2.3 Taxation

Taxation in our model is characterized by a separation between business and household levels. Whereas personal taxes are assumed to be fixed (set, depending on the interpretation of our model, at the national level or by the residence country of the household), business taxes are the strategy variables in the tax competition game. Each regional government can levy two different source-based taxes: a business profit tax (labelled by subscript  $p$ ) and a tax on the capital stock in its jurisdiction (subscript  $k$ ). Tax schedules exhibit constant average rates  $t_x^i$  for  $x = p, k$ . Let  $0 \leq t_p^i \leq \bar{t} < 1$  for the profit tax, with  $\bar{t}$  as an exogenous maximum tax rate.

With regard to personal income taxes we consider both a tax on dividend income with a constant average rate  $\tau_d$  and a tax on interest income at rate  $\tau_r$ . The two tax rates may be equal (as it is the legal norm in OECD countries) or unequal, revealing that personal taxation discriminates against different forms of capital income. The tax rates  $\tau_d$  and  $\tau_r$  are parameters. They nevertheless affect the strategic incentives in the tax competition game.

### 2.4 The investment and finance decisions of the firms

Firms aim at shareholder value maximization which in our settings means that they choose a combination of equity and bonds which allows for the maximum dividend payouts to shareholders. The dividend  $d^i$  to the shareholders of firm  $i$  per unit of stock is simply the return on equity:

$$d^i = \frac{\Pi^i - E^i}{E^i}$$

where  $\Pi^i$  denotes the distributed profits of firm  $i$ . They are given by:

$$\Pi^i = (1-t_p^i) \cdot [F^i(E^i + B^i) - \gamma^i \cdot r^i \cdot B^i - t_k^i \cdot (E^i + B^i)] - B^i \cdot [1 + (1-\gamma^i) \cdot r^i].$$



The term in the first square brackets is the tax base for the local business profit tax: It consists of the firm's sales revenues  $F^i(K^i)$  less a portion  $\gamma^i \in [0,1]$  of interest payments that can be offset from taxable business income in jurisdiction  $i$  and less the capital tax  $t_k^i \cdot K^i$  (we assume that this tax is fully deductible from the business tax).<sup>5</sup> The rest is the repayment and interest on the firm's borrowings. Collecting the respective terms, the total finance cost of one unit of debt amount to  $t_k^i + r^i \cdot (1 - t_p^i \cdot \gamma^i)$ .

If  $\gamma^i = 1$ , i.e., if interest payments are fully deductible from profit taxes, the profit tax comes close to a corporate income tax as it is used in a number of OECD countries. This tax has the property to discriminate against equity finance as it (c.p.) makes bonds the cheaper source of finance. With the other extreme of no interest deductibility ( $\gamma^i = 0$ ), the profit tax equally hits both kinds of finance. Partial interest deductibility (i.e. intermediate values  $\gamma^i \in ]0,1[$ ) are often used with local profit taxes (e.g. with the German *Gewerbeertragsteuer*). We allow the parameter  $\gamma^i$  to vary across jurisdictions. This enables us to assume that the value of  $\gamma^i$  is under the control of the governments which may be relevant for governments who can choose their accounting and reporting rules autonomously.

The firms' decisions are made subject to a constraint which forbids too high leverage. At most a share of  $\sigma^i \in ]0,1[$  of the firms investments can be debt financed:

$$B^i \leq \sigma^i \cdot K^i = \frac{\sigma^i}{1 - \sigma^i} \cdot E^i.$$

Assuming a financial restriction follows Sinn (1987) and drives a number of our results. It is a simple way to explain why in a world of certainty firms should choose a mixed capital structure (i.e., a combination of debt and equity finance). However, there also are non-technical motivations for such an assumption, ranging from credit rationing and legal restrictions to thumb rules of sound finance.

<sup>5</sup> The rate  $t_k^i$  is meant as an *effective* tax rate on business income. E.g., if the business tax itself were deductible from its own tax base, we would have  $t_k^i = \frac{\tilde{t}_k^i}{1 + \tilde{t}_k^i}$  where  $\tilde{t}_k^i$  is the formal tax rate.

We allow the financial constraint  $\sigma^i$  to vary with the location of the firm. As an example that (even local) governments can influence  $\sigma^i$  imagine that governments can give guarantees to banks that they will stand surety for firms in the case of financial emergency. This may induce creditors to accept a higher degree of leverage of these firms. As the capital allocation and hence the tax revenues of governments will vary with  $\gamma^i$  and  $\sigma^i$ , these parameters may as well be employed as strategy variables in a tax revenue maximizing fiscal competition. We will not discuss this issue here, however.<sup>6</sup>

Firm  $i$ 's optimization problem reads ( $i=A,B$ ):

$$\max_{E^i, B^i \geq 0} d^i \quad \text{s.t.} \quad B^i \leq \frac{\sigma^i}{1-\sigma^i} \cdot E^i.$$

From a standard Kuhn-Tucker approach we obtain the optimal decisions as follows:

**LEMMA 1:**

- If  $r^i \cdot (1-t_p^i \cdot \gamma^i) > d^i$ , then  $B^i = 0$ ,  $K^i = E^i$  and  $K^i$  satisfies  $d^i = (1-t_p^i) \cdot [F_k^i - t_k^i] - 1$ .
- If  $r^i \cdot (1-t_p^i \cdot \gamma^i) = d^i$ , then  $K^i$  satisfies  $d^i = (1-t_p^i) \cdot [F_k^i - t_k^i] - 1 = r^i \cdot (1-t_p^i \cdot \gamma^i)$  and the firm is indifferent between all capital structures satisfying  $B^i = K^i - E^i \leq \sigma^i \cdot K^i$ .
- If  $r^i \cdot (1-t_p^i \cdot \gamma^i) < d^i$ , then  $B^i = \sigma^i \cdot K^i$  and  $E^i = (1-\sigma^i) \cdot K^i$ .  $K^i$  satisfies

$$\sigma^i \cdot r^i \cdot (1-t_p^i \cdot \gamma^i) + (1-\sigma^i) \cdot d^i = (1-t_p^i) \cdot [F_k^i - t_k^i] - 1.$$

Lemma 1 reveals the role of the financial restriction  $\sigma^i$ : An unconstrained firm would follow a bang-bang strategy of finance: either completely equity- or completely credit-financed. For the indifference case b) in Lemma 1 we assume without loss of generality that the firm chooses its capital structure according to the rule  $B^i = \sigma^i \cdot K^i$ . Then firm  $i$ 's optimal financial decisions can be summarized as follows:

$$r^i \cdot (1-t_p^i \cdot \gamma^i) \begin{cases} > \\ \leq \end{cases} d^i \Leftrightarrow \begin{cases} B^i = 0, E^i = K^i > 0 \\ B^i = \sigma^i \cdot K^i = \frac{\sigma^i}{1-\sigma^i} \cdot E^i \end{cases}$$

<sup>6</sup> In a companion paper (Wagener (1997)) it is shown that, if it is at the governments' disposal, the financial constraint will be abolished in a tax competition equilibrium. With respect to the parameter of interest deductibility strategic governments will choose an intermediate value (neither zero nor unity).

## 2.5 Portfolio choices and the capital market equilibrium

Capital supply is assumed to be infinitely elastic at an exogenous riskless net rate of return  $\rho > 0$ . We thus assume that the jurisdictions under consideration are small in the sense that they do not exert any influence on capital market prices.

We assume that capital is supplied by households in the form of savings. Savings must be allocated to the four different assets of our model: stocks of firms  $A$  and  $B$  and bonds of the two firms. A share in company  $i$  yields a net return of  $d^i \cdot (1 - \tau_d)$  as compared to  $r^i \cdot (1 - \tau_r)$  per unit of bonds in  $i$ . Given a net rate of return  $\rho$  on (world) capital markets, households will only select those assets whose after-tax return (at least) equals  $\rho$ .

A situation is a *capital markets equilibrium* (CME) if demand equals supply for all assets, i.e., if the optimal amounts of equity and loan capital of the two firms are compatible with the portfolio decisions of the representative consumer. Given a tax vector  $\mathbf{t} := ((t_k^i, t_p^i)_{i=A,B}, \tau_r, \tau_d)$ , Lemma 2 describes the essential features in a CME.<sup>7</sup>

**LEMMA 2:** For  $i=A, B$  define:

$$\alpha^i := \frac{1}{\gamma^i} \cdot \frac{\tau_r - \tau_d}{1 - \tau_d}$$

and

$$\bar{\sigma}^i := \begin{cases} \sigma^i & \text{iff } t_p^i \geq \alpha^i \\ 0 & \text{else} \end{cases}$$

In a CME we have  $B^i = \bar{\sigma}^i \cdot K^i(\mathbf{t})$  and  $E^i = (1 - \bar{\sigma}^i) \cdot K^i(\mathbf{t})$  where  $K^i(\mathbf{t})$  uniquely solves:

$$\rho = \frac{F_k^i - t_k^i - \frac{1}{1 - t_p^i}}{\frac{\bar{\sigma}^i \cdot (1 - t_p^i \cdot \gamma)}{(1 - \tau_r) \cdot (1 - t_p^i)} + \frac{1 - \bar{\sigma}^i}{(1 - \tau_d) \cdot (1 - t_p^i)}} \quad (1)$$

**Proof:**

Assume that we are in a CME. Then for  $i=A, B$  either of the following two cases must hold:

<sup>7</sup> Note the striking similarity of (1) with the optimum condition derived in Sinn (1987, p. 106).

(i) Firm  $i$  is completely equity financed, i.e.,  $B^i = 0$ . Applying Lemma 1, part a), this is the case if  $d^i < (1 - t_p^i \cdot \gamma^i) \cdot r^i$ . Seen from the consumer's perspective,  $B^i = 0$  is only optimal if  $d^i \geq \frac{1 - \tau_r}{1 - \tau_d} \cdot r^i$ . Combining both conditions, it must be true that  $\frac{1 - \tau_r}{1 - \tau_d} < (1 - t_p^i \cdot \gamma^i)$  or  $t_p^i < \alpha^i$ .

As household portfolios contain shares we have  $\rho = d^i \cdot (1 - \tau_d)$ . Inserting this into the corresponding marginal condition of Lemma 1, part a), we obtain:

$$\rho = (1 - t_p^i) \cdot (1 - \tau_d) \cdot \left[ F_k^i - t_k^i - \frac{1}{1 - t_p^i} \right].$$

(ii) Firm  $i$  is leveraged. Following Lemma 1, part c), we thus must have  $d^i \geq (1 - t_p^i \cdot \gamma^i) \cdot r^i$ .

For a consumer to hold both equity and bonds of the same firm it is necessary that

$d^i = \frac{1 - \tau_r}{1 - \tau_d} \cdot r^i$ . Together, we obtain  $\frac{1 - \tau_r}{1 - \tau_d} \geq (1 - t_p^i \cdot \gamma^i)$  or  $t_p^i \geq \alpha^i$ . As both bonds and shares

are held in the portfolios, we have  $\rho = d^i \cdot (1 - \tau_d) = r^i \cdot (1 - \tau_r)$ . Inserting this in the marginal condition of Lemma 1, part c), we end up with the following equilibrium condition:

$$\rho = \frac{F_k^i - t_k^i - \frac{1}{1 - t_p^i}}{\frac{\sigma^i \cdot (1 - t_p^i \cdot \gamma^i)}{(1 - \tau_r) \cdot (1 - t_p^i)} + \frac{1 - \sigma^i}{(1 - \tau_d) \cdot (1 - t_p^i)}}.$$

Condition (1) simply packs cases (i) and (ii) to a single expression.

□

The functions  $K^i(\mathbf{t})$  describe equilibrium values for capital in  $i$  depending on the tax vector  $\mathbf{t}$ .

$\bar{\sigma}^i \in \{0, \sigma^i\}$  is the optimal debt-asset ratio of firm  $i$  (see Section 2.6 for further discussion).

Given our assumptions, the functions  $K^i$  implicitly defined in (1) are continuous in  $\mathbf{t}$ . They are, however, not differentiable at all places where the  $\bar{\sigma}^i$  switch from zero to  $\sigma^i$ . By implicit differentiation of (1) we obtain the comparative static effects of marginal tax changes in a CME as follows:<sup>8</sup>

<sup>8</sup> Whenever in the sequel the superscripts  $i$  and  $j$  occur in the same expression, we assume that  $i \neq j$ , unless explicitly stated otherwise. All partials in Lemma 3 are taken at differentiable points.

**LEMMA 3:**

Let  $x$  be a component of  $\mathbf{t}$  and define  $K_x^i = \frac{\partial K^i}{\partial x}$ . Then:

$$(i) \quad K_{t_p^i}^i = K_{t_k^i}^i \equiv 0.$$

$$(ii) \quad K_{t_p^i}^i = \frac{1}{F_{KK}^i \cdot (1-t_p^i)^2} \cdot \left( 1 + \rho \cdot \left[ \frac{\bar{\sigma}^i \cdot (1-\gamma)}{(1-\tau_r)} + \frac{1-\bar{\sigma}^i}{1-\tau_d} \right] \right) < 0.$$

$$(iii) \quad K_{t_k^i}^i = \frac{1}{F_{KK}^i} < 0.$$

Lemma 3 contains the effects of tax changes on the capital allocation. It can be seen from (i) that the other jurisdiction's tax choices do not affect the amount of capital in the own jurisdiction, and from (ii) and (iii) that increasing own tax rates will drive capital out of the jurisdiction.

## 2.6 Capital structure and taxation

Lemma 2 shows that the corporate capital structure in a CME depends on the local tax rate  $t_p^i$  and the parameter  $\alpha^i$  which incorporates the personal taxes and the possibilities of interest deduction. For government  $i$   $\alpha^i$  defines the scope for setting the profit tax rate  $t_p^i$  without driving firm  $i$  from a full equity finance into a leveraged capital structure. From firm  $i$ 's perspective it measures the cost advantage of equity finance over bond finance *before* local profit taxation.

1. If the personal taxes are such that  $\tau_r = \tau_d$  and hence  $\alpha^i = 0$ , then all firms have a mixed capital structure ( $\bar{\sigma}^i = \sigma^i$ ), regardless of the local tax choices. The same is true if personal taxes on interest income are lower than on dividends (for then  $\alpha^i < 0$ ).
2. If interest payments are non-deductible from the tax base of the profit tax in jurisdiction  $i$ , i.e., if  $\gamma^i = 0$  or  $|\alpha^i| \rightarrow \infty$ , then the sign of the difference between the two personal tax rates alone determines firm  $i$ 's capital structure, regardless of the tax rates  $t_p^i$ .
3. Governments  $A$  and  $B$  can influence the capital structure of the firms within their jurisdiction only if  $\tau_d < \tau_r$  and interest payments can at least partially be offset ( $\gamma^i > 0$ ). Then the value

of  $t_p^i$  determines whether firms use a mixed capital structure or are completely equity-financed.

(Even) With  $\tau_r = \tau_d$  the dominant financial pattern of firms in our model is a combination of equity and loan capital. This observation is mainly driven by two assumptions: first, the construction of the profit tax with the possibility of interest deduction makes equity the more expensive form of finance relative to bonds. Tax systems in our model (as well as in reality) discriminate against equity finance. Second, the financial constraint  $B^i \leq \bar{\sigma}^i \cdot K^i$  forces firms to issue some minimum portion of shares. Without this restriction, firms would prefer a 100% credit finance. Hence, the mixed capital structure of firms may be interpreted as the maximum avoidance of expensive equity finance.

Interestingly, there are cases where profit taxes determine the financial pattern of firms. This severe effect of profit taxes is sometimes neglected in the analysis of taxation and investment.

## 2.7 Tax revenues and the tax competition game

By  $T^i(\mathbf{t})$  we denote the tax revenues in jurisdiction  $i=A, B$  at a tax vector  $\mathbf{t}$ . As personal taxes accrue to some government outside our considerations, tax revenues of governments  $i = A, B$  only comprise the capital tax and the tax on business profits:

$$T^i(\mathbf{t}) = t_k^i \cdot K^i + t_p^i \cdot [F^i(K^i) - t_k^i \cdot K^i - \gamma^i \cdot r^i \cdot B^i]$$

Using the definition of the dividends

$$d^i = \frac{\Pi^i - E^i}{E^i} = \frac{1}{E^i} \cdot [(1 - t_p^i) \cdot (F^i(K^i) - t_k^i \cdot K^i - \gamma^i \cdot r^i \cdot B^i) - K^i - (1 - \gamma^i) \cdot r^i \cdot B^i]$$

and the CME properties

$$r^i = \frac{\rho}{1 - \tau_r}, \quad d^i = \frac{\rho}{1 - \tau_d}, \quad B^i = \bar{\sigma}^i \cdot K^i, \quad \text{and} \quad E^i = (1 - \bar{\sigma}^i) \cdot K^i,$$

we can rewrite tax revenues as

$$T^i(\mathbf{t}) = t_k^i \cdot K^i + \frac{t_p^i}{1 - t_p^i} \cdot \left[ 1 + \frac{1 - \bar{\sigma}^i}{1 - \tau_d} \cdot \rho + (1 - \gamma^i) \cdot \bar{\sigma}^i \cdot \frac{\rho}{1 - \tau_r} \right] \cdot K^i. \quad (2)$$

Local governments aim at maximizing their own tax revenues.<sup>9</sup> For the moment, their strategy variables are the tax rates  $t_p^i$  and  $t_k^i$  ( $i = A, B$ ). When deciding on tax rates, each government anticipates the changes its policies will induce in the allocation of capital (i.e., the comparative statics of Lemma 3). It takes as given the taxation decisions of the other government (Nash behaviour) and personal tax rates. The natural candidate for a solution of the tax competition game is the Nash equilibrium. As a yardstick for the evaluation of tax competition we use the concept of strict efficiency. A strictly efficient solution emerges if the governments collude and aim at joint revenue maximization (allowing for side payments).

### **3. Tax competition with taxes on the capital stock**

#### **3.1 Nash equilibrium and efficiency**

We start our analysis of interjurisdictional tax competition with the rather simple case of competition with taxes on the domestic capital stocks. We therefore exclude the profit tax from the analysis and fix  $t_p^i = 0$  for  $i = A, B$ . Revenue maximizing tax rates for government  $i$  can be found by solving:

$$\frac{\partial T^i}{\partial t_k^i} = K^i + t_k^i \cdot K_{t_k^i}^i = K^i + \frac{t_k^i}{F_{KK}^i} = 0. \quad (3)$$

where we used Lemma 3(iii) to calculate the marginal revenue impact of  $t_k^i$ . Eq. (3) implicitly defines government  $i$ 's best tax choices. We assume that they exist, lie in the interior of the strategy sets, and are unique. As the capital allocation in jurisdiction  $i$  is independent of the other jurisdiction's tax policies (cf. part (i) of Lemma 3), the solution of (3) is a dominant strategy.

<sup>9</sup> For other tax competition models using this objective function see Bond/Samuelson (1989), Sinn (1992), Kanbur/Keen (1993) or Schulze/Koch (1994).

**PROPOSITION 1:** Assume, for  $i=A, B$  the solutions to  $\frac{\partial T^i}{\partial t_k^i} = 0$  are unique and in the interior of the strategy spaces. Then there is a unique Nash equilibrium in dominant strategies. The Nash equilibrium is strictly efficient.

**Proof:**

Existence of a Nash equilibrium is trivial. In an interior Nash equilibrium we have  $\frac{\partial T^i}{\partial t_k^i} = 0$

and hence  $\frac{\partial (T^A + T^B)}{\partial t_k^i} = \frac{\partial T^i}{\partial t_k^i} = 0$ . Hence, the sum  $T^A + T^B$  which emerges in a Nash equilibrium cannot be increased any further.

Proposition 1 is standard: In a setting of small jurisdictions, decentralized policies lead to efficiency (see e.g. Razin/Sadka (1991)). The assumption of a constant rate of return closes the channel for interjurisdictional externalities which otherwise render decentralized optimization in a federation inefficient (this observation dates (at least) back to Oates (1972)). If  $\rho$  were not constant, but an endogenous rate of return to be determined by the interplay of capital demand and supply, spill-over effects of tax policies would prevail through the price channel and tax competition would result in inefficient (more precisely: inefficiently low) tax rates (see DePater/Myers (1992) for a discussion of this kind of *pecuniary* externality).

### 3.2 The influence of personal taxes

The allocation of capital in our model does not only depend on capital and profit tax rates, but also on the personal tax rates on dividend and interest income. It is therefore rather likely that personal tax rates exert influence on the strategic incentives in our setting of interjurisdictional tax competition. We will now demonstrate this for the case of fiscal competition with taxes on the capital stock. We obtain



**PROPOSITION 2:** Higher tax rates  $\tau_d$  or  $\tau_r$  at the personal level lead to a higher equilibrium rate  $t_k^i$  in the capital tax competition game if and only if

$$1 < -\frac{K^i \cdot F_{KKK}^i}{F_{KK}^i} < 2. \quad (4)$$

**Proof:**

Define  $\Phi^i := \frac{\bar{\sigma}^i}{1-\tau_r} + \frac{1-\bar{\sigma}^i}{1-\tau_d} \geq 1$  as a short cut for the denominator in eq. (1) when profit taxes

are absent. The parameter  $\Phi^i$  reflects the influence of personal taxation on the capital allocation and it is the greater, the higher are the personal tax rates  $\tau_r$  and  $\tau_d$ .

Jurisdiction  $i$ 's optimal tax choice is implicitly given by (3). Implicit differentiation and using the properties of the capital demand function yields:

$$\frac{\partial t_k^i}{\partial \Phi^i} = -\frac{K_{\Phi^i}^i - t_k^i \cdot \frac{K_{\Phi^i}^i F_{KKK}^i}{(F_{KK}^i)^2}}{K_{\Phi^i}^i - t_k^i \cdot \frac{K_{\Phi^i}^i F_{KKK}^i}{(F_{KK}^i)^2} + \frac{1}{F_{KK}^i}}$$

Use (1) to calculate that:

$$K_{\Phi^i}^i = \frac{\rho}{F_{KK}^i}$$

Hence, with Lemma 3:

$$\frac{\partial t_k^i}{\partial \Phi^i} = -\rho \cdot \frac{(F_{KK}^i)^2 - t_k^i \cdot F_{KKK}^i}{2 \cdot (F_{KK}^i)^2 - t_k^i \cdot F_{KKK}^i}$$

From (3) we know that in a Nash equilibrium  $t_k^i = -K^i \cdot F_{KK}^i$ . Thus:

$$\frac{\partial t_k^i}{\partial \Phi^i} \geq 0 \Leftrightarrow 1 \leq -\frac{K^i \cdot F_{KKK}^i}{F_{KK}^i} < 2.$$

Condition (4) is purely technological. If the production function violates (4), governments choose lower firm tax rates if personal taxes increase. Unfortunately, condition (4) can hardly be interpreted. One easily checks, however, that for quadratic production functions (with  $F_{KKK}^i = 0$ ) or functions of the type  $F^i(K^i) = (K^i)^{\beta^i}$  with  $0 < \beta^i < 1$  condition (4) can never be satisfied. It therefore seems likely that there is an inverse relationship between personal tax rates competitive capital tax rates. Put differently, higher (lower) personal taxes tend to sharpen (mitigate) capital tax competition in the sense that revenue maximizing local governments play a Nash equilibrium with lower (higher) tax rates on the capital stock.

By choosing appropriate tax rates, the personal tax authority (e.g., the federal government) can in a sense control the behaviour of the capital taxing governments (e.g., the local ones). In a two-tier federation the central government could be seen as a Stackelberg leader and the local governments as followers in an intergovernmental game (note, however, that the inverse casting is also possible). This may lead to a kind of non-cooperative fiscal federalism.

#### 4. Tax competition with profit taxes

We now turn to the case of interjurisdictional tax competition with the profit tax. This analysis is not as simple as the previous one, because the profit tax influences the capital structure of the local firms. *A fortiori*, the strategic incentives and the fiscal choices of the governments will turn out to depend even stronger on the personal tax parameters. To isolate the effects of the profit tax we choose  $t_k^A = t_k^B = 0$ . Tax revenues may then be rewritten as (see (2)):

$$T^i(\mathbf{t}) = \frac{t_p^i}{1-t_p^i} \cdot \frac{K^i(\mathbf{t})}{1-\tau_d} \cdot \left[ 1 - \tau_d + \rho \cdot \left( 1 - \bar{\sigma}^i \cdot \frac{(1-\alpha^i) \cdot \gamma^i}{1-\alpha^i \cdot \gamma^i} \right) \right] \quad (5)$$

Due to part (i) of Lemma 3 jurisdiction  $i$ 's tax revenues do again not depend on the other jurisdiction's profit tax rate  $t_p^j$ . We can therefore write  $T^i$  and  $K^i$  as functions of  $t_p^i$  only (ignoring the parameters  $\tau_r$  and  $\tau_d$  for a moment).

Eq. (5) reveals that tax revenues have a jump at  $t_p^i = \alpha^i$  when firms switch from a full equity finance to a leveraged capital structure. This causes a discontinuous fall in revenues for government  $i$  because now a part of the firm's cash-flow (namely the fraction  $\gamma^i$  of the interest payments) can be deducted from the profit tax base. For  $i=A,B$  we define the continuous part of tax revenues as:

$$H^i(t_p^i) := \frac{t_p^i}{1-t_p^i} \cdot \frac{K^i(t_p^i)}{1-\tau_d}$$

As  $\rho$  and  $K^i$  are continuous (but not everywhere differentiable) functions in  $t_p^i$ , the same is true for  $H^i$ . This is nearly everything we know about  $H^i$ . In order to give more structure on our problem, we make the following

**Assumption A:** For  $i = A, B$ , the functions  $H^i$  are strictly quasi-concave in  $t_p^i$  and have a unique interior maximum  $\hat{t}_p^i \in ]0, \bar{t}^i[$ .

Assumption A implies that tax revenues follow a Laffer-curve. We should hint that this assumption is very strong (see Malcolmson (1986) for a general discussion) and that we cannot give any economically reasonable conditions under which it is fulfilled.

Tax revenues now can be written as follows:

$$T^i(t_p^i) = \begin{cases} (1 - \tau_d + \rho) \cdot H^i(t_p^i) =: \hat{T}^i(t_p^i) & \text{iff } t_p^i < \alpha^i \\ \left(1 - \tau_d + \rho \cdot \left(1 - \sigma^i \cdot \frac{(1 - \alpha^i) \cdot \gamma^i}{1 - \alpha^i \cdot \gamma^i}\right)\right) \cdot H^i(t_p^i) =: \hat{\hat{T}}^i(t_p^i) & \text{else} \end{cases}$$

To get a better understanding, look at Figure 1.

< insert Figure 1 about here >

Tax revenues for government  $i$  are given by the upper of the two curves (i.e., by  $\hat{T}^i$ ) if firm  $i$  is purely equity-financed and by the lower curve (i.e., by  $\hat{\hat{T}}^i$ ) if firm  $i$  has a mixed capital structure.  $\hat{\hat{T}}^i$  is just a fixed fraction of  $\hat{T}^i$ , indicating that governments do better with full-equity firms than with leveraged ones.

Under Assumption A, both curves are of Laffer-type and have the same unique maximum at  $\hat{t}_p^i$ . Firm  $i$  is equity-financed (has a mixed capital structure) if  $t_p^i < (\geq) \alpha^i$ . Now let  $t_\alpha^i$  be the (smallest) value of  $t_p^i$  such that

$$(1 - \tau_d + \rho) \cdot H^i(t_\alpha^i) = \left(1 - \tau_d + \rho \cdot \left(1 - \sigma^i \cdot \frac{(1 - \alpha^i) \cdot \gamma^i}{1 - \alpha^i \cdot \gamma^i}\right)\right) \cdot H^i(\hat{t}_p^i)$$

(see Figure 1). The revenue maximizing tax choices are characterized by

**PROPOSITION 3:** Let Assumption A be satisfied. Then government  $i$  chooses

$$t_p^i = \begin{cases} \alpha^i - \varepsilon & \text{if } \alpha^i \in [t_\alpha^i, \hat{t}_p^i] \\ \hat{t}_p^i & \text{else} \end{cases}$$

where  $\varepsilon > 0$  is infinitely small.

It is obvious that the parameter  $\alpha^i$  which determines the scope for government  $i$ 's profit tax rate to prevent firms to switch to debt finance is of crucial importance to the profit tax choices. Three cases have to be considered (consult Figure 1 once more):

- (i)  $\alpha^i > \hat{t}_p^i$ : In this case it is optimal for government  $i$  to choose  $\hat{t}_p^i$ , i.e. the maximizer of  $H^i$ . This leads to fully equity financed firms.

- (ii)  $t'_\alpha \leq \alpha^i \leq \hat{t}'_p$ : In this case the government chooses the tax rate such that firms just remain fully equity financed (i.e.,  $t'_p = \alpha^i$ ). The government avoids the loss in revenues which will occur due to a switch in financial behaviour and the tax base narrowing through interest deductibility.
- (iii)  $\alpha^i < t'_\alpha$ : In this case it is again optimal for government  $i$  to choose  $\hat{t}'_p$ . Firms then have a mixed capital structure but the high tax rate more than offsets the revenue loss through interest deduction. As degenerate cases this includes all situations with  $\alpha^i \leq 0$  where firms are always leveraged and local governments are fixed to the lower curve in Figure 1.

Note that with OECD-type personal tax systems (i.e., with  $\alpha^i = 0$ ) and at least partial interest deductibility ( $\gamma^i > 0$ ), best responses are always given by  $\hat{t}'_p$ , because then local governments have no influence on the corporate capital structure and the discontinuity problems do not arise. The same is true if dividends are taxed more heavily than interest income (i.e.,  $\alpha^i < 0$ ).

Proposition 3 exhibits a non-monotonic and discontinuous relationship between personal taxation (as reflected in  $\alpha^i$ ) and revenue-maximizing local profit tax rates. Figure 2 illustrates this.

< insert Figure 2 about here >

As compared to the case of capital taxation (cf. Section 3.2) we find two differences. First, in the case of profit taxation the influence of personal taxes on Nash equilibrium tax rates is chiefly determined by the difference in the two tax rates  $\tau_r$  and  $\tau_d$  (recall that  $\alpha^i = \frac{1}{\gamma^i} \cdot \frac{\tau_r - \tau_d}{1 - \tau_d}$ ), whereas with capital tax competition the value of the Nash equilibrium tax rates varied with the absolute values of the two personal tax rates  $\tau_d$  and  $\tau_r$ . Second, the influence is neither continuous nor monotonic. Both peculiarities can of course attributed to the fact that, unlike the capital tax, the profit tax influences the firms' financial decisions.

As a tendency, revenue maximizing local governments try to induce a fully equity finance of their firms in order to prevent the tax base narrowing through interest deductibility. They show this behaviour even if the personal taxes discriminate against equity finance, which may be regarded as a kind of stylized fact in capital income taxation. Revenue maximizing profit taxation then contributes to eliminating this discrimination.

There is very little new to be said about tax competition in the actual scenario. With an exogenous rate of return, each government's revenues and thus optimal tax choices do not

depend on what the other government does. As there are no interjurisdictional externalities, we trivially obtain

**PROPOSITION 4:** The fiscal choices  $(t_p^A, t_p^B)$  made according to Proposition 3 are strictly efficient (i.e. jointly revenue maximizing).

We conclude this section with an interesting observation: Consider a federation where local governments only have tax *rate* sovereignty, but the tax base is codified in a federal law (as it is the case with the German local business tax). Hence,  $\gamma^A = \gamma^B$  and thus  $\alpha^A = \alpha^B = \alpha$ . Then one possible equilibrium configuration is  $(t_p^A, t_p^B) = (\alpha - \varepsilon, \alpha - \varepsilon)$ , i.e., both governments choose the same tax rate. This may even be true if jurisdictions are different with respect to production functions or financial constraints. Our model can thus explain a relatively low variance amongst local business taxes in spite of rather heterogenous jurisdictions. Generally, however, tax rates will differ across jurisdictions, and perhaps even induce different financial patterns of firms.

## **5. Capital taxes and profit taxes compared**

In a number of countries (local) governments levy taxes on the capital stock invested within their jurisdiction, in others they use local profit taxes, in some countries (such as Germany) both instruments are available. It is worthwhile to investigate the effects and incentives of these institutional arrangements. At first sight, capital and profit taxes seem to be quite different things and one would not expect any simple relation between (revenue maximizing) tax rates on these bases. Here we demonstrate that this intuition may be incorrect.

Suppose, both taxes are available as policy instruments. Then government  $i$ 's tax revenues are given by (2). The close relationship between profit and capital taxes becomes obvious from their marginal revenue impacts:

**LEMMA 4:** For  $i=A, B$ :

$$\frac{\partial T^i}{\partial t_p^i} = C^i(\mathbf{t}) \cdot \frac{\partial T^i}{\partial t_k^i}$$

$$\text{with } C^i(\mathbf{t}) := \frac{1 - \tau_d + \rho \cdot \left( 1 - \bar{\sigma}^i \cdot \frac{(1 - \alpha^i) \cdot \gamma^i}{1 - \alpha^i \cdot \gamma^i} \right)}{(1 - t_p^i)^2 \cdot (1 - \tau_d)} > 0.$$

**Proof:**

Use Lemma 3 to check that  $K_{t_p^i}^i = \frac{C^i(\mathbf{t})}{F_{KK}^i} = C^i(\mathbf{t}) \cdot K_{t_k^i}^i$ . Now calculate the partials of  $T^i$ .

Lemma 4 says that an increase in the capital tax rate leads to an increase in total tax revenues if and only if an increase in the profit tax rate increases tax revenues. The reason for this can be seen from tax revenues (2): Both capital tax and the profit tax revenues can in a CME be expressed as linear functions of  $K^i$ . The factors in front of  $K^i$  have the property to exactly compensate for the different partial effects of  $t_k^i$  and  $t_p^i$  on  $K^i$ .

Especially, Lemma 4 implies that:

$$\frac{\partial T^i}{\partial t_p^i} = 0 \Leftrightarrow \frac{\partial T^i}{\partial t_k^i} = 0.$$

I.e., if a government maximizes its tax revenues with respect to one of the taxes, then there is no scope for a revenue change through the other tax. Any increase in a tax rate will be (more than) offset by a decline in the tax base. We can summarize this in

**PROPOSITION 5:**

Profit taxes and capital taxes are perfect substitutes for each other in the sense that any change  $(d t_k^i, d t_p^i)$  in tax policies satisfying

$$d t_k^i = -C^i(\mathbf{t}) \cdot d t_p^i \quad (6)$$

is revenue neutral.

Hence, profit and capital taxes are interchangeable. It does not play any role whether governments are endowed with a profit tax, a capital tax or both as policy instruments; all institutional arrangements do equally well.

Note that the functions  $C^i(\mathbf{t})$  are discontinuous at  $t_p^i = \alpha^i$ , which must be taken into account when integrating the differential equation (6). For our special case of an exogenous net rate of return the functions  $C^i(\mathbf{t})$  do neither depend on  $t_k^i$  nor on  $\sigma^i$ ,  $t_k^i$  or  $t_p^i$ . We can therefore find an explicit solution of (6). Any pair  $(t_k^i, t_p^i)$  satisfying

$$t_k^i + \frac{t_p^i}{1-t_p^i} \cdot \left[ 1 + \frac{\rho}{1-\tau_d} \cdot \left( 1 - \bar{\sigma}^i \cdot \frac{(1-\alpha^i) \cdot \gamma^i}{1-\alpha^i \cdot \gamma^i} \right) \right] = const. \quad (7)$$

yields the same tax revenues ( $t_p^i \neq \alpha^i$ ). In particular, a profit tax at rate  $t_p^i = t_0 \in [0, \bar{t}]$  can be replaced by a tax on the capital stock at a rate of

$$t_k^i = \frac{1}{1-\tau_d} \cdot \int_0^{t_0} (1-t_p^i)^{-2} \cdot \left( 1-\tau_d + \rho \cdot \left( 1-\sigma^i \cdot \frac{(1-\alpha^i) \cdot \gamma^i}{1-\alpha^i \cdot \gamma^i} \right) \right) dt_p^i$$

or:

$$t_k^i = \begin{cases} \frac{t_0}{1-t_0} \cdot \frac{1-\tau_d + \rho}{1-\tau_d} & \text{if } t_0 \leq \alpha^i \\ \frac{t_0}{1-t_0} \cdot \frac{1-\tau_d + \rho}{1-\tau_d} + \frac{\rho \cdot \sigma^i}{1-\tau_d} \cdot \frac{1-\gamma^i}{1-\alpha^i \cdot \gamma^i} \cdot \left[ \frac{\alpha^i}{1-\alpha^i} - \frac{t_0}{1-t_0} \right] & \text{else} \end{cases}$$

without incurring a change in tax revenues.

Lemma 4 and Proposition 5 immediately carry over to interjurisdictional tax competition: If a pair  $(t_k^i, t_p^i)$  is a Nash equilibrium strategy for government  $i$ , then any pair constructed according to (6) is a Nash equilibrium strategy as well. Especially, there are Nash equilibrium strategies where one of the two tax rates is zero.

We should emphasize an important point: Two tax pairs yielding the same revenue do in general not lead to the same allocation of capital. They bring about different values of the  $K^i$  and of the equilibrium return  $\rho$  (supposed, this is endogenous). For the case of an exogenous rate of return this can easily be verified by inserting different tax pairs which all satisfy the equal revenue property (7) into the CME conditions given in Lemma 2. The resulting CME conditions will be different.

There is one prominent exception to this general rule. If interest is fully tax deductible ( $\gamma^i = 1$ ) and firms have full financial flexibility ( $\sigma^i = 1$ ) then  $C^i(t) = \frac{1}{(1-t_p^i)^2}$ . Hence, according to (7)

all pairs  $(t_k^i, t_p^i)$  with

$$t_k^i + \frac{t_p^i}{1-t_p^i} = \bar{a} = \text{const.} \quad (8)$$

are revenue equivalent. The respective CME condition is:

$$\rho = (1-\tau_r) \cdot \left[ F_K^i - t_k^i - \frac{1}{1-t_p^i} \right]$$

Replacing  $t_k^i$  according to (8) shows that the capital allocation does only depend on  $\bar{a}$ , but not on its components. We sum this up in

**PROPOSITION 6:** Suppose,  $\sigma^i = \gamma^i = 1$ . Then all pairs of taxes  $(t_k^i, t_p^i)$  satisfying (8) are strategically and allocationally equivalent.

Proposition 5 has a straightforward implication for a recent discussion in Germany: The federal government decided to abolish the local capital tax (so-called *Gewerbekapitalsteuer*). Seen against the light of our results, local governments can compensate for this loss by an appropriate increase in the local profit tax (the so-called *Gewerbeertragsteuer*). If additionally the conditions of Proposition 6 hold, this tax reform will leave the allocation of capital unchanged.<sup>10</sup>

## **6. Concluding remarks**

This paper aims at analysing the strategic incentives in different kinds of local business taxation. We focus on profit and capital taxes because they represent the tax instruments used most often in reality. The analysis differs from existing approaches in this area by incorporating a detailed (but still rudimentary) model of corporate finance and capital market equilibrium. We focussed on the case of small jurisdictions which take the equilibrium rate of return as exogenously given. This is probably appropriate if the jurisdictions are local communities. It may, however, no longer be appropriate in the "international" interpretation of our model when the competing agents are national governments. In the Appendix we show how this assumption can be relaxed to allow for an endogenous price formation in capital markets. Furthermore we explore whether analogous results to those derived in the text can also be obtained for the more general setting. Except for the fact that tax competition equilibria now become inefficient, it turns out that the central messages concerning the influence personal taxes on strategic business taxation and the "equivalence" of capital and profit taxes remain unaffected. This indicates a certain robustness of our results.

Two directions for further research follow directly from our main messages:

- The strategic incentives for business taxation depend to a great extent on decisions made on personal income taxes. These interdependencies call for an integrated treatment of

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<sup>10</sup> The allocational efficiency of profit and property taxes is in contrast to Richter (1991) where both kinds taxes are needed to implement an (efficient) allocation of capital.



corporate and personal tax competition (which may take place between different levels of government in a federation).

- In our model it turned out that, from a strategic viewpoint, capital and profit taxes are substitutes. An open question is whether this is a specific feature of the analysis presented here or whether such a result can also be established in more sophisticated models.

### **Appendix: The case of an endogenous rate of return**

Here we drop the assumption that jurisdictions are small and price-taking. Instead, we generalize the model to allow for endogenous price formation in the capital market and then briefly survey whether and to what extent our results have to be modified.

Price effects can be incorporated if one assumes that capital supply (i.e., household saving) is a weakly increasing function  $S$  of the net rate of return  $\rho$ :  $S = S(\rho)$  with  $S'(\rho) \geq 0$ . Note that this includes both the cases of a constant capital supply ( $S' \equiv 0$ ) and, in the limit, of an exogenous rate of return ( $S' \rightarrow \infty$ ) as discussed in the previous sections. The CME can then be derived as follows: With an endogenous rate  $\rho$  the functions  $K^i$  implicitly defined by (1) depend both on  $\rho$  and  $\mathbf{t}$ :  $K^i = K^i(\rho, \mathbf{t})$ . By implicit differentiation of (1) we obtain that capital demand (c.p.) decreases with the "price" of capital:

$$K_{\rho}^i := \frac{\partial K^i}{\partial \rho} = \left[ \frac{\bar{\sigma}^i \cdot (1 - t_p^i \cdot \gamma^i)}{(1 - \tau_r) \cdot (1 - t_p^i)} + \frac{1 - \bar{\sigma}^i}{(1 - \tau_d) \cdot (1 - t_p^i)} \right] \cdot (F_{KK}^i)^{-1} < 0.$$

In a CME the net rate of return has to be such that capital supply equals capital demand:

$$S(\rho) = K^A(\rho, \mathbf{t}) + K^B(\rho, \mathbf{t}).$$

Denote the solution of this equation by  $\rho(\mathbf{t})$ . Let  $x$  be a component of  $\mathbf{t}$ . Then the marginal effect of a change in  $x$  on  $\rho$  is given by:

$$\frac{\partial \rho}{\partial x} = \frac{K_x^A + K_x^B}{S' - K_{\rho}^A - K_{\rho}^B} < 0,$$

where the  $K_x^i$  are given by Lemma 3. The equilibrium values for the capital stocks in the two jurisdictions are given by

$$\tilde{K}^i(\mathbf{t}) := K^i(\rho(\mathbf{t}), \mathbf{t})$$

and comparative statics are obtained by

$$\tilde{K}_x^i := \frac{\partial \tilde{K}^i}{\partial x} = K_\rho^i \cdot \frac{\partial \rho}{\partial x} + K_x^i$$

for every component  $x$  of  $\mathbf{t}$ .

We can now pursue the analyses of Sections 3 to 5 with the only difference that  $K_x^i$  and  $\rho$  have to be replaced by  $\tilde{K}_x^i$  and  $\rho(\mathbf{t})$ , respectively. This replacement, however, is not without consequences. Especially, we now have interjurisdictional externalities: if jurisdiction  $j$  changes one of its tax rates  $t_p^j$  or  $t_k^j$  this affects capital stocks in jurisdiction  $i$ :

$$\tilde{K}_{t_p^j}^i = K_\rho^i \cdot \frac{\partial \rho}{\partial t_p^j} + K_{t_p^j}^i = K_\rho^i \cdot \frac{\partial \rho}{\partial t_p^j} > 0$$

(similarly for  $t_k^j$ ). This also affects strategic incentives in the tax competition game. Without going into detail (see Wagener (1997)) we informally list how our results of the main text have to be modified:

**Proposition 1:** Nash equilibria in the capital tax game are no longer in dominant strategies. In a Nash equilibrium tax rates are inefficiently low.

**Proposition 2:** There is no analogous result for the case of an endogenous rate of return.

**Proposition 3:** Figure 1 must be modified in so far as the maximizer of the lower Laffer curve now lies to the right of the maximizer of the upper one. Qualitatively, this does not change too much. Especially the non-monotonic and discontinuous influence of personal taxes on Nash profit taxes remains valid.

**Proposition 4:** Nash equilibria in the profit tax game are no longer in dominant strategies. In a Nash equilibrium tax rates are inefficiently low.

**Lemma 4:** Surprisingly, this result remains unchanged.

**Proposition 5:** Consequently, this result does not change either.

**Proposition 6:** Even this result holds independently of the variability of  $\rho$ .

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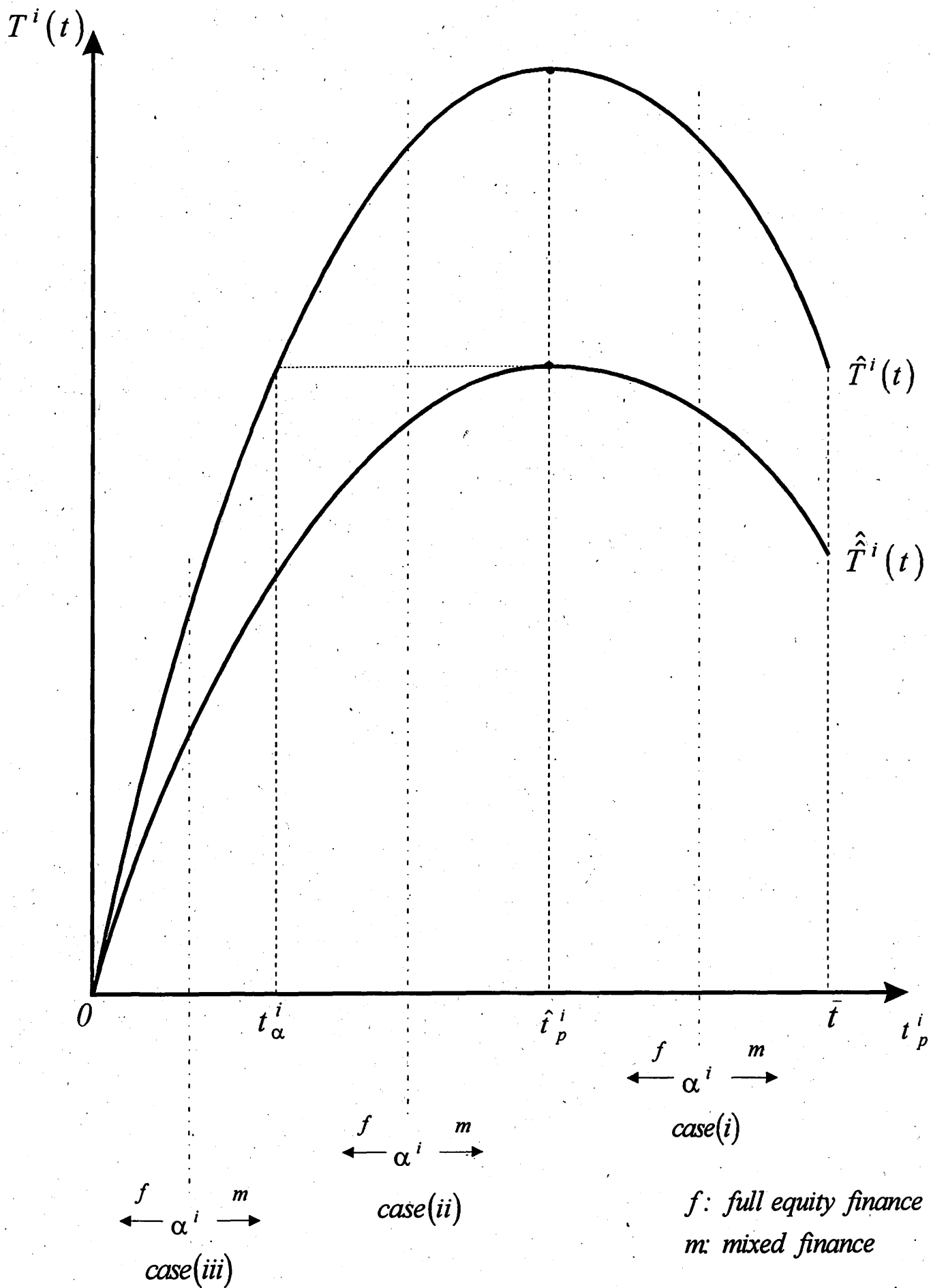


Figure 1

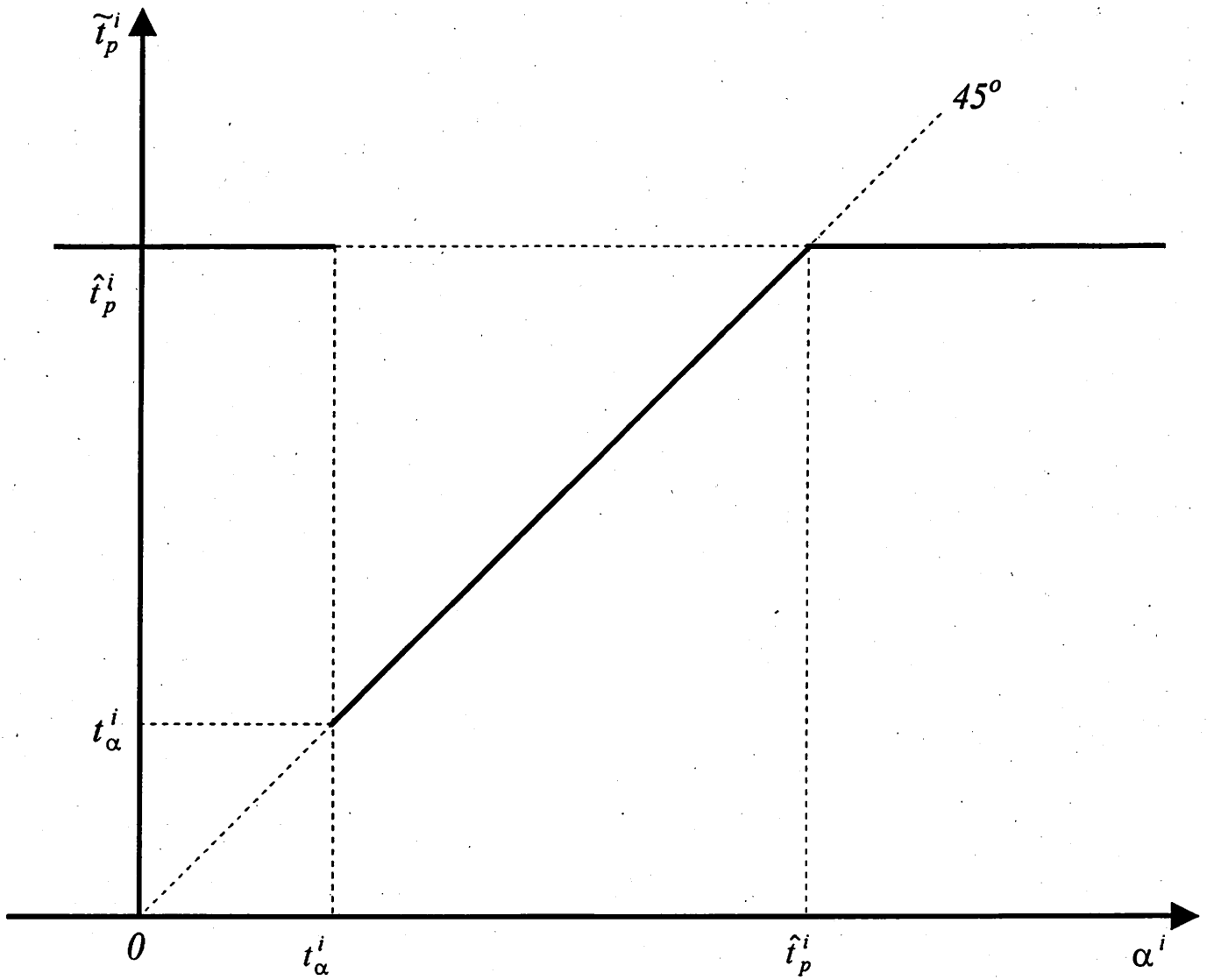


Figure 2

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- 16-90 **Klaus Schöler**, Konsistente konjekturale Reaktionen in einem zweidimensionalen räumlichen Wettbewerbsmarkt
- 17-90 **Rüdiger Pethig**, International Environmental Policy and Enforcement Deficits
- 18-91 **Rüdiger Pethig and Klaus Fiedler**, Efficient Pricing of Drinking Water
- 19-91 **Klaus Schöler**, Konsistente konjekturale Reaktionen und Marktstrukturen in einem räumlichen Oligopol
- 20-91 **Axel A. Weber**, Stochastic Process Switching and Intervention in Exchange Rate Target Zones: Empirical Evidence from the EMS
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- 28-92 **Jürgen Ehlgén**, Lösen des stochastischen Wachstumsmodells durch Parameterisieren der Entscheidungsfunktion
- 29-92 **Alfred W. Marusev und Andreas Pfungsten**, Zur arbitragefreien Fortrechnung von Zinsstruktur-Kurven
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- 32-92 **Günter Knieps and Rüdiger Pethig**, Uncertainty, Capacity Costs and Competition in the Electric Power Industry
- 33-92 **Walter Buhr**, Regional Economic Growth by Policy-Induced Capital Flows: I. Theoretical Approach
- 34-92 **Walter Buhr**, Regional Economic Growth by Policy-Induced Capital Flows: II. Policy Simulation Results

- 35-92 **Andreas Pfingsten and Reiner Wolff, Endowment Changes in Economic Equilibrium: The Dutch Disease Revisited**
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