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**International Tax Competition
A Federal Approach**

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Introduction

Motivation

The international integration of factor and commodity markets implies that national authorities are increasingly affected by policy measures of other countries. National governments' policy making can no longer be seen in isolation. A policy reform in one country is likely to induce policy reforms in other countries, which in turn affect the welfare in the first country. Given the policy interdependence, each country competes with its social security, redistribution, regulation as well as tax systems for mobile resources. Thus, the growing concern by economists about the benefits and costs of system competition is not surprising.¹ One aspect of system competition which has received a lot of attention in the empirical and theoretical literature is capital tax competition. Under this form of tax competition governments try to attract mobile capital by reducing tax rates. The theoretical predictions seem to be empirically confirmed by recent capital tax reforms in most industrial countries which resulted in lower capital tax rates.² Besides increasing investments by domestic firms the main motivation for these tax cuts is to attract foreign direct investments. Following the theoretical and empirical research economists and politicians have advocated harmonization, or at least coordination measures, in the field of capital taxation to avoid a "race to the bottom".³

¹Among many others, see, e.g., Siebert and Knoop (1993) and Sinn (1998) for an analysis of system competition.

²For instance, from 1985 to 1995 Sweden reduced the corporate tax rate from 57% to 28%, Norway from 51% to 28%, and France from 50% to 33.33% [Tanzi (1998)]. Germany followed almost the same pattern. From 1985 to 1995 the corporate tax rate was lowered from 56% on retained and 36% on distributed earnings to 45% and 30%, respectively. The latest tax reform in Germany reduced both tax rates to a common rate of 25%.

³For instance, these policy measures have been advocated by Sinn (1990) and Cnossen and Bovenberg (1997).

So far, most of the literature analyzes the desirability and feasibility of tax coordination within a system of independent countries thereby abstracting from the institutional setting of fiscal federalism. However, many states have a federal structure which, in principle, does not leave the costs and benefits of tax coordination unaffected. Therefore, the present study deals with the issue of whether the potential gains of tax coordination can be realized in a federal system. It adopts a theoretical approach to this issue and, thereby, does not contribute to the empirical literature on capital tax competition.

Model

Throughout the analysis the capital tax competition model introduced by Zodrow and Mieszkowski (1986) serves as a point of departure.⁴ The basic assumptions of this model are source-based capital taxation, perfect capital mobility, and benevolent governments. Since these are crucial for the subsequent analysis, the next paragraphs provide a discussion of the assumptions and relates them to the existing literature on tax competition.

Source-Based Capital Taxation The two extreme forms of international capital taxation are source-based and residence-based capital taxation. Under the former, capital is taxed where it is generated, whereas under the latter capital taxation occurs in the country where the owner of the capital resides. Examined from the point of view of efficiency the residence-based system is superior to the source-based system.⁵ However, the efficiency criterion is not the only one relevant for practical tax policy. In particular, it is the administrative costs which receive attention in the policy-oriented literature on capital taxation. Since capital markets become more integrated, capital mobility imposes restrictions on the ability of the national tax authorities to tax capital income. If capital income is taxed on a residence basis, national tax authorities must have information on both domestic and foreign capital income. However, the latter is difficult to observe for national tax authorities. The implementation of the capital tax system according to the world income principle requires an information exchange among tax authorities concerning foreign capital income. The necessity of a World Tax Organization responsible for information

⁴An overview on the literature on tax competition is presented in Oates (1999).

⁵See, e.g., Mintz and Tulkens (1996).

exchange has been pointed out by Tanzi (1998). Up to now, such an institution has not been established, and it is highly questionable if it will ever become a realistic policy option.⁶ Given the difficulties in administering a residence-based capital tax system, countries rely on source-based capital tax systems as well.

Capital Mobility The assumption of perfect capital mobility is a standard feature in the tax competition literature. However, most of the literature on capital tax competition assumes rather than explains perfect capital mobility.

From an empirical point of view, the assumption of perfect capital mobility has been heavily criticized. Feldstein and Horioka (1980) report that capital is quite immobile internationally. In their empirical study, they examine the correlation between national savings and investment across 16 OECD countries over the period 1960-1974.⁷ In a closed economy savings equals investment. In an open economy this relation is not expected to hold because, due to international capital flows, additional national savings does not necessarily increase national investment. Therefore, the correlation should be very low with perfect capital mobility. The empirical findings, however, suggest a relatively high correlation indicating low capital mobility.⁸ This result, which has become known as the Feldstein-Horioka-Puzzle, has been confirmed, e.g., by Penati and Dooley (1984) and Bayoumi (1990).

From a methodological point of view, the finding has been criticized as it does not account for the so-called endogeneity problem. This means that some determinants influence national savings and investment simultaneously and in the same direction. For instance, one of these endogenous mechanisms is the current account solvency.⁹ Hence, a perfect correlation between national savings and national investment cannot be interpreted as an indicator for capital immobility. A high correlation does

⁶For a discussion of the legal, technical, as well as political constraints of a world-wide information exchange among tax authorities see Tanzi (1995, 1998).

⁷To be more precise, Feldstein and Horioka related the ratio of national saving to GDP (S/Y) to the ratio of national investment to GDP (I/Y) by estimating the equation

$$(I/Y)_t = \alpha + \beta(S/Y)_t + \epsilon_t$$

with ϵ as an error term.

⁸The estimated β coefficient is 0.89 with a standard error of 0.07 and $R^2 = 0.91$.

⁹Coakley and Kulasi (1997) argue that a high correlation is implied by the current account solvency condition. In the short run, current account imbalances are possible resulting from capital mobility. But in the long run the solvency condition must hold.

not reveal any information about the degree of capital mobility. Analogously, a low correlation between savings and investment is a sufficient condition for capital mobility.¹⁰

Recent papers take the endogenous relation between savings and investment into account. However, the empirical results do not provide a clear answer. For instance, Hussein (1998) analyzes international capital mobility over 23 OECD countries from 1960 to 1993. He shows that the hypothesis of capital immobility can be rejected for most countries under consideration when controlling for the endogeneity problem. The empirical findings support the hypothesis of capital immobility in the last 30 years for only a few of the countries examined.¹¹ In contrast, Coakley and Kulasi (1997) find a correlation between national savings and investment. However, the correlation is interpreted as an indicator for current account solvency rather than for capital immobility.¹² In sum, the empirical findings do not suggest perfect capital mobility. A low capital mobility in turn can be concluded from the empirical findings, neither.

Based on this controversy, Gordon and Bovenberg (1994, 1996) and Razin, Sadka, and Yuen (1998) construct a model to explain imperfect capital mobility. They use a two-period model of a small capital-importing country (henceforth domestic country). National output depends on capital input and a random productivity factor. Domestic investors learn of the realization of the stochastic parameter prior to investment. Hence, their investment decision is made under full information and is not changed relative to previous models. Foreign investors learn of the realization of the parameter after their investment decision is made. The only piece of information they have is the probability distribution of the random productivity parameter. The authors find that foreign investors are overcharged for their domestic investments due to asymmetric information. The resulting equilibrium capital allocation is inefficient as the domestic marginal productivity is not driven down to the world rate of interest. Additionally, the model implies real interest rate differentials across

¹⁰Alternatively, Sachsida and Abi-Ramia Caetano (2000) demonstrate that the Feldstein-Horioka approach measures the substitutability between external and domestic savings rather than international capital mobility.

¹¹According to Hussein (1998) one possible explanation for this result is that capital inflows and outflows just cancelled out.

¹²Sinn (1992a) and Bayoumi and Rose (1993) analyze the investment-savings correlation using regional data since the current account solvency mechanism is not present among regions within a nation. Their estimates indicate a low correlation suggesting a high degree of capital mobility.

countries. The latter theoretical finding is consistent with empirical regularities presented in Frenkel, Razin, and Sadka (1991) and provide an endogenous explanation of imperfect capital mobility. In the subsequent analysis investors have perfect information. Therefore, given the information symmetry and the absence of capital control mechanisms, there is no reason (at least on theoretical grounds) to assume imperfect capital mobility.

Benevolent Governments The issue of tax competition can be tackled by either adopting the neoclassical or public choice perspective.¹³ The neoclassical approach assumes governments which maximize social welfare. With benevolent governments tax competition only causes distortions in the tax systems and policy coordination is proposed as a policy remedy.

Advocates of the public choice approach assume that this assumption is in error. They assume that politicians have a private agenda and determine tax policy to serve their own rather than the citizen's interest. In general, the public choice approach analyzes the design of institutional arrangements in which governments act and set taxes. Following Brennan and Buchanan (1980) the institutional environment has to be chosen so as to provide politicians with sufficient incentives to reduce wasteful activities.

As pointed out, e.g., by Sinn (1992b), tax competition is one appropriate institutional setting to tame the Leviathan behavior of governments. Tax competition counteracts the distortions caused by politicians themselves. Now, tax coordination loses its desirable properties since it is equivalent to a fiscal cartelization of self-serving politicians. For this reason, advocates of the public choice approach reject any form of tax coordination.

In the following, the neoclassical approach to tax competition is pursued. Thus, given the inefficiency of this institutional setting the aim of the subsequent models is to analyze whether the negative effects of tax competition can be mitigated in a federal economy.

Organization

The analysis is organized into three chapters.

¹³See, e.g., Frey and Eichenberger (1996) for a discussion of these two approaches.

Chapter 1 Chapter 1 introduces the basic capital tax competition model as elaborated by Zodrow and Mieszkowski (1986) and extends basic capital tax competition in various ways. First, besides a source-based capital tax the government is allowed to use a labor income tax. Furthermore, the symmetry assumption is dropped in two ways. First, regions are allowed to differ with respect to their factor endowments and, second, they are asymmetric with respect to their preferences for public goods. Finally, the implications of household mobility are considered.

Chapter 2 In chapter 2, in addition to the regional level a central level is introduced into the basic tax competition model. The rationale for this extension is to analyze whether the inefficiency of decentralized capital taxation can be offset by providing unconditional grants to the regions. In contrast to the existing literature the issue is tackled in a federal system with capital taxation at the lower and labor taxation at the upper levels of government. The analysis allows for Nash behavior at both levels of government and for Stackelberg behavior by the regional or central government.

Chapter 3 In chapter 3 the efficiency effects of tax coordination are discussed. Two forms of tax coordination are considered. First, capital taxation still occurs at the regional level. In this case, tax coordination is modeled by a coordinated increase in the capital tax rate. Special attention is paid to capital tax coordination among regions with different preferences for public goods since this institutional setting is largely unexplored. Second, capital taxes are reassigned to a central government. However, following Oates (1972) the central level is imperfectly informed about regional preferences for local public goods and, thus, tax coordination may be restricted by asymmetric information. Additionally, tax coordination takes place under full and no commitment by the central government. In particular, the latter assumption on commitment has not received much attention in the literature on public finance in federal systems thus far.

The main results are summarized at the end of each chapter and some concluding remarks are presented at the end of the study.

Chapter 1

Tax Competition Model

In this chapter, the basic capital tax competition model is presented. The model is static as it is the perceived distortionary character of source-based capital taxation which is of interest in the subsequent analysis. This effect in turn can already be analyzed within the simpler static framework.¹ The chapter is organized as follows. Section 1.1 develops the model. This is done in a rigorous fashion as the analysis in the subsequent chapters employs the same standard tax competition model as a point of departure. Extensions of the basic framework are presented in section 1.2. Subsection 1.2.1 explores the implication of capital tax competition if, besides a source-based capital tax, a labor tax is available to the local government. Moreover, the assumption of symmetric regions is dropped in subsections 1.2.2 and 1.2.3. Specifically, regions are allowed to be asymmetric in two respects. First, regions differ with respect to their factor endowment in subsection 1.2.2. Additionally, the impact of preference differences among regions on capital tax competition is considered in subsection 1.2.3. Finally, the basic tax competition model is extended by allowing for household mobility in addition to capital mobility. This analysis is presented in subsection 1.2.4. Section 1.3 summarizes the main theoretical findings of this chapter.

¹For an analysis of tax competition models in a two-period framework see, e.g. Gordon (1986), Razin and Sadka (1991), Bucovetsky and Wilson (1991), and Hoyt and Toma (1991). Tax competition models in continuous time are presented, e.g., in Razin and Yuen (1999) and Wildasin (1999). See also Dixit (1985) for an overview on tax policy in open economies.

1.1 Basic Model

The basic capital tax competition model, as modeled in Zodrow and Mieszkowski (1986) and Wilson (1986), consists of n symmetric regions. Due to perfect capital mobility and the restriction to a source-based capital tax, all regions are engaged in capital tax competition.² However, before turning to the implications of capital tax competition for the efficiency of resource allocation, the private and public sector of the economy have to be modeled first.

1.1.1 Private Sector

The private sector of each region is given by a representative household and a representative firm.

Household Households derive utility of the consumption of a private good c and a public good g . Preferences are given by the concave utility function $u = u(c, g)$, which exhibits positive and declining marginal utility $\partial u / \partial c \equiv u_c$ and $\partial u / \partial g \equiv u_g$, respectively.³ Private consumption is equal to the household's income I , which can be decomposed into capital and non-capital income. Due to the static character of the model and, hence, the absence of a savings decision, capital supply is exogenously determined at the level \tilde{k} . The household receives a rate of return on capital given by r . In addition to capital income the second source of income is due to the supply of a fixed factor and is denoted by I_f . The fixed factor may be land or an exogenous labor supply. Therefore, total income is given by

$$I = I_f + r\tilde{k}. \quad (1.1)$$

In this simple framework the household has no decision variable at hand as (i) factor supply is fixed, (ii) public goods are provided by the local government, and (iii) total income can only be spent on one private consumption good. For this reason, a household's optimization problem does not have to be solved and the direct utility function coincides with the indirect utility function.

Firm Output x is produced using capital and the fixed factor as inputs. The production function is given by $x = f(k, l)$ where k denotes capital input and l

²Capital tax competition in the presence of imperfect capital mobility is presented in Lee (1997).

³In all subsequent chapters partial derivatives are denoted by subscripts.

the fixed factor. The technology exhibits constant returns to scale, is concave, and possesses the usual properties: $\partial f/\partial k \equiv f_k > 0$, $\partial f/\partial l \equiv f_l > 0$, $\partial^2 f/\partial k^2 \equiv f_{kk} < 0$, $\partial^2 f/\partial l^2 \equiv f_{ll} < 0$, and $\partial^2 f/\partial k\partial l = \partial^2 f/\partial l\partial k \equiv f_{kl}$. The regional government imposes a source-based capital tax at a rate t . Therefore, the producer price of capital is the sum of the interest rate r and the tax rate t . The price per unit of the fixed factor employed in production is w . The firm chooses input levels in order to maximize profit π . Thus, the profit maximizing input choices can be derived by solving

$$\max_{k,l} \pi = f(k, l) - (r + t)k - wl, \quad (1.2)$$

which yields the first order conditions

$$(k) : f_k = r + t \quad \text{and} \quad (l) : f_l = w. \quad (1.3)$$

Eq. (1.3) implicitly defines capital demand k and fixed factor demand l as a function of $r + t$ and w .

Market equilibrium In this simple economy there are n fixed factor markets and, due to perfect capital mobility, one world capital market. Equilibrium in national fixed factor markets is determined by the fixed factor demand function and the fixed factor supply. Therefore, in these markets a change in fixed factor demand only leads to an adjustment of the price w . By construction, the equilibrium quantity, however, is unaffected.

Regions supply their capital stock in the world capital market which is allocated across regions according to the return on capital. Perfect capital mobility and arbitrage behavior implies that in equilibrium capital earns the same rate of return r in each country. As countries are endowed with the same amount of capital \tilde{k} , total capital supply is $n\tilde{k}$. Thus, the capital market equilibrium is characterized by the capital market clearing condition

$$n\tilde{k} = \sum_{i=1}^n k^i, \quad (1.4)$$

where national capital demand k^i is implicitly defined by the first-order condition

$$f_k^i = r + t^i, \quad i = 1, \dots, n. \quad (1.5)$$

The characterization of the capital market equilibrium does not require national fixed factor markets. Thus, the national fixed factor market clearing condition and

the first-order condition $f_l = w$ can be neglected. As noted above the equilibrium amount is exogenous and identical in all countries. Hence, differences in the marginal productivity of capital, f_k^i , can only be attributed to different national tax rates, t^i , and not to the fixed factor.

For the subsequent analysis it is necessary to derive the impact of a single region's marginal increase in the capital tax rate on the international allocation of capital and the world interest rate r . The response of r , k^i , and k^j due to a marginal increase in the tax rate t^i can be obtained by differentiating Eqs. (1.4) and (1.5) with respect to r , k^i , k^j and t^i .

In what follows attention is confined to symmetric equilibria, i.e. $k^i = k^j$ and $f_{kk}^i = f_{kk}^j$. Hence, the responses are given by

$$\frac{\partial k^i}{\partial t^i} = \frac{n-1}{n} \frac{1}{f_{kk}}, \quad i = 1, \dots, n \quad (1.6)$$

$$\frac{\partial k^j}{\partial t^i} = -\frac{1}{n} \frac{1}{f_{kk}}, \quad i, j = 1, \dots, n, \quad i \neq j \quad (1.7)$$

$$\frac{\partial r}{\partial t^i} = -\frac{1}{n}, \quad i = 1, \dots, n \quad (1.8)$$

(for a derivation see appendix A.1 at the end of this chapter). The equations reveal that the capital reaction and the interest rate reaction depend on the total number of regions n . For the subsequent analysis it proves useful to illustrate the influence of n on the slope of the reaction functions in more detail. Starting with Eq. (1.8), $n = 1$ implies $\frac{\partial r}{\partial t^i} = -1$. In an economy with only one region the source-based capital tax base is identical to capital endowment \tilde{k} . By assumption the regional capital stock is fixed and, hence, cannot react to capital taxation. Therefore, the firm is able to shift the whole tax burden on the household by raising the interest rate proportionally to the rise in the capital tax rate. However, for a finite n and $n \geq 2$, the source-based capital tax base may differ from the region's capital endowment. Now, the capital supplier can react to the region's capital tax rate by allocating its capital endowment to foreign regions with a more favorable tax treatment. Put differently, a rise in the capital tax rate above the level of other regions causes an outflow of capital. The firm is no longer able to shift the total tax burden on the household. Therefore, if n is finite and $n \geq 2$, Eq. (1.8) implies $-1 < \frac{\partial r}{\partial t^i} < 0$. If $n \rightarrow \infty$, the change in the world interest rate approaches zero, i.e. $\frac{\partial r}{\partial t^i} \rightarrow 0$. This reflects the fact that regions are small relative to the rest of the world and, consequently, have no market power. From the perspective of each region the region's capital supply

function is infinitely elastic. Hence, the region's tax policy no longer exerts any influence on the world interest rate.

The impact of the number of regions on the response of capital demand to tax rate changes can analogously be derived. For $n = 1$ Eq. (1.6) reduces to $\frac{\partial k^i}{\partial t^i} = 0$. However, for larger values of n , $\frac{\partial k^i}{\partial t^i}$ rises in absolute terms. That is, the higher the number of regions n the more intense capital demand reacts to a marginal increase in the capital tax rate. The response becomes greatest in absolute terms for $n \rightarrow \infty$. In this case $\frac{\partial k^i}{\partial t^i}$ approaches $\frac{1}{f_{kk}}$.

The magnitude of $\frac{\partial k^i}{\partial t^i}$ is inversely related to the magnitude of $\frac{\partial r}{\partial t^i}$. Recall, if $n = 1$, capital employment k^i equals capital endowment \tilde{k} . Consequently, capital demand does not react to a change in tax policy. $\frac{\partial r}{\partial t^i}$ in turn becomes largest in absolute terms. With $n > 1$ the region is no longer a closed economy. Capital employment reacts to tax rate changes. With an increasing n the response of $\frac{\partial k^i}{\partial t^i}$ increases whereas the reaction of $\frac{\partial r}{\partial t^i}$ becomes smaller reflecting reduced market power.

1.1.2 Government

In this subsection it is analyzed how regional governments choose their policy variables and how the policy outcome can be characterized in terms of efficiency. The first part of the subsection is devoted to the derivation of efficiency conditions whereas the second part characterizes the efficiency of decentralized government behavior.

Efficiency Due to the fixity of the immobile factor and the absence of a savings decision the international allocation of capital is the only endogenous factor allocation which can be evaluated in terms of efficiency. An efficient allocation of capital is achieved if a reallocation of capital cannot increase the sum of national output. Hence, the efficiency condition for the international allocation of capital is given by

$$f_k^i = f_k^j, \quad i, j = 1, \dots, n, \quad i \neq j. \quad (1.9)$$

An illustration of condition (1.9) is provided in figure 1.1. The figure shows the world capital market equilibrium for the case $n = 2$. The horizontal axis depicts the amount of capital employed in region 1. The highest value k^1 can take is the world capital supply $2\tilde{k}$. Graphically, capital input in region 2 is thus given by the difference between the equilibrium level of k^1 (any given point on the horizontal axis)

and $2\tilde{k}$. For simplicity, the marginal productivity of capital curves, f_k^i , are assumed to be linear. First, an economy without capital taxation is considered. In this case, the capital market equilibrium, characterized by Eqs. (1.4) and (1.5), is given by point A , where the marginal productivity of capital curves intersect. The resulting regional capital choice is k_0^1 and k_0^2 , respectively. Moreover, due to the symmetry assumption capital input in both regions is identical $k_0^1 = k_0^2$ and the world capital interest rate is r_0 . In this equilibrium the efficiency condition for the international allocation of capital is fulfilled, i.e. a reallocation of capital between regions cannot increase the sum of regional output which is given by the area $E0k_0^1A + H(2\tilde{k})k_0^2A$. Now, consider a situation in which capital is only taxed in region 1. Equivalently, one could allow for capital taxation in both regions with $t^1 > t^2$. The net-of-tax marginal capital productivity curve, which is relevant for capital demand in region 1, is given by $f_k^1 - t^1$. As implied by conditions (1.4) and (1.5) the capital market equilibrium is at point B . Capital input in region 1 decreases from k_0^1 to k_1^1 and, correspondingly, k^2 increases by the same amount. Due to capital taxation in region 1 the marginal productivity of capital in regions 1 and 2 are not equated in the equilibrium. Specifically, $f_k^1 > f_k^2$ which enables an increase in world output by reallocating capital from region 2 to region 1 until $f_k^1 = f_k^2$. To see this graphically, note that the change of the interregional capital allocation reduces output in region 1 by the area $CAk_0^1k_1^1$ and increases output in region 2 by the area $BAk_0^1k_1^1$. The resulting loss of world output is illustrated by the triangle ABC .

As a second point of reference, the allocation of national output between private and public goods is characterized in terms of efficiency. The condition for an efficient allocation of private and public goods is given by the well-known Samuelson rule. In its general form the Samuelson rule states that the sum of the marginal rates of substitution between private and public goods over all individuals should be equal to the marginal rate of transformation between private and public goods. In the basic tax competition model local governments provide a local public good which is solely consumed by the representative consumer. Additionally, by assumption, the national output can be transformed on a one-to-one basis either in a private or a public good. Therefore, the Samuelson rule adjusted to the model under consideration is simply

$$\frac{u_g}{u_c} = 1. \tag{1.10}$$

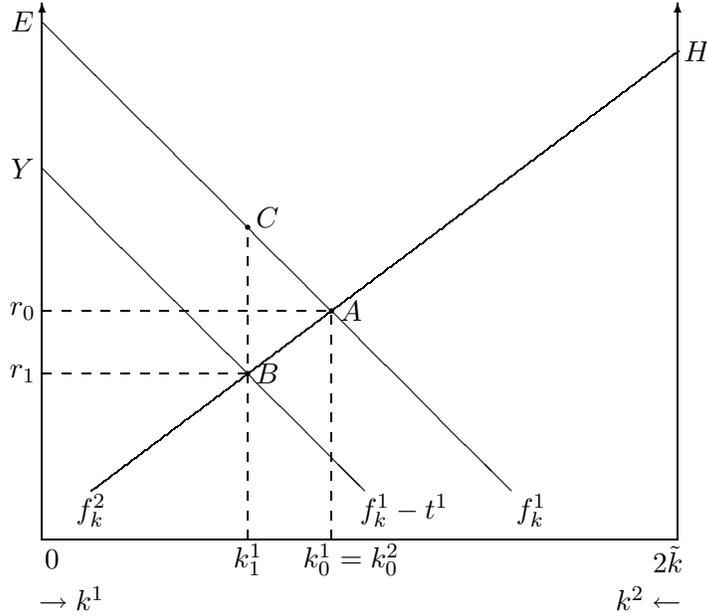


Figure 1.1: Interregional capital allocation with symmetric regions.

Decentralized Government Behavior After having characterized the first-best allocation, this paragraph analyzes whether decentralized government behavior follows the efficiency rules presented above. Therefore, first the government's decision problem is presented and in a second step, it is solved for the optimal decentralized tax and expenditure policy.

Local governments are assumed to be benevolent. Due to the assumption of a single household the government's objective function reduces to the utility function of the representative household. The government is restricted to source-based capital taxation. Local tax revenues tk are recycled by providing a local public good g .⁴ Thus, the budget constraint is given by⁵

$$tk = g. \quad (1.11)$$

Private consumption c equals household's income given by Eq. (1.1). To analyze how private income is determined in general equilibrium the wage rate w is written as a function of the regional capital choice. Applying the euler theorem and using

⁴See also Zodrow and Mieszkowski (1986) for a model with public input provision. Keen and Marchand (1997) present a model with both public consumption good and public input provision. Redistribution and capital taxation is considered in López, Marchand, and Pestieau (1998).

⁵As long as no confusion can occur the regional superscript is omitted.

Eq. (1.3) the wage rate can be rewritten as $w = f(k) - f_k k$. Therefore, private consumption is given by

$$c = f(k) - f_k k + r\tilde{k}, \quad (1.12)$$

where the fixed factor supply is normalized to unity and the private good is chosen as a numéraire. The local government sets t and, thereby, g by taking the reaction of regional capital employment and the world interest rate into account. These reactions are given by Eqs. (1.6) and (1.8). However, it behaves as a Nash competitor towards other regions, i.e. it takes the policy choices of other regions as given. Using this information the optimization problem can be stated as follows

$$\max_t u(f(k) - f_k k + r\tilde{k}, tk)$$

subject to Eqs. (1.6) and (1.8). Differentiating the objective function (1.13) with respect to t yields⁶

$$(t) : \quad u_c \left(-f_{kk} \frac{\partial k}{\partial t} k + \frac{\partial r}{\partial t} \tilde{k} \right) + u_g \left(k + t \frac{\partial k}{\partial t} \right) = 0. \quad (1.13)$$

The first bracketed term reflects the change in private consumption due to a marginal increase in t . In general, the capital tax rate affects private consumption in two ways. First, a marginal increase in t drives out capital ($\frac{\partial k}{\partial t} < 0$) and, thereby, reduces the productivity of the fixed factor. Consequently, the fixed factor income is decreased. Second, if the country is sufficiently large a higher t lowers the world interest rate ($\frac{\partial r}{\partial t} < 0$). Hence, in addition to the reduction of the fixed factor income, the second source of income is reduced as well. The second bracketed term describes how tax revenues are affected by a marginal tax increase. On the one hand, local tax revenues increase as t is increased. But on the other hand, the tax base erodes due to an outflow of capital which decreases tax revenues. Note, at an interior optimum the first effects must dominate the latter. Otherwise, an increase in t lowers private consumption as well as tax revenues. In this case it is optimal to set $t = 0$.

Since each region behaves in the manner described above all regions choose the same tax rate and local public spending. In equilibrium the regional capital allocation is

⁶In the basic capital tax competition model the capital tax rate, t , rather than local public spending, g , is used as a strategic variable. For an analysis of expenditure competition models see, e.g., Bayindir Upmann (1998) (public infrastructure as a strategic variable) and Hindriks (1999) (transfers as strategic variables). An endogenous choice of strategic variables is provided in Wildasin (1991).

not changed and regional capital input equals regional capital endowment. Hence, in a symmetric equilibrium ($k = \tilde{k}$)⁷ the first-order condition (1.13) reduces to

$$(t) : \quad u_c \left(\left(-f_{kk} \frac{\partial k}{\partial t} + \frac{\partial r}{\partial t} \right) k \right) + u_g \left(k + t \frac{\partial k}{\partial t} \right) = 0, \quad (1.14)$$

which can be simplified by using Eqs. (1.6) and (1.8). This yields

$$u_c(-k) + u_g \left(k + t \frac{\partial k}{\partial t} \right) = 0. \quad (1.15)$$

Rearranging the terms yields the familiar expression

$$\frac{u_g}{u_c} = \frac{1}{1 + \epsilon_{k,t}} \quad \text{with } \epsilon_{k,t} := \frac{\partial k}{\partial t} \frac{t}{k} < 0. \quad (1.16)$$

Eq. (1.16) reveals that the marginal rate of substitution is equated to the term $1/(1 + \epsilon_{k,t})$. The term on the r.h.s. of Eq. (1.16) reflects the marginal costs the local government faces if it decides to raise an additional unit of tax revenues (to be more precise a marginal increase in tax revenues). Therefore, this term is referred to as the marginal costs of public funds (henceforth MCPF). The costs the local government faces can be decomposed into two parts. The first part consists of the pure resource reallocation cost from the private sector to the public sector which is given by the marginal rate of transformation. This is reflected by the term 1 in the denominator of the MCPF. The second part refers to the distortionary effect of source-based capital taxation as perceived by the local government. This is given by the price elasticity of regional capital demand $\epsilon_{k,t}$. More precisely, starting from an interregional tax differential of 0 the local government perceives an outflow of capital in response to a marginal increase in the capital tax rate. From the perspective of each region the perceived outflow of capital is a cost component which is taken into account when deciding on the optimal level of t . Thus, the MCPF exceeds unity. The local decision maker increases t and, thereby, g until the marginal rate of substitution equals the MCPF as perceived by the region. Consequently, the

⁷In all chapters the existence, uniqueness, and stability of a Nash equilibrium is assumed. These assumptions are a standard feature in tax competition literature. Without existence of a Nash equilibrium the analysis of tax competition would be of no use. Furthermore, all three assumptions are necessary for any meaningful comparative static analysis. Note, in an environment with symmetric regions, the existence and uniqueness of a Nash equilibrium imply a symmetric equilibrium. A more detailed analysis of Nash equilibria in tax competition models is given in Wildasin (1988) and Koch and Schulze (1998).

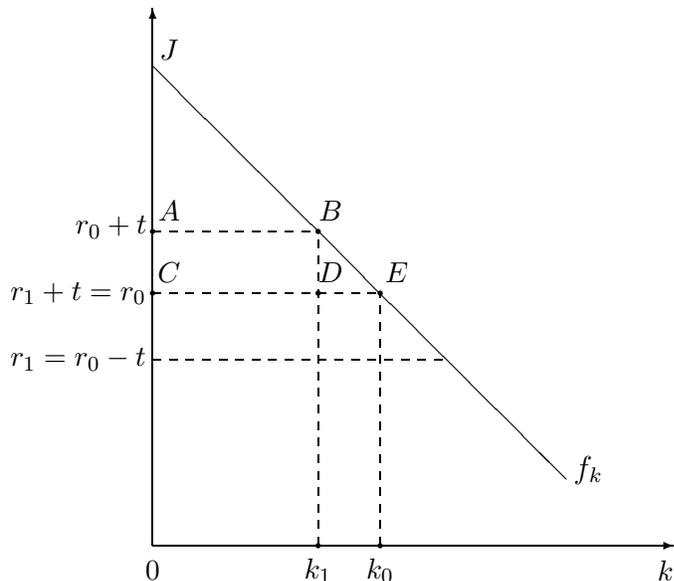


Figure 1.2: Capital taxation in a small open economy.

marginal rate of substitution exceeds unity. Local public goods are underprovided.⁸ In contrast, if capital taxation is not distortionary, e.g. capital is immobile or a residence-based capital tax is available, $\epsilon_{k,t} = 0$. In this case, the MCPF coincides with the marginal rate of transformation and capital taxation is only a resource reallocation process from the private sector to the public sector. This main result of the capital tax competition literature is summarized in proposition 1.1.

Proposition 1.1: *If the regional government is restricted to use a source-based capital tax, local public goods are underprovided.*

The line of reasoning underlying proposition 1.1 is depicted in figure 1.2. Consider a small open region ($n \rightarrow \infty$) which does not initially tax capital. With $t = 0$ the price of capital equals the interest rate r_0 . Capital input is thus given by k_0 . Fixed factor income amounts to the area CJE and capital income is represented by the area CEk_00 . From the perspective of a small open region the introduction of a capital tax rate t leaves the world interest rate unaffected. The price of capital rises by exactly the capital tax rate. Now, capital input reduces to k_1 and the

⁸The marginal cost of public funds can also fall below unity due to foreign ownership of firms [see Huizinga and Nielsen (1997)].

perceived capital income of the representative household is still given by $r_0\tilde{k}$. However, due to the outflow of capital the fixed factor income decreases by the area $ABEC$. The area $ABDC$ is turned into capital tax revenues. In contrast, the area BDE is the perceived excess burden of capital taxation which results in a MCPF exceeding unity. For this reason the level of local public goods is inefficiently low in equilibrium. As noted above, each region behaves in the same way and regards the source-based capital tax as distortionary. That is, all regions choose the same tax rate and, consequently, the world interest rate decreases by t . After the introduction of the capital tax the interest rate is given by $r_1 = r_0 - t$. The equilibrium capital allocation is unaltered and a loss of fixed factor income does not occur. In contrast, since $r_0 - r_1 = t$, capital tax revenues fall on capital income, i.e. $(r_0 - r_1)\tilde{k} = tk_0$. Thus, the excess burden of capital taxation is only perceived by regions and does not exist in a symmetric equilibrium.

1.2 Model Extensions

In this section, the basic tax competition model is extended in different ways. In subsection 1.2.1 the set of tax instruments is extended whereas in subsections 1.2.2 and 1.2.3 the assumption of asymmetric regions is dropped. Finally, subsection 1.2.4 introduces household mobility.

1.2.1 Multiple Tax Instruments

In the basic capital tax competition model the regional government is restricted to a source-based capital tax. Other distortionary taxes are not available. This section extends the basic model with respect to the set of tax instruments available to the government. First, a wage tax is introduced. Second, the capital tax policy is briefly analyzed if, besides a source-based capital tax, a residence-based capital tax is available.

Wage Tax Suppose a wage tax is considered in the basic capital tax competition model with labor as the fixed factor. Due to exogenous labor supply the wage tax is a lump-sum tax and it is optimal to collect all tax revenues on the inelastically supplied labor. In this case local public good provision is efficient. Bucovetsky and Wilson (1991) extend the analysis by allowing for a wage tax in the presence

of an endogenous labor supply decision. The introduction of a wage tax modifies the basic model in the following way. The household preferences are now given by $u = u(c, \ell) + b(g)$ with ℓ as the amount of leisure enjoyed by the household. This variable is endogenous and, hence, is chosen to maximize the utility of the representative household. The labor supply L is given by $L = 1 - \ell$ where the time endowment of the household is normalized to unity. Therefore, the optimization problem is changed to

$$\max_L u(c, 1 - L) + b(g) \quad (1.17)$$

subject to the budget constraint

$$L(w - \tau) + r\tilde{k} = c. \quad (1.18)$$

The problem can be stated as follows

$$\max_L \mathcal{L} = u(L(w - \tau) + r\tilde{k}, 1 - L) + b(g). \quad (1.19)$$

The optimal labor-leisure choice is characterized by the first-order condition

$$(L) : \quad u_c(w - \tau) - u_L = 0 \quad (1.20)$$

which implicitly determines the labor supply function $L(w - \tau, r)$. Due to the assumed additive structure of preferences local public good provision g does not affect the labor-leisure choice. In contrast, a general formulation of preferences, $u = u(c, 1 - L, g)$, would imply a public expenditure effect on labor supply. In most of the tax competition literature this effect is excluded by appropriate specification of preferences.⁹

The reaction of labor supply to a change in the net wage can be derived by using the Slutsky equation. In general, the sign of the reaction can be negative as well as positive depending on whether or not the income effect (if leisure is normal) dominates the substitution effect. The optimization procedure yields the indirect utility function $v(t, \tau) + b(g)$.

Before the optimal tax system can be derived labor demand and the labor market have to be introduced. Labor demand $l(w, r + t)$ is given by the profit maximizing

⁹See, e.g., Fuest and Huber (1999). In contrast, Bucovetsky and Wilson (1991) use a more general formulation of preferences by assuming weak separability between private commodities and public consumption. However, note the subsequent results are not modified if weak instead of additive separability is assumed.

behavior of the representative firm. In contrast to the basic tax competition model, capital demand is given by the first-order condition for capital $f_k = r + t$ as well as the first-order condition for labor $f_l = w$. In the basic model the first-order condition $f_k = r + t$ is only relevant since, with a fixed labor supply, equilibrium labor employment cannot react to changes in the wage rate and, hence, can be omitted when deriving the impact of the tax policy on capital demand. However, with an endogenous labor-leisure choice both first-order conditions determine how factor demand reacts to different tax policies. Additionally, the labor market clearing condition $l(w, r + t) = L(w - \tau, r)$ and the capital market clearing condition $n\tilde{k} = \sum_{i=1}^n k^i$ imply that both the wage rate w and the interest rate r are affected by t and τ .

The government's optimization problem is thus given by

$$\max_{t, \tau} \quad v[w(r + t) - \tau, r] + b \left\{ \left(t \frac{k}{l} (r + t) + \tau \right) L[w(r + t) - \tau, r] \right\} \quad (1.21)$$

subject to $r = r(t, \tau)$. The optimal tax policy is summarized in proposition 1.2.

Proposition 1.2: *If the number of countries n is finite, both labor and capital tax instruments are used in equilibrium, i.e. $t > 0$ and $\tau > 0$. However, if $n \rightarrow \infty$, τ is strictly positive and $t = 0$.*

Proof: See appendix A.2.

Proposition 1.2 is the static equivalent to proposition 1 in Bucovetsky and Wilson (1991) which is derived in a two-period setting. Both assertions in proposition 1.2 have a straightforward explanation. A finite n corresponds to the case of a large open economy. For given capital tax rates of other regions a change in the capital tax rate of one region affects the world interest rate. Therefore, each region faces a finitely elastic capital supply. Additionally, labor supply is also finitely elastic. Consequently, if n is finite, it is optimal for the region's government to equate the distortions arising from both tax instruments. This behavior results in strictly positive equilibrium tax rates t and τ .

However, if n is infinite, no region possesses market power in the world capital market. Each region faces an infinitely elastic capital supply. In contrast, the elasticity

of labor supply is still finite. Hence, for each single region optimality requires to set the source-based capital tax to 0 and to finance local public good provision by labor income taxation.

The above outlined extension introduces a second source of inefficiency. In the basic tax competition model local public goods are inefficiently provided. However, the use of the labor income tax distorts the labor-leisure choice. Hence, in equilibrium local public good provision as well as labor supply are distorted. The existence of the second distortion has striking implications for the efficiency of the tax system. To verify this, recall that efficiency requires the collection of all tax revenues on the inelastically supplied capital and to set $\tau = 0$. In the case of a small open economy the source-based capital tax is not used at all and all tax revenues are collected on the elastically supplied labor. Therefore, an infinite n implies an even lower tax rate t , though starting from the basic tax competition model the capital tax rate should be increased rather than decreased.

As shown in the previous section capital mobility exerts a downward pressure on the source-based capital tax. However, the labor tax rate does not remain unaffected by capital mobility. The influence of capital mobility on the choice of the labor tax rate can best be illustrated if the government is restricted to use the labor income tax, i.e. $t \equiv 0$. With this modification the regional government's optimization problem becomes

$$\max_{\tau} \quad v(w(r) - \tau, r) + b(\tau L(w - \tau, r)) \quad (1.22)$$

subject to $r = r(\tau)$. Thus, local public good provision can be characterized by

$$\frac{b_g}{u_c} = \frac{1}{1 + \eta - \eta^s \frac{dw}{dr} \frac{dr}{d\tau}} \quad (1.23)$$

$$= \frac{1}{\underbrace{1 + \eta}_{=:a} - \underbrace{\frac{\eta^s}{n} \frac{dw}{dr}}_{=:b} \kappa} \quad (1.24)$$

with

$$\eta := -\frac{\partial L}{\partial(w - \tau)} \frac{\tau}{L}, \quad \eta^s := -\frac{\partial L^s}{\partial(w - \tau)} \frac{\tau}{L^s} < 0 \quad \text{and} \quad \kappa < 0. \quad (1.25)$$

(For a derivation see appendix A.3 at the end of this chapter.) η denotes the elasticity of Marshallian labor supply with respect to τ . η^s refers to the elasticity of

Hicksian labor supply with respect to τ . The former can be positive as well as negative whereas the latter is unambiguously negative. To identify the influence of capital mobility on the choice of τ , note that the term a in Eq. (1.24) describes the influence of labor taxation on labor supply irrespective of the number of regions. Specifically, η reflects the change in labor supply in response to an increase in τ for given gross wage w . This term is well known from Atkinson and Stern (1974).¹⁰ It represents the marginal cost of public funds for the case of labor income taxation and fixed factor prices, w and r . The marginal cost of public funds with fixed factor prices $\frac{1}{1+\eta}$ exceeds unity if $L_{w-\tau} > 0$. Under this assumption an increase in τ reduces labor supply and, hence, the tax base. The erosion of the tax base due to distortionary taxation enters the government's decision on g . It results in an inefficiently low provision of local public goods according to $\frac{b_g}{u_c} = \frac{1}{1+\eta} > 1$ which is referred to as the Atkinson-Stern rule.¹¹

This effect is already known from source-based capital taxation. But, the crucial difference between source-based capital taxation with symmetric regions and labor income taxation is that in the former case the reduction in the tax base is only perceived and does not occur in equilibrium. In the latter case the equilibrium tax base is reduced.

The impact of a tax induced change in w on labor supply is given by the term b in Eq. (1.24) which in turn depends on the number of regions n . As $\kappa < 0$, $\frac{dw}{dr} < 0$ and $\eta^s < 0$, the term b is positive. Thus, both terms have an opposite impact on the marginal cost of public funds. Additionally, observe that the term b is decreasing in n .

At first sight it seems surprising that the number of regions enter the second term. Labor is immobile and, therefore, the labor income tax is expected to affect the outcome of the regional labor market irrespective of the number of regions. However, all labor markets are linked through capital mobility. Labor income taxation in one region affects the labor market in other regions through interregional reallocation of

¹⁰For a textbook treatment of the Atkinson-Stern rule see Myles (1995). Public good provision with distortionary taxation is also considered in Wildasin (1984), Kaplow (1998), and Browning and Liu (1998).

¹¹To demonstrate the importance of the assumption $L_{w-\tau} > 0$ for the result derived above, consider the case in which leisure is a Giffen good, i.e. $L_{w-\tau} < 0$. Now, an increase in τ has a positive effect on labor supply. Labor income tax revenues rise as both the tax base and the tax rate are higher. In this case the marginal cost of public funds is driven below unity and local public goods are overprovided.

mobile capital.

A more detailed insight on the role of capital mobility for labor income taxation can be obtained by considering the case of a closed economy first. A closed economy is given if $n = 1$. If $L_{w-\tau} > 0$, an increase in τ reduces labor supply. Consequently, the marginal productivity of capital is lowered which results in a decrease in the capital market interest rate r . As shown in appendix A.2, the factor price frontier, $\frac{dw}{dr}$, is negatively sloped. Hence, the equilibrium wage rate increases which counteracts the negative influence of the increased wage tax on labor supply. In sum, the burden of labor income taxation can partially be shifted on the factor capital.

An open economy corresponds to $n > 1$. Relative to the case of a closed economy, the term b decreases and, therefore, the positive effect of labor income taxation on local public good provision is reduced. This is due to the limiting influence of capital mobility on the ability to shift the burden of labor income taxation on capital. More specifically, if $1 < n < \infty$, i.e. each region is a large open economy, an increase in τ reduces labor supply. In contrast to a closed economy, the reduced labor supply not only decreases the interest rate r but also implies higher wages. It also leads to an outflow of capital which, in turn, lowers the marginal productivity of labor ($f_{kl} > 0$). This has a negative effect on the wage rate. Hence, the introduction of capital mobility leads to a decrease in r and to an outflow of capital in response to a higher labor income tax rate. The latter effect is responsible for the diminishing impact of the term b on local public good provision.

If $n \rightarrow \infty$, i.e. each region is a small open economy, the region can no longer influence the interest rate r . A rise in τ still reduces labor supply. However, the reduced marginal productivity of capital and, hence, lower capital demand, does not result in a lower r and, consequently, in higher wages. Therefore, the increase in w induced by a decrease in r , which is present under capital immobility, does not exist from the perspective of a small open economy. The only capital market response to a higher τ is an outflow of capital. Accordingly, the counteracting effect due to the endogeneity of the wage rate vanishes in the case of a small open economy. This is represented by the fact that $-\frac{\eta^s}{n} \frac{dw}{dr} \kappa \rightarrow 0$ if $n \rightarrow \infty$. Now, the marginal cost of public funds coincides with the Atkinson-Stern rule under fixed factor prices.

However, the fixity of factor prices is only perceived by the government. Recall, in a symmetric equilibrium capital employment equals capital endowment. The world interest rate r is lowered and, consequently, the wage rate w is increased. Thus, the equilibrium marginal cost of public funds is given by the expression for the marginal cost of public funds which applies in a closed economy, i.e. it is given by Eq. (1.24) for $n = 1$.

In sum, the positive effect of labor income taxation on the marginal cost of public funds, given by the term b in Eq. (1.24), decreases in response to a rise in n . Therefore, starting from a closed economy the labor income tax rate is negatively related to the number of regions n . Hence, despite the absence of a source-based capital tax, the mobility of capital has a negative influence on the tax rate τ and, thus, on local public good provision.

Residence-Based Capital Tax Bucovetsky and Wilson (1991) also consider the case of a residence-based capital tax instead of a wage tax. However, the case is not of interest in this setting for two reasons. First, in the absence of a savings decision a residence-based capital tax is a lump-sum tax. The solution of the optimal tax problem is trivial.¹² Second, as noted in the introduction, a residence-based capital tax is excluded from the analysis due to the lack of information of foreign-source capital income necessary for implementation.

1.2.2 Asymmetric Regions: Factor Endowment Differences

Up to now, it is assumed that regions are symmetric, i.e. regions are identical in all respects. With this assumption equilibrium fiscal policy is identical across regions. The main analytical results from the basic symmetric tax competition model is that regions underprovide local public goods when competing for mobile capital. However, given by the symmetric tax policy, the interregional allocation of capital is efficient. It is interesting to analyze whether these findings are robust with respect to the relaxation of the symmetry assumption. In general, there are multiple possibilities of dropping the symmetry assumption. One approach would be to model tax competition across regions with different factor endowments. Another approach

¹²For a general discussion of the efficiency properties of the source-based and residence-based capital tax system see Mintz and Tulkens (1996).

of introducing asymmetric tax competition would be to allow for interregional taste differences for local public goods.

The literature on asymmetric tax competition has largely focused on the former modeling approach.¹³ Bucovetsky (1991) considers the case of a tax competition game played between regions of different size whereas size differences are modeled by a different labor endowment. However, the analysis is restricted to the case of a quadratic production function. Wilson (1991) extends the analysis to the case of a neoclassical production function which underlies the symmetric tax competition literature.¹⁴ As the results significantly differ from those derived in the symmetric case the main results and their intuition are presented below.

The Model The analysis is restricted to an economy consisting of two regions. Each region is endowed with a fixed amount of households L^i which supply one unit of labor. Per capita capital endowment $\bar{k} := \frac{\tilde{k}^i}{L^i}$ is assumed to be identical across regions. \tilde{k}^i denotes the region's capital endowment. The household's budget constraint changes to $c = w - r\bar{k}$. Firms use labor l^i and capital k^i to produce a homogeneous good using a constant returns to scale production technology $f(k^i, l^i)$. Implied by the constant returns to scale property the production technology can be rewritten in per-capita form $F(K^i)$ where $K := \frac{k^i}{l^i}$. Again, profit maximization gives $F'(K^i) = r + t^i$. Therefore, per-capita consumption and local public good provision are given by

$$c^i = F(K^i) - F'(K^i)K^i + r\bar{k} \quad \text{and} \quad g^i = t^i l^i K^i, \quad i = 1, 2. \quad (1.26)$$

Households derive utility of c^i and g^i according to the preference function $u(c^i, g^i)$. The capital market clearing condition now becomes

$$l^1 \bar{k} + l^2 \bar{k} = l^1 K^1 + l^2 K^2, \quad (1.27)$$

¹³Only in the commodity tax competition literature are interregional taste differences considered. See, e.g., Mintz and Tulkens (1986), De Crombrugghe and Tulkens (1990), and Haufler (1996).

¹⁴Hwang and Choe (1995) extend the analysis in Wilson (1991) by allowing for interregional labor and capital endowment differences. Arnold and Fuest (1999) also analyze asymmetric tax competition due to factor endowment differences. However, in their setting the government provides public inputs rather than public consumption goods.

where the labor market clearing condition $L^i = l^i$ has already been inserted. Comparative static analysis yields

$$\frac{\partial K^i}{\partial t^i} = \frac{l^i}{l^2 F''(K^1) + l^1 F''(K^2)}, \quad i = 1, 2 \quad (1.28)$$

$$\frac{\partial r}{\partial t^i} = \frac{-l^i F''(K^j)}{l^2 F''(K^1) + l^1 F''(K^2)}, \quad i = 1, 2, \quad i \neq j. \quad (1.29)$$

Eqs. (1.28) and (1.29) reveal that labor endowment influences the reaction of capital demand and the interest rate to a change in the source-based capital tax rate. The dependence of $\frac{\partial K^i}{\partial t^i}$ and $\frac{\partial r}{\partial t^i}$ on labor endowment is the driving force for the results derived below.

Government The government's optimization problem becomes

$$\max_{t^i} u \left(F(K^i) - F'(K^i)K^i + r\bar{k}, t^i l^i K^i \right) \quad i = 1, 2 \quad (1.30)$$

subject to $K^i = K^i(t^i)$ and $r = r(t^i)$. Differentiation with respect to t^i gives

$$(t^i): \quad u_c \left(-F''(K^i) \frac{\partial K^i}{\partial t^i} K^i + \frac{\partial r}{\partial t^i} \bar{k} \right) + u_g \left(K^i + t^i \frac{\partial K^i}{\partial t^i} \right) = 0 \quad i = 1, 2. \quad (1.31)$$

Using Eq. (1.28) and rearranging simplifies the first-order condition to

$$L^i \frac{u_g^i}{u_c^i} = \frac{1 + (1 - \frac{\bar{k}}{K^i}) \frac{\partial r}{\partial t^i}}{1 + \varepsilon} \quad \text{with} \quad \varepsilon := \frac{\partial K^i}{\partial t^i} \frac{t^i}{K^i} \quad i = 1, 2. \quad (1.32)$$

The numerator on the r.h.s. of Eq. (1.32) reflects the change in private consumption c^i resulting from a marginal increase in t^i whereas the denominator refers to the change in tax revenues in response to an increase in t^i . Hence, the ratio describes how much consumption a region must sacrifice in order to raise one additional unit of tax revenues. In an optimum, the marginal cost of public funds are equated to the sum of the marginal rates of substitution, $L^i \frac{u_g^i}{u_c^i}$.¹⁵

The optimality condition (1.32) provides insight into the main difference between symmetric and asymmetric tax competition games. With symmetric tax competition, i.e. $L^1 = L^2 = L$ and, hence, $K^i = \bar{k}$, the bracketed term in the numerator

¹⁵Since the number of households residing in a region is greater unity, the marginal rates of substitution have to be summed up over all L^i households in order to characterize local public good provision in terms of efficiency. Given by the assumption of homogeneous households, the sum simplifies to $L^i \frac{u_g^i}{u_c^i}$.

in Eq. (1.32) becomes 0. Local public good provision can thus be characterized by $L \frac{u_g}{u_c} = \frac{1}{1+\varepsilon}$. This condition is identical to the condition derived in the last section, except for the fact that L is normalized to unity in the basic tax competition model. However, if regions are asymmetrically endowed with labor, i.e. $L^1 \neq L^2$, the bracketed term in the numerator on the r.h.s. of Eq. (1.32) does not vanish. Depending on whether the bracketed term is positive, negative or 0, the marginal cost of public funds decreases, increases or is unchanged relative to the symmetric outcome. This, in turn, depends on the magnitude of the ratio $\frac{\bar{k}}{K^i}$.

The magnitude of the ratio $\frac{\bar{k}}{K^i}$ is determined by the size of the region L^i as well as by the tax rates (t^1, t^2) . Throughout the rest of the subsection it is assumed that $L^1 > L^2$. For this reason, region 1 (2) is referred to as the large (small) region.

Intuition for the equilibrium sign of the tax differential $t^1 - t^2$ can be gained by returning to the slopes of the reaction functions given by Eqs. (1.28) and (1.29). The denominator of Eq. (1.28) is identical for both regions. However, the larger the numerator of $\frac{\partial K^i}{\partial t^i}$ the larger L^i . As $L^1 > L^2$, the perceived reaction of capital employment to a change in the capital tax rate must be larger in absolute value in the small region. Put differently, the small region perceives a higher outflow of capital when marginally raising t^2 than the large region. This implies a lower increase in tax revenues and a lower denominator in Eq. (1.32).

As given by Eq. (1.29) the change in the interest rate is also affected by the size of the region. Starting from the situation $\bar{k} = k^i$ the anticipated reduction in r is lower in the small region relative to the reaction in the large region. Therefore, the large region has more market power. It can shift a huger fraction of the capital tax burden on the other region by being better able to influence the interest rate. In sum, the perceived marginal cost of public funds in the larger region is lower than in the small region. Hence, the large region has more incentives to increase the capital tax rate. In contrast, the small region perceives a relative high outflow of capital when raising the tax rate. As shown by Wilson (1991), these effects are responsible for the large region choosing a strictly higher tax rate than the small region, i.e. $t^1 > t^2$.¹⁶

The increased market power of the large region seems to be an advantage of the

¹⁶A formal proof of this result is given in Wilson (1991), prop. 2, p. 433.

large region. However, the first-order conditions for profit maximization imply

$$f'(k^1) - t^1 = r = f'(k^2) - t^2. \quad (1.33)$$

As $t^1 > t^2$ the marginal productivity of capital in the large region must be higher than in the small region, i.e. $f'(k^1) > f'(k^2)$. The assumption of a diminishing marginal productivity of capital gives $k^1 < \bar{k} < k^2$. Hence, in equilibrium, per capita capital employment in the small region exceeds per capita capital employment in the large region. The capital import increases private as well as public consumption. The small region is better off in equilibrium than the large region though the large region possesses more market power.¹⁷ The result shows that a higher market power does not imply a more favorable market allocation for the corresponding region. A different result has been derived in the tariff war literature [see e.g. Kennan and Riezman (1988)]. In the tariff war literature the larger region is better able to manipulate the terms of trade in its favor and can improve its welfare. However, as shown above, the benefit of largeness disappears in the tax competition framework.¹⁸

DePater and Myers (1994) identify an additional effect which leads to inefficiency once one allows for asymmetric regions. If a region raises its capital tax rate, the net-of-tax return to capital r decreases. This not only reduces capital income in the same region but, due to capital mobility, lowers capital income in other regions as well. However, the latter effect is not accounted for when raising the capital tax rate, but affects the well-being of residents in other regions.¹⁹ If regions are symmetric, this effect does not play a role in a symmetric equilibrium. More precisely, suppose a system of n identical regions where n is finite, i.e. regions are large enough to influence r . A rise in the capital tax rate in region i implies a reduction in the capital income in region i by $\frac{\partial r}{\partial t^i} \tilde{k}$ and in the other regions by $(n-1) \frac{\partial r}{\partial t^i} \tilde{k}$. Only the former effect is part of the region i 's optimization problem. As all regions are identical in all respects, the same is done by all regions. Hence, from the perspective of region i the effect of its tax rate decision on other regions and the effect of the tax rate

¹⁷This conclusion is formally proved in Wilson (1991), prop. 1, p. 430.

¹⁸Haufler and Wooton (1999) show that in the case of tax competition for direct investments larger regions are better off than smaller regions if transaction costs are zero.

¹⁹This effect is mediated via the price system. For this reason the effect is referred to as a pecuniary externality.

decision of all other regions on region i is given by

$$(n-1)\frac{\partial r}{\partial t^i}\tilde{k} = \sum_{\substack{j=1 \\ i \neq j}}^n \frac{\partial r}{\partial t^j}\tilde{k} \quad (1.34)$$

$$= (n-1)\frac{\partial r}{\partial t^j}\tilde{k}. \quad (1.35)$$

Consequently, in a symmetric equilibrium both effects cancel each other. Thus, with symmetric capital tax competition this effect is of no concern. However, with asymmetric regions does Eq. (1.34) not hold. For this reason, asymmetric tax competition produces an additional effect that has to be corrected if an efficient allocation is to be achieved. In contrast to the aforementioned capital reallocation in response to a capital tax rate increase, this effect is not only perceived. It is an equilibrium phenomenon.²⁰

1.2.3 Asymmetric Regions: Taste Differences

In this subsection, asymmetry across regions is modeled by taste differences for local public goods. Hence, in contrast to the existing literature on asymmetric tax competition, regions do not differ with respect to their factor endowments and, thus, with respect to their influence on the world interest rate. Here, the asymmetry is modeled by a different marginal rate of substitution between private and public consumption. The subsequent analysis shows that in a high preference region local public goods are always underprovided. However, local public good provision in low preference regions is ambiguous. Specifically, local public goods can be underprovided, overprovided and efficiently provided.

The Model The economy consists of two regions which are identical in all respects except of their preferences for local public goods. The preferences are given by $u^i(c^i, g^i)$, $i = h, l$. The asymmetry between both regions is represented by

$$\frac{u_g^h}{u_c^h} > \frac{u_g^l}{u_c^l}. \quad (1.36)$$

Eq 1.36 states that, for a given allocation (c, g) , the marginal rate of substitution between c and g is higher in the h -type region than in the l -type region. This implies

²⁰Note, in the absence of symmetric regions the negative interest rate externality is counteracted by a wage rate externality since the regional wage rate is increasing in foreign capital tax rates. Thus, the magnitude of both types of externalities determine the sign of the overall pecuniary externality.

a high (low) preference for the local public good in a $h(l)$ -type region. The regions are endowed with a capital stock \tilde{k} and a fixed factor, e.g. land.

Each region produces a homogeneous good with a constant return to scale technology $f(k)$ using capital k and the fixed factor as inputs.²¹ Output can be used on a one-to-one basis either for private or public consumption. Profit maximization implies a capital demand characterized by

$$f'(k^i) = r + t^i, \quad i = h, l, \quad (1.37)$$

where r is the interest rate and $t^i > 0$ the source-based capital tax rate in region i . Hence, the region's private consumption is given by

$$c^i = f(k^i) - f'(k^i)k^i + r\tilde{k}, \quad i = h, l. \quad (1.38)$$

The region's government recycles the capital tax revenues by providing a local public good $g^i = t^i k^i$. Other tax instruments are not available to the government.

Capital is mobile between both regions. The capital market equilibrium is characterized by the capital market clearing condition $k^h + k^l = 2\tilde{k}$ and the first-order condition (1.37). This implies

$$\frac{\partial k^i}{\partial t^i} = \frac{1}{f''(k^h) + f''(k^l)} \quad \text{and} \quad \frac{\partial r}{\partial t^i} = \frac{-f''(k^j)}{f''(k^h) + f''(k^l)}, \quad i, j = h, l, \quad i \neq j. \quad (1.39)$$

Government In this paragraph the policy outcome of decentralized source-based capital taxation in the h - and l -type regions is derived.

The regions' optimization problem is as follows

$$\max_{t^i} u^i(f(k^i) - f'(k^i)k^i + r\tilde{k}, t^i k^i), \quad i = h, l. \quad (1.40)$$

The first-order condition for t^i is

$$(t^i) : \quad u_c^i \left(-f''(k^i) \frac{\partial k^i}{\partial t^i} k^i + \frac{\partial r}{\partial t^i} \tilde{k} \right) + u_g^i \left(t^i \frac{\partial k^i}{\partial t^i} + k^i \right) = 0, \quad i = h, l. \quad (1.41)$$

Inserting Eq. (1.39) in the first-order condition yields

$$\frac{u_g^i}{u_c^i} = \frac{f''(k^i)k^i + f''(k^j)\tilde{k}}{t^i + k^i(f''(k^h) + f''(k^l))}, \quad i, j = h, l, \quad i \neq j. \quad (1.42)$$

²¹For simplicity, the fixed factor is omitted from the notation.

To be better able to compare the outcome of symmetric tax competition with the outcome of asymmetric tax competition it is useful to rewrite Eq. (1.42) as follows

$$\frac{u_g^i}{u_c^i} = \frac{1}{1 + \epsilon_{k^i, t^i}} + \frac{f''(k^j)\delta^i}{t^i + k^i[f''(k^i) + f''(k^j)]}, \quad (1.43)$$

with

$$\epsilon_{k^i, t^i} := \frac{\partial k^i}{\partial t^i} \frac{t^i}{k^i} \quad \text{and} \quad \delta^i := \tilde{k} - k^i, \quad j, i = h, l, \quad i \neq j. \quad (1.44)$$

The first term on the r.h.s. of Eq. (1.43) is already well known from the analysis of symmetric tax competition. It reflects the impact of the perceived outflow of capital in response to an increase in the source-based capital tax rate on local public good provision. Recall, with symmetric tax competition the outflow of capital is only perceived since, in a symmetric equilibrium, capital employment equals capital endowment. However, with asymmetric tax competition this may no longer be the case. The influence of the asymmetry between both regions on local public good provision is summarized by the second term on the r.h.s. of Eq. (1.43). The sign of the term is given by the sign of δ^i .²² δ^i measures the magnitude of capital reallocation between regions and is defined as the difference between capital endowment and capital employment. A positive δ^i indicates a capital export of region i whereas a negative δ^i indicates a capital import. Hence, the impact of asymmetric tax competition on local public good provision depends on whether the region under consideration is a capital exporter or capital importer. In capital exporting regions the marginal cost of public funds increases relative to the outcome of symmetric tax competition. As already noted, with symmetric tax competition no capital reallocation occurs in equilibrium. Now, with a positive δ^i , the outflow of capital is not only perceived by the region's government. It also occurs in equilibrium.

In contrast, in the case of a capital importing region the second term on the r.h.s. of Eq. (1.43) becomes negative. Consequently, the marginal cost of public funds is

²²To see this, multiply the numerator and denominator of the second term by $\partial k^i / \partial t^i = 1/[f''(k^i) + f''(k^j)]$. This yields

$$\frac{f''(k^j)\delta^i}{t^i + k^i[f''(k^i) + f''(k^j)]} = \frac{\frac{f''(k^j)\delta^i}{f''(k^i) + f''(k^j)}}{t^i \frac{\partial k^i}{\partial t^i} + k^i}. \quad (1.45)$$

By the optimizing behavior of governments, i.e. $\frac{k^i}{t^i \frac{\partial k^i}{\partial t^i} + k^i} > 1$, the denominator on the r.h.s. of Eq. (1.45) is positive. Therefore, the sign of the second term of Eq. (1.43) is determined by the sign of δ^i .

lowered due to the asymmetry of regions.

Eq. (1.43) reveals that the efficiency of local public good provision depends on the interregional capital allocation which in turn depends on the tax differential $t^h - t^l$. The following implication for the sign of the tax differential $t^h - t^l$ can be derived.

Lemma 1.1: *In a tax competition equilibrium t^h is strictly larger than t^l , i.e. $t^h > t^l$.*

Proof: The proof is done by contradiction. Note, both regions play Nash, i.e. they choose a best-response for given tax rate of the other region. Formally, let $t_{i \in \{h,l\}}^{i*} = \text{argmax}\{u^i(t^i, t^j)\}$, $i \neq j$. Hence,

$$u^i(t^{i*}, t^{j*}) \geq u^i(t^i, t^{j*}), \quad i, j = h, l, \quad i \neq j. \quad (1.46)$$

Thus, the Nash equilibrium implies

$$u^i(c^i, g^i) \geq u^i(c^j, g^j), \quad i, j = h, l, \quad i \neq j, \quad (1.47)$$

where $c^i = c^i(t^{i*}, t^{j*})$ and $g^i = g^i(t^{i*}, t^{j*})$. The proof proceeds in two steps. First, $t^{l*} = t^{h*}$ is ruled out as an equilibrium solution. In a second step, $t^{l*} > t^{h*}$ is proved to be incompatible with a Nash equilibrium.

If $t^{l*} = t^{h*}$, it follows that $k^h = k^l$, $c^h = c^l$ and $g^h = g^l$. Consequently, the r.h.s. of Eq. (1.42) is identical for both regions. However, this contradicts Eq. (1.36). Thus, $t^{l*} \neq t^{h*}$.

If $t^{h*} < t^{l*}$, $k^h > k^l$ and $c^h > c^l$. Additionally, Eq. (1.47) requires $g^h < g^l$. However, implied by Eq. (1.36) this allocation violates Eq. (1.47) at least for one type of region. Hence, $t^{h*} > t^{l*}$. This completes the proof. \square

The assumption necessary for lemma 1.1 is that a Nash equilibrium exists. In contrast to Wilson (1991) and Hwang and Choe (1995) lemma 1.1 does not require the best response functions implicitly defined by Eq. (1.42) to be continuous. Additionally, with taste differences instead of endowment differences the interregional tax differential $t^h - t^l$ can be signed in an easier way as in Wilson (1991) and Hwang and Choe (1995).

Two clarifying remarks concerning lemma 1.1 are helpful. The first remark refers

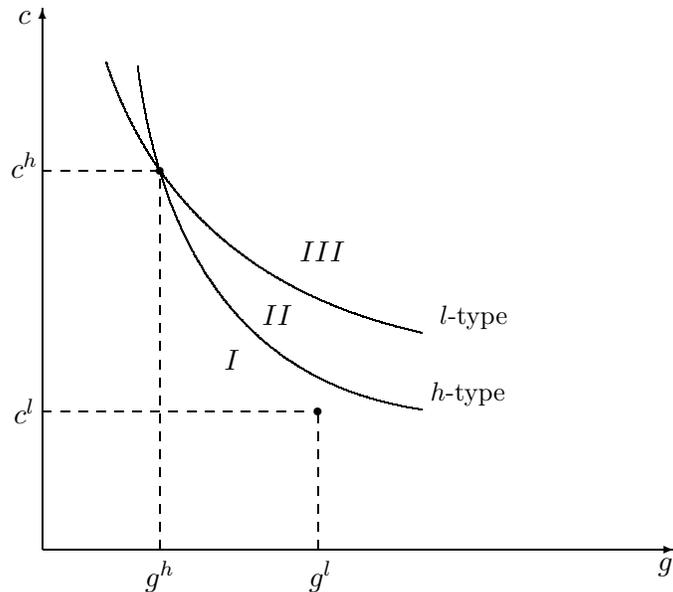


Figure 1.3: Asymmetric tax competition: tax rate structure.

to Eq. (1.47) which states that a Nash equilibrium is incentive compatible. To see that Eq. (1.47) follows from Eq. (1.46) suppose the equilibrium tax rates are given by t^{h*} and t^{l*} . If Eq. (1.47) does not hold for both types of regions, i.e. $u^h(c^h, g^h) < u^h(c^l, g^l)$ and $u^l(c^l, g^l) < u^l(c^h, g^h)$, both regions have an incentive to change their tax rate choices. Each region can attain its more preferred allocation by simply adopting the tax rate of the other type of region. Thus, t^{h*} and t^{l*} do not constitute a Nash equilibrium which violates the initial assumption.

The second remark refers to the assertion of lemma 1.1 that $t^h < t^l$ is incompatible with Eq. (1.47) and Eq. (1.36). This point is illustrated in figure 1.3 with private consumption c on the vertical axis and the amount of local public goods on the horizontal axis. As depicted in figure 1.3 the indifference curves of the two types of regions intersect only once. This property is implied by Eq. (1.36). For this reason Eq. (1.36) is usually referred to as the single-crossing property. The allocations (c^h, g^h) and (c^l, g^l) correspond to $t^h < t^l$. To see this, note $c^h > c^l$ follows directly from the negative tax differential. In contrast, $g^h < g^l$ is implied by the negative tax differential and Eq. (1.47). The inequality $g^h \geq g^l$ would imply $u^l(c^l, g^l) < u^l(c^h, g^h)$. In this case, $t^h < t^l$ cannot constitute a Nash equilibrium.

By construction, both allocations lie on the same indifference curve of the h -type re-

gion. However, as indifference curves of both regions intersect only once, the l -type region strictly prefers (c^h, g^h) to (c^l, g^l) which violates Eq. (1.47). A similar line of reasoning can be applied if (c^l, g^l) lies in area *II* or *III*.

After having characterized the sign of the equilibrium tax differential, the efficiency of the resulting local public good provision is characterized next. First, the analysis turns to the h -type region.

Proposition 1.3: *Local public goods are underprovided in the h -type region, i.e. $\frac{u_g^h}{u_c^h} > 1$.*

Proof: Use lemma 1.1, Eq. (1.42), and note that an overprovision and efficient provision of the local public good requires a negative tax rate t^h which violates the nonnegativity constraint for t^h . \square

The rationale for this result is straightforward. For a given tax rate t^l , a marginal tax increase in a h -type region leads to an outflow of capital. The reduction in the capital tax base implies a marginal cost of public funds greater unity. Hence, the capital tax rate is set inefficiently low. So far, this result is in line with the existing literature on tax competition. However, in contrast to the literature on symmetric tax competition the equilibrium capital allocation is not identical across regions. As $t^h > t^l$, $k^h < \tilde{k}$. In equilibrium, the h -type region exports capital to the l -type region. With symmetric tax competition the outflow of capital is only perceived and does not occur in equilibrium, i.e. capital employment equals capital endowment.

The optimal policy in both types of regions is not identical. Rewriting Eq. (1.42) yields proposition 1.4.

Proposition 1.4: *Local public good provision in the l -type region is characterized by*

$$\frac{u_g^l}{u_c^l} \left\{ \begin{array}{l} > \\ = \\ < \end{array} \right\} 1 \quad \text{if} \quad f''(k^h)\tilde{k} \left\{ \begin{array}{l} < \\ = \\ > \end{array} \right\} f''(k^h)k^l + t^l. \quad (1.48)$$

Analogous to the h -type region the government in the l -type region perceives an

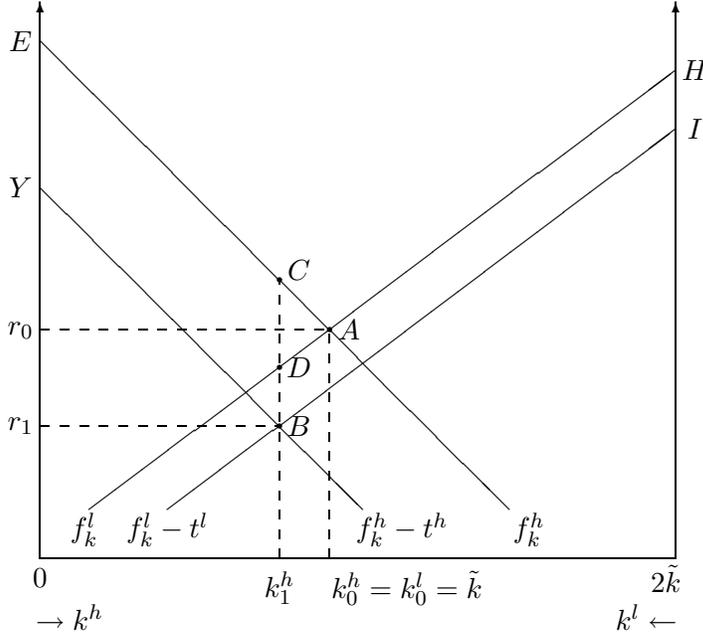


Figure 1.4: Asymmetric tax competition: policy outcome.

outflow of capital when increasing t^l for a given t^h . The marginal cost of public funds as perceived by the l -type region exceeds unity. Hence, the tax rate t^l is set inefficiently low. However, the crucial difference between both types of regions is that the l -type region imports capital, i.e. $\tilde{k} < k^l$, which increases capital tax revenues $t^l k^l$. The influx of capital counteracts the effect of the inefficiently low capital tax rate on local public good provision. Therefore, three cases can be distinguished: (i) the tax rate effect dominates resulting in an underprovision of g^l , (ii) the tax rate effect and the capital import effect nullify each other; consequently, g^l is efficiently provided, and (iii) the capital import effect dominates, i.e. g^l is overprovided.

These three cases are reflected by condition (1.48) in proposition 1.4. For a given tax rate t^l and starting from the situation described in case (i), a higher capital import implies a decrease of the r.h.s of condition (1.48). Hence, for a certain amount of capital imports the r.h.s. equals the l.h.s. and the inefficient local public good provision is turned into an efficient provision of g^l . Furthermore, a sufficiently high capital import implies an overprovision of the local public good.

The efficiency of the interregional capital allocation is depicted in figure 1.4. In the

absence of capital taxation the marginal productivity of capital is equalized across regions. Thus, the interregional capital allocation is efficient. Regional output in the h -type region and in the l -type region is given by the area $E Ak_0^h 0$ and $H Ak_0^h(2\tilde{k})$, respectively. With capital taxation in both regions the net-of-tax marginal productivity curves shift downward. Due to $t^h > t^l > 0$ the downward shift of the $f_k^h - t^h$ -curve exceeds the reduction in $f_k^l - t^l$. In the new equilibrium regional output in the h -type region amounts to $E C k_1^h 0$. Correspondingly, regional output in the l -type region is indicated by $H D k_1^h(2\tilde{k})$. Distinct regional capital tax rates yield an inefficient interregional capital allocation. The reduction in aggregate output is given by the area CAD which is borne by the h -type region. Furthermore, the h -type region also bears the l -type region's benefit of having low preferences for public goods. The benefit is due to a higher regional output relative to the initial situation and is reflected by the area $AD k_1^h k_0^h$. For this reason, the h -type region's reduction in regional output equals the excess burden of distinct capital taxation plus the increase in regional output in the l -type region.

1.2.4 Household Mobility

Much of the literature on capital tax competition assumes a perfectly immobile population. One implication of this assumption and the exogenous labor-leisure choice in the basic tax competition model is that labor taxes are lump-sum taxes. With a labor tax and a source-based capital tax local public good provision follows the Samuelson Rule. In this case the source-based capital tax is not part of the optimal tax system. The same holds if a residence-based tax on capital and a source-based capital tax is available to the government. In the setting of the basic tax competition model the former is equivalent to a lump-sum tax. The relaxation of the assumption of an immobile population has striking implications for the efficiency of local public policy. Hence, some of these implications are summarized in this subsection.

Myers (1990) examines the efficiency of local public good provision in the presence of perfect household mobility. In that model, regions are endowed with a fixed quantity of land and each household inelastically supplies one unit of labor at the place of residence. Local governments compete for mobile labor by providing a local public good which is financed by a source-based tax on land and a labor tax. Now, the labor tax is no longer a lump-sum tax as it enters the endogenous location deci-

sion. However, the source-based land tax (property tax) is nondistortionary as it is independent of the place of residence. In addition to the available tax instruments, the regional government can make transfers to other regions.²³ The entire population is homogeneous and, resides where utility is highest. Migration implies that equilibrium utility is equalized across regions. The migration equilibrium condition has an important impact on the outcome of the regional government's maximization problem. Intuition for this result can be gained by the following remark. In addition to the public budget constraint, the regional government is constrained by migration. Any change in regional public policy induces a relocation of households until the migration equilibrium condition holds. Myers (1990) shows that in equilibrium Samuelson levels of local public goods are provided and the population distribution is efficient.²⁴ This result seems to be surprising because households may leave the region in response to an unfavorable public policy. Hence, the marginal cost of public funds of labor taxation exceed unity. But perfect household mobility implies that utility maximization in one region carries over to the maximization of utility in all regions. Consequently, regional optimization is equivalent to a maximization from the entire economy's viewpoint. Myers (1990) refers to this effect as "strong incentive equivalence". The availability of transfers is crucial for this result as voluntary transfers are made to induce an efficient allocation of households. For this reason, perfect household mobility is not a source of inefficiency for decentralized decision making as long as transfers are available at the regional level.

Myers' analysis concentrates on the role of perfect household mobility for the efficiency of local public policy. The analysis does not consider the impact of capital mobility on local public finance which is of primary interest in this analysis. Both capital mobility and household mobility are considered by Wilson (1995), Burbidge and Myers (1994), and Wellisch (1995).

²³The issue of household mobility is also considered by Flatters, Henderson, and Mieszkowski (1974) and Boadway and Flatters (1982). In contrast to Myers (1990) the local government has no access to a transfer instrument in both papers. They show that an efficient allocation of households and an efficient provision of local public goods are incompatible. Thus, they conclude that there is a need for a federally-mandated transfer system to achieve efficiency.

²⁴An efficient distribution of the population requires an equalization of the marginal net benefit of the population across regions. The condition for an efficient interregional allocation of population can be rationalized as follows. Since each household supplies one unit of labor l an inflow of one household raises regional output by f_l . The additional household not only increases output by f_l , but also consumes a fraction of the additional output denoted by c . Thus, the marginal net benefit of the population is given by the difference $f_l - c$.

The implication of a source-based capital tax in the presence of both household mobility and capital mobility is considered by Burbidge and Myers (1994) and Wellisch (1995). Burbidge and Myers (1994) adopt the “attachment-to-home-approach” of Mansoorian and Myers (1993). According to this approach, households have a preference for a particular region for cultural reasons. Hence, the analysis allows for different degrees of household mobility. Households are endowed with land and capital, and inelastically supply one unit of labor at the place of residence. They consider three tax regimes: (i) a source-based tax on land and a residence-based tax on households (head tax), (ii) the aforementioned two tax instruments plus a source-based capital tax, and (iii) a source-based capital tax and a head tax. Under tax regime (i) the Nash equilibrium is efficient. This is not surprising as local public good provision is financed by the nondistortionary land tax. The more interesting tax regimes are regimes (ii) and (iii) as both include a source-based capital tax. Burbidge and Myers (1994) show that under tax regime (ii) the Nash equilibrium is efficient. In contrast, tax regime (iii) results in inefficiencies in general.

The model in Wellisch (1995) is very close to the basic tax competition model. The only difference between the latter and Wellisch’s analysis is the introduction of perfect household mobility. In particular, the set of fiscal policy instruments does not include a transfer instrument as in Myers (1990) and public expenditures have to be financed by a source-based capital tax. In this setting Wellisch (1995) shows that the local public goods are efficiently provided. Moreover, the efficient distribution of the population is realized. In sum, with perfect household mobility and homogenous population the restriction to a source-based capital tax does not limit local governments in their attempt to pursue efficiency. The reason for this result is similar to the one in Myers (1990). The migration equilibrium condition ensures that all effects of decentralized decision making are taken into account when deciding on the source-based capital tax. Thus, the local government perceives a migration response in addition to the perceived outflow of capital. Both perceived reactions in response to an increase in the tax rate imply an efficient outcome. The implication is that there is no inefficiency in local public finance which has to be corrected, e.g., by a central government.²⁵

²⁵The impact of household mobility on the efficiency of decentralized public finance is addressed in a variety of other papers as well. See, e.g., Krellove (1993) for an analysis of tax export and

1.3 Summary

In this chapter, the influence of capital mobility on local public finance has been analyzed. This has been done in the framework of a system of regions which compete for scarce capital. Regions do not just compete for scarce capital to increase regional production and, therefore, to increase income generated in regional production. Since fiscal authorities are restricted to source-based capital taxes, a higher capital employment also results in higher local public good provision and, hence, regional welfare. A residence-based capital tax is not available to governments.

In the basic tax competition model presented in section 1.1 the analysis has been restricted to the case of symmetric regions and to source-based capital taxes as the only tax instrument. Governments choose the capital tax rate for given tax rates of the other governments. By increasing the capital tax rate, capital leaves the region and relocates in regions with a higher net return on capital. Governments account for this effect in their decision-making. The perceived reduction in the tax base raises the marginal cost of public funds above unity. Optimality in decentralized decision-making requires to equate the marginal cost of public funds to the marginal rate of substitution between private and public consumption. Hence, local public goods are underprovided in equilibrium.

However, the outflow of capital is only perceived. Due to the symmetry assumption all regions choose the same capital tax rate. Thus, the equilibrium is characterized by a regional capital employment which equals regional capital endowment. No capital outflow occurs in equilibrium.

The basic tax competition model has been extended in several ways. The extensions can be categorized with respect to the assumption (symmetry assumption, source-based capital tax as the only tax instrument, and household immobility) which has been dropped.

The assumption of the limited availability of tax instruments is dropped first. The introduction of a labor income tax requires endogeneizing the labor-leisure choice. Otherwise, the labor income tax is a lump-sum tax. In this case local public goods are provided efficiently by collecting all tax revenues on the inelastically supplied factor. In the presence of an endogenous labor-leisure choice the analysis is more

Wrede (1998) for a model with Leviathan governments.

complex. Both the source-based capital tax and the labor income tax are distortionary from the perspective of a single region. The basic difference between both tax instruments is that the former results in no equilibrium factor distortions. The latter implies a change in the supply of labor and in an equilibrium distortion. Therefore, from a social point of view the labor tax should not be used. Instead the source-based capital tax ought to be increased. However, optimal taxation from the regions' point of view results in the opposite outcome. With a finite number of regions both tax instruments are used. Since regions possess market power they face a finite elasticity of capital supply. The optimal tax policy is to equate the perceived distortions arising from capital taxation to those arising from labor income taxation. The marginal cost of public funds is still greater unity. Consequently, local public goods are underprovided. If the number of regions converges to infinity, the capital tax is not used in equilibrium. Now, regions are small relative to the rest of the world. They face an infinite elasticity of capital supply. Hence, tax revenues are only collected on the finitely elastically supplied labor. However, the tax policy is the opposite to what social optimality requires. The capital tax rate should be set to zero instead of setting the labor income tax rate to zero.

The symmetry assumption is dropped in two ways. First, asymmetry is introduced by allowing for factor endowment differences. The second approach models asymmetric regions by introducing taste differences for local public goods. The analysis reveals that in both cases the equilibrium interregional capital allocation is inefficient. In general, local public good provision is inefficient as well. Furthermore, the analysis shows that regions with a lower factor endowment or lower preferences for local public goods are better off in equilibrium than regions with higher factor endowments or preferences for local public goods.

The last section has reviewed the literature on tax competition and household mobility. With perfect household mobility and capital mobility the restriction to source-based capital taxation is no barrier for the regional government to achieve an efficient local public good provision and an efficient interregional population distribution. The rationale for this result is that the perceived outflow of capital in response to source-based capital taxation is offset by the residence choice of the population.

Appendix A

Appendix to Chapter 1

A.1 Comparative Static Analysis

In this appendix, the comparative static analysis of regional capital employment k^i , $i = 1, \dots, n$ and the world interest rate r with respect to regional tax rates t^i , $i = 1, \dots, n$ is presented. In a first step the capital market clearing condition

$$n\tilde{k} = \sum_{i=1}^n k^i \quad (\text{A.1})$$

and the first-order condition for regional capital demand

$$f_k^i = r + t^i \quad i = 1, \dots, n. \quad (\text{A.2})$$

are differentiated with respect to k^i , r and t^i . In matrix form this yields

$$\begin{pmatrix} 1 & \dots & 1 & 0 \\ f_{kk}^1 & 0 & 0 & -1 \\ 0 & f_{kk}^2 & 0 & -1 \\ 0 & 0 & f_{kk}^3 & 0 & \dots & 0 & -1 \\ \vdots & \vdots & & \ddots & & \vdots & \\ \vdots & \vdots & & & \ddots & \vdots & \\ 0 & 0 & \dots & f_{kk}^n & -1 \end{pmatrix} \begin{pmatrix} dk^1 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ dk^n \\ dr \end{pmatrix} = \begin{pmatrix} 0 \\ dt^1 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ dt^n \end{pmatrix}$$

Solving for dk^i and dr by applying Cramer's Rule gives

$$\frac{\partial k^i}{\partial t^i} = \frac{\sum_{m=1, m \neq i}^n \prod_{h=1, h \neq i, m}^n f_{kk}^h}{\Lambda}, \quad (\text{A.3})$$

$$\frac{\partial k^j}{\partial t^i} = -\frac{\prod_{h=1, h \neq i, j}^n f_{kk}^h}{\Lambda}, \quad i \neq j, \quad (\text{A.4})$$

$$\frac{\partial r}{\partial t^i} = -\frac{\prod_{h=1, h \neq i}^n f_{kk}^h}{\Lambda}, \quad (\text{A.5})$$

with

$$\Lambda := \sum_{m=1}^n \Pi_{h=1}^n \frac{f_{kk}^h}{f_{kk}^m}. \quad (\text{A.6})$$

In the analysis attention is confined to symmetric equilibria, i.e. $k^i = k^j$ and $f_{kk}^i = f_{kk}^j$. Hence, the expressions simplify to

$$\frac{\partial k^i}{\partial t^i} = \frac{n-1}{n} \frac{1}{f_{kk}}, \quad i = 1, \dots, n, \quad (\text{A.7})$$

$$\frac{\partial k^j}{\partial t^i} = -\frac{1}{n} \frac{1}{f_{kk}}, \quad i = 1, \dots, n, \quad i \neq j, \quad (\text{A.8})$$

$$\frac{\partial r}{\partial t^i} = -\frac{1}{n}, \quad i = 1, \dots, n. \quad (\text{A.9})$$

A.2 Proof of Proposition 1.2

In this part of the appendix the optimal tax policy in a static model is derived if the government has access to a source-based capital tax and a labor income tax. Before turning to the government's optimization problem some results are derived which are needed to solve the government's optimal taxation problem.

The firm's factor demand is given by the first-order conditions

$$f_l = w \text{ and } f_k = r + t. \quad (\text{A.10})$$

Eq. (A.10) implicitly defines the factor price frontier $w = w(r + t)$. The constant returns to scale property of the production technology $f(l, k)$ implies a negatively-sloped factor price frontier, i.e.

$$\frac{dw}{d(r + t)} = -\frac{k}{l} < 0. \quad (\text{A.11})$$

By rewriting the production function to $\tilde{f}(\frac{k}{l})$ and noting, that $f_k = \tilde{f}' = r + t$, the change in capital intensity due to a change in $r + t$ can be stated as follows

$$\frac{d\frac{k}{l}}{d(r + t)} = \frac{1}{\tilde{f}''} < 0. \quad (\text{A.12})$$

Using the Slutsky equation L_r and $L_{w-\tau}$ can be decomposed into the substitution and income effect

$$L_{w-\tau}^s = L_{w-\tau} + L_c \frac{\partial e}{\partial (w - \tau)} \text{ and } L_r^s = L_r + L_c \frac{\partial e}{\partial r} = 0 \quad (\text{A.13})$$

with $e(w - \tau, r, u)$ as the expenditure function and L^s as the Hicksian labor supply function. Note, a change in r has an income effect on labor supply. However, a substitution effect is not present, i.e. $L_r^s = 0$. By the envelope theorem one obtains $\frac{\partial e}{\partial r} = -\tilde{k}$ and $\frac{\partial e}{\partial w - \tau} = -L$. Inserting these results in Eq. (A.13), using the fact that $k = \tilde{k}$ in a symmetric equilibrium, and subtracting both Slutsky equations from each other one arrives at the expression

$$kL_{w-\tau} - LL_r = kL_{w-\tau}^s. \quad (\text{A.14})$$

The terms representing the income effects are eliminated and only the terms representing the total and the substitution effects enter the expression. Additionally, observe that the envelope theorem also implies

$$v_{w-\tau} = u_c L \quad \text{and} \quad v_r = u_c \tilde{k}. \quad (\text{A.15})$$

The capital market clearing condition can be rewritten to

$$n\tilde{k} = \sum_{i=1}^n \frac{k^i}{l^i} (r+t) L^i(w(r+t) - \tau, r). \quad (\text{A.16})$$

Differentiating Eq. (A.16) with respect to r , t , and τ and using Eq. (A.11) gives

$$\frac{dr}{dt} = -\frac{\frac{d(k/l)}{dt} L - \left(\frac{k}{l}\right)^2 L_{w-\tau}}{\gamma} \quad \text{and} \quad \frac{dr}{d\tau} = \frac{\frac{k}{l} L_{w-\tau}}{\gamma} \quad (\text{A.17})$$

with

$$\gamma := n \left[\frac{d(k/l)}{dr} L - \frac{k}{l} \left(L_{w-\tau} \frac{k}{l} - L_r \right) \right]. \quad (\text{A.18})$$

Now, one can obtain the optimal tax policy. The government's optimization problem can be stated as follows

$$\max_{t, \tau} v[w(r+t) - \tau, r] + b \left\{ \left(t \frac{k}{l} (r+t) + \tau \right) L[w(r+t) - \tau, r] \right\} \quad (\text{A.19})$$

subject to $r = r(t, \tau)$. The first-order conditions are

$$\begin{aligned} (t) : \quad & v_{w-\tau} \left[\frac{dw}{d(r+t)} \left(\frac{dr}{dt} + 1 \right) \right] + v_r \frac{dr}{dt} + b_g \left\{ L \left[\frac{k}{l} + t \frac{d\frac{k}{l}}{d(r+t)} \left(\frac{dr}{dt} + 1 \right) \right] \right. \\ & \left. + \left(t \frac{k}{l} + \tau \right) \left[L_{w-\tau} \frac{dw}{d(r+t)} \left(\frac{dr}{dt} + 1 \right) + L_r \frac{dr}{dt} \right] \right\} = 0 \end{aligned} \quad (\text{A.20})$$

$$\begin{aligned} (\tau) : \quad & v_{w-\tau} \left[\frac{dw}{d(r+t)} \frac{dr}{d\tau} - 1 \right] + v_r \frac{dr}{d\tau} + b_g \left\{ L \left(t \frac{d\frac{k}{l}}{d(r+t)} \frac{dr}{d\tau} + 1 \right) \right. \\ & \left. + \left(t \frac{k}{l} + \tau \right) \left[L_{w-\tau} \left(\frac{dw}{d(r+t)} \frac{dr}{d\tau} - 1 \right) + L_r \frac{dr}{d\tau} \right] \right\} = 0. \end{aligned} \quad (\text{A.21})$$

Using Eqs. (A.11), (A.15), and (A.17) and subtracting both first-order conditions yields

$$\left(t \frac{k}{l} + \tau\right) \left(\frac{k}{l} L_{w-\tau} - L_r\right) = t \left(-\gamma + \frac{d^k}{d(r+t)} L\right). \quad (\text{A.22})$$

Inserting Eqs. (A.18) and (A.14) gives

$$\tau \frac{k}{l} L_{w-\tau}^s = t(n-1) \left[-\frac{d^k}{d(r+t)} L + \frac{k}{l} L_{w-\tau}^s\right]. \quad (\text{A.23})$$

Rearranging yields

$$\frac{t}{\tau} = \frac{\frac{k}{l} L_{w-\tau}^s}{(n-1) \left[-\frac{d^k}{d(r+t)} L + \frac{k}{l} L_{w-\tau}^s\right]}. \quad (\text{A.24})$$

As $L_{w-\tau}^s$ is positive and $d^k/d(r+t)$ is negative the numerator as well as the denominator of the r.h.s. of Eq. (A.24) are positive. Hence, if n is finite, both tax instruments are used in equilibrium. However, if $n \rightarrow \infty$, the source-based capital tax is set to 0 and the budget is solely financed by the labor income tax.

A.3 Labor Income Taxation

In this part of the appendix the optimal tax policy is derived if the government only has access to a labor income tax. With the labor income tax τ as the only tax instrument the optimization problem changes to

$$\max_{\tau} \quad v(w(r) - \tau, r) + b(\tau L(w - \tau, r)) \quad (\text{A.25})$$

subject to $r = r(\tau)$. The first-order condition is

$$(\tau) : v_{w-\tau} \left[\frac{dw}{dr} \frac{dr}{d\tau} - 1 \right] + v_r \frac{dr}{d\tau} + b_g \left\{ L + \tau \left[L_{w-\tau} \left(\frac{dw}{dr} \frac{dr}{d\tau} - 1 \right) + L_r \frac{dr}{d\tau} \right] \right\} = 0. \quad (\text{A.26})$$

Using Eqs. (A.11), (A.14), (A.15) and rearranging yields

$$\frac{b_g}{u_c} = \frac{1}{1 + \eta - \eta^s \frac{dw}{dr} \frac{dr}{d\tau}} \quad (\text{A.27})$$

where

$$\eta := -\frac{\partial L}{\partial(w-\tau)} \frac{\tau}{L} \quad \text{and} \quad \eta^s := -\frac{\partial L^s}{\partial(w-\tau)} \frac{\tau}{L^s} < 0. \quad (\text{A.28})$$

To identify the influence of the number of regions n on the level of local public goods it is useful to rewrite the condition as follows

$$\frac{b_g}{u_c} = \frac{1}{1 + \eta - \frac{\eta^s}{n} \frac{dw}{dr} \kappa}. \quad (\text{A.29})$$

Note, by Eqs. (A.14) and (A.17)

$$\frac{dr}{d\tau} = \frac{1}{n} \kappa \quad (\text{A.30})$$

with

$$\kappa := \frac{\frac{k}{l} L_{w-\tau}}{\frac{d(k/l)}{dr} L - \frac{k}{l} (L_{w-\tau}^s \frac{k}{l})}. \quad (\text{A.31})$$

If $L_{w-\tau} > 0$, κ is unambiguously negative.

Chapter 2

Capital Taxation in a Federal System

In the last chapter, the analysis is restricted to a system of independent regions. Each unit of government decides independently how much local public goods to provide and, if multiple taxes are available, which taxes are used in funding public expenditures. The resulting inefficiency in local public good provision is due to the mobility of the tax base. One objective of this chapter is to provide a systematic description of the inefficiency result. A further objective is to extend the setting of the previous chapter by allowing for a multi-tier federal state. Specifically, the impact of capital mobility on public finance within a two-tier federal system is analyzed. Thus, the chapter is organized as follows: after an introduction in section 2.1 the concept of fiscal externalities is presented in sections 2.2 and 2.3. Section 2.4 introduces a model of public finance in a two-tier federal system - a central government and two regional governments. In this model capital taxation occurs at the lower level whereas a labor income tax is assigned to the central level. Section 2.5 summarizes and concludes the chapter.

2.1 Introduction

As mentioned in the last chapter, capital mobility gives rise to an inefficient decentralized decision making if tax revenues have to be raised by a source-based capital tax. The obvious intuition for this result is that each regional government acts independently. It selects a public policy to maximize the utility of its residents and, thus, acts in the best interest of its residents. However, in choosing the optimal policy it neglects the impact of its decision on nonresidents. This effect is ignored

by the regional government resulting in an inefficient capital tax rate. Gordon (1983) and Wilson (1989) identify the source of this failure as a fiscal externality. To see how the inefficiency result relates to externalities, recall that in the basic tax competition model a rise in the capital tax rate implies a reduction of the tax base. But the outflow of capital is equivalent to an inflow of capital and, thus, a higher tax base in other regions. The capital tax raising region does not account for this beneficial externality. Consequently, the capital tax rate is inefficiently low. This explanation for the inefficiency result in local public finance is a familiar concept in economics. In contrast to the “usual” externalities (e.g. environmental externalities) fiscal externalities only operate among fiscal decision units. More precisely, fiscal externalities are due to the behavior of a decision unit not anticipating the reaction of other fiscal decision units when making its decision. To provide a better understanding of this issue suppose there is a system of two independent regions. Everything else is assumed to be identical to the structure of the basic tax competition model. If one region anticipates the reaction of the other region, due to its tax rate decision, fiscal externalities would not arise. It would take into account that a capital outflow corresponds to an inflow of capital in the other region which in turn affects the decision of the other regional government. The illustration reveals that the existence of fiscal externalities crucially depends on the behavioral assumption underlying public decision making.

As motivated above, optimal taxation within a federal system is closely connected to the strategic interaction between decision units. A more detailed analysis of this issue is given in the rest of this section. However, before turning to the issue of optimal taxation in a federal system the traditional optimal taxation approach is briefly reviewed with respect to the behavioral assumption of the policy maker. This is done in the next paragraph. In the second paragraph the optimal taxation approach is applied to a federal system.

Optimal Taxation The traditional optimal taxation approach seeks to minimize the overall distortions caused by a tax system.¹ The classical problem in the theory of optimal taxation is to analyze the optimal commodity tax structure if a lump-sum tax is not available and one good (e.g. leisure) is not taxable.² In general, the

¹See, e.g., Mirrlees (1986) for a survey on the theory of optimal taxation.

²The most known optimality conditions are the Ramsey rule, the Corlett-Hague rule, and the Inverse-Elasticity rule where the Corlett-Hague rule and the Inverse-Elasticity rule are only special

distortions in the private agents' decisions can take different forms, e.g. substitution effects in the labor-leisure choice, substitution effects in the intertemporal consumption choice, or a reduction in the firms' investments. The tax planner takes the effects of the tax system on the private agents' decisions into account and chooses the tax rates so as to spread the distortions evenly over all decisions. The optimal tax system is thus characterized by an equalization of the welfare loss resulting from the different forms of distortions. More precisely, private agents decide for a given tax system. The tax planner (i.e. the government) knows the reaction functions of private agents and uses this information when deciding on the tax system. That is, the government acts as a Stackelberg leader whereas the private agents behave in a Nash manner. Therefore, these behavioral assumptions ensure that all effects of the tax system are internalized by the government. Externalities do not arise from the tax system.

The traditional optimal tax problem either assumes the existence of only one government for all private agents or that the tax decision of one government has no effect on other governments. Hence, the traditional approach abstracts from any intergovernmental relations. However, this assumption is not appropriate as neither only one government exists for all private agents nor, in a world with multiple governments, intergovernmental effects of national tax systems are negligible.

Optimal Taxation in a Federal System The relaxation of this assumption leads to the application of the optimal-taxation methodology to fiscal federalism which dates back to Gordon (1983). In general, the optimal taxation approach to fiscal federalism analyzes how a tax system should be designed if, in addition to private agents within the state, other states and the private agents therein are affected by the tax policy. Consequently, this approach encompasses the traditional approach to optimal taxation as both the intra- and interregional effects of the tax policy are subject to optimization. The optimization procedure results in an optimal federal tax system which serves as a reference for intergovernmental tax system design. In addition to characterizing the optimal federal tax system, the optimal taxation approach to fiscal federalism aims at identifying fiscal externalities responsible for a deviation of the implemented tax system from the optimal tax system. Since Gordon's contribution, a large amount of literature has evolved

cases of the Ramsey rule; see Mirrlees (1986).

which deals with the issue of identifying inefficiencies in federal policy making. As mentioned above, the sources of inefficiency can be summarized by the concept of fiscal externalities which simply states that not all effects of the region's tax policy are internalized. The occurrence of fiscal externalities in turn can be traced back to the behavioral assumption underlying public decision making. More precisely, fiscal externalities result from a dichotomy of behavior. The regional government anticipates the change in the supply and demand behavior of its residence which is consistent with the traditional optimal taxation approach. However, the reaction of other states to a change in tax policy is not anticipated. That is, the region's government behaves as a Stackelberg leader towards its residents, but behaves in a Nash manner towards other regions and their residents.³

In sum, the behavioral assumption of fiscal decision units is an important element in the optimal taxation approach to fiscal federalism. In particular, the question whether the efficiency of decentralized source-based capital taxation can be improved in a federal system crucially depends on the behavior of governments at each level of the federation. For this reason the interaction between fiscal externalities and the above mentioned behavioral assumptions is highlighted in the rest of this chapter. First, a survey on different forms of fiscal externalities is presented in the next subsection, which goes beyond the types of externalities detected in Gordon (1983).

2.2 Fiscal Externalities: An Overview

In general fiscal externalities can take two forms. They can be direct or indirect. Both forms of fiscal externalities are illustrated in figure 2.1 for the case of a two-tier federal state with two regions at the lower level. A direct fiscal externality occurs when a change in the government's fiscal policy has an effect on private agents (e.g. households) of other regions. Policy changes also affect the residents of the same region. However, this effect is internalized by the regional government. The direct horizontal fiscal effect can be due to a change in the expenditure policy or tax policy. One example of a direct horizontal fiscal externality caused by tax policy is tax exporting. Tax exporting refers to a situation where a part of a region's tax revenue is borne by non-residents. This kind of negative direct fiscal externality oc-

³For a general discussion of game-theoretic concepts in the theory of fiscal federalism see Pfingsten and Wagner (1995).

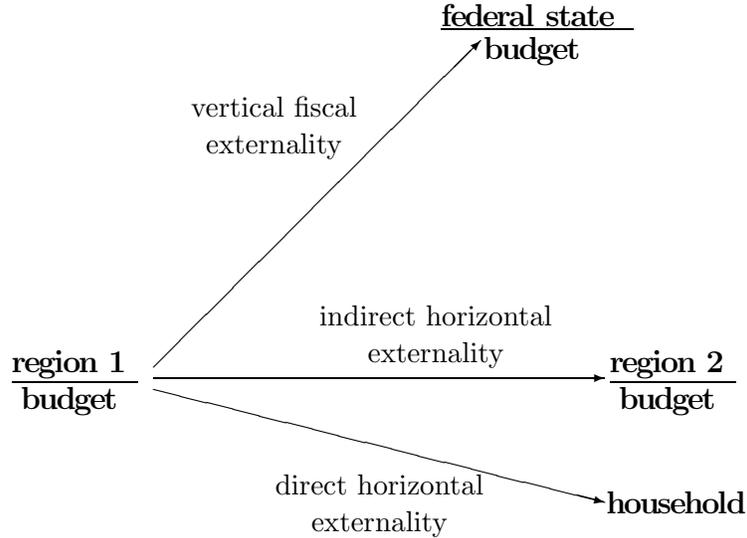


Figure 2.1: Fiscal externalities.

curs when taxes are imposed on goods which are exported and tax revenues accrue to the country of origin. The benevolent government sets the tax rate to maximize the utility of the residents. Hence, the government has an incentive to impose too high tax rates as not all negative effects of the tax policy enter the optimization problem. Put differently, the private marginal cost of public funds is lower than the social marginal cost of public funds.⁴ A detailed analysis of this issue is given, e.g., in Arnott and Grieson (1981) and Wildasin (1987). In contrast, indirect fiscal externalities occur when the fiscal policy of a government affects the fiscal policy of other governments. In general, indirect fiscal externalities can be categorized in horizontal fiscal externalities and vertical fiscal externalities. The distinguishing feature between both kinds of fiscal externalities is that the latter can only occur in federal states while the existence of the former is not restricted to federal states. Horizontal fiscal externalities can even occur between independent states. The nature and implications of both forms of fiscal externalities are presented in the following two subsections.

⁴The social marginal cost of public funds encompasses all effects of a marginal increase in the tax rate. If the government accounts for all effects of its tax rate decision, the private marginal cost of public funds coincide with the social marginal cost of public funds.

2.2.1 Horizontal Fiscal Externalities

As mentioned above, horizontal fiscal externalities arise on the same level of governments. The implications for the government's decision making are comparable to those when a direct fiscal externality occurs. A benevolent government does not take all consequences of its decision into account and, therefore, chooses an inefficient public policy. However, the direction of the distortion depends on the nature of the horizontal fiscal externality. A positive fiscal externality implies a higher marginal cost of public funds as perceived by the government relative to the social marginal cost of public funds. In this case, the distortion would result in an inefficiently low value of the public policy instrument. A negative fiscal externality has the opposite effect. The perceived marginal cost of public funds is too low compared to the social marginal cost of public funds. Consequently, the policy instruments are set at an inefficiently high level. The existence of horizontal fiscal externalities requires some form of factor or commodity mobility. Factor or commodity mobility is the mean by which negative or positive effects of regional fiscal policy are transmitted to other regions. Without any form of mobility regions act in isolation and, consequently, horizontal fiscal externalities cannot arise. Most of the literature dealing with horizontal fiscal externalities assumes the tax base itself is mobile and that regions are engaged in tax competition.⁵ In these models the precise nature of the horizontal fiscal externality depends on the tax instrument used to compete for a mobile tax base. Three strands of literature on tax competition have been developed: capital tax competition with immobile households, labor tax competition with mobile households, and commodity tax competition.

Capital Mobility As mentioned in the previous section, if a government is restricted to a source-based capital tax it perceives an outflow of capital when increasing the tax rate. In addition to the social marginal rate of transformation, the decline in the capital tax base is seen as a cost component for providing a local public good. As a result, local public goods are underprovided. The inefficient low level of the local public good can be explained by a positive horizontal fiscal

⁵However, the existence of horizontal fiscal externalities does not require a mobile tax base. As shown in the last chapter an immobile, but endogenously determined tax base is sufficient for fiscal spillovers to arise. Recall, labor income taxation in the presence of capital mobility implies a positive horizontal fiscal externality. As a consequence, the labor income tax rate is inefficiently low though labor itself is immobile.

externality. Specifically, when deciding on the level of the tax rate the government perceives an outflow of capital. However, this leads to an inflow of capital in other regions. Consequently, capital tax revenues rise in regions which enjoy a capital inflow. Therefore, the source of inefficiency are externalities which are a familiar explanation concept for inefficiencies in the economic literature. Here the externality takes the form of a positive horizontal fiscal externality.

Household Mobility Households are immobile in the basic capital tax competition model. The introduction of household mobility has striking implications for the efficiency of decentralized public policy. If one allows for perfect household mobility in the basic tax competition model, local public good provision is efficient [see Wellisch (1995)]. In this setting regions still perceive an outflow of capital in response to a rise in the capital tax rate. However, this does not imply a positive horizontal fiscal externality as in the basic tax competition model. The reason is that migration takes place until utility is equated across regions. The utility-equalizing effect of perfect household mobility ensures that a region maximizes utility in all rather than only in its own region. To put it differently, the migration equilibrium condition acts as an internalization scheme. All effects of an increase in the source-based capital tax are internalized via the migration equilibrium condition. As a consequence, perfect household mobility induces “strong incentive equivalence” among regions and, thus, with symmetric regions no externalities are associated with the use of a source-based capital tax.

Commodity Exchange In addition to the tax competition literature on mobile capital and mobile labor, a third strand of literature on commodity tax competition has been developed. Mintz and Tulkens (1986) consider a model with two regions in which each region consists of a representative consumer who consumes a private good, a public good, and leisure. The private consumption good can be domestically produced or imported from the other region. Households import goods by cross-border shopping. They incur transportation costs by traveling to the foreign region. The local government finances public good provision by a commodity tax. Interregional commodity exchange is taxed on an origin basis, i.e. a commodity is taxed where it is produced irrespective of where it is consumed. A labor income tax is not available to the government. The commodity tax rates are chosen non-cooperatively as to maximize the utility of representative household.

In general, two kinds of fiscal externalities can occur in this setting. First, an increase in a region's tax rate increases the consumer price for the consumption of the imported commodity. This in turn affects utility of the representative household in the foreign region in a negative way. The negative direct fiscal externality is referred to as the private consumption effect. Second, a rise in a region's tax rate also implies higher tax revenues in the other region and thereby, increases public good provision.⁶ This positive indirect horizontal fiscal externality is referred to as the public consumption effect. Both effects work in opposite directions.

Mintz and Tulkens (1986) show that, if cross-border shopping occurs at least in one region and production occurs in both regions, tax rates are inefficiently chosen due to the existence of fiscal externalities.⁷ As both fiscal externalities have an opposite sign it is possible that the tax rates are inefficiently low as well as inefficiently high in each of the two regions. The authors show that the case of an inefficiently high tax rate in both regions can be excluded. That is, under the conditions stated above, it is not possible that the negative fiscal externality outweighs the positive fiscal externality in both regions.

Haufler (1998) concludes that in the Mintz-Tulkens setting the case of inefficiently low tax rates in both regions can also be excluded in general. Consequently, in one region the tax rate is too low whereas the tax rate in the other region is chosen too high relative to the efficient level. Hence, in the low tax region the positive externality dominates and in the high tax region the negative externality is the dominating effect.

The difference between capital tax competition and commodity tax competition as modeled by Mintz and Tulkens (1986) is that the former allows for the mobility of the tax base whereas the latter does not allow for an interregional reallocation of the tax base in response to tax rate changes. With commodity tax competition the household's consumption choice react to changes in both states' tax policy. However, a reduction of the tax base does not occur. Consequently, both regions do

⁶More specifically, an increase in the tax rate may have two effects on production and, therefore, on the tax base in the foreign region. First, the tax rise implies higher consumption of the imported commodity. Second, as the consumer in the foreign region faces a higher price for the imported good consumption of the domestically produced good increases. The total effect of a tax increase on the consumption of domestically produced commodities in the other region is positive. Hence, the tax base increases which reflects the positive indirect fiscal externality [see prop. 2 and 4 in Mintz and Tulkens (1986)].

⁷These two restrictions correspond to regime 2 and 3 in Mintz and Tulkens (1986).

not really compete for a tax base.⁸ A second difference between the basic capital tax competition model and the model considered here is that in the commodity tax competition approach the indirect horizontal fiscal externality occurs in equilibrium and is not only perceived.⁹

Empirical Results While most of the literature on horizontal fiscal externalities is of theoretical nature there are also some empirical studies. Stephenson and Hewett (1985) analyze the interdependence between motor fuel tax revenues in the U.S. states of Iowa and Missouri. They find that a 1% increase in Missouri's motor fuel tax rate causes a 10.8% rise in Iowa's motor fuel tax revenues. Conversely, the elasticity of Missouri's motor fuel tax revenues with respect to Iowa's motor fuel tax rate is 14.85%. Both results confirm the theoretical finding that the tax rate decision in one region has an impact on other regions due to the mobility of the tax base (here the mobility of consumers, i.e. cross-border shopping). The positive effect of a tax rate increase in one region on tax revenues in other regions imply an overestimation of the marginal cost of public funds if it ignores the fiscal interregional effects. Hence, the empirical result suggests too low motor fuel tax rates in both states.

Büttner (1999) deals with the question whether tax competition can be identified in local public finance in Germany. In contrast to the United States and Canada, there is almost no source for horizontal fiscal externalities due to tax rate decisions in Germany since tax rates are determined at the upper level of government (Bund). However, one exception is the business tax (Gewerbesteuer) which is assigned to the lowest level of government (Kommunen). The empirical analysis reveals that business tax rates are positively related to those of neighboring regions. This result is in line with the theoretical literature. Moreover, Büttner (1999) shows that tax rates are positively related to the population size. Hence, larger regions set higher tax rates. Again, this result is consistent with the literature on asymmetric tax competition as well. Recall, as shown by see Bucovetsky (1991) and Wilson (1991),

⁸For this reason, Wilson (1999) finds it difficult to classify Mintz and Tulkens (1986) as a tax competition model.

⁹DeCrombrughe and Tulkens (1990) and Lockwood (1993) also address commodity tax competition. In particular, see Lockwood (1993) for an analysis of commodity tax competition under both the origin-based and the destination-based principle.

asymmetric tax competition implies distinct equilibrium tax rates. Larger regions possess more market power and, thus, perceive a smaller outflow of capital when raising the tax rate. The marginal cost of public funds are lower and, consequently, the resulting tax rate is higher.

Accordingly, the empirical literature on interregional tax interdependence confirms the results derived in the theoretical tax competition literature.¹⁰

2.2.2 Vertical Fiscal Externalities

The literature in public finance has devoted much interest to the analysis of horizontal fiscal externalities. However, that is not the only kind of fiscal externality which can arise from expenditure and tax policy. A second type of fiscal externalities are vertical fiscal externalities. It is only recently that these fiscal externalities have received attention in the public finance literature. Though the first papers dealing with vertical fiscal externalities are Flowers (1988) and Johnson (1988) it is the paper by Boadway and Keen (1996) and a survey by Dahlby (1996) which have directed more attention to this type of fiscal externality.

Vertical fiscal externalities can only occur in a federal system, i.e. in a state with at least two levels of government. In general, vertical fiscal externalities arise if one level of government neglects the impact its fiscal decisions have on fiscal policy of the other levels of government. The fiscal decision variables can include public expenditures as well as tax rates. Most of the following analysis concentrates on tax rates rather than public expenditures as the policy variable which creates vertical spillovers. Vertical fiscal externalities arising from tax rate decisions can be categorized with respect to its direction and source. An illustration of this categorization is given in the next two paragraphs.

Direction of Vertical Fiscal Externalities In the case of vertical fiscal externalities multiple levels of government are simultaneously engaged in tax setting. Thus, a vertical spillover can go from a lower level to an upper level of government and vice versa. The former is referred to as bottom-up vertical fiscal externality. Conversely, the latter is called top-down vertical fiscal externality. For the efficiency of public decision making the direction of the vertical spillover is irrelevant. Only

¹⁰See also Case (1993) for an empirical analysis of tax competition and Fujii, Kahled, and Mak (1985) for an empirical study on tax export.

the sign and magnitude of it matter.

Sources of Vertical Fiscal Externalities Vertical spillovers are due to the fact that both levels of government use the same tax base. The resulting concurrent taxation can have different sources. The most obvious source of vertical fiscal externalities is a perfect tax base overlap. A perfect tax base overlap is given if more than one level of government is assigned a tax which is applied to the same tax base. One prerequisite for perfect tax base overlap to arise is that each layer must have tax-setting powers. Tax sharing agreements among different layers do not cause vertical spillovers. Under this institutional arrangement tax revenues are shared, but only one layer has tax setting power. For instance, in Germany major tax revenues such as the income tax, value-added tax, and the corporate tax are shared at least among the Bund and the Länder. However, tax-setting powers are assigned to the Bund.

This source of vertical fiscal externalities has been analyzed by Wrede (1996), Boadway and Keen (1996), and Boadway, Marchand, and Vigneault (1996). Wrede (1996) uses a model where different layers of government have access to the same tax base which in turn is mobile among the member states of the federation. Regions play Nash. That is, the regional government selects the tax rate for given tax rates of other regions. If the mobile tax base could not leave the federation, i.e. the tax base would only be mobile within the federation, vertical fiscal externalities would not occur. From the perspective of the federal layer, the tax base is immobile and, hence, a federal tax rate change would not change the tax base of the lower layer. In this case, the federal tax is a lump-sum tax. To introduce vertical fiscal externalities Wrede (1996) has allowed for the possibility that capital can also be allocated outside the federation. A natural application of this model is capital tax competition. With a tax base overlap, decentralized capital taxation leads to a positive horizontal fiscal externality and a negative bottom-up vertical fiscal externality as some capital leaves the federation and, thus, can no longer be taxed by the central government. Additionally, centralized capital taxation causes a negative top-down vertical fiscal externality. In response to central tax decisions the tax base of the lower level of governments shrinks which is not taken into account as the upper level of government plays Nash.

By contrast, Boadway and Keen (1996) and Boadway, Marchand, and Vigneault (1998) develop a model where both levels of government tax labor income. The

distinctive feature between these two models and that of Wrede (1996) is that in the latter the tax base can only react due to the mobility assumption whereas in the former the tax base reacts due to the mobility as well as an endogenous labor-leisure choice. The two papers also differ from Wrede (1996) with respect to the behavioral assumption of the central government. In both papers the central government acts as a Stackelberg leader. As motivated at the beginning of this chapter this difference has important implications for the occurrence of fiscal externalities. A detailed description of Boadway and Keen (1996) and Boadway, Marchand, and Vigneault (1998) is given in Sections 2.3 and 2.4.

A different source of concurrent taxation is given if two levels of government use different tax bases but taxes paid at one level of government reduce the tax liability towards the other level of government. In general, this kind of concurrent taxation can take two forms. First, the tax liability towards one layer can be deducted from the tax base of the other layer. This is referred to as tax deductibility.¹¹ In the second form, the tax liability towards one layer can be subtracted from the tax liability towards the other level of government. This form of tax treatment is called tax credit. For instance, the U.S. personal income tax system exhibits this institutional feature. The personal income tax paid at the state level can be deducted from the tax base of the federal income tax. Moreover, in some states the federal income tax can even be deducted from the state income tax (reciprocal tax deductibility).

The deductibility of taxes among different layers of government has important implications for the efficiency of public decision making in a federal state. Consider the case of a regional government which chooses its tax policy based on given federal tax rates. If regional taxes can be deducted from the federal tax the lower level of government does not account for the impact of its decision on the federal budget. *Ceteris paribus*, an increase in regional tax revenues lowers federal tax revenues. This bottom-up vertical fiscal externality is negative in sign. Hence, tax deductibility lowers the perceived marginal cost of public funds at the regional level.

As vertical tax spillovers are implied by tax law, Keen (1998) refers to both perfect tax base overlap and tax deductibility as formal concurrency. Additionally, Keen (1998) distinguishes between formal concurrency and effective concurrency. The latter is not rooted in tax law. In the case of effective concurrency the source of

¹¹It should be stressed that tax deductibility is not only restricted to a federal system. It can also occur in a unitary nation.

the vertical fiscal externalities are relative price changes due to a tax decision of one layer. To state it more precisely, suppose two levels of governments have access to different tax bases. If the lower level of government changes its tax rate, e.g. a labor tax in the presence of an endogenous labor-leisure choice, equilibrium employment is changed. In general, this does not leave the upper level budget unaltered. For instance, if the upper layer taxes profits the tax induced reaction of equilibrium employment also affects profits. Hence, the tax base of the upper level of government reacts to a tax rate change of the lower level of government through general equilibrium effects (relative price changes). Note, in contrast to tax deductibility this form of vertical fiscal externalities can be negative as well as positive in sign.

Dahlby, Mintz, and Wilson (1999) analyze the interaction between tax deductibility and vertical fiscal externalities through general equilibrium effects.¹² They derive the optimal deductibility rate, i.e. the deductibility rate that neutralizes the vertical spillover. In their setting the federal government anticipates the reaction an increase in the federal tax rate exerts on the regional budget. The vertical spillover can be decomposed into a direct effect due to tax deductibility and an indirect effect arising from general equilibrium effects. The optimal deductibility rate depends on the sign and magnitude of the change in the federal budget due to a rise in the regional tax rate. Since the direct effect is unambiguously negative, the optimal rate is determined by the sign and magnitude of the indirect effect. Dahlby, Mintz, and Wilson (1999) show that if the indirect effect is zero, i.e. besides tax deductibility the federal budget is unaffected by regional tax policy, the optimal deductibility rate is 0. By setting the rate at 0 no vertical fiscal externalities occur. However, if the indirect effect is negative the federal budget is negatively affected by both effects. For a given tax assignment the direct effect cannot be altered. However, because of the endogeneity of the deductibility rate the negative indirect effect can be counteracted by choosing a negative deductibility rate. Now, the direct effect becomes positive. The optimal negative rate neutralizes the negative indirect effect. On the other hand, a positive indirect effect requires a positive deductibility rate. Specifically, if the federal tax base increases by less than 1 Euro (due to the indirect

¹²See also Dahlby and Wilson (1999) for an analysis of this issue. They examine the provision of productivity enhancing activities in a federal state. In contrast to Dahlby, Mintz, and Wilson (1999) they confine attention to vertical fiscal externalities due to general equilibrium effects and expenditure externalities.

effect) in response to a 1 Euro rise in state tax revenues the optimal deductibility rate is lower than one. A one-to-one relation between a rise in state tax revenues and the federal tax base calls for a full deductibility of state taxes from the federal tax base, i.e. the optimal deductibility rate is 1. The positive indirect vertical fiscal externality is neutralized by allowing for a negative direct vertical fiscal externality where the magnitude of the latter is adjusted to that of the former.

Empirical Results Most papers dealing with vertical fiscal externalities are theoretical in nature. However, there are a few papers which analyze vertical spillovers empirically.¹³ Besley and Rosen (1998) analyze consumption tax interdependence in the U.S. federal system. In the U.S. both the federal and state layers tax gasoline and cigarettes. The empirical analysis aims at estimating the magnitude of the responses of the state gasoline and cigarette tax to federal tax rate increases. Besley and Rosen (1998) find that a 10-cent per gallon increase in the federal tax rate on gasoline is followed by a 3.2-cent increase in the state tax rate. Additionally, a 10-cent per pack increase in the federal tax rate on cigarettes implies a 2.7-cent increase in the state cigarette tax. The responses are found to be statistically significant. Both results suggest that there is a strong tax interdependence in the U.S. consumption tax system.

Esteller-Moré and Solé-Ollé (1999) quantify the magnitude of the personal income tax independence in the U.S. federal system. As outlined before in the U.S. personal income tax system the state income tax can be deducted from the federal income tax base. Esteller-Moré and Solé-Ollé (1999) also perform an empirical test for the existence of vertical fiscal externalities by estimating the response of the state tax rate to a rise in the federal income tax rate. They find that there is a significant positive reaction of the state personal income tax rate when the federal government increases its own income tax rate. More precisely, a 1 point increase in the federal tax rate leads to an increase of approximately 0.25 points in the state tax rate. Unfortunately, a decomposition of the total state response into a reaction resulting from tax deductibility and a reaction arising from general equilibrium effects cannot be derived in the analysis. This would require a benchmark with either only tax

¹³Feenberg, Mitrusi, and Poterba (1997), Fullerton and Rogers (1993) provide an empirical analysis of the impact changes in U.S. federal tax rates have on the economy. However, they assume constant state tax rates. Hence, these papers are not directed at testing for vertical fiscal externalities.

deductibility effects or general equilibrium effects. In sum, both Besley and Rosen (1998) and Esteller-Moré and Solé-Ollé (1999) confirm that vertical fiscal externalities are not only of theoretical interest but also of empirical relevance.

2.3 Boadway and Keen (1996) - A Neutrality Result

Boadway and Keen (1996) (BK henceforth) provide a systematic analysis of vertical fiscal externalities. The main finding in BK is that fiscal externalities arising from concurrent labor taxation and household mobility are of no concern if the federal government acts as a Stackelberg leader. To get a better understanding of the neutrality result the model is presented in the remainder of this section. This enables to draw parallels between the model in BK and a federal setting with source-based capital taxation at the lower level analyzed in the next section.

In BK the federal government taxes labor income at the rate t and the local government at the rate τ . Hence, the total labor income tax amounts to $T = t + \tau$. The federal government's budget constraint is $nS + G = ntl$. G is the level of a national public good provided by the central government, n is the number of regions within the federation, l is the employment level, and S denotes an unconditional transfer which can either go from the federal government to the regions or vice versa. The local government's budget constraint is $g = \tau l + S$ where g is a local public good provided by the regional government.

First, attention is restricted to the case of household immobility. With this restriction the only household's endogenous decision is the labor-leisure choice. The regional government sets τ to maximize the indirect utility function of the representative household. The upper level's tax rate decision is taken as given and, thereby, the impact of its tax decision on federal tax revenues is neglected. The marginal cost of public funds at the regional level is equated to the marginal rate of substitution between private income and local public goods. As labor supply is decreased in response to an increase in τ , a negative bottom-up vertical fiscal externality results from decentralized fiscal policy. Hence, the tax rate τ is set too high.

The federal government chooses t to maximize the indirect utility function of the representative household.¹⁴ In contrast to local governments the federal government acts as a Stackelberg leader. It takes all effects of its decision into account when deciding on t . Specifically, it anticipates the impact of its decisions on regional tax revenues and the induced change in τ . If labor tax revenues are the only source of tax revenues for the upper and lower level of government a solution to the federal optimization problem is to set the tax rate t to 0. With $t = 0$ federal labor tax revenues are 0 and the regional fiscal decision would not exert a negative effect on labor tax revenues at the upper level. That is a negative bottom-up vertical fiscal externality does not arise. Federal expenditures are financed by a transfer from the lower to the upper levels of government.

However, this is not a general solution of the model considered in BK since, in addition to labor, a second input factor is used in production. The second input factor, e.g. land, is exogenous and immobile. This gives rise to rents which can be taxed away without causing distortions. In BK these rents are taxed at 100% and shared among both levels of government. A fraction of θ accrues to the federal level and the corresponding fraction $1 - \theta$ accrues to the regional level. With this modification a tax rate t of 0 cannot eliminate vertical fiscal externalities. Federal labor tax revenues are still zero. But the regional choice of τ affects rents and, therefore, the second source of federal tax revenues. This negative bottom-up vertical fiscal externality is not eliminated by setting $t = 0$. Now, it is optimal to choose $t \neq 0$ and to allow for vertical spillovers on both sources of federal tax revenues. However, the federal government can still choose t to induce a total labor income tax T which would be chosen in a unitary nation, i.e. in the absence of vertical fiscal externalities. To see this, consider T^* as the total income tax rate chosen in a unitary nation. In the federal setting of BK the regional government selects an inefficiently high τ due to the existence of negative vertical spillovers. As the total tax rate is the sum of t and τ , the federal government can mitigate the inefficiency in decentralized decision making by setting t appropriately, i.e. $t = T^* - \tau$. Thus, the central government acting as a Stackelberg leader can implement the same tax policy as in a unitary

¹⁴Though the federal labor tax rate t is applied to all n regions the federal government's objective function can be restricted to the indirect utility function of the representative household. A welfare functional with the indirect utility of all regions as arguments is not necessary as regions are not linked through household mobility or international capital markets.

nation. To put it differently, the central government can mitigate the inefficiency caused by the Nash behavior of the regional government.

If labor tax revenues are the only source of tax revenues and t is optimally set to 0 transfers flow from the regional to the federal budget. However, with two sources of tax revenues the direction of transfers is ambiguous. As one usually expects transfers go from the center to the regions. But transfers from the regions to the center cannot be excluded. The direction of transfers depends on which level of government has the less distortionary tax instrument at hand. That is, transfers go from whichever layer has the less distortionary tax instrument to whichever layer has the more distortionary tax instrument.

So far, only vertical fiscal externalities are present in this model. To introduce horizontal fiscal externalities the tax base must become mobile. BK allows for horizontal fiscal externalities by introducing perfect household mobility. Now, households can choose the region where they reside and supply labor and, thus, move to the region where utility is highest. In a migration equilibrium households' utility is equalized across regions. This equilibrium condition is a crucial factor for the efficiency of decentralized decision making. As shown in chapter 1 the utility-equalizing effect of perfect household mobility ensures that all effects of local decision making are internalized ("strong incentive equivalence"). Hence, as shown by BK, horizontal fiscal externalities do not arise. The regional optimal policy under household immobility and perfect household mobility coincide and the neutrality result derived under household immobility applies here as well.

BK modify the model by restricting attention to the case of labor mobility. Households are free to work in any region while remaining residents of the initial region. The regional labor tax now becomes a source-based labor tax. With this modification the interregional net wage differential rather than the interregional utility is equalized. Under labor mobility the local governments optimization problem is similar to that in the basic tax competition model. In addition to the effects under labor immobility, a rise in the labor tax rate reduces the net wage which leads to an outflow of labor. As a result a positive horizontal fiscal externality arises. At the same time, the fixed factor income decreases. Due to rent sharing this in turn reduces regional tax revenues (with fraction $1 - \theta$) and federal tax revenues (with

fraction θ). The latter effect is not accounted for by the regional government. For this reason, it constitutes a negative bottom-up vertical fiscal externality. Since both effects are different in sign the impact of labor mobility on the regional government's policy choice depends on which externality dominates. BK show that the federal government has enough policy instruments to replicate the unitary nation outcome. The optimal federal policy requires a higher federal labor tax rate t and a rise in transfers to the regions relative to the optimal federal policy under labor immobility. This indicates a lower regional labor tax rate τ as $T^* = \tau + t$. The result confirms the finding in the basic tax competition model that factor mobility increases the marginal cost of public funds at the regional level which translates into a lower tax rate relative to factor immobility. Summing up, in the setting of BK fiscal externalities arising from concurrent taxation and from the mobility of the tax base can be internalized. Crucial for this result is that the federal government moves first.

2.4 Fiscal Externalities: A Model

In this section, a model of federal taxation is presented. The section is structured as follows. After a literature review in section 2.4.1 the model set-up is introduced in section 2.4.2. In section 2.4.3 the outcome in a unitary nation is analyzed, which serves as a benchmark in this section. A two-tier federal system and the policy outcome under both-sided Nash behavior is presented in section 2.4.4. Section 2.4.5 examines the interaction between the federal and state levels if the federal government can commit to its policy. In section 2.4.6 the direction of commitment is reversed and the implications for the choice of policy variables are discussed. Finally, section 2.4.7 includes a summary and conclusion.

2.4.1 Introduction

Following the seminal papers by Zodrow and Mieszkowski (1986) and Wilson (1986), a stream of literature has explored the implications of tax competition for public good provision. In the simplest model with perfectly mobile capital, an immobile fixed factor, and a restriction on source-based capital taxes, local public goods are underprovided due to horizontal fiscal externalities. In a variety of contributions the role of the federal government in internalizing fiscal externalities has received much

attention. The idea that a central institution is established to internalize externalities is not new in economics (see, e.g., the evolution of international institutions that deal with environmental problems). Applied to the European Union (EU) this would imply a potential role for the central level in the EU to internalize fiscal externalities created by capital tax competition among member states.

In the following paragraphs different approaches to capture this idea are presented. One of the early papers is Gordon (1983). Gordon's primary objective is to detect inefficiencies that may occur in the decentralized form of public decision-making. In addition to horizontal fiscal externalities other sources of inefficiencies are explored in Gordon (1983) as well. Examples include congestion cost which may change in one region due to the fiscal policy in a neighboring region or public good spillovers. Although Gordon (1983) introduces a central level when characterizing the fully coordinated policy outcome, the paper does not introduce a federal and regional level simultaneously. Hence, the interaction between different levels of government is not captured by that analysis.

A different paper is Johnson (1988). The paper addresses the question of the appropriate federal level to redistribute income. Common to Gordon (1983), Johnson (1988) compares the centralized with the decentralized outcome to explore inefficiencies in decentralized redistribution. The paper identifies horizontal and vertical fiscal externalities associated with decentralized redistribution. They are due to migration responses as well as benefit spillovers. However, also common to Gordon (1983), the federal level is not explicitly modeled in the analysis. Thus, strategic interaction in a federal state is not captured in this paper, either.

Smart (1998) examines the influence of an intergovernmental transfer system on the efficiency of local public finance. In that paper the federal level is represented by a transfer formula and, thus, an explicit representation of the federal government is not part of the model. The paper shows that equalization grants may increase the tax rate chosen by the regional government. Applied to capital tax competition, the equalization grant may internalize horizontal fiscal externalities and, hence, reduces the marginal cost of public funds as perceived by regions. Specifically, in the case of an unconditional grant, i.e. a grant independent of the level of local public good

provision, the local policy choice is not affected by the grant. Only with conditional grants, the regional government takes into account how the grant changes in response to a change in local public policy. As a consequence, the regional tax rate decision is altered according to the specification of the intergovernmental transfer system.¹⁵

Sobel (1997) analyzes the optimal structure of taxation in a federal system. The paper compares the efficiency properties of two institutional settings. Under the first institutional setting, tax revenues are collected at the lower level of government. The second institutional setting is characterized by centralized tax collection. The characterization of the federal level is restricted to the inability to differentiate tax rates across regions. That is, the federal government is assumed to levy uniform tax rates. While abstracting from horizontal fiscal externalities, optimal taxation calls for decentralized tax collection. It enables governments to set non-uniform tax rates. Additionally, as pointed out by Sobel (1997), a federal system with multiple levels of tax setting authorities is non-optimal due to the existence of vertical fiscal externalities. However, Sobel (1997) provides no further formal analysis of this issue.

So far, the cited literature has the common characteristic of a missing federal level. As shown in section 2.3, Boadway and Keen (1996) explicitly consider a federal government. The paper demonstrates that the federal government, acting as a first mover, can internalize horizontal and vertical fiscal spillovers. Thus, the widely-accepted argument that a central government is needed to achieve efficiency holds in this setting.

Boadway, Marchand, and Vigneault (1998) extend the analysis of Boadway and Keen (1996) to the case where redistribution and public good provision is undertaken by both levels of governments. Decentralized redistribution is subject to inefficiencies due to migration responses of taxpayers and aid recipients. Besides this horizontal fiscal externality, a vertical fiscal externality arises as both levels of government use the same tax base. With this model specification the federal level is able to offset

¹⁵A further analysis of intergovernmental grant design is given in Wildasin (1989), De Pater and Myers (1990), and Dahlby (1996). In particular, Wildasin (1989) presents the design of conditional grants to internalize horizontal fiscal externalities arising from capital tax competition. De Pater and Myers (1990) analyze the grant structure aimed at internalizing pecuniary externalities.

all fiscal externalities. Thus, the result of Boadway and Keen (1996) carries over to the case of redistribution. Therefore, the analysis shows that redistribution can be decentralized.¹⁶

Sato (2000) extends Boadway and Keen (1996) by allowing for different degrees of household mobility and heterogeneous regions. In this extended framework, Sato (2000) arrives at the same result as Boadway and Keen (1996). Fiscal externalities can be internalized by a federal government that commits to its policy. That is, a federally mandated interregional transfer system is sufficient to replicate the fully centralized outcome where, of course, fiscal externalities cannot arise. As a result, full centralization and decentralization in the form of a federal system are equivalent in the setting considered by Sato (2000). Recall, a special feature of this setting is that both levels of government use the same tax base.

Common to all papers that explicitly model a federal government is the assumption of a Stackelberg leadership by the federal government. The state acts as a follower and chooses its policy for given federal policy. Whether this assumption is appropriate is not obvious. There are good reasons to assume that the state is better able to commit to its own policy. As noted by Keen (1998), states within the Russian federation are in a better position to commit to their own policy than the federal government. Additionally, Dahlby (1996) reports that Ontario, as a member of the Canadian federation, is more likely to be a Stackelberg leader since 40% of federal tax revenues stem from Ontario. Similarly, in the EU it is highly questionable whether the central level has the ability to commit to its policy and the member states take Brussels' policy choice as given.

The objective of this section is to contrast both assumptions concerning federal-state interaction.¹⁷ The primary intention is to analyze two questions. First, to what extent does the allocation of public goods depend on the specification of federal-state interaction and second, in what way is the federal financial structure determined

¹⁶There is one additional paper that considers the interaction between the federal and state level in a federal system. Dixit and Londregan (1998) examine the choice of redistributive politics in a federation by modeling the political process leading to different politics. The subsequent analysis abstracts from redistributive and political considerations.

¹⁷Persson and Tabellini (1990, 1994a) show that the assumption on commitment is critical to the welfare effects of fiscal policy. However, they analyze the interaction between private agents and governments.

by the behavioral assumption? In contrast to the existing literature the analysis shows that a federal state is not always able to replicate the outcome of a unitary nation. In particular, the deviation from the unitary nation optimum depends on the specification of federal-state interaction.

The model in this section also differs from the above mentioned literature with respect to the federal tax assignment. Boadway and Keen (1996), Sato (2000), and Boadway, Marchand, and Vigneault (1998) consider a model of tax base overlap. Both levels tax labor income, which creates a vertical and horizontal fiscal externality. In the subsequent analysis, only the upper level of government imposes a labor income tax. States levy a source-based capital tax and, hence, are engaged in capital tax competition. The modification allows to analyze whether the equivalence between a fully centralized and a decentralized tax system still holds if both levels of the federation are assigned different rather than the same tax bases. Thereby, this section addresses the issue whether the result derived in Boadway and Keen (1996), Sato (2000), and Boadway, Marchand, and Vigneault (1998) is robust to changes in the tax assignment.¹⁸

There is one paper that explicitly models federal-state interaction as a game with states as Stackelberg leaders. Silva and Caplan (1997) analyze the design of federal environmental policy to control transboundary pollution. Within their framework they show that a Stackelberg leadership by states enables an efficient environmental policy whereas the traditional assumption of Stackelberg leadership by the federal level results in an inefficient outcome.¹⁹

2.4.2 The Model Set-Up

Consider an economy with 2 identical regions. Each state consists of a representative household and a representative firm. The representative household derives utility

¹⁸Hoyt and Jensen (1996) also consider a model in which states have access to a source-based capital tax and the federal level taxes labor income. They examine the welfare effects of a commitment by the federal level. However, they do not analyze the specific nature of the financial structure within the federation and the implications for local public good provision.

¹⁹Other papers using a common agency approach are Bernheim and Whinston (1986, 1987), Dixit (1996), Dixit, Grossman, and Helpman (1997), Grossman and Helpman (1994) and Rama and Tabellini (1998). However, they concentrate on the interaction between private agents and the government rather than between different levels of government.

from a private good c , leisure ℓ , and a local public good g provided by the state government. For simplicity we restrict attention to additive-separable preferences

$$u = c + h(\ell) + b(g), \quad (2.1)$$

where $h(\cdot)$ and $b(\cdot)$ are strictly increasing and strictly concave. Time endowment is normalized to unity which implies a labor supply of $L = 1 - \ell$. Some further remarks concerning the preference structure will be made below. Utility is maximized subject to the budget constraint

$$c = I_f + (w - \tau)L + r\tilde{k}, \quad (2.2)$$

where I_f is income generated from a fixed and immobile factor (say land), τ is the labor income tax rate, r is the interest rate, and \tilde{k} the capital endowment of each state. The labor supply decision is characterized by the first-order condition

$$(w - \tau) - h' = 0. \quad (2.3)$$

The additive-separable structure of preferences ensures that no income effect affects the labor supply decision. Only substitution effects influence the choice of L . Therefore, an increase in the net wage rate $w - \tau$ leads to an increase in labor supply, i.e. $L' > 0$.

The preference structure is quite restrictive. However, it has been assumed for two reasons. First, the additive separability of preferences in public consumption is a necessary condition to exclude vertical fiscal externalities. To see this, assume that preferences are given by $u = c + b(\ell, g)$. In this case, labor supply depends on τ and g which in turn depends on τ and t . Hence, $L = L(\tau, t)$. In a federal state with centralized labor taxation and decentralized capital taxation the lower level choice of t affects the tax base of the upper level. The specification of preferences results in an expenditure externality. Specifically, there is a bottom-up vertical fiscal externality from which the subsequent analysis abstracts. The second remark refers to the assumption that preferences are additively separable in private consumption and leisure. To demonstrate the appropriateness of this assumption consider the preference structure $u = h(c, \ell) + b(g)$. For instance, the preference structure is assumed by Boadway and Keen (1996).²⁰ In this case, labor supply is influenced

²⁰In Boadway and Keen (1996) the upper level provides a national public good G and the lower level a local public good g . In their analysis, preferences are given by $u = h(c, \ell) + b(g) + B(G)$. Here, the upper level does not provide a national public good. Hence, the corresponding preference structure for the institutional framework in this analysis is $u = h(c, \ell) + b(g)$.

by τ and the level of private consumption which in turn is determined by τ and t . Therefore, the more general specification of preferences imply a bottom-up vertical fiscal externality. However, this type of fiscal externality is assumed to be absent here.

Each state produces a single good with a constant returns to scale technology $f(l, k)$.²¹ The representative firm in each state maximizes profits $\pi = f(l, k) - wl - (r + t)k$ with t as the source-based capital tax rate. The profit maximizing input choices are given by the familiar first-order conditions

$$f_l = w, \quad (2.4)$$

$$f_k = r + t. \quad (2.5)$$

As mentioned in subsection 2.2.2, besides perfect tax base overlap and tax deductibility, general equilibrium effects are a source of vertical fiscal externalities. Though no formal concurrency exists, the tax rate choice of one level of government influences tax revenues of other levels of government by a change in relative prices. Note, with $f_{lk} \neq 0$ factor demand is given by $k = k(r + t, w)$ and $l = l(r + t, w)$, respectively. Thus, the capital (labor) tax rate influences labor (capital) demand. As in equilibrium labor demand is identical to the labor tax base, tax revenues of other levels of government are affected by an increase in the capital tax rate t . Hence, $f_{lk} \neq 0$ causes effective concurrency.

For this reason, $f_{lk} \equiv 0$ in the following analysis. The corresponding factor demand functions are thus given by $l = l(w)$ and $k = k(r + t)$. The assumption $f_{lk} \equiv 0$ implies a separation of labor and capital demand.

To complete the description of the model the conditions for a factor market equilibrium have to be introduced. The capital market equilibrium is given by Eq. (2.5) for each region and the capital market clearing condition $k^1 + k^2 = 2\tilde{k}$. The response of k^i to a capital tax increase is given by

$$\frac{\partial k^i}{\partial t^i} = \frac{1}{\Delta} \quad i = 1, 2, \quad (2.6)$$

$$\frac{\partial k^i}{\partial t^j} = \frac{-1}{\Delta} \quad i, j = 1, 2 \quad i \neq j, \quad (2.7)$$

²¹To be precise, the technology exhibits constant returns to scale in all three production factors. For simplicity, the fixed and immobile factor is omitted from notation.

$$\frac{\partial r}{\partial t^j} = \frac{-f_{kk}^i}{\Delta} \quad i, j = 1, 2 \quad i \neq j, \quad (2.8)$$

$$\text{with } \Delta := f_{kk}^1 + f_{kk}^2 < 0. \quad (2.9)$$

Due to the separation of labor and capital demand and the fixity of total capital supply the equilibrium level of capital employment in region i only reacts to changes in the capital tax rate t^i as well as to changes in the capital tax rate of region j . The labor income tax τ does not affect capital employment. Top-down vertical fiscal externalities induced by general equilibrium effects are not present in this model.

The labor market equilibrium is characterized by Eqs. (2.3) and (2.4), and the labor market clearing condition $l^i = L^i$. Comparative static analysis yields

$$\frac{\partial l^i}{\partial \tau} = \frac{-1}{\sigma} \quad \text{and} \quad \frac{\partial w}{\partial \tau} = \frac{f_{ll}}{\sigma} \quad (2.10)$$

$$\text{with } \sigma := -h'' - f_{ll} > 0. \quad (2.11)$$

The equilibrium level of l^i is only influenced by τ . The capital tax rate t does not affect the labor market. This result is due to the assumption $f_{lk} \equiv 0$, which separates factor demands, and the additive-separable preferences, which imply $L = L(w - \tau)$. Both sides of the labor market are not affected by t .

In this model a source-based capital tax and a labor income tax is available to the governments. Both are distortionary. The former is distortionary if capital is taxed at the lower level of the federal state. The latter distorts the resource allocation due to the endogeneity of the labor-leisure choice. However, rents are not taxed though a rent tax is nondistortionary since the fixed factor does not react to a rent tax.²² However, if one allows for rent taxation by the lower level of government the tax base would be affected by the labor tax decision of the upper level of government. Hence, vertical fiscal externalities would arise. By contrast, rent taxation by the upper level of government yields an efficient allocation of resources if tax revenues are sufficient to finance the first-best level of g . In this case the optimal taxation problem becomes trivial.

2.4.3 The Unitary Nation

As a point of reference the optimal policy in a unitary nation is derived first. In this setting the central government has access to a source-based capital tax and a labor

²²Boadway and Keen (1996) assume a 100% tax on rents. Recall, besides concurrent labor taxation, rent taxation and sharing of tax receipts is the reason for the occurrence of vertical fiscal externalities.



Figure 2.2: Sequence of decisions: unitary nation.

income tax. The decision sequence is depicted in figure 2.2. At the first stage of the game the government selects the policy variables anticipating the private agents' reactions. Private agents make their choices at the second stage of the game. Public revenues are recycled by providing a local public good g . Hence, the budget constraint takes the form $g^1 + g^2 = \tau(l^1 + l^2) + t^1k^1 + t^2k^2$. The government selects t^i, τ , and g^i by maximizing the Benthamite welfare functional $u^1(\cdot) + u^2(\cdot)$ subject to the budget constraint.

The optimal policy can be characterized without having to set up the decision problem and to solve for the optimal policy formally.

Proposition 2.1: *In a unitary nation the government provides local public goods efficiently. In equilibrium, the source-based capital tax is levied at a uniform rate and the labor income tax is set to 0.*

The intuition for this result is straightforward. The government can induce an efficient interregional allocation of capital by setting $t^1 = t^2$. With uniform capital taxation the source-based capital tax is equivalent to a lump-sum tax which yields an efficient provision of local public goods, i.e. $b_g^i = 1$. Therefore, it is optimal to have all tax revenues collected on the inelastic supply of capital and to set the distortionary labor income tax, τ , to 0.

2.4.4 The Federal State: Nash Behavior

In subsection 2.4.3 the optimal tax policy in a unitary nation has been analyzed. In this section a second level of government is introduced. From now on it is assumed that the federal system consists of two layers: the federal level and the state level. State governments are in a position to impose a source-based capital tax t^i . The tax revenues are recycled by providing a local public good g^i . The federal government provides transfers s^i which are financed by a uniform labor income tax τ . The



Figure 2.3: Sequence of decisions: federal state with both-sided Nash behavior.

decision sequence is depicted in figure 2.3. At stage 1 of the game both levels of government choose their policy instruments simultaneously, i.e. they behave as Nash competitors. Each level of government chooses its policy instruments without anticipating how the tax and expenditure policy of other public decision units reacts to its decision. However, they account for the effect of their decisions on the behavior of private agents. At the second stage of the game private agents decide on k and l for given policy instruments.

State Government First, the optimization problem at the state level is solved. The state government sets its policy variables t^i , for given s^i , τ as well as t^j , $j \neq i$, to maximize the utility of the representative household. Therefore, the optimization problem for state 1 is as follows

$$\max_{t^1} f(k^1, l^1) - f_k k^1 - \tau l^1 + r\tilde{k} + h(1 - l^1) + b^1(t^1 k^1 + s^1). \quad (2.12)$$

The first-order condition for t^1 is

$$(t^1) : -f_{k^1}^1 k_{t^1}^1 k^1 + r_{t^1} \tilde{k} + b_g^1(t^1 k_{t^1}^1 + k^1) = 0. \quad (2.13)$$

The state government equates the marginal change in private consumption due to a higher tax rate t^1 to the marginal benefit given by an increase in local public spending. Inserting Eqs. (2.6) and (2.8) yields

$$b_g^1 = \frac{k^1}{t^1 k_{t^1}^1 + k^1} > 1 \quad (2.14)$$

$$= \frac{1}{1 + \epsilon_{k^1, t^1}} \quad \text{with} \quad \epsilon_{k^1, t^1} := \frac{\partial k^1}{\partial t^1} \frac{t^1}{k^1} \quad (2.15)$$

Due to the distortionary character of source-based capital taxation local public goods are underprovided. The state's marginal cost of public funds (r.h.s. of Eq. (2.14); henceforth SMCPF) is greater than unity as states perceive an outflow of capital if they increase their capital tax rate for a given tax rate of the other state. At

an optimum the benefits of taxation given by the marginal utility of local public goods are equated to the costs of taxation represented by the term $k^1/(k^1 + t^1 k_{t^1}^1)$. The optimization problem of state 2 is identical to that of state 1 and, therefore, it is not repeated here. The first-order condition (2.13) together with the state's budget constraint determine the reaction functions $t^1 = t^1(s^1, \tau)$ and $t^2 = t^2(s^2, \tau)$, respectively.²³

Federal Government Under the assumption of Nash behavior, the federal government's optimization problem is as follows. For given states' policy choices (t^1, t^2) it solves

$$\max_{s^1, s^2, \tau} \mathcal{L} = f(k^1, l^1) - f_k k^1 - \tau l^1 + r\tilde{k} + h(1 - l^1) + b^1(t^1 k^1 + s^1) \quad (2.16)$$

$$+ f(k^2, l^2) - f_k k^2 - \tau l^2 + r\tilde{k} + h(1 - l^2) + b^2(t^2 k^2 + s^2) \quad (2.17)$$

$$+ \mu[s^1 + s^2 - \tau(l^1 + l^2)]. \quad (2.18)$$

The first-order conditions are

$$(s^1) : b_g^1 + \mu = 0 \quad (2.19)$$

$$(s^2) : b_g^2 + \mu = 0 \quad (2.20)$$

$$(\tau) : -l^1 - l^2 + \mu(-l^1 - l^2 - \tau l_\tau^1 - \tau l_\tau^2) = 0 \quad (2.21)$$

which yields

$$b_g^i = \frac{l^i}{l^i + \tau l_\tau^i} > 1 \quad i = 1, 2 \quad (2.22)$$

$$= \frac{1}{1 + \eta_{i, \tau}} \quad \text{with} \quad \eta_{i, \tau} := \frac{\partial l^i}{\partial \tau} \frac{\tau}{l^i} \quad i = 1, 2. \quad (2.23)$$

The federal government sets transfers and the tax rate as to equate the marginal rate of substitution to the marginal cost of public funds at the federal level (r.h.s. of Eq. (2.22); henceforth FMCPF). Labor income taxation induces households to reduce their labor supply. Therefore, with an increase in τ the federal tax base shrinks which is taken into account by the federal policy maker when deciding on its policy variables.²⁴ The first-order conditions give the reaction functions $s^1 = s^1(t^1, t^2)$,

²³The existence of an interior solution is assumed in all games analyzed in this chapter.

²⁴In the literature, different representations of the marginal cost of public funds in the presence of labor income taxation are discussed. For example, some authors use the compensated labor supply function or the uncompensated labor supply function for analyzing the marginal cost of public funds (see e.g. Håkonsen (1998)). For the preference function used in this section both measures are identical as the compensated and uncompensated labor supply function coincide.

$s^2 = s^2(t^1, t^2)$, and $\tau = \tau(t^1, t^2)$. Let (t^N, τ^N, s^N) denote the solution to the system of reaction functions $s^1 = s^1(t^1, t^2)$, $s^2 = s^2(t^1, t^2)$, $\tau = \tau(t^1, t^2)$, $t^1 = t^1(s^1, \tau)$ and $t^2 = t^2(s^2, \tau)$.²⁵

The optimal policy under both-sided Nash behavior has an interesting feature. By inspection of Eqs. (2.14) and (2.22) one can infer that in equilibrium the SMCPF is equated to the FMCPF, i.e. the marginal cost of public funds at both levels of government coincide. This result seems to be in line with optimal taxation theory which implies that distortions have to be equated in a second-best equilibrium. However, in contrast to the distortion at the federal level the distortion at the state level is only perceived and does not occur in a symmetric equilibrium. Therefore, as shown in section 2.4.3, optimal taxation requires setting the labor income tax to zero and to finance the budget solely by the capital tax. The result is summarized in the following proposition.

Proposition 2.2: *If governments at the state level and the federal government decide simultaneously (Nash behavior), both tax instruments are used in a symmetric equilibrium. The marginal cost of public funds at both levels of government are equated which implies an inefficient provision of local public goods.*

As shown in chapter 1 the magnitude of labor taxation is influenced by capital mobility. Recall, with interdependent factor markets a rise in τ does not only affect labor supply. The reduction in labor supply reduces the marginal productivity of capital and, hence, the tax-setting government perceives an outflow of capital. This additional effect causes an undertaxation of labor relative to the optimal policy under capital immobility. However, in this setting the undertaxation result is not replicated as from the perspective of the labor tax-setting government capital is immobile. For this reason, an outflow of capital is not perceived in response to an increase in the labor tax rate. Even if one extends the analysis by allowing capital to leave the federation, the labor tax rate is not negatively affected by capital mobility. This is implied by the separation of factor markets. Recall, factor markets are separated since $f_{kl} \equiv 0$. Thus, the marginal productivity of labor does not react to changes in labor supply. The marginal cost of public funds due to labor taxation

²⁵The superscript N stands for Nash behavior.

under capital mobility and capital immobility are identical.²⁶

Two further remarks are in place here.

Remark 1: Up to now it is assumed that transfers flow from the federal government to states as one would expect in a federal system. Boadway and Keen (1996) showed that this may not be optimal from a welfare-theoretic point of view. If the states have a less distortionary tax instrument in hand than the federal government, a transfer from the states to the federal level is welfare enhancing. However, in this setting a negative transfer s^1 would not yield the same result as in Boadway and Keen (1996) since it would only imply a subsidization of labor. However, a reversal of the direction of transfers could be obtained by introducing a national public good G which is provided by the federal government. With this extension and non-cooperative behavior of states, a flow of transfers from the federal level to the state level or vice versa cannot be excluded.

Remark 2: Fiscal cartelization as considered by Flowers (1988) would yield a different result. In case of fiscal cartelization states collude and, hence, choose t by coordinating their tax decisions. Consequently, horizontal fiscal externalities are internalized and states realize that the source-based capital tax is equivalent to a non-distortionary residence-based capital tax (recall, \tilde{k} is exogenous). In this modified setting the optimal tax and transfer policy is to set τ and s^i to zero and finance local public good provision solely by capital tax revenues. The rationale behind this result is that the labor income tax is distortionary ($l' > 0$) whereas the capital tax is a lump-sum tax. Hence, the cooperative behavior at the state level leads to Pareto-efficient provision of g .

²⁶Note, with capital mobility, interdependent factor markets, and $t \equiv 0$ the marginal cost of public funds due to labor taxation is given by

$$\text{SMCPF} = \frac{1}{1 + \eta - \eta^s \frac{\partial w}{\partial r} \frac{\partial r}{\partial \tau}}. \quad (2.24)$$

The term $\eta^s \frac{\partial w}{\partial r} \frac{\partial r}{\partial \tau}$ in the denominator represents the influence of capital mobility on the marginal cost of public funds. With $f_{kl} \equiv 0$ this term vanishes and the expression for the marginal cost of public funds reduces to Eq. (2.23).

Welfare Implications As shown above, both-sided Nash behavior implies positive tax rates t and τ . To represent the welfare implications of this finding a tax reform is conducted in all regions. The tax reform is modeled as a marginal increase in the capital tax rate and a marginal decrease in the labor tax rate, i.e. $dt > 0$ and $d\tau < 0$, where the starting point is the Nash equilibrium. Differentiating $u = u(t, \tau)$ with respect to both tax rates yields²⁷

$$du = \underbrace{[u_c(-k) + u_g(k + tk_t)]}_{=0} dt + \underbrace{[u_c(-l) + u_g(l + \tau l_\tau)]}_{=0} d\tau \quad (2.25)$$

From the perspective of the regional government the tax reform leaves utility of the representative household unaltered. The tax rate change, dt , affects utility by $u_c(-k) + u_g(k + tk_t)$ and the marginal decrease in τ affects utility by $u_c(-l) + u_g(l + \tau l_\tau)$. Starting from the Nash equilibrium (t^N, τ^N) both first-order utility effects are zero. Recall, the first-order conditions for t and τ coincide with both terms in Eq. (2.25). However, as this tax reform is conducted in all regions, $dk = 0$ in a symmetric equilibrium. Consequently, from the perspective of the federal government the change in utility due to the tax reform reduces to

$$du = [u_c(-k) + u_g(k)] dt + [u_c(-l) + u_g(l + \tau l_\tau)] d\tau. \quad (2.26)$$

By the first-order condition of the federal government's optimization problem the second term in Eq. (2.26) is still zero. The first term in Eq. (2.26), however, is positive. To see this, recall that by the optimizing behavior of the state government $u_c(-k) + u_g(k + tk_t) = 0$. Since $tk_t < 0$, the term $u_c(-k) + u_g(k) > 0$. Therefore, for $dt > 0$ and $d\tau < 0$, du is unambiguously positive. This result is not surprising. The first-best policy requires to set $\tau = 0$ and to collect all tax revenues by a uniform capital tax on the inelastically supplied capital. Therefore, a tax system which makes more use of the capital tax $dt > 0$ and less use of the labor tax $d\tau < 0$ is Pareto improving.

Though the change in utility is positive, the underlying change in private consumption c and in public consumption g is not unambiguously determined. Rearranging Eq. (2.26) yields

$$du = u_c \underbrace{[(-k)dt + (-l)d\tau]}_{=dc} + u_g \underbrace{[(k)dt + (l + \tau l_\tau)d\tau]}_{=dg}. \quad (2.27)$$

²⁷For the preference function used in this section $u_c = 1$ and $u_g = b_g$.

The change in utility can be decomposed into a private and a public consumption effect. The former refers to the change in private consumption due to the tax reform. The latter describes how public consumption is affected by the change in the tax structure. For $dt = -d\tau > 0$ the change in c and g can be rewritten to

$$dc = (-k + l)dt \quad \text{and} \quad dg = (k - l - \tau l_\tau)dt \quad (2.28)$$

Eq. (2.28) reveals that dc and dg can be positive as well as negative. A higher capital tax rate lowers c by k . As $dt = -d\tau > 0$, private consumption also increases by l . In general, one cannot determine which of the two counteracting effects dominates. Additionally, for $dt > 0$ public consumption increases by k . The corresponding reduction in τ causes labor tax revenues to fall by l . But labor tax revenues also rise by $-\tau l_\tau$ as labor supply and, hence, the labor tax base responds positively to a lower labor tax rate.

Depending on the sign of the expression $k - l$ two cases can be distinguished. If $k - l > 0$ at the initial equilibrium, $\frac{dc}{dt}$ is negative. Furthermore, since $\tau l_\tau < 0$ public consumption increases, i.e. $\frac{dg}{dt} > 0$. In contrast, a negative sign of $k - l$ implies a higher private consumption level, i.e. $\frac{dc}{dt} > 0$. Now, the change in public consumption is ambiguous. Specifically, it is positive (negative) if $k - l < (>)\tau l_\tau$. Hence, a Pareto-improving tax reform can go along with a reduction or a rise in public consumption. This observation plays a crucial role in the subsequent subsection.

The second-best outcome crucially depends on the Nash-behavior assumption and the resulting horizontal fiscal externality at the state level. Therefore, in the next two sections the assumption is partially lifted. In section 2.4.5 the federal government is assumed to act as a Stackelberg leader and state governments still play Nash. In section 2.4.6 the behavioral assumption is reversed. State governments move first and the federal government plays Nash.

2.4.5 The Federal State: Federal Government as Stackelberg Leader

In this section, it is analyzed whether the inefficiency resulting from the separation of decision powers between the two layers of the federal system can be mitigated by allowing the federal government to move first. Except of the change in the behavioral assumption the model remains unaltered. The sequence of decisions is depicted



Figure 2.4: Sequence of decisions: federal state and Stackelberg leadership by a federal government.

in figure 2.4. By moving first the federal government chooses s^i and τ at the first stage of the game. It anticipates the reaction of the state governments as well as the reaction of private agents. The state government acts as a follower. At the second stage of the game states decide on their policy variables taking the policy variables of the federal government as given. However, as in the previous section they anticipate the reaction of private agents. For given policy variables, private agents move at the third stage of the game.

The interdependence of the endogenous variables is shown in figure 2.5. The federal governments's policy variables s^i and τ determine the choice of the states' capital tax rate t^i . However, they also influence the choice of private agents k^i and l^i . The latter impact can be decomposed in a direct and an indirect effect. The choice of τ exerts a direct influence on l^i . Additionally, the outcome of the third stage of the game is affected by the influence of s^i and τ on t^i which in turn enters the private agents' optimization problem. This constitutes the indirect effect. The game is solved by backward induction in order to identify a subgame-perfect equilibrium in pure strategies.

State Government The state government sets its policy variable t^i for given s^i and τ to maximize the utility of the representative household. The optimal policy of state i is characterized by the reaction function $t^i = t^i(s^i, \tau)$ implicitly defined by Eq. (2.14). The slope of the reaction function plays a crucial role in answering the question whether the federal government's ability to commit to its policy can achieve a better result than under both-sided Nash behavior. Differentiating Eq. (2.14) with respect to t^i and the federal policy instruments s^i and τ yields

$$\frac{dt^i}{d\tau} = 0 \quad \text{and} \quad \frac{dt^i}{ds^i} = \frac{b_{gg}^i}{\partial \frac{k^1}{t^1 k_{t^1}^1 + k^1} / \partial t^i - b_{gg}^i g_{t^i}^i} \quad i = 1, 2. \quad (2.29)$$

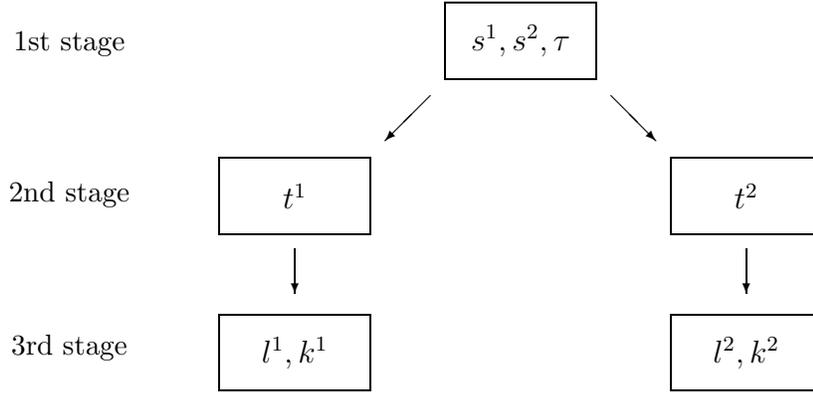


Figure 2.5: Stackelberg leadership by the federal government: policy variables.

A change in the federal tax rate does not affect the choice of t^i . This result is due to the separability assumption between firms' capital demand and labor demand. However, the transfer influences the optimal tax policy at the state level. To sign the states' reaction to a marginal increase note that $g_{t^i}^i$ is positive by the optimizing behavior of the states. Additionally, observe that the SMCPF is increasing in t^i .²⁸ This together with the assumption $b_{gg}^i < 0$ implies that the capital tax rate of state i is decreasing in s^i .

Federal Government The federal government chooses the transfer policy and tax policy to maximize the Benthamite welfare functional subject to the states' reaction functions $t^1 = t^1(s^1)$ and $t^2 = t^2(s^2)$ and the budget constraint $s^1 + s^2 = \tau(l^1 + l^2)$.

$$\max_{s^1, s^2, \tau} \mathcal{L} = f(k^1, l^1) - f_k k^1 - \tau l^1 + r\tilde{k} + h(1 - l^1) + b^1(t^1 k^1 + s^1) \quad (2.30)$$

$$+ f(k^2, l^2) - f_k k^2 - \tau l^2 + r\tilde{k} + h(1 - l^2) + b^2(t^2 k^2 + s^2) \quad (2.31)$$

$$+ \mu[s^1 + s^2 - \tau(l^1 + l^2)]. \quad (2.32)$$

The optimal policy is given by the first-order conditions

$$(s^1) : \quad b_g^1 + \mu + b_g^2 g_{t^1}^2 t_{s^1}^1 = 0 \quad (2.33)$$

²⁸To see this, note that $\partial \frac{k^i}{t^i k_{t^i}^i + k^i} / \partial t^i$ is unambiguously positive if $\partial^2 k^i / \partial (t^i)^2 \leq 0$. Using Eq. (2.6) the second derivative of k^i becomes $-\frac{1}{\Delta^2} \frac{\partial \Delta}{\partial t^i}$ which is zero if $\frac{\partial \Delta}{\partial t^i} = 0$. Differentiating Δ with respect to t^i gives $f_{kkk}^i k_{t^i}^i + f_{kkk}^j k_{t^i}^j$, $i \neq j$. As $k_{t^i}^i = -k_{t^i}^j$, $i \neq j$, $\frac{\partial \Delta}{\partial t^i} = 0$ in a symmetric equilibrium. Hence, $\partial^2 k^i / \partial (t^i)^2 = 0$ and $\partial \frac{k^i}{t^i k_{t^i}^i + k^i} / \partial t^i$ is unambiguously positive.

$$(s^2) : \quad b_g^2 + \mu + b_g^1 g_{t^2}^1 t_{s^2}^2 = 0 \quad (2.34)$$

$$(\tau) : \quad -l^1 - l^2 + \mu(-l^1 - l^2 - \tau l_\tau^1 - \tau l_\tau^2) = 0 \quad (2.35)$$

where the first-order conditions have already been simplified by using conditions (2.3), (2.7), and (2.14). The assumption of identical states implies that the federal government does not need to differentiate its policy across states and, in a symmetric equilibrium of the federation, the first-order conditions reduce to

$$b_g^i (1 + g_{t^i}^j t_{s^i}^i) = \frac{l^i}{l^i + \tau l_\tau^i} \quad i, j = 1, 2 \quad i \neq j. \quad (2.36)$$

Let $(t^{Sf}, \tau^{Sf}, s^{Sf})$ denote the optimal policy under this regime.²⁹ The optimality condition under Stackelberg-leadership by the federal government differs from the outcome under both-sided Nash behavior by the term $g_{t^i}^j t_{s^i}^i$. $g_{t^i}^j$ reflects the impact of a marginal tax increase in state i on tax revenues in state j . The positive horizontal fiscal externality which is responsible for the inefficiently low taxation of capital is now part of the optimization problem of the federal government. To characterize the optimal policy recall that the optimal solution under both-sided Nash behavior (t^N, τ^N, s^N) satisfies Eq. (2.22). Inserting this policy vector in Eq. (2.36) yields the inequality

$$b_g^i (1 + g_{t^i}^j t_{s^i}^i) < \frac{l^i}{l^i + \tau l_\tau^i} \quad i, j = 1, 2 \quad i \neq j. \quad (2.37)$$

By Eq. (2.29) the bracketed term $(1 + g_{t^i}^j t_{s^i}^i)$ is lower than unity. Hence, evaluated at (t^N, τ^N, s^N) the equality in Eq. (2.36) is turned into an inequality as given by Eq. (2.37). Given the mild assumption $\frac{\partial}{\partial \tau} (\frac{l^i}{l^i + \tau l_\tau^i}) > 0$ an optimal response is to lower τ and, consequently, the r.h.s. of the inequality.³⁰ Note, the federal budget constraint implies a reduction in s^i which in turn induces the state government to choose a higher capital tax rate. The latter response is implied by the negatively-sloped reaction function $t^i = t^i(s^i)$. Therefore, one gets the following result.

Proposition 2.3: *If the federal government moves first (Stackelberg leadership), the source-based capital tax increases relative to the Nash outcome, i.e. $t^{Sf} > t^N$. The labor income tax decreases, i.e. $\tau^{Sf} < \tau^N$.*

²⁹The superscript *Sf* stands for Stackelberg leadership by the federal government.

³⁰The assumption $\frac{\partial}{\partial \tau} (\frac{l^i}{l^i + \tau l_\tau^i}) > 0$ is not very restrictive. Note, that a sufficient condition for this term to become positive is $\partial^2 l^i / \partial \tau^2 < 0$. By Eq. (2.10) a sufficient condition for this requirement to be satisfied is that h' is strictly convex in ℓ and f_l is strictly concave in l , i.e. $h''' > 0$ and $f_{ll} < 0$.

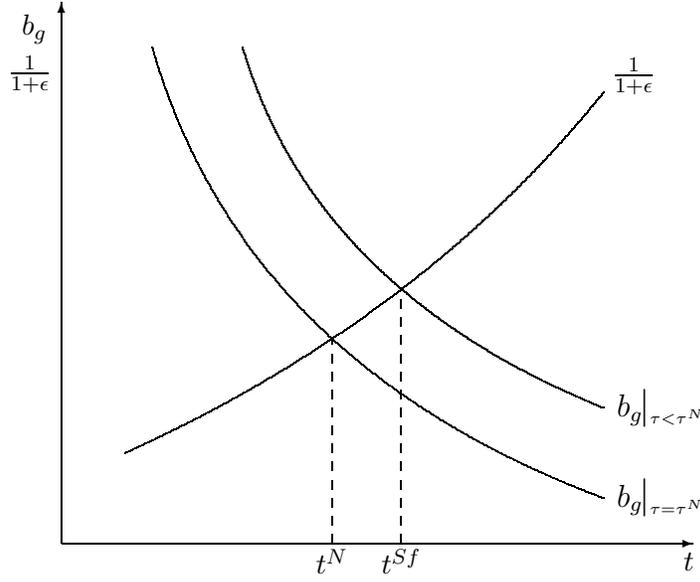


Figure 2.6: Stackelberg leadership by the federal level: choice of tax rate.

An illustration of this proposition is given in figure 2.6. The upward-sloping curve represents the marginal cost of public funds due to source-based capital taxation $\frac{1}{1+\epsilon}$. The downward-sloping curves represent the marginal utility of local public goods for different values of τ . Note, the b_g -curves are depicted from the perspective of the regional government. The Nash behavior by the regional government implies a shift of the b_g -curve if federal policy changes. To put it differently, the transfer volume s acts as a shift parameter of $b_g(tk + s)$.

At the equilibrium under both-sided Nash behavior $\tau = \tau^N$ which enters b_g through the magnitude of the transfer s^N . Thus, for given federal policy variables the marginal utility curve relevant for regional optimization is given by $b_g|_{\tau=\tau^N}$. The regional government equates the marginal utility of local public goods with the marginal cost of public funds. Hence, the optimal tax rate is t^N . Given by the Stackelberg leadership by the federal government $\tau^N > \tau^{Sf}$ and, thus, $s^N > s^{Sf}$. A lower transfer volume shifts the b_g -curve upwards. Now, the relevant b_g -curve becomes $b_g|_{\tau<\tau^N}$. The marginal cost of public funds $\frac{1}{1+\epsilon}$, however, remains unchanged. From the perspective of the regional government each level of t is associated with a higher marginal utility of local public goods. Consequently, the optimal tax rate t^{Sf} exceeds t^N .

This result is in sharp contrast to Boadway and Keen (1996) and Boadway, Marchand, and Vigneault (1998) where the federal government can replicate the unitary nation optimum by committing to its policy. As shown in the previous subsection, the unitary nation optimum is the Pareto-efficient allocation for g^i . However, the federal state as a Stackelberg leader cannot achieve this outcome. The rationale behind this result is straightforward. A federal tax rate of 0 would have no effect on the states' decision and the level of local public good provision is simply the uncoordinated tax competition equilibrium given by Eq. (2.14). However, a positive labor income tax rate allows the federal government to influence the states' tax rate t by making transfers to the states. Starting at $\tau = 0$, a marginal increase in τ leads to FMCPF greater unity. Hence, it is optimal for the federal government to increase τ and, thereby, to reduce t up to the point where the marginal benefit of an increase in τ , given by the reduction in SMCPF adjusted for the negative impact on t , is equated to the marginal cost of taxation at the state level given by the FMCPF. Therefore, in equilibrium the states' perceived marginal cost of an increase in t is not unity and horizontal fiscal externalities are not fully internalized.

This does not leave local public good provision unaffected. The sign of the difference $g(t^{Sf}, \tau^{Sf}) - g(t^N, \tau^N)$ cannot be derived from the change in tax rates. This is due to the fact that t increases and τ decreases. Accordingly, capital tax revenues increases while labor tax revenues decrease. Having only this information one cannot conclude which effect dominates. However, the induced change of g^i can be inferred from Eq. (2.14) which is shown in proposition 2.4.

Proposition 2.4: *Under Stackelberg leadership by the federal level local public goods are underprovided. Specifically, local public good provision decreases relative to the Nash level of g .*

Proof: Given by $\partial \frac{k^i}{k^i + t^i k_{t^i}^i} / \partial t^i > 0$, $\partial \frac{k^i}{k^i + t^i k_{t^i}^i} / \partial \tau = 0$, and the optimality condition $b_g^i = \frac{k^i}{k^i + t^i k_{t^i}^i}$ [Eq. 2.14], the reversal of the tax structure implied by proposition 2.3, translates into a higher SMCPF and, thus, b_g^i . Hence, given by the strict concavity of $b(\cdot)$, g^i is unambiguously lowered. \square

At first sight this result seems to be contradictory to proposition 2.3 stating that the state government makes more use of the source-based capital tax. Recall, under the assumption of both-sided Nash behavior local public goods are underprovided. This result is due to the inefficiently low capital tax rate and the use of the distortionary labor tax. Relative to the first-best policy, g^i and t^i are too low and τ is too high. The Stackelberg leadership by the federal government reduces τ and, thereby, increases t^i . For this reason the tax structure moves towards the first-best structure. One may expect a corresponding increase of g towards the first-best level. However, given by the Nash behavior by states any increase in t translates into a higher marginal utility of public goods. For this reason local public good provision becomes more inefficient relative to g^N (see also figure 2.6 for an illustration). This result is also consistent with the finding in the last subsection. The welfare analysis of public policy under both-sided Nash behavior has revealed that a rise in t and a lower τ is Pareto-improving. Moreover, the welfare-enhancing policy can go along with a reduction in g . Exactly this happens under Stackelberg leadership by the federal government.

Modification In the first part of this subsection it has been assumed that the federal government sets s^i separately and, thereby, perceives a capital reallocation. As given by the slope of the reaction function in Eq. (2.29) an increase in s^i induces a lower capital tax rate t^i . Consequently, capital is attracted to region i in response to a rise in s^i , i.e. $\frac{\partial k^i}{\partial s^i} = k_{t^i}^i t_{s^i}^i > 0$. However, implied by symmetry both regions receive identical transfers. Hence, in equilibrium capital reallocation does not take place. Therefore, it is questionable why the federal government does not anticipate this effect and, thus, why the transfer volume is not chosen simultaneously. An alternative formulation of the optimization problem is to set $s^i = s$. Note, the modification does not affect the state's optimization problem. The reaction of the state government to federal policy is still given by Eq. (2.29). Before turning the federal government's optimization problem it is useful to derive the response of the interest rate r to a higher capital tax rate in both states. Setting $dt^1 = dt^2 = dt$ and differentiating Eq. (2.5) and the capital market clearing condition $k^1 + k^2 = 2\tilde{k}$ with respect to t gives $\frac{dr}{dt} = -1$.

The federal government's objective function remains unchanged. The first-order

conditions for s and τ are

$$(s) : \quad \left(\frac{dr}{dt} \tilde{k} + b_g^1 k^1 \right) t_s + b_g^1 + \left(\frac{dr}{dt} \tilde{k} + b_g^2 k^2 \right) t_s + b_g^2 + 2\mu = 0 \quad (2.38)$$

$$(\tau) : \quad -l^1 - l^2 + \mu \left(-l^1 - l^2 - \tau l_\tau^1 - \tau l_\tau^2 \right) = 0. \quad (2.39)$$

Rewriting both first-order conditions yield

$$b_g^i (1 + k^i t_s) - k^i t_s = \frac{l^i}{l^i + \tau l_\tau^i} \quad i = 1, 2. \quad (2.40)$$

In addition to the direct effect on local public good provision, an increase in s has two counteracting effects on utility. First, a higher transfer volume corresponds to a decrease in t and thus, to lower capital tax revenues. This impact is represented by the term $k t_s$ in the bracketed term. Additionally, the induced reduction in t increases the interest rate on a one-to-one basis. For this reason interest income rises which is indicated by the term $-k^i t_s$. Hence, a positive and a negative effect are present and at first sight it is not obvious which effect dominates. However, inserting the Eq. (2.14) into Eq. (2.40) gives

$$b_g^i (1 - t k_t^i t_s) = \frac{l^i}{l^i + \tau l_\tau^i}. \quad (2.41)$$

Since the r.h.s. of Eq. (2.41) is greater than unity and the bracketed term on the l.h.s. lies in the interval $(0,1)$, local public goods are underprovided, i.e. $b_g^i > 1$. Following the same line of reasoning as applied above one arrives at $\tau^{Sf} < \tau^N$ and, consequently, at $t^{Sf} > t^N$. Local public good provision under this modified assumption is still characterized by $g^{Sf} < g^N$. Therefore, the modification of the assumption used in the former paragraph does not qualitatively change the result.

2.4.6 The Federal State: States as Stackelberg Leaders

In this section, states are assumed to act as Stackelberg leaders. The sequence of decisions is depicted in figure 2.7. At the first stage of the game states simultaneously select the capital tax rate t^i . A state government plays Nash towards the other state government. However, they choose the policy instrument taking the reaction of the federal government and private agents into account. At the second stage of the game the federal level determines its policy variables s^i, τ for given states' policy variables. By contrast, it anticipates the reaction of private agents to its choice. Private agents move at the third stage of the game. Their choice variables

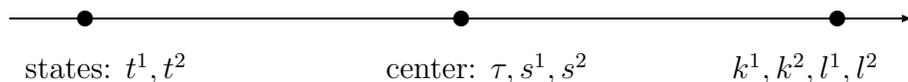


Figure 2.7: Sequence of decisions: federal state with Stackelberg leadership by states.

are chosen for given policy of the federal level and state level. The corresponding interdependence of decision variables is shown in figure 2.8. The state government's policy choice t^i affects the federal transfer policy s^i and tax policy τ . Moreover, it enters the decision problem of private agents. Therefore, t^i has a direct impact on k^i and an indirect effect through the impact of t^i on s^i and τ , which in turn affects the household's optimization problem. Thus, the federal policy variables and the private agents' decision variables are determined by t^i . Again, the game is solved by backward induction to identify a subgame-perfect equilibrium.

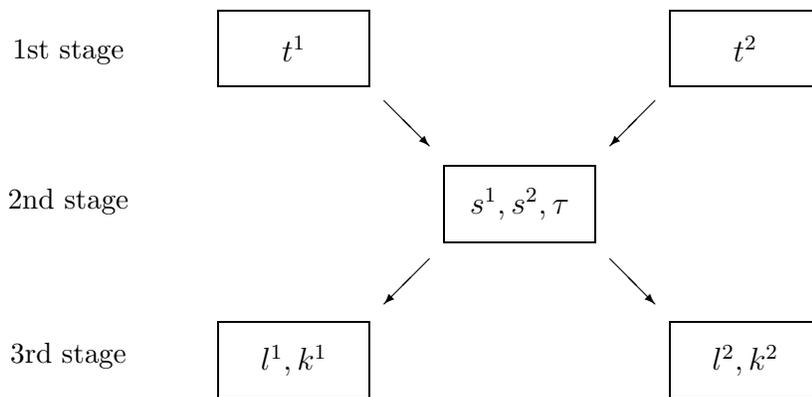


Figure 2.8: Stackelberg leadership by states: policy variables.

Federal Government The federal government's optimization problem is solved first. For given states' policy choices (t^1, t^2) , the optimal federal policy is characterized by Eq. (2.22). The federal government equates the marginal rate of substitution to the FMCPF. The optimality condition implicitly defines the federal government's reaction functions $s^1 = s^1(t^1, t^2)$, $s^2 = s^2(t^1, t^2)$ and $\tau = \tau(t^1, t^2)$. The slopes of the reaction functions are crucial for analyzing whether the perceived marginal cost of public funds at the state level decreases and, hence, whether the capital tax rate increases relative to the Nash outcome. Total differentiation of Eq. (2.22) (for both

regions) and the federal budget constraint $s^1 + s^2 = \tau(l^1 + l^2)$ and solving for ds^1 , ds^2 and $d\tau$ yields $(dt^2 = 0)$ ³¹

$$\frac{ds^1}{dt^1} = \frac{\beta(t^1 k_{t^1}^1 + k^1) + \alpha}{|A|} \quad (2.42)$$

$$\frac{ds^2}{dt^1} = \frac{\beta(t^2 k_{t^1}^2) - \alpha}{|A|} \quad (2.43)$$

$$\frac{d\tau}{dt^1} = \frac{b_{gg}^1 b_{gg}^2 (t^2 k_{t^1}^2) + b_{gg}^1 b_{gg}^2 (t^1 k_{t^1}^1 + k^1)}{|A|} \quad (2.44)$$

with

$$\alpha := -b_{gg}^1 \underbrace{(t^1 k_{t^1}^1 + k^1)}_{=g_{t^1}^1} \frac{\partial \frac{l^2}{l^2 + \tau l_\tau^2}}{\partial \tau} + b_{gg}^2 \underbrace{t^2 k_{t^1}^2}_{=g_{t^1}^2} \frac{\partial \frac{l^1}{l^1 + \tau l_\tau^1}}{\partial \tau} \quad \text{and} \quad (2.45)$$

$$\beta := b_{gg}^1 b_{gg}^2 \sum_{i=1}^2 (l^i + \tau l_\tau^i) > 0. \quad (2.46)$$

(See Appendix A1 for a derivation.) Provided $\frac{\partial}{\partial \tau}(\frac{l^i}{l^i + \tau l_\tau^i}) > 0$, τ_{t^1} is negative (see Appendix A1). Hence, the optimal response of the federal government to a marginal increase in t^1 is to reduce the income tax rate τ . This implies that the state government anticipates a reduction in the labor income tax when increasing t^1 which in turn reduces the perceived cost of capital taxation.

The derivation of $\text{sign}[s_{t^1}^1]$ is slightly more complicated. The term α plays a crucial role in signing the slope. α can be interpreted as a measure for the impact of a change in t^1 on tax revenues in both states. To see this, note that an increase in t^1 implies a rise in tax revenues in state 1 by $g_{t^1}^1 = t^1 k_{t^1}^1 + k^1$. However, due to the mobility of capital some capital leaves state 1 leading to a decrease in tax revenues by an amount of $t^1 k_{t^1}^1$. Although the reduction in tax revenues due to the responsiveness of the tax base in region 1 corresponds to the rise in tax revenues in state 2, i.e. $-t^1 k_{t^1}^1 = t^2 k_{t^1}^2$, it is still ambiguous whether $g_{t^1}^1$ exceeds $g_{t^1}^2$ or not. If the rise in tax revenues of state 1 induced by an increase in t^1 exceeds the loss of tax revenues due to capital mobility, i.e. $g_{t^1}^1 > g_{t^1}^2$, α becomes positive and vice versa. For this reason, α can be interpreted as a measure for the intensiveness of the horizontal fiscal externality. A positive α indicates a low horizontal fiscal externality. In contrast, a negative α reveals a large horizontal fiscal externality. This interpretation is useful in understanding the results derived below.

³¹The slope of the reaction functions is only derived with respect to a marginal change in t^1 . By symmetry, the slope of the reaction functions, with respect to t^2 , is analogous.

characterization		$\frac{ds^1}{dt^1}$	$\frac{ds^2}{dt^1}$	$\frac{d\tau}{dt^1}$
Case (i):	$\alpha > 0$	-	+-	-
Case (ii):	$\alpha < 0$ and $\beta(t^1 \frac{\partial k^1}{\partial t^1} + k^1) > \alpha $	-	-	-
Case (iii):	$\alpha < 0$ and $\beta(t^1 \frac{\partial k^1}{\partial t^1} + k^1) < \alpha $	+	-	-
Case (iv):	$\alpha < 0$ and $\beta(t^1 \frac{\partial k^1}{\partial t^1} + k^1) = \alpha $	0	-	-
Case (v):	$\alpha = 0$	-	-	-

Table 2.1: Stackelberg leadership by states: comparative static analysis.

By inspection of Eqs. (2.42) and (2.43) one can infer that the equilibrium transfers s^1 and s^2 depend on the sign and magnitude of α as well as on the magnitude of β . Therefore, in order to give a complete characterization of $\text{sign}[s_{t^1}^1]$ five cases have to be considered:

Case (i): If $\alpha > 0$, $s_{t^1}^1 < 0$. As outlined above, a positive α indicates a low capital reallocation due to capital taxation. The increase in tax revenues in state 2 resulting from an inflow of capital is lower than in state 1. This implies the inequality $b_g^2 > b_g^1$. Recall, in a symmetric equilibrium $b_g^2 = b_g^1$. According to Eq. (2.42), the federal government decreases s^1 to equate b_g^1 to b_g^2 . The federal policy instrument τ exerts the same influence on the FMCPF of both states and is lowered to restore Eq. (2.22).³²

Case (ii): If $\alpha < 0$ and $\beta(t^1 k_{t^1}^1 + k^1) > |\alpha|$, $s_{t^1}^1 < 0$. A negative α indicates a high capital reallocation due to capital taxation. The increase in tax revenues in state 2, resulting from an inflow of capital, exceeds that in state 1 as given by Eq. (2.45). This implies the inequality $b_g^2 < b_g^1$. The federal government decreases s^1 . However, this response does not eliminate the aforementioned inequality. By inspection of Eq. (2.43), s^2 is also decreased. This is done until the inequality is turned into an equality, i.e. $b_g^1 = b_g^2$. The federal policy instrument τ is lowered to restore

³²Note, that the FMCPF only depends on τ and, consequently, is not affected by a change in t^1 . As τ is the same for both states, the labor income tax rate can solely be used for a simultaneous and identical reaction of the FMCPF in state 1 and 2. It is left to changes in s^1 and s^2 to eliminate interstate differences.

Eq. (2.22).

Case (iii): If $\alpha < 0$ and $\beta(t^1 k_{t^1}^1 + k^1) < |\alpha|$, $s_{t^1}^1 > 0$. In equilibrium a marginal increase in t^1 increases the transfer s^1 to state 1 and lowers the labor income tax rate τ . This is financed by a marginal decrease in the transfer to state 2 since, for a negative α , $s_{t^1}^2$ is negative [see Eq. (2.43)].

Case (iv): If $\alpha < 0$ and $\beta(t^1 k_{t^1}^1 + k^1) = |\alpha|$, $s_{t^1}^1 = 0$. The transfer s^1 is unaffected by a change in t^1 . However, both τ and s^2 are negatively affected by a marginal increase in t^1 .

Case (v): If $\alpha = 0$, the responses of s^1 , s^2 , and τ are identical to those in case (ii). That is, the transfer s^1 and the labor income tax rate τ are lowered in response to an increase in t^1 . Furthermore, a change in t^1 reduces s^2 .

The results of the comparative static analysis are summarized in table 2.1.

State Government The state maximizes the utility of the representative household anticipating the reaction of the federal government given by $s^1 = s^1(t^1, t^2)$, $s^2 = s^2(t^1, t^2)$, and $\tau = \tau(t^1, t^2)$. The optimization problem

$$\max_{t^1} f(k^1, l^1) - f_k k^1 - \tau l^1 + r \tilde{k} + h(1 - l^1) + b^1(t^1 k^1 + s^1) \quad (2.47)$$

gives the first-order condition

$$-f_{kk}^1 k_{t^1}^1 k^1 + r_{t^1} \tilde{k} - l^1 \tau_{t^1} + b_g^1(t^1 k_{t^1}^1 + k^1 + s_{t^1}^1) = 0. \quad (2.48)$$

The state does not only equate the direct marginal cost, $-f_{kk}^1 k_{t^1}^1 k^1 + r_{t^1} \tilde{k}$, and benefit, $b_g^1(t^1 k_{t^1}^1 + k^1)$, of capital taxation, which occurs if states cannot commit to its policy. It also takes into account how the induced change in the federal policy variables affects private consumption, $-l^1 \tau_{t^1}$, and utility derived from local public good provision, $b_g^1 s_{t^1}^1$. However, the effect of the change in τ , due to a higher t^1 , on region 2 is neglected. In a symmetric equilibrium Eqs. (2.22) and (2.48) yield

$$\frac{l^1}{l^1 + \tau l_\tau^1} = \frac{l^1 \tau_{t^1} + k^1}{t^1 k_{t^1}^1 + k^1 + s_{t^1}^1}. \quad (2.49)$$

Let $(t^{Ss}, \tau^{Ss}, s^{Ss})$ denote the solution to Eqs. (2.22) and (2.49).³³ In general, the SMC PF is not equated to the FMCPF, if the additional effects due the Stackelberg leadership by states are not vanishing, i.e. $b_g^1 s_{t^1}^1 - l^1 \tau_{t^1} \neq 0$. In this case the marginal

³³The superscript *Ss* stands for S Stackelberg leadership by s states.

cost of public funds as perceived by the state acting as a Stackelberg leader differs from the SMCPF. This first result is summarized in proposition 2.5

Proposition 2.5: *Provided $b_g^i s_{t^i}^i - l^i \tau_{t^i} \neq 0$, the SMCPF is not equated to the FMCPF. Thus, if states move first (Stackelberg behavior) local public good provision differs from the outcome under both-sided Nash behavior.*

The anticipated reduction of the labor income tax, in response to an increase in t^1 , leads to a lower marginal cost of public funds at the state level relative to the SMCPF. The reduction in the perceived marginal cost of public funds implies a higher capital tax rate. To put it differently, the reduction in τ partly internalizes the positive horizontal fiscal externality which is the source of inefficiently low capital taxes. However, the total change in the perceived marginal cost of public funds also depends on the reaction of s^1 . Unfortunately, $\text{sign}[s_{t^1}^1]$ can be positive as well as negative. A positive sign would imply a further reduction of the r.h.s. of Eq. (2.49). A negative sign would have the opposite effect.

To give a characterization of the equilibrium allocation a more detailed description of the equilibrium tax rates is necessary. Therefore, the analysis proceeds in two steps. First, general conditions are derived under which the policy outcome under the Stackelberg leadership of the states differs from that under both-sided Nash behavior presented in section 2.4.4. In a second step, the implications for local public good provision are analyzed. Following both steps one is able to answer the question whether or not the institutional setting under consideration allows for a Pareto improvement.

To determine the change in the capital tax rate t^1 for all five cases, lemma 2.1 states conditions for t^{Ss} to be lower, equal, or greater than t^N .

Lemma 2.1: *If $s_{t^1}^1 \geq 0$, the capital tax rate under Stackelberg leadership by states exceeds the capital tax rate under both-sided Nash behavior, i.e. $t^{Ss} > t^N$. If $s_{t^1}^1 < 0$ the effect on the tax rate t^1 is given by*

$$-l^1 \tau_{t^1} \left\{ \begin{array}{l} < \\ = \\ > \end{array} \right\} |b_g^1 s_{t^1}^1| \Rightarrow \left\{ \begin{array}{l} t^{Ss} < t^N \\ t^{Ss} = t^N \\ t^{Ss} > t^N \end{array} \right\}. \quad (2.50)$$

Proof: From Eq. (2.48) the optimal state behavior is characterized by $b_g^1(k^1 + t^1 k_{t^1}^1) + b_g^1 s_{t^1}^1 = k^1 + l^1 \tau_{t^1}$. Starting from the Nash outcome t^N as given by Eq. (2.14), the state's incentive to deviate from t^N depends on the terms $b_g^1 s_{t^1}^1$ and $l^1 \tau_{t^1}$. By Eq. (2.44), $l^1 \tau_{t^1}$ is negative. If $b_g^1 s_{t^1}^1$ is nonnegative [cases (iii) and (iv)] the state can increase after-tax labor income as well as local public good provision by setting $t^{Ss} > t^N$.

To prove the second assertion, consider the opposite case. If $s_{t^1}^1 < 0$ and $-l^1 \tau_{t^1}$ exceeds $|b_g^1 s_{t^1}^1|$, the state can improve utility of the representative household by choosing a tax rate $t^{Ss} > t^N$. The marginal increase in utility due to the decrease in the labor income tax outweighs the marginal decrease in utility resulting from a marginal reduction in transfer s^1 . The reverse holds for $s_{t^1}^1 < 0$ and $-l^1 \tau_{t^1} < |b_g^1 s_{t^1}^1|$. For the special case $s_{t^1}^1 < 0$ and $-l^1 \tau_{t^1} = |b_g^1 s_{t^1}^1|$ the opposite effects nullify each other. The state has no incentive to deviate from the tax rate t^N . \square

The impact of the slope of the response functions on the tax rate can be inferred from Eq. (2.50) only for cases (iii) and (iv). In case (iii), $\tau_{t^1} < 0$ and $s_{t^1}^1 > 0$. Lemma 2.1 predicts that state 1 chooses a higher capital tax rate than under the Nash-policy regime presented in section 2.4.4, i.e. $t^{Ss} > t^N$. The reason for this result is that the state government anticipates two effects when increasing t . First, the labor income tax is lowered leading to higher private consumption. Second, the transfer from the federal government to the state is increased. Both positive effects counteract the perceived outflow of capital and, thereby, imply a partial internalization of the positive horizontal fiscal externality. Hence, they provide incentives to the state to set t^{Ss} above the inefficiently low level t^N . In case (iv), $\tau_{t^1} < 0$ and $s_{t^1}^1 = 0$. Following an analogous line of reasoning yields $t^{Ss} > t^N$.

In cases (i), (ii), and (v), transfer s^1 reacts in the opposite direction as in case (iii), while the labor income tax rate is still decreased with an increase in t . The implication for t^{Ss} , relative to t^N , cannot be derived without having a more precise condition than Eq. (2.50), which is given in lemma 2.2.

Lemma 2.2: *In cases (i), (ii), and (v) condition (2.50) is equivalent to the following condition*

$$0 \begin{matrix} < \\ > \end{matrix} \frac{1}{2} \beta [(t^1 k_{t^1}^1 + k^1) - t^2 k_{t^1}^2] + \alpha \Rightarrow \left\{ \begin{array}{l} t^{Ss} < t^N \\ t^{Ss} = t^N \\ t^{Ss} > t^N \end{array} \right\}. \quad (2.51)$$

Proof: See Appendix A.2.

In case (i), $t^1 k_{t^1}^1 + k^1 > t^2 k_{t^1}^2$, which implies $\alpha > 0$. Consequently, state 1 chooses a tax rate $t^{Ss} < t^N$. The decrease of s^1 , in response to a marginal increase in t^1 , dominates the positive effect of a lower labor income tax rate. Therefore, starting from t^N state 1 can increase utility of the representative household by a further reduction in t^1 . In case (ii), $t^1 k_{t^1}^1 + k^1 < t^2 k_{t^1}^2$ and, thus, α becomes negative. This implies a negative term on the r.h.s. of Eq. (2.51). The positive effect of a lower labor income tax rate in response to a marginal increase in t^1 dominates the decrease in s^1 . Hence, the optimal policy of the state government is to set $t^{Ss} > t^N$. In case (v), $t^1 k_{t^1}^1 + k^1 = t^2 k_{t^1}^2$ and, therefore, $\alpha = 0$. Consequently, $t^{Ss} = t^N$.

The influence of the institutional setting analyzed in this section on the capital tax rate relative to the Nash outcome is summarized in proposition 2.6.

Proposition 2.6: *If $\alpha > 0$ [case (i)], the capital tax rate under Stackelberg leadership by states is strictly lower than the optimal capital tax rate under both-sided Nash behavior, i.e. $t^{Ss} < t^N$. Conversely, if $\alpha < 0$ [cases (ii) and (iv)], the capital tax rate under Stackelberg leadership by states is strictly higher than the optimal capital tax rate under both-sided Nash behavior, i.e. $t^{Ss} > t^N$. If $\alpha = 0$ [case (v)], the capital tax rate under Stackelberg leadership by states is identical as that under both-sided Nash behavior, i.e. $t^{Ss} = t^N$.*

Implied by proposition 2.6, α plays a crucial role in answering the question whether the Stackelberg leadership by states allows for a Pareto improvement relative to the both-sided Nash policy. Recall, α can be given an economic interpretation. As noted earlier, a positive α indicates low equilibrium horizontal fiscal externalities, i.e. $g_{t^i}^i - g_{t^i}^j > 0$. By contrast, a negative sign gives rise to large equilibrium horizontal fiscal externalities. Thus, if equilibrium horizontal fiscal externalities are low [case (i)], the source-based capital tax t^{Ss} is even lower relative to t^N . However, high equilibrium horizontal fiscal externalities (defined by $\alpha < 0$) call for a rise in the source-based capital tax rate. If α vanishes, the source-based capital tax rate coincides with t^N . In this case, the Stackelberg leadership by states and the insti-

tutional setting of both-sided Nash behavior are equivalent.

A better understanding for this result can be gained by analyzing the role of Eqs. (2.42) and (2.44) in signing α . A positive α [case (i)] implies a rise in the marginal cost of public funds of states as given by the r.h.s. of Eq. (2.49) relative to the SMC PF. To see this, note that in all five cases $\tau_{t^1} < 0$ which lowers the marginal cost of public funds. The impact of $\tau_{t^1} < 0$ is counteracted by $s_{t^1}^1 < 0$ which, by itself, raises the marginal cost of public funds. Since the latter effect dominates, the marginal cost of public funds is increased implying a lower capital tax rate t^{Ss} .³⁴ In contrast, the marginal cost of public funds is lowered in cases (ii), (iii), and (iv) underlying $\alpha < 0$. More specifically, in case (ii) $\tau_{t^1} < 0$ dominates $s_{t^1}^1 < 0$.³⁵ Additionally, in case (iv) the counteracting effect vanishes, i.e. $\tau_{t^1} < 0$ and $s_{t^1}^1 = 0$, whereas in case (iii) both effects reduce the marginal cost of public funds. For this reason, $t^{Ss} > t^N$ if $\alpha < 0$. Summing up, if horizontal fiscal externalities are high, the Stackelberg leadership by states implies a reduction in the marginal cost of decentralized capital taxation and vice versa. Only for $\alpha = 0$ the policy outcome does not change.³⁶

As given by Eq. (2.44), τ moves in the opposite direction as t . Therefore, if $\alpha > 0$ the equilibrium labor tax rate is higher than τ^N . Thus, from an efficiency point of view the overtaxation of labor is even increased. Recall, in the Nash outcome labor income has already been overtaxed since in the benchmark of a unitary nation optimality requires τ to be set equal to 0. Therefore, low horizontal fiscal externalities increase the incentive to tax labor income if states move first. In contrast, if $\alpha < 0$, the incentive to use labor tax revenues is reduced. However, it is not fully eliminated.

Figure 2.9 depicts the decision problem of the federal government. The upward-sloping curve is the marginal cost of public funds due to labor taxation $\frac{1}{1+\eta}$. Different values of the source-based capital tax t correspond to different b_g -curves. This is due to the assumption that the federal government plays Nash. Thus, capital tax revenues are given for the federal government and determine the locus of the

³⁴For a formal proof of this result see Lemma 2.2.

³⁵Again, a formal proof of this result is presented in Lemma 2.2.

³⁶The result, that the internalization of externalities depends on its magnitude, can already be found in the literature. See Klibanoff and Morduch (1995) for a model where agents bargain to internalize externalities. Common to the result in this analysis, Klibanoff and Morduch (1995) demonstrate that only for sufficiently high externalities a Pareto improvement is achieved.

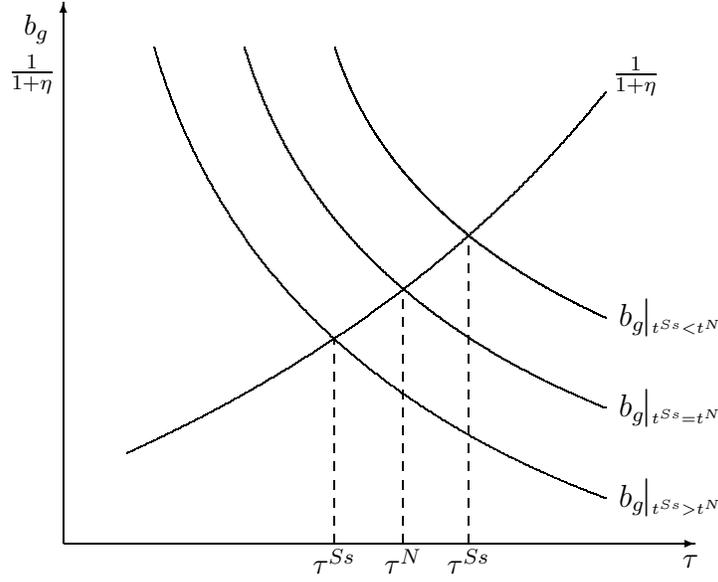


Figure 2.9: Stackelberg leadership by states: choice of tax rate.

b_g -curve. Under both-sided Nash behavior the capital tax rate is given by $t = t^N$. The corresponding b_g -curve is $b_g|_{t^{Ss}=t^N}$. The optimizing behavior of the upper level implies a labor tax rate choice of τ^N .

A negative α induces the state government to set $t^{Ss} > t^N$. Capital tax revenues rise. Since they act as a shift parameter, the b_g -curve shifts downwards. The relevant b_g -curve becomes $b_g|_{t^{Ss}>t^N}$. In this case, the labor tax is less beneficial for the federal government as the marginal utility of local public goods is lower for all τ . However, the marginal cost of public funds is not altered. Therefore, the federal government chooses a lower labor tax rate $\tau^{Ss} < \tau^N$.

Conversely, $\alpha > 0$ implies $t^{Ss} < t^N$. Capital tax revenues are lower and, hence, the b_g -curve shifts upwards. Now, the federal level optimizes for the given $b_g|_{t^{Ss}<t^N}$. From the perspective of the federal government, each level of τ is associated with a higher level of b_g . For this reason, the optimal choice of τ increases.

The implications for local public good provision are presented in proposition 2.7.

Proposition 2.7: *Suppose $\partial \frac{t^i}{t^i + \tau t_\tau^i} / \partial \tau > 0$. If $\alpha > (<)$ 0, local public good provision decreases (increases) relative to the Nash level of g . The underprovision of local public goods is increased (lowered). If $\alpha = 0$, local public good provision is*

unaltered relative to the Nash level of g .

Proof: Note that the FMCPF is unaffected by a change in t , i.e. $\partial \frac{l^i}{l^i + \tau l_\tau^i} / \partial t = 0$ and by assumption is increasing in τ , i.e. $\partial \frac{l^i}{l^i + \tau l_\tau^i} / \partial \tau > 0$. Furthermore, given by the optimality condition of the federal government, $b_g = \frac{1}{1+\eta}$ [Eq. (2.22)], any change in the FMCPF implies a corresponding change in b_g . Combining these effects and using proposition 2.6 implies that, if $\alpha > 0$ ($t^{Ss} < t^N$ and, as given by Eq. (2.44), $\tau^{Ss} > \tau^N$), both the FMCPF and b_g increase. Hence, $g^{Ss} < g^N$ where the last step follows from the strict concavity of $b(\cdot)$. An analogous argument can be applied if $\alpha \leq 0$. \square

Given by proposition 2.7 local public good provision moves in the same direction as the source-based capital tax. Thus, any improvement in the efficiency in the tax structure translates into an enhanced efficiency in local public good provision and vice versa. This result is in contrast to the findings in the last subsection. Under Stackelberg leadership by the federal government a more efficient tax structure results in a lower level of local public goods.

2.4.7 Conclusion

In this section, the federal-state interaction in a federation is of interest. Traditional contributions rest on the assumption that the federal level can commit to its policy. Within this framework it is shown that the federal government replicates the unitary nation optimum. In the existing literature the structure of the financial relation between the federal and state level is not discussed. The idea of this model is to reverse the direction of commitment and to analyze the implications of the direction of commitment for the allocation of local public goods and the financial structure between both levels of the federation. The problem is analyzed within a model of a two layer federal system with labor income taxation at the upper level and source-based capital taxation at the lower level.

Financial Structure The financial structure, i.e. the choice of tax rates, is summarized in table 2.2. In a unitary state all revenues are collected on the inelastically supplied capital. Under this regime the source-based capital tax is a lump-sum tax as total capital supply is exogenous. The distortionary labor tax is set to 0. In-

	t	τ	s
Unitary Nation	> 0	$= 0$	$= 0$
Federal State			
Nash	$t^N > 0$	$\tau^N > 0$	$s^N > 0$
Stackelberg: Sf	$t^{Sf} > t^N$	$0 < \tau^{Sf} < \tau^N$	$0 < s^{Sf} < s^N$
Stackelberg: Ss	$\alpha < 0$ $t^{Ss} > t^N$	$0 < \tau^{Ss} < \tau^N$	$0 < s^{Ss} < s^N$
	$\alpha = 0$ $t^{Ss} = t^N$	$\tau^{Ss} = \tau^N$	$s^{Ss} = s^N$
	$\alpha > 0$ $0 < t^{Ss} < t^N$	$\tau^{Ss} > \tau^N$	$s^{Ss} > s^N$

Table 2.2: Tax structure in a federal state under different behavioral assumptions.

tergovernmental transfers are of no use in a one-layer state. Hence, $s = 0$. The introduction of a two-layer federal economy with capital taxation at the lower level and labor taxation at the upper level changes the financial structure. With both levels of government playing Nash the capital tax rate as well as the labor tax rate are levied at positive rates. The reason for this result is that decentralized capital taxation causes horizontal fiscal externalities. Therefore, from the perspective of the regional government the use of the source-based tax implies a marginal cost of public funds above unity. Thus, the capital tax rate is set at an inefficiently low level. The federal level can improve the allocation by choosing a positive labor tax rate. The resulting labor tax revenues flow into the regional budgets, i.e. $s^N > 0$.

The Stackelberg-leadership by the federal government causes regions to set the capital tax at a higher level relative to the outcome under both-sided Nash-behavior. The underlying intuition is as follows. The upper level anticipates the reaction of the lower level to its policy choice. Specifically, the federal government anticipates a reduction in t^{Sf} if τ^{Sf} increases. Additionally, the federal level takes into account that a change in t only causes a reallocation of the capital tax base. The behavioral assumption implies a lower level of the labor tax rate, i.e. $\tau^{Sf} < \tau^N$ and, thus, a higher capital tax rate. The transfer volume decreases.

The optimal policy under Stackelberg leadership by states is not as clear cut as under Stackelberg-leadership by the federal government. The crucial factor for the result is the term α . α can be interpreted as a measure for the intensiveness of the horizontal fiscal externality. Depending on the sign of α three cases can be distinguished. A negative sign indicates a high horizontal fiscal externality. In this case, the capital tax rate is set at a higher level because the regional level anticipates a positive response of the federal government's policy variables to an increase in t^{Ss} . Though the labor tax rate always decreases, the transfer can be negatively as well as positively affected with $\alpha < 0$. If s is negatively affected by a rise in t , the impact of a decreasing labor tax rate dominates. For this reason, a high horizontal fiscal externality causes regions to choose a higher capital tax rate and, accordingly, horizontal fiscal externalities are partially internalized.

In contrast, a positive sign of α indicates a low horizontal fiscal externality. In this case the regional government anticipates a negative response by the federal government to a higher capital tax rate. More specifically, the reaction of the labor tax rate is still negative. However, with $\alpha > 0$ the transfer volume is negatively affected by a rise in t . The driving force for the result is that the latter effect dominates. Thus, the perceived marginal cost of public funds by capital taxation increases rather than decreases. Consequently, capital employment is taxed at a lower rate and the deviation from the outcome in a unitary nation increases. With $\alpha = 0$ the positive effect of a lower labor tax rate in response to a higher capital tax rate is offset by lower transfers. For this reason, the tax policy under Stackelberg leadership by states and both-sided Nash behavior coincide.

The labor tax rate moves in the opposite direction as t . Accordingly, a positive, negative or vanishing α causes the labor tax rate to rise, fall or stay constant relative to the labor tax rate chosen under both-sided Nash behavior.

Local Public Good Provision The consequences for local public good provision are presented in table 2.3. In a unitary nation, local public good provision is efficient, i.e. $b_g = 1$. In contrast, the level of local public goods is inefficient in a federal state, i.e. $b_g > 1$. More precisely, if only the lower level of government plays Nash and the upper level acts as a first mover, local public good provision decreases relative to g^N . This result is somewhat surprising as horizontal fiscal externalities

are partially internalized under Stackelberg leadership by the federal government. However, a rise in t corresponds to a decline in τ and the latter effect dominates. Thus, total tax revenues and local public good provision are lowered relative to g^N .

Again, under Stackelberg leadership by states, the result depends on the sign of α . Given $\alpha < 0$, local public good provision increases. Though the labor tax rate decreases the capital tax rate rises. The latter effect outweighs the former, which translates into a higher level of g , i.e. $g^{Ss} > g^N$. Thus, a high horizontal fiscal externality in combination with states acting as first movers results in the most preferable policy outcome in a federal state. The capital tax rate and local public good provision move towards the first-best levels. The distortionary labor tax is reduced.

Conversely, a positive α lowers g . The declining capital tax rate has a dominant effect on total tax revenues. For this reason a low horizontal fiscal externality worsens the outcome relative to the outcome under both-sided Nash-behavior, i.e. $g^{Ss} < g^N$, $t^{Ss} < t^N$, and $\tau^{Ss} > \tau^N$. Put differently, the federal state as a whole makes more use of the distortionary tax instrument, lowers the capital tax rate, which is nondistortionary from the entire economy's perspective, and reduces local public good provision.

With $\alpha = 0$ the outcome under Stackelberg leadership by states does not deviate from that under both-sided Nash behavior. Accordingly, local public spending g^{Ss} equals g^N .

The aim of this section is not to evaluate which assumption concerning the federal-state interaction is more appropriate. This definitely depends on the specific country under consideration. Therefore, it cannot be excluded that none of the Stackelberg leadership assumptions is appropriate. If both levels of government do not have the ability to commit to their actions, then the assumption of Nash behavior for both levels will fit better.

In this section, one abstracts from political considerations. But the constitution, the voting systems, and the power of selfish politicians will have an influence on the commitment ability in a federation. Therefore, a positive analysis is useful to approach the question, which level of a federation is more likely to act as a Stackelberg

	b_g	g
Uniform Nation	$= 1$	> 0
Federal State		
Nash	> 1	$g^N > 0$
Stackelberg: Sf	> 1	$g^{Sf} < g^N$
Stackelberg: Ss	$\alpha < 0$	$g^{Ss} > g^N$
	$\alpha = 0$	$g^{Ss} = g^N$
	$\alpha > 0$	$g^{Ss} < g^N$

Table 2.3: Local public good provision under different behavioral assumptions.

leader. This is of particular importance to evaluate the potential role of the central level of the European Union to internalize fiscal externalities. Here, attention is restricted to examining the consequences of different behavioral assumptions.

2.5 Summary

In the last chapter, capital tax competition is analyzed within a system of independent governments. A source-based capital tax has adverse implications for decentralized local public good provision. Though the capital tax is non-distortionary from the entire economy's perspective, regions perceive an outflow when raising the capital tax rate. This provides incentives for regions to make less use of the capital tax rate leading to inefficiently low capital tax rates. Regions neglect that an outflow of capital corresponds to an inflow of capital and, hence, a higher tax base in other regions.

In the first part of this chapter, the basic reason for the inefficiency result is identified. The underlying mechanism for the inefficiency result can be summarized by the concept of fiscal externalities. This categorization is consistent with the existing literature in economics which traces inefficiencies back to externalities. Fiscal externalities are effects from one fiscal decision unit on another, which are ignored

by the former. In general, fiscal externalities can take two forms. Horizontal fiscal externalities operate at the same level of government. Applied to the basic tax competition model the perceived outflow of capital followed by a rise in the capital tax rate is a positive horizontal fiscal externality. The outflow of capital affects fiscal decision units in other regions as it increases their capital tax base. For this reason, the capital tax rate is set at an inefficiently low level.

The second form of fiscal externalities are vertical fiscal externalities. By definition, they can only operate in multi-layer states. A vertical fiscal externality arises if a government's fiscal decision influences policy variables of governments at different layers. Vertical fiscal externalities can be due to tax base overlap, tax deductibility, and general equilibrium effects. Tax base overlap and tax deductibility are referred to as formal concurrency, since the source of the externality is rooted in institutional (formal) arrangements. However, what matters is effective concurrency, i.e. an ultimate effect on a government's budget in response to a policy of a government at a different layer. The latter can also occur due to general equilibrium effects.

It is only recently that vertical fiscal externalities have received attention in the literature. Boadway and Keen (1996) consider a two-layer state with tax base overlap and labor mobility (only in the extension). This gives rise to vertical and horizontal fiscal externalities. Before Boadway and Keen (1996), there were already multiple approaches to address vertical fiscal externalities. However, these approaches abstract from an explicit modeling of the federal government. Boadway and Keen (1996) show that fiscal externalities are of no concern in their setting. They assume a Stackelberg leadership of the federal government. By committing to its policy, the federal government is able to nullify all fiscal externalities. Thus, the federal government can replicate the policy outcome of a unitary nation where fiscal externalities are absent. This result is confirmed in a broader setting by Boadway, Marchand, and Vigneault (1998).

These two approaches assume a tax-base overlap, i.e. both levels of government tax the same base, and a Stackelberg leadership by the federal government. Hence, it is interesting to alter the assumptions and to analyze whether the findings are robust to these changes. In the second part of this chapter a model is presented where tax base overlap does not occur. The upper level of government taxes labor

income while the lower level has access to a source-based capital tax. Additionally, both the federal and the regional level rather than only the upper level, are assumed to act as a Stackelberg leader. The following questions are examined.

- First, to what extent does the behavioral assumption determine the ability of a federal system to internalize fiscal externalities?
- Second, in the absence of perfect tax-base overlap does the Stackelberg leadership by the federal government guarantee a replication of the unitary nation outcome?

Within this framework, it is shown that the Stackelberg leadership by the federal government does not guarantee an internalization of fiscal externalities. The commitment ability by the federal government brings about a Pareto-improvement relative to the Nash outcome. But the unitary nation's policy is not replicated. Thus, the second question can be answered with "No".

The answer to the first question is more complex. In general, the reversal of the usually assumed behavioral assumption yields different outcomes. Under Stackelberg leadership by the federal level, the outcome is unambiguous. The capital tax rate rises, the labor tax rate decreases, and local public good provision is reduced relative to the Nash outcome. In contrast, the policy outcome under Stackelberg leadership by states is ambiguous. Depending on the magnitude of the horizontal fiscal externality (represented by α) two cases can be distinguished. A low horizontal fiscal externality implies a lower capital tax rate, a higher labor tax rate, and a reduction in local public good provision. Therefore, the allocation is inferior to the Nash outcome. The bias in the regional marginal cost of public funds is increased rather than decreased.

A high horizontal fiscal externality has the opposite effect. The capital tax rate rises, the labor tax rate decreases and local public good provision is higher. Thus, a Stackelberg leadership by states in combination with a high horizontal fiscal externality implements the allocation which is closest to the benchmark allocation of a unitary nation. In this case, the commitment ability by states yields a superior result as a commitment ability by the federal government. This result is in sharp contrast to the findings in the literature on taxation in federal systems.

Appendix A

Appendix to Chapter 2

A.1 Slope of the Reaction Functions

In this part of the appendix the slopes of the reaction functions $s^1 = s^1(t^1, t^2)$, $s^2 = s^2(t^1, t^2)$, and $\tau = \tau(t^1, t^2)$ are derived. Therefore, Eq. (2.22) (for both regions) and the federal budget constraint $s^1 + s^2 = \tau(l^1 + l^2)$ are totally differentiated and written in matrix form ($dt^2 = 0$)

$$\underbrace{\begin{pmatrix} b_{gg}^1 & 0 & -\frac{\partial \frac{l^1}{l^1 + \tau l_\tau^1}}{\partial \tau} \\ 0 & b_{gg}^2 & -\frac{\partial \frac{l^2}{l^2 + \tau l_\tau^2}}{\partial \tau} \\ 1 & 1 & -\sum_{i=1}^2 (l^i + \tau l_\tau^i) \end{pmatrix}}_{=:A} \begin{pmatrix} ds^1 \\ ds^2 \\ d\tau \end{pmatrix} = \begin{pmatrix} -b_{gg}^1 (t^1 k_{t^1}^1 + k^1) dt^1 \\ -b_{gg}^2 t^2 k_{t^1}^2 dt^1 \\ 0 \end{pmatrix}$$

The determinants of the coefficient matrix A and the matrices $A^i, i = 1, 2, 3$ are as follows:

$$|A| = b_{gg}^1 \left[-b_{gg}^2 \sum_{i=1}^2 (l^i + \tau l_\tau^i) + \frac{\partial \frac{l^2}{l^2 + \tau l_\tau^2}}{\partial \tau} \right] + b_{gg}^2 \frac{\partial \frac{l^1}{l^1 + \tau l_\tau^1}}{\partial \tau} < 0 \quad (\text{A.1})$$

$$|A^1| = -b_{gg}^1 (t^1 k_{t^1}^1 + k^1) dt^1 \left[-b_{gg}^2 \sum_{i=1}^2 (l^i + \tau l_\tau^i) + \frac{\partial \frac{l^2}{l^2 + \tau l_\tau^2}}{\partial \tau} \right] + \frac{\partial \frac{l^1}{l^1 + \tau l_\tau^1}}{\partial \tau} b_{gg}^2 t^2 k_{t^1}^2 dt^1 \quad (\text{A.2})$$

$$|A^2| = b_{gg}^1 b_{gg}^2 t^2 k_{t^1}^2 \sum_{i=1}^2 (l^i + \tau l_\tau^i) dt^1 + b_{gg}^1 (t^1 k_{t^1}^1 + k^1) \frac{\partial \frac{l^2}{l^2 + \tau l_\tau^2}}{\partial \tau} dt^1 - \frac{\partial \frac{l^1}{l^1 + \tau l_\tau^1}}{\partial \tau} b_{gg}^2 t^2 k_{t^1}^2 dt^1 \quad (\text{A.3})$$

$$|A^3| = b_{gg}^1 b_{gg}^2 (t^2 k_{t^1}^2) dt^1 + b_{gg}^1 b_{gg}^2 (t^1 k_{t^1}^1 + k^1) dt^1 > 0. \quad (\text{A.4})$$

In order to sign $|A|$ the sign of $l^i + \tau l_\tau^i$ and $\frac{\partial \frac{l^i}{l^i + \tau l_\tau^i}}{\partial \tau}$ have to be determined first. $l^i + \tau l_\tau^i$ is positive. Otherwise, the federal government would end up on the downward-sloping side of the Laffer curve. However, as implied by the federal maximization problem this is not the case. In contrast, the sign of the expression $\frac{\partial \frac{l^i}{l^i + \tau l_\tau^i}}{\partial \tau}$ cannot be specified without making further assumptions. Note, the second-order condition of the federal government's optimization problem only implies the inequality $b_{gg}^i < \frac{\partial \frac{l^i}{l^i + \tau l_\tau^i}}{\partial \tau}$. In general, the sign can be positive as well as negative. To simplify the analysis $\frac{\partial \frac{l^i}{l^i + \tau l_\tau^i}}{\partial \tau}$ is assumed to be positive in the subsequent analysis. As shown in footnote 30 a sufficient condition for this assumption to hold is $h''' > 0$ and $f_{ll} < 0$. Therefore, $\text{sign}[|A|]$ is negative.

To specify the sign of $|A^1|$ and $|A^2|$ it will prove useful to rewrite them as follows

$$|A^1| = [\beta(t^1 k_{t^1}^1 + k^1) + \alpha] dt^1 \quad \text{and} \quad |A^2| = [\beta(t^2 k_{t^1}^2) - \alpha] dt^1. \quad (\text{A.5})$$

with

$$\alpha := -b_{gg}^1 (t^1 k_{t^1}^1 + k^1) \frac{\partial \frac{l^2}{l^2 + \tau l_\tau^2}}{\partial \tau} + b_{gg}^2 t^2 k_{t^1}^2 \frac{\partial \frac{l^1}{l^1 + \tau l_\tau^1}}{\partial \tau} \quad \text{and} \quad (\text{A.6})$$

$$\beta := b_{gg}^1 b_{gg}^2 \sum_{i=1}^2 (l^i + \tau l_\tau^i). \quad (\text{A.7})$$

The sign of the determinants $|A^1|$ and $|A^2|$ depends on the sign and magnitude of α and β . Since α cannot unambiguously be signed, the sign of $|A^1|$ and $|A^2|$ is ambiguous as well. In contrast, the sign of $|A^3|$ is strictly positive since $t^2 k_{t^1}^2$ and $t^1 k_{t^1}^1 + k^1$ are both strictly positive.

Applying Cramer's rule, the slope of the response functions is given by

$$\frac{ds^1}{dt^1} = \frac{\beta(t^1 k_{t^1}^1 + k^1) + \alpha}{|A|} \quad (\text{A.8})$$

$$\frac{ds^2}{dt^1} = \frac{\beta(t^2 k_{t^1}^2) - \alpha}{|A|} \quad (\text{A.9})$$

$$\frac{d\tau}{dt^1} = \frac{b_{gg}^1 b_{gg}^2 (t^2 k_{t^1}^2) + b_{gg}^1 b_{gg}^2 (t^1 k_{t^1}^1 + k^1)}{|A|}. \quad (\text{A.10})$$

A.2 Proof of Lemma 2.2

In this part of the appendix Lemma 2.2 is proved, i.e. the impact of the optimal response functions on the magnitude of the tax rate t^1 is derived for cases (i),(ii),

and (v) in section (2.4.6). Substituting Eqs. (2.42) and (2.44) into Eq. (2.50) yields

$$-l^1 \frac{b_{gg}^1 b_{gg}^2 (t^2 k_{t^1}^2) + b_{gg}^1 b_{gg}^2 (t^1 k_{t^1}^1 + k^1)}{|A|} \begin{matrix} \leq \\ > \end{matrix} b_g^1 \left| \frac{\beta (t^1 k_{t^1}^1 + k^1) + \alpha}{|A|} \right|. \quad (\text{A.11})$$

Multiplying by $-|A| > 0$ gives

$$l^1 \left[b_{gg}^1 b_{gg}^2 (t^2 k_{t^1}^2) + b_{gg}^1 b_{gg}^2 (t^1 k_{t^1}^1 + k^1) \right] \begin{matrix} \leq \\ > \end{matrix} b_g^1 \left| \beta (t^1 k_{t^1}^1 + k^1) + \alpha \right| \quad (\text{A.12})$$

Using the fact that in equilibrium $b_g^1 = \frac{l^1}{l^1 + \tau l^1}$ [see Eq. (2.22)] and rearranging condition A.12 lead to

$$\frac{1}{2} \beta (t^1 k_{t^1}^1 + k^1 + t^2 k_{t^1}^2) \begin{matrix} \leq \\ > \end{matrix} \left| \beta (t^1 k_{t^1}^1 + k^1) + \alpha \right| \quad (\text{A.13})$$

with $\beta > 0$ as given by Eq. (2.46). As in cases (i), (ii), and (v), $\beta(t^1 k_{t^1}^1 + k^1) + \alpha > 0$, the inequality can be rewritten to

$$0 \begin{matrix} \leq \\ > \end{matrix} \frac{1}{2} \beta \left[(t^1 k_{t^1}^1 + k^1) - t^2 k_{t^1}^2 \right] + \alpha. \quad (\text{A.14})$$

Note, this inequality corresponds to the initial situation

$$-l^1 \tau_{t^1} \begin{matrix} \leq \\ > \end{matrix} \left| b_g^1 s_{t^1}^1 \right| \quad (\text{A.15})$$

and to the tax rate as given by Eq. (2.50) in Lemma 2.1.

Chapter 3

Capital Tax Coordination

The following chapter addresses the issue of tax coordination which is an additional way of mitigating inefficiencies in local public spending. The analysis focuses on different tax coordination measures and characterizes its allocative and distributional implications. The latter are now taken into account as they are crucial for the regions' incentives to participate in tax coordination. Specifically, the allocative and redistributive implications of capital tax coordination in the presence of symmetric and asymmetric information are analyzed.

The chapter is organized as follows. The first section gives an introduction to the issue of tax coordination. In section 3.2, different approaches to tax coordination are presented and their welfare implications are derived. Tax coordination under asymmetric information is analyzed in section 3.3 and a formal model of tax coordination under asymmetric information is presented in section 3.4. The model is extended in various ways. Section 3.5 focuses on the role of commitment for tax coordination. The constraints for tax coordination imposed by voluntary participation are explicitly modeled in section 3.6. Section 3.7 completes the analysis by summarizing the basic results and drawing conclusions.

3.1 Introduction

In the last chapter a central government was introduced to the basic tax competition model. Within this extended framework, capital taxation still occurs at the regional level. The central government taxes labor income at a uniform rate. The aim of the analysis is to answer the question whether a central government using unconditional grants is able to internalize horizontal fiscal externalities arising

from capital tax competition. Until now regions have behaved non-cooperatively, either as Nash competitors or Stackelberg leaders. In this chapter the assumption of non-cooperative behavior is dropped. This is done in order to analyze the welfare implications of tax coordination. More specifically, tax coordination is analyzed with respect to its ability to increase efficiency of local public good provision and of the capital allocation. Recall, the inefficiency of decentralized capital taxation rests on horizontal fiscal externalities, which only occur due to non-cooperative behavior among regions. Therefore, it is interesting to contrast the effects of tax coordination and tax competition.

In general, tax coordination can take different forms. The crucial difference between them is whether the tax authority remains at the regional level or whether it is allocated to a central level. With the former definition of tax coordination taxation is still decentralized. In this case tax coordination is modeled as a simultaneous increase in tax rates where the initial allocation is the uncoordinated Nash equilibrium. Even if one restricts attention to this form of tax coordination there are still different ways of modeling the coordinated tax increase. Tax coordination could imply that all regions increase the tax rate by the same amount. This is a very common way of modeling tax coordination with decentralized taxation in the literature.¹ However, tax coordination could also imply that a region unilaterally agrees to change the tax rate. For instance, with interregional tax rate differential the low tax country could agree to increase its tax rate and, thereby, move towards the tax rate level in the high tax country. This is exactly the approach of commodity tax coordination adopted in the European Union. A third form of tax coordination is that all regions adjust their tax rates towards an average level of taxation, i.e. high tax regions lower their tax rates whereas low tax regions increase their tax rates. This form of tax coordination has been suggested for coordinating corporate taxation within the European Union.

Most of the literature on tax coordination chooses this decentralized approach to identify welfare improving tax reforms. The next section provides a brief summary of the literature and derives the welfare properties of tax coordination with decentralized capital taxation.

¹See, e.g., Keen (1989), Wrede (1996), and Fuest and Huber (1999).

A second definition of tax coordination requires a reassignment of taxes within a federal state. The inefficiency of local public finance stems from the fact that regions ignore positive effects of their policy on neighboring regions. Hence, it is intuitive to suggest a reassignment of the authority to tax to a level of government that internalizes all effects of taxation. Thus, horizontal fiscal externalities do not arise. With centralized taxation the central government selects the tax rates by maximizing some welfare functional. This requires that the central government has all information relevant for efficient decision making. However, in many models with centralized policy coordination the assumption of perfect information at the central level is abandoned in favor of the assumption of asymmetric information. That is, it is assumed that private information is held by regions, e.g. concerning regional production possibilities or preferences. The central government designs a self-selection mechanism under which each region has an incentive to reveal its private information. These mechanisms of tax coordination are analyzed with respect to its welfare properties.

Most of the literature restricts attention to a welfare comparison of policy coordination under symmetric and asymmetric information. A comparison of the welfare performance of centralized and decentralized policy making is often neglected. The rationale for this is that even with asymmetric information the central government can implement the same allocation as under tax competition. Thus, under centralized taxation welfare is either just as high or even higher as under uncoordinated decentralized taxation. The information asymmetry restricts the central government in its policy design. However, it cannot restrict the ability of centralized policy coordination to outperform decentralized capital taxation. This may only occur if, besides the assumption of perfect information, additional assumptions are dropped. In that sense, asymmetric information is only a necessary but not a sufficient condition for decentralization to yield higher welfare than centralization. Most of the chapter deals with this centralized form of policy coordination. In section 3.3 the literature on centralized policy coordination is surveyed. A formal analysis of centralized capital taxation is presented in sections 3.4 to 3.6.

In order for tax coordination to work regions must either be willing to change their tax rates from the Nash equilibrium level or to reallocate the tax authority to a central government. Thus, both forms of tax coordination will be more likely if

all regions benefit from the policy measure. Applied to tax policy reforms within the European Union this requirement becomes very restrictive as tax coordination policy is unanimously decided upon. Therefore, all regions must benefit from tax coordination. Otherwise, the uncoordinated Nash equilibrium tax rates are applied. For this reason the change in regions' utility due to tax coordination and, thus, the incentive to participate in any form of tax coordination receives special attention under both forms of tax coordination.

3.2 Tax Coordination

Edwards and Keen (1996) analyze the effects of capital tax coordination in the presence of a private agenda of the government. In their setting the government cares about utility of the representative citizen. The policy maker also derives utility from wasteful expenditures, i.e. from the fraction of capital tax revenues that is not spent on public goods. Therefore, Edwards and Keen (1996) relax the assumption of benevolent governments and allow for capital tax competition with governments which are neither entirely benevolent nor wholly self-serving. Tax coordination yields the following results. A simultaneous rise in all regions' tax rates unambiguously increases the well-being of the policy maker. In that sense, tax coordination is beneficial as capital tax competition restrict governments to a lower level of welfare. However, as the interest of the government is not perfectly alligned to the interest of the representative citizen this result does not have to carry over to the citizen's utility change. Specifically, the effect of tax coordination on utility of the representative citizen is ambiguous. The intuition for this result is straightforward. A coordinated increase in the capital tax rate is equivalent to a lump-sum tax on capital. Thus, tax coordination constitutes a lump-sum transfer from the citizen to the government in order to finance public as well as wasteful expenditures. The citizen's utility is only affected by private consumption and public consumption and not by wasteful expenditures. Thus, in Edwards and Keen (1996) public consumption and wasteful expenditures increase while private consumption decreases due to tax coordination. If the private consumption effect dominates the public consumption effect, the citizen's utility decreases though local public goods are underprovided in the uncoordinated equilibrium.² However, policy makers unambiguously benefit

²Recall, with symmetric regions and benevolent governments local public goods are underprovided. In this case private consumption also decreases while public consumption increases in

from the tax reform as the net impact of all three effects must be positive. If one allows for the extreme forms of government's behavior one arrives at clear-cut results. With purely selfish governments, tax coordination is harmful for the citizen. In contrast, if one allows for wholly benevolent governments tax coordination enhances the citizen's utility.

Fuest and Huber (1999) analyze the effect of tax coordination if both capital and labor taxes are available to the government. Additionally, they allow for competitive and non-competitive labor markets. As the results of tax coordination in the presence of competitive labor markets are presented in more detail in the next section the current survey is restricted to the results derived with non-competitive labor markets. In this setting unemployment exists and wages are determined by bargaining between firms and unions. If the government takes the wage rate emerging from the bargaining process as given, the uncoordinated capital tax is set at a negative rate. The reason for this is that the government subsidizes capital to attract capital and, thus, to reduce unemployment. A coordinated increase in all capital tax rates lowers welfare. This seems to be surprising as any uncoordinated increase in the capital tax rate (even if the tax rate is negative) causes an outflow of capital which is needed to alleviate unemployment. A coordinated increase leaves capital allocation unchanged. Therefore, one might expect welfare to rise. However, the higher capital tax rate drives up wages. For this reason employment is reduced and, consequently, private and public consumption as well. Hence, welfare is lowered. As shown by Fuest and Huber (1999) a coordinated increase in the labor tax rate reduces welfare, too. To understand this result a similar line of reasoning can be applied. In contrast, if governments anticipate the effect their tax policy has on the bargaining outcome, the results are slightly modified. Now, both a coordinated increase in the capital tax rate and a coordinated increase in the labor tax rate enhances welfare if the wage elasticity of labor demand is sufficiently high.

A large amount of literature on tax coordination deals with the issue of commodity tax coordination. Mintz and Tulkens (1986) set up a general equilibrium model of cross-border shopping (see chapter 2) and derive the welfare properties of tax

response to tax coordination. However, unlike the case of partially selfish governments, tax coordination is unambiguously beneficial for the citizen since all additional tax revenues are spent on public goods.

coordination. Starting from the uncoordinated Nash equilibrium, tax coordination either takes the form of a rise in the high tax region's tax rate or an increase in the low tax region's tax rate. Since the initial situation is a Nash equilibrium, the utility effect of the region which marginally coordinates its tax rate is always zero.³ For this reason, the welfare effect of tax coordination is solely determined by the impact on utility of other regions. They show that a commodity tax increase in the high tax region benefits the low tax region. However, starting from a Nash equilibrium the total effect of a tax increase in the low tax region on the high tax region cannot be signed as this policy measure involves a negative private and a positive public consumption effect (tax base effect). Accordingly, the welfare effect cannot be unambiguously signed. De Crombrughe and Tulkens (1990) conclude that the positive public consumption effect dominates in the Mintz-Tulkens setting indicating an inefficiently low equilibrium tax rate. However, Haufler (1998) obtains a different result. He demonstrates that the welfare effect in the high tax region cannot be signed without making specific assumptions concerning the shape of the utility function and the transaction cost function. Therefore, in the general setting of Mintz-Tulkens the result derived in Mintz and Tulkens (1986) still holds.

Haufler (1996) modifies the framework of Mintz and Tulkens (1986) by introducing further assumptions on the shape of the transaction cost function for cross-border shopping. Additionally, in contrast to Mintz and Tulkens (1986) each region produces only one homogeneous good which is imported and exported at the same time. Tax coordination is modeled either as a minimum tax rate or as an increase in the cost of cross-border shopping. The analysis reveals that tax coordination generally benefits the high tax region. The result for the low tax region is ambiguous. For example, the low tax region benefits from this policy measure if the tax differential in the initial uncoordinated equilibrium is sufficiently high.

In contrast, Kanbur and Keen (1993) consider the case of commodity tax coordination in a partial equilibrium setting where governments only care about public consumption, i.e. they maximize tax revenues. In this model tax coordination takes the form of a minimum tax as well as an increase in the cost of cross-border shopping. Kanbur and Keen (1993) show that tax coordination is beneficial for

³Note, the first-order utility effects are identical to the first-order conditions characterizing the initial allocation.

all regions. That is, the allocation implied by commodity tax competition can be improved if private consumption effects do not enter the objective function of the government.

3.2.1 Capital Taxation

In the following two paragraphs the welfare effects of capital tax coordination in the presence of symmetric and asymmetric regions are derived. In both cases tax coordination takes place under symmetric information.⁴

Symmetric Capital Tax Competition The welfare implications of a simultaneous increase in the capital tax rate are analyzed by deriving the total differential of household's utility evaluated at the uncoordinated Nash equilibrium. The underlying model is given by the basic tax competition model presented in chapter 1. Differentiating the utility function $u = u(c, g)$ with respect to the capital tax rate t gives⁵

$$du = (-u_c \tilde{k} + u_g k) dt. \quad (3.1)$$

According to Eq. (3.1) du can be positive as well as negative. However, starting at a uncoordinated Nash equilibrium characterized by

$$-u_c \tilde{k} + u_g (tk_t + k) = 0, \quad (3.2)$$

utility unambiguously increases in response to a simultaneous increase in all tax rates. The intuition for this result is straightforward. The coordinated rise in t reduces the interest rate on a one to one basis. Capital income and, thus, private consumption is lowered by \tilde{k} . On the other hand capital tax revenues increase by k . A negative effect on tax revenues does not exist. The tax base remains unchanged as the tax reform does not alter interregional capital employment. Therefore, the tax reform results in lower private consumption and higher public consumption. In general, one cannot determine which effect dominates. However, if one starts at the Nash equilibrium of the basic tax competition model, the positive public consumption effect outweighs the negative private consumption effect. As private consumption is too high and public consumption too low at the uncoordinated Nash

⁴For an analysis of policy coordination in a decentralized system and under asymmetric information see Klibanoff and Morduch (1995).

⁵As long as no confusion occurs regional superscripts are omitted.

equilibrium relative to the efficient consumption levels, the increase in public consumption and decrease in private consumption is welfare enhancing. Due to the symmetry assumption this result holds for all regions.⁶

Asymmetric Capital Tax Competition Furthermore, it is interesting to analyze if this result carries over to the case of asymmetric regions.⁷ Consider the model of asymmetric tax competition due to taste differences presented in chapter 1. In that framework capital tax rates are inefficiently low in equilibrium. Local public good provision is also inefficiently low in high preference regions. However, in low preference regions local public goods can be underprovided, overprovided as well as efficiently provided. This result is due to capital reallocation from high preference to the low preference regions. Although the capital tax rate is too low, tax revenues may be sufficient to finance the efficient or even a higher level of local public goods. Furthermore, due to the positive tax differential $t^h - t^l$ capital allocation is inefficient. Recall, the latter inefficiency does not occur with symmetric regions since equilibrium tax rates are identical.

Given these two sources of inefficiency a coordinated tax reform can be evaluated with respect to its ability to increase the efficiency of local public good provision and to achieve a more efficient interregional capital allocation. The latter requires a reduction in the interregional tax differential $t^h - t^l$ whereas the former can -a priori- also be achieved by a comovement of regional tax rates leaving the tax differential unaffected. The subsequent analysis adopts the latter concept of decentralized tax coordination first. In general, three policy options are available to narrow the tax differential:

- the capital tax rate in the low tax region is marginally increased,
- the capital tax rate in the high tax region is marginally decreased, or
- both policy measures are applied simultaneously.

⁶Konrad and Schjelderup (1999) present a model of partial capital tax coordination in the basic tax competition framework. A more general analysis of partial policy coordination is given in Burbidge, De Pater, Myers, and Sengupta (1997).

⁷Capital tax coordination among asymmetric regions is also considered in Grazzini and Ypersele (1998). In their model regions differ with respect to their factor endowment.

In the first case a marginal increase in t^l leaves utility in low tax regions unaffected. The starting point is the uncoordinated Nash equilibrium where the first-order condition for t^l holds.⁸ Thus, this form of tax coordination is neutral with respect to utility in low tax regions and the welfare effect of the tax reform is solely determined by $\frac{du^h}{dt^l}$. In high tax regions the change in utility du^h is given by

$$du^h = \left\{ u_c^h \left[-f_{kk}(k^h) \frac{\partial k^h}{\partial t^l} k^h + \frac{\partial r}{\partial t^l} \tilde{k} \right] + u_g^h \left(t^h \frac{\partial k^h}{\partial t^l} \right) \right\} dt^l. \quad (3.3)$$

Rewriting Eq. (3.3) yields⁹

$$du^h = \left\{ u_c^h \left[\frac{f_{kk}(k^h)}{f_{kk}(k^h) + f_{kk}(k^l)} (k^h - \tilde{k}) \right] + u_g^h \left(t^h \frac{\partial k^h}{\partial t^l} \right) \right\} dt^l. \quad (3.4)$$

Evaluated at the initial equilibrium the sign of $\frac{du^h}{dt^l}$ is ambiguous. Interest income decreases by $\left\{ f_{kk}(k^h) / [f_{kk}(k^h) + f_{kk}(k^l)] \right\} \tilde{k}$ whereas rents, i.e. income from the supply of the fixed factor, rise by $\left\{ f_{kk}(k^h) / [f_{kk}(k^h) + f_{kk}(k^l)] \right\} k^h$. In the uncoordinated equilibrium $k^h < \tilde{k}$. Therefore, the negative interest rate effect dominates and private consumption is lowered due to the marginal rise in t^l . Public consumption unambiguously increases. Hence, the utility effect in the high tax region cannot be determined without putting more structure to the model. In sum, a tax coordination modeled as a unilateral increase in the capital tax rate provides no clear-cut results concerning the incentive to agree to this form of tax coordination.

A second possibility to narrow the tax differential is to decrease t^h unilaterally. Again, starting at the uncoordinated Nash equilibrium, a marginal decrease in t^h

⁸Note, at the initial equilibrium, t^l is characterized by the first-order condition

$$u_c^l \left[-f_{kk}(k^l) \frac{\partial k^l}{\partial t^l} k^l + \frac{\partial r}{\partial t^l} \tilde{k} \right] + u_g^l \left(k^l + t^l \frac{\partial k^l}{\partial t^l} \right) = 0.$$

Therefore, both a marginal increase and a marginal decrease leaves utility unchanged.

⁹For simplicity, consider an economy with one high preference region and one low preference region. In this economy the reaction of capital demand, k^h , and the interest rate, r , to a marginal increase in t^l are given by

$$\frac{\partial k^h}{\partial t^l} = \frac{-1}{f_{kk}(k^h) + f_{kk}(k^l)} \quad \text{and} \quad \frac{\partial r}{\partial t^l} = \frac{-f_{kk}(k^h)}{f_{kk}(k^h) + f_{kk}(k^l)}.$$

Inserting these expressions in Eq. (3.3) yields Eq. (3.4). Since at the initial equilibrium $k^h - \tilde{k} < 0$, the change in consumption is negative. In contrast, due to $\frac{\partial k^h}{\partial t^l} > 0$ the change in public consumption g^h is positive. Thus, the sign of $\frac{du^h}{dt^l}$ is ambiguous.

has no impact on utility in high tax regions. The change in utility in low preference regions du^l is given by

$$du^l = \left\{ u_c^l \left[\frac{f_{kk}(k^l)}{f_{kk}(k^l) + f_{kk}(k^h)} (k^l - \tilde{k}) \right] + u_g^l \left(t^l \frac{\partial k^l}{\partial t^h} \right) \right\} dt^h. \quad (3.5)$$

The derivation of this expression is equivalent to the derivation of Eq. (3.4). In this case interest income increases due to $dt^h < 0$. On the other hand fixed factor income is lowered. Since $k^l > \tilde{k}$ in the initial equilibrium, the latter effect dominates. Private consumption c^l is reduced. A lower capital tax rate in the high tax regions causes capital to leave low tax regions. For this reason, the capital tax base and, thus, capital tax revenues shrink. Hence, both private and public consumption are lowered in the low preference region in response to a decrease in t^h . Therefore, the low preference region has no incentive to participate in this kind of tax coordination. In contrast, the high preference region is indifferent.

The third way of narrowing the tax differential is a simultaneous application of the two unilateral tax coordination measures analyzed above. The effect of this form of tax coordination on utility can be inferred from the above analysis. Now, utility is affected by the tax decrease in t^h and the tax increase in t^l . Thus, the change in utility of the high preference region is given by

$$\begin{aligned} du^h &= \underbrace{\left\{ u_c^h \left[-f_{kk}(k^h) \frac{\partial k^h}{\partial t^h} k^h + \frac{\partial r}{\partial t^h} \tilde{k} \right] + u_g^h \left(k^h + t^h \frac{\partial k^h}{\partial t^h} \right) \right\}}_{=0} dt^h \\ &+ \left\{ u_c^h \left[-f_{kk}(k^h) \frac{\partial k^h}{\partial t^l} k^h + \frac{\partial r}{\partial t^l} \tilde{k} \right] + u_g^h \left(t^h \frac{\partial k^h}{\partial t^l} \right) \right\} dt^l. \end{aligned} \quad (3.6)$$

Starting in the uncoordinated Nash equilibrium, the first term is zero and only the second term determines the sign of du^h . This term is equivalent to Eq. (3.3). Therefore, the above discussion of the welfare effects for high preference regions in case of a unilateral increase in t^l applies here as well. That is, the sign of du^h is ambiguous. The impact on utility in low preference regions can be derived in a similar manner. The impact of the marginal increase in t^l on u^l is zero and the impact of a marginal decrease in t^h on u^l is decisive for the sign of du^l . Since the corresponding expression coincides with Eq. (3.5), private consumption and public consumption decrease in response to a lower t^h . Due to the reduced tax rate in the high preference regions and the induced outflow of capital, low preference regions are worse off. Clearly,

they have no incentive to participate in tax coordination. The result that low tax regions are reluctant in agreeing to capital tax coordination is consistent with the literature commodity tax coordination. For instance Mintz and Tulkens (1986) and Haufler (1998) show that in the case of commodity taxation low tax regions do not always benefit from tax coordination and, thus, they are more likely to be opposed to tax coordination. The result is also reflected by practical tax policy within the European Union where especially low tax regions do not agree to, e.g., corporate tax coordination and capital income tax coordination.

The second form of tax coordination requires a coordinated change in both tax rates in order to keep the tax differential constant. Clearly, this tax reform does not aim at improving the efficiency of the capital allocation. The only potential allocative rationale for this policy measure is to reduce the inefficiency in local public good provision. With respect to the rise in t^l the utility effects of this policy proposal are equivalent to those derived above. That is, u^l stays constant and the effect on u^h is ambiguous. Furthermore, the rise in t^h still leaves u^h unaffected. However, unlike the previously analyzed tax reform, utility in the low preference region rises [see Eq. (3.5)]. Both the tax base and the net consumption effect are now positive. This result indicates that the low tax region only agrees to a tax reform package that entails either no change or a rise in t^h . This requirement constitutes a “participation constraint” which restricts the set of implementable capital tax reforms.

In sum, the analysis shows that in contrast to symmetric regions where a coordinated marginal tax increase is unambiguously positive the result is less clear cut with asymmetric regions. Therefore, the incentive to participate in tax coordination is less obvious with asymmetric than with symmetric regions. That is, if du is negative for one type of region it will be opposed to tax coordination measures. Additionally, as the initial situation is a Nash equilibrium the other type of region which benefits from tax coordination does not unilaterally change the capital tax rate. Thus, tax coordination does not occur unless compensation payments are made.

3.2.2 Capital and Labor Taxation

This subsection refers to the model of capital tax competition with multiple tax instruments considered in chapter 1. Note, with capital and labor taxation local public good provision is still inefficient. The rationale for this result are positive fiscal externalities, which imply that the capital tax rate is set too low. As shown in chapter 1 this gives rise to distortionary labor taxation. In the following, the welfare properties of tax coordination is briefly analyzed within the model of capital and labor taxation. Tax coordination is introduced in two ways. First, the impact of a coordinated increase in the capital tax rates for given labor tax rates is analyzed. In the second step, labor tax rates are marginally increased while holding the capital tax rates constant.

Differentiating the indirect utility function $v = v(t, \tau)$ with respect to all capital tax rates while holding the labor tax rate constant yields

$$\frac{dv}{dt} = \lambda \left(\frac{u_g}{u_c} - 1 \right) \tilde{k} \quad (3.7)$$

where λ is the Lagrange multiplier of the household's optimization problem and thus, by the envelope theorem represents the marginal utility of private income. A derivation of Eq. (3.7) is given in Fuest and Huber (1999). As local public goods are underprovided in the uncoordinated Nash equilibrium the term in brackets is positive. This result is not surprising. If local governments are restricted to a source-based capital tax the coordinated increase in the capital tax rate is utility enhancing. This result carries over to the case where local governments have access to both capital and labor taxes, as in both models the reason for the undertaxation of capital are positive horizontal fiscal externalities.

It is more interesting to analyze whether this result also carries over to labor tax coordination. Differentiating the indirect utility function $v = v(t, \tau)$ with respect to τ in all regions while holding the capital tax rate constant yields

$$\frac{dv}{d\tau} = \lambda \left(1 - \frac{u_g}{u_c} \right) \frac{\partial r}{\partial \tau} \tilde{k}. \quad (3.8)$$

A formal proof of this result is given in Fuest and Huber (1999, appendix 1). Observe, the term in brackets and $\frac{\partial r}{\partial \tau}$ are negative. It turns out that, starting from the uncoordinated Nash equilibrium, a coordinated increase in τ increases utility. The

intuition for this result is presented in chapter 1. Recall, an uncoordinated rise in τ reduces labor supply and, thus, lowers the marginal productivity of capital. The latter implies a perceived outflow of capital which increases the marginal cost of public funds of labor taxation to the region. The region equates the marginal rate of substitution between private and public consumption to the perceived marginal cost of public funds. However, the capital outflow is only perceived and does not occur in equilibrium. Thus, the perceived marginal cost of public funds exceeds the equilibrium marginal cost of public funds. For this reason, the equilibrium marginal rate of substitution between private and public consumption is higher than the equilibrium marginal cost of public funds. The level of labor taxation is lower than the level which would prevail in the absence of capital mobility. In sum, due to the horizontal fiscal externality, the labor tax rate is set too low. Since at the initial equilibrium the marginal rate of substitution is higher than the marginal cost of public funds, a coordinated increase in τ is utility enhancing.

3.3 Tax Coordination and Asymmetric Information: An Overview

In general, policy coordination by centralization has received a lot of attention in the literature. However, most of the early literature conducts policy coordination in a symmetric information environment. For instance, in the context of redistribution Boadway and Flatters (1982) derive an interregional transfer system which achieves production efficiency and provides assistance to the poor. Moreover, Pfingsten and Wagener (1997) determine a transfer mechanisms where the central government is fully informed about the characteristics of each region. In that paper the centrally mandated transfer system is designed as to ensure that each takes full account of the effects its redistribution policy has on other regions. Put differently, under symmetric information a transfer is determined that internalizes all fiscal externalities resulting from redistribution at the regional level.

Asymmetric information is already implicitly considered in Oates (1972). Oates (1972) states in the well-known decentralization theorem that in the absence of cost-savings from centralized local public good provision and of interjurisdictional externalities welfare with decentralized public finance is at least as high as with

centralized public finance. The theorem contains an implicit assumption concerning the reflection of interregional differences in centralized policy. Oates (1972) assumes that centralized governments are constrained to supply a homogeneous local public good, and that only decentralization of governments can accommodate for heterogeneity in local preferences. This behavior can be motivated in two ways. First, the central government has full information about, e.g., regional preference differences. However, it does not use the information to compute the first-best levels of local public goods for each type of region. It is only used to derive the level of local public goods which is optimal on average. In this case, the central government is forced to a uniform policy for some exogenous reasons. The second strand of explanation bases on asymmetric information. Regional governments have perfect information about regional preferences whereas the central government only knows the distribution of preferences. Now, in order to derive Oates' result one has to assume that a self-selection mechanism is not applied by the central government.¹⁰ That is, the central government does not try to design regional policy packages which induces a truthful revelation of private information. In the absence of any self-selection mechanism the central government is forced to apply uniform policies across regions. It is the latter strand of explanation which is applied to motivate the decentralization theorem. Given this motivation, the theorem can be stated in the following way. In the absence of cost-savings from centralized local public good provision and of interjurisdictional externalities decentralization is favored to centralization as a decentralized policy can be adjusted to regional characteristics.

It is only recently that asymmetric information has entered literature on policy coordination in an explicit way. The assumption of asymmetric information between the central and regional level has been introduced into the literature on centralized policy-making in multiple ways. Raff and Wilson (1997) examine the issue of income redistribution across regions and to mobile workers. In that setting regions differ with respect to their productivity. Furthermore, regions choose an effort level which affects the productivity-enhancing effect of local public inputs provided by regions. However, the effort level is not observable by the central government. With symmetric information the central government is able to coordinate regional policies so as to achieve an efficient allocation. However, with asymmetric information the

¹⁰Self-selection mechanisms are a standard tool of analysis in contract theory to mitigate problems arising from asymmetric information. For an overview see, e.g., Salanié (1997).

optimal centralized policy requires a misallocation of labor across regions. Furthermore, the efficient effort level is not exerted in all regions. As a result, asymmetric information hinders the central government in implementing the efficient allocation.

In contrast to Raff and Wilson (1997), Bordignon, Manasse, and Tabellini (1996) assume that the labor income tax base varies across regions. More specifically, labor income in each region is subject to a productivity shock which results in distinct labor productivities and, thus, labor income. The realization of the labor productivity shock becomes known to regions, but not to the central government. Thus, the central government faces an adverse selection problem. Regions also collect tax revenues where the amount of tax receipts depend on the effort level of regional tax authorities which in turn is private information of regions. Hence, in addition to the adverse selection problem, the central level is also restricted by a moral hazard problem. The aim of the central government is to design an interregional transfer system for redistributing income from high income regions to low income regions. With symmetric information local public good provision is equalized across regions and the labor tax rate in the high income region is larger than in the low income region. Additionally, as redistribution is lump-sum, regional tax enforcement decisions are not distorted. Under asymmetric information the full information results do not hold anymore. Local public spending is lower in poor regions though they have a higher labor tax rate than rich regions. Moreover, as redistribution is no longer lump sum, the regional tax enforcement is distorted. This implies that redistribution is incomplete and coordinated redistributive politics are restricted by asymmetric information.

Unlike Bordignon, Manasse, and Tabellini (1996), Boadway, Horiba, and Jha (1999) investigate the structure of grants if the costs of producing public goods rather than income is private information. Public goods are provided by decentralized agencies. They are financed by a labor tax determined by the central government. The absence of perfect information causes local public goods to be overprovided (underprovided) in the case of a low (high)-cost agency. Boadway, Horiba, and Jha (1999) extend the model by allowing agencies to exert an unobservable effort level. In this case, the optimal grant must induce each agency to exert an optimal effort level in addition to revealing its private information. For the low-cost agency the above

mentioned result still holds. However, for the high-cost agency the deviation from the full-information outcome becomes ambiguous.

Lockwood (1999) examines the design of intergovernmental transfers in a setting where the stochastic shock hitting regions can occur in three ways. The random variable of the regional economy can be income, the costs of producing public goods, or preferences for public goods. In that sense, Lockwood (1999) provides a unifying framework for analyzing centralized decision making under asymmetric information. Other papers only consider one type of shock. Recall, Boadway, Horiba, and Jha (1998) allow for regional differences in the cost of producing public goods. Raff and Wilson (1997) and Bordignon, Manasse, and Tabellini (1996) allow for interregional differences in income. Specifically, the former introduces differences in the marginal productivity of public inputs while the latter considers the case of labor productivity differences. Bucovetsky, Marchand, and Pestieau (1998) introduce differences in the marginal willingness to pay for the public good. In addition to the possibility of multiple forms of shocks, Lockwood (1999) considers interregional externalities from local public good provision. Thereby, the reason for establishing an intergovernmental transfer system is explicitly modeled.¹¹

In general, the optimal incentive-compatible policy is very sensitive to variations in the nature of the shock. Since in the model examined in the next section, regions differ with respect to their preference for local public goods, the results in Lockwood (1999) are only summarized for the case of stochastic demand for public goods. With asymmetric information concerning the regional preferences for local public goods and lump-sum taxation, Lockwood (1999) shows that an efficient provision of local public goods is an exception rather than the rule. Only for regions with the highest and the lowest demand for local public goods the quantity is efficient. But for all intermediate types of regions local public goods are overprovided. In contrast, if externalities are absent, the high preference region is assigned an inefficiently high level of local public goods and regions with a low preference region receives an inefficiently low level of local public goods. There is only one intermediate type of region where local public good provision is efficient. At this preference type the overprovision result is turned into an underprovision result. If taxation is distortionary, the

¹¹Lockwood (1999) assumes risk-averse agents which justifies an intergovernmental transfer system to provide insurance to regions. However, even with risk-neutral agents, the existence of interregional externalities create demand for a transfer system.

results derived under lump-sum taxation still hold.¹²

Common to all papers summarized above is the existence of an intergovernmental transfer system. The transfer system is needed either to provide insurance, to redistribute income across regions, or to internalize interregional externalities from local public good provision. Dhillon, Perroni and Sharf (1999) analyze the coordination of capital tax rates if a transfer system is not available to the central government. Tax coordination is modeled as a centralization of capital taxation. The central government chooses the source-based capital tax rates for each state. Regions select one tax rate out of the set of tax rates offered by the central level. They use the corresponding tax revenues to provide local public goods. Thus, the central government does not only determine capital tax rates, but also chooses the level of local public good provision in each region. The central government has imperfect information about regional preferences for local public goods. Capital tax rates are chosen as to maximize the sum of expected utilities across regions. Dhillon, Perroni and Sharf (1999) characterize the tax rates, which are implementable by the central government. They show that with two types of preferences the capital tax rate for the high preference region must be higher than that for the low preference region in order to be implementable. However, they do not characterize the efficiency of local public good provision.¹³

¹²Persson and Tabellini (1996a) and (1996b) examine the optimal policy design in a federal setting if both levels of government face shocks. The question considered in the papers is to what extent insurance and redistribution is provided at the lower level of government and thus, to what extent the central government can improve the decentralized outcome. However, in contrast to the literature summarized in this section, central decision making is not analyzed under asymmetric information as both levels have imperfect but symmetric information about the nature of the shock. Only in Persson and Tabellini (1996b) does an information asymmetry arise due to the introduction of a moral hazard problem at the lower level. Thus, the lower level possesses more information about actions taken at that level than the central government. The information asymmetry becomes relevant as the central level wants to provide insurance against random shocks.

¹³Other papers dealing with centralized decision making and asymmetric information are Cremer, Marchand, and Pestieau (1996), Cremer and Pestieau (1997), and Cornes and Silva (2000). See Gilbert and Picard (1996) for an endogenous determination of the optimal size of a region if policy making is partly centralized and regions have an informational advantage.

3.4 Tax Coordination and Asymmetric Information: A Model

In this section, a model of centralized capital tax coordination under asymmetric information is presented. The section is structured as follows. An introduction is given in subsection 3.4.1 which relates the model analyzed in this section to other models reviewed in section 3.3. After having described the model set-up in subsection 3.4.2, the optimal policy under full information and capital mobility is derived in subsection 3.4.3. To highlight the impact of capital mobility on the optimal policy under asymmetric information the central government's optimization problem is solved for the case of asymmetric information and capital immobility in subsection 3.4.4. The optimal centralized capital tax rates under capital mobility and asymmetric information are characterized in subsection 3.4.5. Subsection 3.4.6 concludes.

3.4.1 Introduction

The model presented in this section is concerned with the effects of centralized capital taxation on the interregional allocation of capital and the provision of local public goods if the central authority is imperfectly informed about the regional preferences for local public goods. This institutional framework (centralized capital taxation and imperfect information) and the resulting allocative consequences are of interest for two reasons.

First, a large amount of literature in public finance has been devoted to the welfare effects of tax competition. The simplest model with perfectly mobile capital, an immobile fixed factor, and a restriction on source-based capital taxes, has first been analyzed in the seminal papers by Zodrow and Mieszkowski (1986), and Wilson (1986). As shown in chapter 1, tax competition for mobile capital leads to inefficient outcomes. The reasons can be summarized by the concept of horizontal fiscal externalities, which states that decentralized taxation of capital leads to positive externalities on tax revenues of other jurisdictions. These effects are not taken into account by each jurisdiction when deciding on the capital tax rate. Consequently, the resulting level of local public goods is inefficient as the perceived cost of raising public funds differs from the marginal rate of transformation. Several proposals have been made to circumvent the inefficient outcome. Wildasin (1989) analyzes

how an intergovernmental transfer scheme should be designed to internalize fiscal externalities without explicitly modeling the central authority needed to implement the transfer scheme. Another strand of literature explores capital tax rate coordination as a solution to inefficient tax competition [see Keen (1989)].¹⁴ However, these models also leave the question unanswered if there is a central authority for tax coordination or if coordinated tax rates are the result of decentralized coordination. In this section, the former view is followed by explicitly introducing a central authority with tax setting powers.¹⁵ Second, however, a decentralization of local expenditure policy is beneficial as, stated by the decentralization theorem [Oates (1972)], local decision makers have more information relevant for an efficient decentralized public expenditure policy than central decision makers.

There is an increasing amount of literature that assumes asymmetric information between regions and centers which has been surveyed in section 3.3. However, the interaction between factor mobility and centralized public policy under asymmetric information has only been investigated by a few papers. Raff and Wilson (1997) examine the problem of redistributing income across regions and to workers if workers are interregionally mobile. In contrast, Bucovetsky, Marchand, and Pestieau (1998)¹⁶ consider the case of capital tax coordination in the presence of asymmetric information and capital mobility among the member states of the federation. In particular, it is the latter interaction which is of interest in the remainder of this section.¹⁷

Specifically, this section aims at analyzing the allocative implications of informational imperfections if the central government is engaged in capital tax coordination. The information asymmetry is analyzed as a principal-agent problem. In the subsequent model, regional authorities have perfect information concerning the pref-

¹⁴Other models analyze the case of tax rate harmonization which implies equal capital tax rates across regions [e.g. Sinn (1990)]. This policy can be viewed as a special outcome of tax rate coordination.

¹⁵More recent papers on capital tax competition analyze how political mechanisms may offset the inefficiency arising in the basic model; see e.g. Persson and Tabellini (1992) and Haufler (1997). Here, one abstracts from these mechanisms.

¹⁶A corrigendum to this paper is presented in Bucovetsky, Marchand, and Pestieau (1999).

¹⁷For this reason, the subsequent analysis is based on Bucovetsky, Marchand, and Pestieau (1998). Huber (1999) also analyzes capital taxation in the presence of asymmetric information and capital mobility. However, his analysis is based on Stiglitz (1982) where the government is imperfectly informed about the labor productivity of taxpayers. Thus, he does not address the interaction between different levels of government.

erences for local public goods. However, the central decision maker only knows the distribution of local preferences. The central state tries to overcome the information asymmetry by a self-selection mechanism. It offers different contracts to the regions consisting of a private and a local public good. Regions choose the contract which gives them the highest utility. In order to ensure that regions do not misrepresent their types, the contracts must satisfy the incentive-compatibility constraints. These constraints are imposed on the central government's optimization problem by the information asymmetry and, due to the assumed fixed capital supply, the requirement of incentive compatibility is the only potential source of inefficiency.

This institutional setting can be viewed as a special case of a general mechanism design game with the following typical three stages. At stage 1, the principal (here: the central government) designs contracts specifying private and public consumption. At stage 2 regions decide to participate in the tax coordination game, i.e. regions, that are initially endowed with the right to choose the capital tax rate, decide whether or not to transfer the right to the central government. At the third stage of the game, regions simultaneously announce their types and, thereby, choose a contract proposed by the central government. In the general formulation, the central government's behavior is constrained by the above mentioned incentive-compatibility and the participation constraints. The latter guarantees that regions have an incentive to participate in the tax coordination game. Here, it is assumed that the participation decision has already been made at some point in the past and that regions are bounded to the participation decision. Hence, in this section the participation constraint can be omitted. The implications of an endogenous participation decision is highlighted in section 3.6.

The analysis shows that with full information the efficient allocation is realized. However, being restricted by the information asymmetry the central government is unable to implement the efficient allocation. Both the interregional capital allocation and local public good provision is inefficient.¹⁸

¹⁸It should be noted here that centralized capital taxation under asymmetric information can replicate the outcome of decentralized capital taxation. For this reason, the introduction of asymmetric information does not limit the central government's ability to outperform the decentralized outcome. In that sense, this section does not provide a theory of decentralization. An attempt to develop such a theory is made in section 3.5.

3.4.2 The Model

The model considered here is based on Bucovetsky, Marchand, and Pestieau (1998). The federation is assumed to consist of N regions. In each region, the representative household is endowed with both factors of production: capital \tilde{k} and labor. Labor supply is exogenous and normalized to 1. The household income is given by

$$c = w + r\tilde{k} - T\tilde{k} \quad (3.9)$$

where w is the wage rate, r the interest rate, and T a lump-sum tax on capital. Households derive utility from private consumption c and from a local public good g provided by the central state. Regional output can be transformed on a one to one basis either in a private good c or in a local public good g . The utility function is quasi-linear in private consumption

$$u(c, g) = c + \theta v(g) \quad (3.10)$$

with θ as a parameter measuring the preference for public goods which differs across regions. For simplicity, the distribution of θ is discrete. θ can take two values θ^h and θ^l , $\theta^h > \theta^l$. Regions with $\theta = \theta^h$ have a high preference for public goods whereas $\theta = \theta^l$ indicates that the region has a low preference for public goods. The number of regions with a high and a low preference is denoted by N^h and N^l , respectively. The proportions of regions with $\theta = \theta^h$ and $\theta = \theta^l$ are, therefore, $n^h = N^h/N$ and $n^l = N^l/N$ with $n^h + n^l = 1$.¹⁹

The inequality $\theta^h > \theta^l$ results in

$$-\frac{dc^h}{dg^h} = \frac{\frac{\partial u^h}{\partial g^h}}{\frac{\partial u^h}{\partial c^h}} > \frac{\frac{\partial u^l}{\partial g^l}}{\frac{\partial u^l}{\partial c^l}} = -\frac{dc^l}{dg^l} \quad (3.11)$$

which is the well-known Spence-Mirrlees condition.²⁰ It implies that any pair of indifference curves (of θ^h - and θ^l -type regions) drawn in (g,c) -space intersect only once. That is, for any allocation (g,c) the indifference curve of θ^h -type regions is steeper than the indifference curve of θ^l -type regions.

¹⁹In Dhillon, Perroni, and Scharf (1999) the regions' taste parameter is independently distributed. Thus, in contrast to the model considered here the regions' types are uncorrelated.

²⁰Alternatively, the expression is also called the single-crossing property or the self-sorting condition.

Firms are assumed to be profit maximizers. The production technology $f(k)$ exhibits constant returns to scale.²¹ The profit is given by

$$\pi = f(k) - w - (r + t)k. \quad (3.12)$$

Regional capital employment k is taxed at a rate t . Firms maximize Eq. (3.12) with respect to k which leads to the first-order condition

$$f'(k) = r + t. \quad (3.13)$$

Capital k is employed until the marginal productivity of capital equals the gross price of capital $r + t$. Eq. (3.13) implicitly defines regional capital employment as a function of the source-based capital tax rate t and the interest rate r . The wage rate w equals $f(k) - f'(k)k$. Regional consumption is thus given by

$$c = f(k) - f'(k)k + r\tilde{k} - T\tilde{k}. \quad (3.14)$$

The conditions for a capital market equilibrium differ depending on the mobility of capital. Under capital immobility the first-order condition (3.13) and the capital market clearing condition, $k = \tilde{k}$, characterize the capital market equilibrium. Under capital mobility, the first-order condition is unaffected. However, the capital market clearing condition changes to

$$n^h k^h + n^l k^l = \tilde{k} \quad (3.15)$$

with k^h and k^l as capital employment in high and low preference regions. The central state taxes capital employment and recycles regional tax revenues tk^i to the region by providing a local public good g^i . Furthermore, the central government pays a transfer s^i to each region which is financed by the lump-sum tax on capital T . The level of local public goods is chosen as to maximize the Benthamite welfare functional

$$W(t^h, t^l) = n^h u^h + n^l u^l \quad (3.16)$$

subject to the budget constraints

$$t^i k^i + s^i = g^i \quad \text{and} \quad n^h s^h + n^l s^l = T\tilde{k} \quad i = l, h. \quad (3.17)$$

The constraints show that local public good supply in each region must be financed by regional tax revenues and an unconditional transfer. However, the budget constraints are not the only constraints (besides the non-negativity constraints) which

²¹The fixed factor is omitted from the notation throughout the analysis.

have to be considered by the central government. As mentioned above, it is assumed that the central government does not know the realization of the parameter θ for each region. The only piece of information available to the central government is the distribution of the parameter in the federation, n^h and n^l . Therefore, the central government offers contracts (c^i, g^i) to the regions. They in turn choose the contract which gives them the highest utility. In order to prevent regions from mimicking types other than the true one, the contracts must satisfy the incentive-compatibility constraints

$$(ICC^l) : c^l + \theta^l v(g^l) \geq c^h + \theta^l v(g^h) \quad (3.18)$$

$$(ICC^h) : c^h + \theta^h v(g^h) \geq c^l + \theta^h v(g^l). \quad (3.19)$$

These constraints ensure that a region chooses the contract which is designed for it.²²

3.4.3 Centralized Taxation, Capital Mobility, and Symmetric Information

As a point of reference, the optimal tax policy is derived for the case of capital mobility and symmetric information. With symmetric information the central government possesses the same information as the regions. Therefore, each region can be identified with respect to its preferences and the optimal contracts can be implemented without having to rely on reports from the regions.

Capital Market The main difference between capital mobility and immobility is that capital employment reacts to different capital taxation. With capital mobility the reaction of regional capital employment of θ^h - and θ^l -type regions and the capital market interest rate can be obtained by totally differentiating the first-order conditions $f'(k^i) = t^i + r$ and the capital market clearing condition (3.15). The reaction of k^h , k^l , and r to a change in t^i is given by

$$dk^h = \frac{-n^l(-dt^h + dt^l)}{\vartheta} \quad (3.20)$$

$$dk^l = \frac{n^h(-dt^h + dt^l)}{\vartheta} \quad (3.21)$$

²²As mentioned in the introduction, the incentive-compatibility constraints are the only constraints imposed on the central government's optimization problem. The participation constraint can be neglected as the participation decision has already been made.

$$dr = \frac{-n^h f''(k^l) dt^h - n^l f''(k^h) dt^l}{\vartheta} \quad (3.22)$$

$$\text{with } \vartheta := n^h f''(k^l) + n^l f''(k^h). \quad (3.23)$$

Capital leaves the region in reaction to an increase in regional capital taxation $\frac{\partial k^i}{\partial t^i} < 0$ and is attracted by higher capital taxation in regions with different preferences $\frac{\partial k^i}{\partial t^j} > 0$; $i \neq j$. The interest rate is negatively affected by a rise in the tax rate t^i . Therefore, an increase in the regional tax rate not only leads to an inflow of capital in the other type of region, but also decreases capital income in both types of regions.

Government In the case of symmetric information and capital mobility the central government is only restricted by the response of capital to a tax differential $t^h - t^l$. The provision of local public goods and the corresponding tax rates may therefore be affected by capital mobility.

Before turning to the optimization problem it is useful to rewrite the objective function $W(t^h, t^l) = n^h [c^h + \theta^h v(g^h)] + n^l [c^l + \theta^l v(g^l)]$ to

$$W(t^h, t^l) = n^h [f(k^h) - f'(k^h)k^h + r\tilde{k} - T\tilde{k} + \theta^h v(t^h k^h + s^h)] \quad (3.24)$$

$$\begin{aligned} &+ n^l [f(k^l) - f'(k^l)k^l + r\tilde{k} - T\tilde{k} + \theta^l v(t^l k^l + s^l)] \\ &= n^h [f(k^h) - t^h k^h - n^h s^h - n^l s^l + \theta^h v(t^h k^h + s^h)] \quad (3.25) \\ &+ n^l [f(k^l) - t^l k^l - n^h s^h - n^l s^l + \theta^l v(t^l k^l + s^l)]. \end{aligned}$$

The first equality has been derived by inserting Eqs. (3.14) and (3.17). The second equality follows from the fact that $f'(k^i) = r + t^i$, $n^h s^h + n^l s^l = T\tilde{k}$, and $n^h k^h + n^l k^l = \tilde{k}$. The optimization problem of the central government is thus given by

$$\begin{aligned} \max_{t^h, t^l, s^h, s^l} \mathcal{L} &= n^l f(k^l) + n^h f(k^h) - n^l t^l k^l - n^h t^h k^h - n^h s^h - n^l s^l \quad (3.26) \\ &+ n^l \theta^l v(t^l k^l + s^l) + n^h \theta^h v(t^h k^h + s^h) \end{aligned}$$

with the first-order conditions

$$\begin{aligned} (t^h) : \quad &n^h f'(k^h) \frac{\partial k^h}{\partial t^h} + n^l f'(k^l) \frac{\partial k^l}{\partial t^h} - n^h k^h - n^h t^h \frac{\partial k^h}{\partial t^h} - n^l t^l \frac{\partial k^l}{\partial t^h} \quad (3.27) \\ &+ n^l \theta^l v'(g^l) t^l \frac{\partial k^l}{\partial t^h} + n^h \theta^h v'(g^h) \left(k^h + t^h \frac{\partial k^h}{\partial t^h} \right) = 0, \end{aligned}$$

$$(t^l) : \quad n^h f'(k^h) \frac{\partial k^h}{\partial t^l} + n^l f'(k^l) \frac{\partial k^l}{\partial t^l} - n^l k^l - n^h t^h \frac{\partial k^h}{\partial t^l} - n^l t^l \frac{\partial k^l}{\partial t^l} \quad (3.28)$$

$$\begin{aligned}
& +n^l\theta^l v'(g^l) \left(k^l + t^l \frac{\partial k^l}{\partial t^l} \right) + n^h\theta^h v'(g^h) t^h \frac{\partial k^h}{\partial t^l} = 0, \\
(s^h) : & \quad -n^h + n^h\theta^h v'(g^h) = 0, \tag{3.29}
\end{aligned}$$

$$(s^l) : \quad -n^l + n^l\theta^l v'(g^l) = 0, \tag{3.30}$$

which gives proposition 3.1.

Proposition 3.1: *With symmetric information and capital mobility,*

- (i) *local public goods are efficiently provided, i.e. $\theta^h v'(g^h) = 1$ and $\theta^l v'(g^l) = 1$, and*
- (ii) *the interregional capital allocation is efficient, i.e. $t^h = t^l$.*

Proof: The first assertion of proposition 3.1 can be proved by rearranging the first-order conditions (3.29) and (3.30) which yields

$$\theta^i v'(g^i) = 1 \quad i = h, l. \tag{3.31}$$

Inserting Eq. (3.13) and $n^h \frac{\partial k^h}{\partial t^h} + n^l \frac{\partial k^l}{\partial t^h} = 0$, the first-order condition (3.27) becomes

$$-n^h k^h + n^l \theta^l v'(g^l) t^l \frac{\partial k^l}{\partial t^h} + n^h \theta^h v'(g^h) \left(k^h + t^h \frac{\partial k^h}{\partial t^h} \right) = 0. \tag{3.32}$$

Using Eqs. (3.20) and (3.21) yields

$$n^h k^h [\theta^h v'(g^h) - 1] + n^l \frac{\partial k^l}{\partial t^h} [\theta^l v'(g^l) t^l - \theta^h v'(g^h) t^h] = 0. \tag{3.33}$$

Now, for $\theta^i v'(g^i) = 1$, Eq. (3.33) reduces to $n^l \frac{\partial k^l}{\partial t^h} (t^l - t^h) = 0$ which can only hold for $t^h = t^l$. This proves the second assertion of proposition 3.1. \square

Proposition 3.1 reveals that capital mobility and symmetric information does not interfere with an efficient allocation of resources if an interregional transfer is available to the central government. In each type of region capital endowment equals capital employment. Thus, tax revenues which stem from the source-based capital tax are identical in both types of regions. However, since $\theta^h > \theta^l$ the provision of local public goods according to the Samuelson rule requires $g^h > g^l$. At least in one type of region source-based capital tax revenues are not sufficient to finance the efficient level of g^i . The budget deficit is financed by a transfer from the center to the region which is financed by the lump-sum tax T . In sum, the central government has enough policy instruments to implement the efficient allocation. For

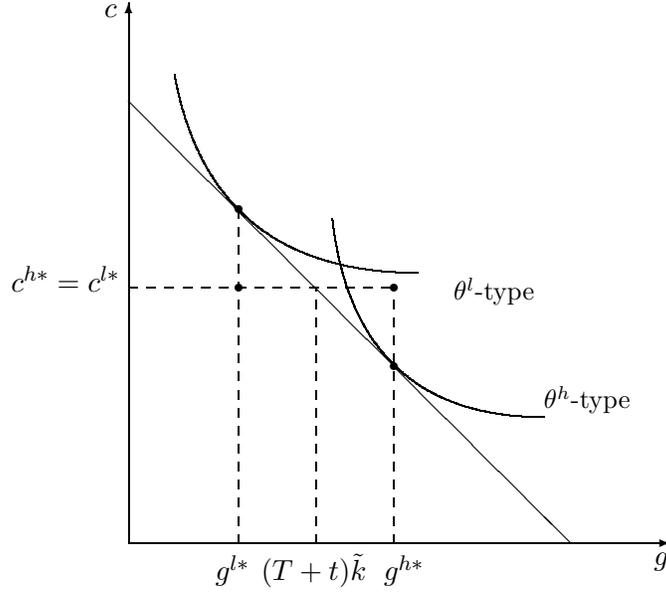


Figure 3.1: Resource allocation with a transfer scheme: symmetric information and capital mobility.

the case $N^h = N^l = 1$ the resource allocation drawn in (g, c) -space is depicted in figure 3.1. The first-best levels of g^i and c^i are denoted by g^{i*} and c^{i*} , respectively. For $N^h = N^l = 1$ total tax revenues amount to $T\tilde{k} + t^h k^h + T\tilde{k} + t^l k^l$. Given by proposition 3.1, capital taxes are uniform across regions ($t^h = t^l = t$) and, thus, the regional tax base becomes $k^h = k^l = \tilde{k}$. Using this information total tax revenues reduce to $2(T+t)\tilde{k}$ which must be sufficient to finance aggregate spending, i.e. $(T+t)\tilde{k} = \frac{g^{h*} + g^{l*}}{2}$. This implies that tax revenues raised in the $\theta^l(\theta^h)$ -type region exceed (fall below) local public good spending in the same region. The budget surplus in the θ^l -type region amounts to $(T+t)\tilde{k} - g^{l*} = -s^l > 0$ which is used to finance the budget deficit in the θ^h -type region, i.e. $-s^l = s^h$. As a consequence, private consumption is equalized across regions and the contracts allocated to both regions only differ with respect to the level of local public good provision. This fact already suggests that there may be incentive problems in implementing the efficient allocation under asymmetric information.

3.4.4 Centralized Taxation with Capital Immobility

Before turning to the optimization problem under asymmetric information and capital mobility it is useful to derive the optimal contracts under asymmetric information and capital immobility first. Thereby, one is able to identify which effects are due to capital mobility and which one results from the asymmetry of information.

Under capital immobility the impact of taxation on the regional interest rate r^i can be obtained by totally differentiating the first-order condition, $f'(k^i) = t^i + r^i$, and the capital market clearing condition, $k^i = \tilde{k}$, which gives

$$\frac{dr^i}{dt^i} = -1 \quad i = l, h. \quad (3.34)$$

Capital taxation leads to a proportional reduction in the regional interest rate. With a well-informed central government (full information concerning the regions' taste for public goods) and immobile capital the optimization problem could be solved for each region separately. The outcome would be an allocation of regional public goods according to the Samuelson rule. However, the information asymmetry does not allow a separate determination of the local public good levels as the contract choice of θ^l -type regions has to be taken into account when determining the contract (c^h, g^h) and vice versa. Both contracts are connected via the incentive-compatibility constraints²³

$$(ICC^l) : \quad f(k^l) - f'(k^l)k^l + r^l\tilde{k} + \theta^l v(t^l k^l + s^l) \geq \quad (3.35)$$

$$f(k^h) - f'(k^h)k^h + r^h\tilde{k} + \theta^l v(t^h k^h + s^h)$$

$$(ICC^h) : \quad f(k^h) - f'(k^h)k^h + r^h\tilde{k} + \theta^h v(t^h k^h + s^h) \geq \quad (3.36)$$

$$f(k^l) - f'(k^l)k^l + r^l\tilde{k} + \theta^h v(t^l k^l + s^l).$$

Capital immobility implies that regional capital endowment \tilde{k} equals capital employment k^i which simplifies the incentive-compatibility conditions to

$$(ICC^l) : \quad r^l\tilde{k} + \theta^l v(t^l\tilde{k} + s^l) \geq r^h\tilde{k} + \theta^l v(t^h\tilde{k} + s^h) \quad (3.37)$$

$$(ICC^h) : \quad r^h\tilde{k} + \theta^h v(t^h\tilde{k} + s^h) \geq r^l\tilde{k} + \theta^h v(t^l\tilde{k} + s^l). \quad (3.38)$$

The constraints (3.37) and (3.38), together with the Spence-Mirrlees condition, imply lemma 3.1.

²³Irrespective of whether capital is mobile or immobile the term $T\tilde{k}$ appears on both sides of the incentive-compatibility constraint. Thus, the term can be omitted from further notation.

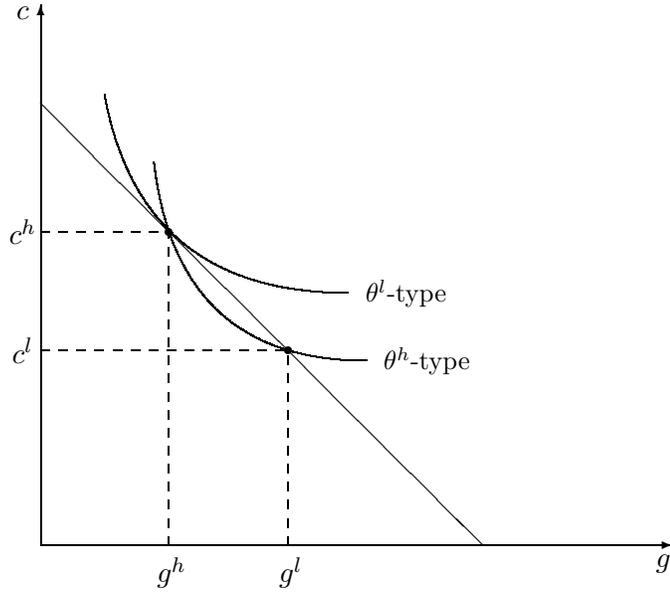


Figure 3.2: Capital tax differential $t^h - t^l < 0$ under capital immobility.

Lemma 3.1: *The incentive-compatibility conditions and the Spence-Mirrlees condition imply $t^h \geq t^l$.*

Proof: If $t^h < t^l$, private consumption in θ^l -type regions is lower than in θ^h -type regions, i.e. $c^h > c^l$. In order to satisfy Eqs. (3.37) and (3.38) public good provision in θ^l -type regions must be higher than in θ^h -type regions. However, due to the Spence-Mirrlees condition these contracts are not incentive compatible since it is optimal for θ^l -type regions to mimic θ^h -type regions. \square

Lemma 3.1 requires a non-negative tax differential $t^h - t^l$. That is, the incentive-compatibility conditions restrict the set of implementable tax policies. Coordinated policies with a lower capital tax rate in θ^h -type regions than in θ^l -type regions are ruled out by the incentive-compatibility conditions. The rationale of lemma 3.1 is depicted in figure 3.2. Since c^i is strictly decreasing in t^i , private consumption in θ^l -type regions is lower than in θ^h -type regions if $t^h < t^l$. In general, with a transfer system it is ambiguous which type of regions has higher local public spending.

However, the incentive-compatibility conditions require $g^l > g^h$. Otherwise, the contract designed for θ^h -type regions would contain both higher levels of private and public consumption. Clearly, in this case θ^l -type regions do not have an incentive to reveal their type. Thus, $c^l < c^h$ and $g^h < g^l$. These contracts are depicted in figure 3.2. Consider θ^h -type regions are indifferent between both contracts. Implied by the Spence-Mirrlees condition the indifference curves of both types of regions intersect only once and at the intersection the indifference curve of θ^l -type regions has a lower slope (in absolute terms) than the indifference curve of θ^h -type regions. Thus, evaluated at the point (g^h, c^h) the marginal rate of substitution in θ^h -type regions exceeds the marginal rate of substitution in θ^l -type regions. Observe, since θ^h -type regions derive the same utility of both contracts, the willingness to pay for $g^l - g^h$ is given by $c^h - c^l$. However, given the Spence-Mirrlees condition the θ^l -type regions' willingness to pay for $g^l - g^h$ is lower than $c^h - c^l$. For this reason, θ^l -type regions strictly prefer the contract (c^h, g^h) to (c^l, g^l) which violates the incentive-compatibility condition.

As mentioned above, the central government is assumed to maximize a Benthamite welfare functional. The optimization problem is therefore as follows:

$$\max_{t^h, t^l, s^h, s^l} W(t^h, t^l) = n^h [c^h + \theta^h v(g^h)] + n^l [c^l + \theta^l v(g^l)] \quad (3.39)$$

subject to Eqs. (3.13), (3.14), (3.17), (3.34), the capital market clearing condition $k = \tilde{k}$ and the incentive-compatibility conditions (3.37) and (3.38). The Lagrangean is

$$\begin{aligned} \max_{t^h, t^l, s^h, s^l} \mathcal{L} = & n^h [f(\tilde{k}) - t^h \tilde{k} + \theta^h v(t^h \tilde{k} + s^h)] \\ & + n^l [f(\tilde{k}) - t^l \tilde{k} + \theta^l v(t^l \tilde{k} + s^l)] - n^h s^h - n^l s^l \\ & + \mu^h [r^h \tilde{k} + \theta^h v(t^h \tilde{k} + s^h) - r^l \tilde{k} - \theta^h v(t^l \tilde{k} + s^l)] \\ & + \mu^l [r^l \tilde{k} + \theta^l v(t^l \tilde{k} + s^l) - r^h \tilde{k} - \theta^l v(t^h \tilde{k} + s^h)]. \end{aligned} \quad (3.40)$$

Differentiating the Lagrangean with respect to t^h, t^l gives the first-order conditions²⁴

$$(t^h) : (n^h + \mu^h) [-1 + \theta^h v'(g^h)] + \mu^l [1 - \theta^l v'(g^h)] = 0 \quad (3.41)$$

$$(t^l) : (n^l + \mu^l) [-1 + \theta^l v'(g^l)] + \mu^h [1 - \theta^h v'(g^l)] = 0 \quad (3.42)$$

²⁴For notational ease the complementary-slackness conditions are omitted.

which gives proposition 3.2.

Proposition 3.2: *With asymmetric information and capital immobility, public goods are efficiently provided, i.e. $\theta^h v'(g^h) = 1$ and $\theta^l v'(g^l) = 1$. The first-best allocation is incentive compatible.*

Proof: See appendix A.1.

The economic intuition for this result is straightforward. With capital immobility, regional capital employment does not react to a change in the tax rate. The regional marginal cost of public funds is equal to the marginal rate of transformation. Therefore, it does not matter which contract the regions choose the marginal cost of public funds is the same for all levels of g . The decisive factor for the choice of contract is the regional marginal rate of substitution. Note, the Spence-Mirrlees condition guarantees that in both regions the marginal rate of substitution is different for a given allocation (g, c) . The non-distortionary character of capital taxation in combination with the Spence-Mirrlees condition is sufficient to separate both types with a first-best contract (g^{h*}, c^{h*}) and (g^{l*}, c^{l*}) .

Proposition 3.2 has been derived without relying on the first-order conditions for s^h and s^l . Put differently, even if $s^h \equiv 0$ and $s^l \equiv 0$, proposition 3.2 holds. A central government without access to an interregional transfer scheme is still able to separate types by offering first-best contracts, which is illustrated in figure 3.3. For the local public good level g^{l*} the marginal rate of substitution in θ^h -type regions is higher than the marginal cost of public funds. θ^h -type regions' marginal willingness to pay for an additional unit of local public goods is higher than the price they have to pay. For the local public good level g^{h*} both the marginal willingness to pay and the price for an additional unit of local public goods are equated. Consequently, the contract (g^{h*}, c^{h*}) lies on a higher indifference curve for the θ^h -type region than the contract (g^{l*}, c^{l*}) . This shows that it is optimal for θ^h -type regions to choose the first-best contract (g^{h*}, c^{h*}) which is designed for this type of region. Due to the Spence-Mirrlees condition the marginal rate of substitution in θ^l -type regions is lower than the marginal cost of public funds for the contract (g^{h*}, c^{h*}) . Following the same line of argument as above shows that it is optimal for θ^l -type regions to choose the first-best contract (g^{l*}, c^{l*}) . Therefore, the incentive-compatibility condi-

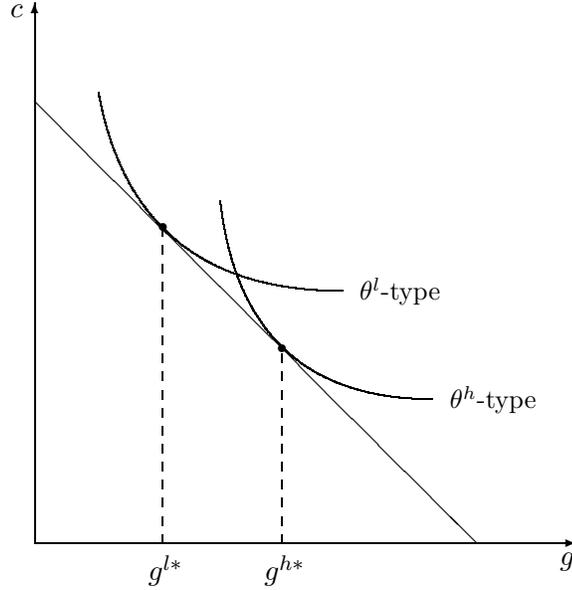


Figure 3.3: Resource allocation: asymmetric information and capital immobility.

tions are not binding and the first-best allocation can be implemented by the central government.

3.4.5 Centralized Taxation with Capital Mobility

The crucial difference between subsection 3.4.3 and this subsection is the introduction of asymmetric information. Capital is still perfectly mobile among regions. Therefore, the reaction of regional capital employment of θ^h -type and θ^l -type regions and the capital market interest rate is given by Eqs. (3.20), (3.21), and (3.22). Additionally, Eq. (3.15) constitutes the capital market clearing condition.

Perfect capital mobility and equal capital endowments imply that capital income $r\tilde{k}$ is identical in all regions. As a result, capital income does not affect the regions' decision whether to reveal their types or not. Hence, with asymmetric information and capital mobility the incentive-compatibility conditions change to

$$(ICC^l) : \quad f(k^l) - f'(k^l)k^l + \theta^l v(t^l k^l + s^l) \geq \quad (3.43)$$

$$f(k^h) - f'(k^h)k^h + \theta^l v(t^h k^h + s^h)$$

$$(ICC^h) : \quad f(k^h) - f'(k^h)k^h + \theta^h v(t^h k^h + s^h) \geq \quad (3.44)$$

$$f(k^l) - f'(k^l)k^l + \theta^h v(t^l k^l + s^l).$$

A finding similar to lemma 3.1 can be established for the case of capital mobility.

Lemma 3.2: *The incentive-compatibility condition and the Spence-Mirrlees condition imply $t^h \geq t^l$.*

Proof: If $t^h < t^l$, private consumption c^l is lower than c^h as $\frac{\partial c^i}{\partial t^i} = -f''(k^i) \frac{\partial k^i}{\partial t^i} k^i + \frac{\partial r}{\partial t^i} \tilde{k} < 0, i = l, h$. To maintain incentive compatibility it is necessary that $g^h < g^l$. However, given the Spence-Mirrlees condition at least one incentive-compatibility constraint is violated. \square

The rationale for this result is similar to that underlying lemma 3.1. In contrast to capital immobility, a tax differential causes a reduction in capital demand in high tax regions and an inflow of capital in low tax regions. For this reason, a negative tax differential $t^h - t^l$ leads to $k^h > k^l$ making it even more preferable for θ^l -type regions to choose the contract (c^h, g^h) . Recall, under capital immobility $k^h = k^l = \tilde{k}$ an interregional capital reallocation in response to a tax differential does not occur. Thus, in order to be incentive compatible the optimal contract for θ^h -type regions must entail a capital tax rate at least as high as the optimal capital tax rate offered to θ^l -type regions.

The central government chooses the contracts (c^h, g^h) and (c^l, g^l) by solving the optimization problem

$$\begin{aligned} \max_{t^h, t^l, s^h, s^l} \quad \mathcal{L} = & n^l f(k^l) + n^h f(k^h) - n^l t^l k^l - n^h t^h k^h - n^l s^l - n^h s^h \quad (3.45) \\ & + n^l \theta^l v(t^l k^l + s^l) + n^h \theta^h v(t^h k^h + s^h) \\ & + \mu^h \left\{ f(k^h) - f'(k^h)k^h - f(k^l) + f'(k^l)k^l \right. \\ & + \left. \theta^h \left[v(t^h k^h + s^h) - v(t^l k^l + s^l) \right] \right\} \\ & + \mu^l \left\{ f(k^l) - f'(k^l)k^l - f(k^h) + f'(k^h)k^h \right. \\ & + \left. \theta^l \left[v(t^l k^l + s^l) - v(t^h k^h + s^h) \right] \right\} \end{aligned}$$

where μ^h and μ^l denote the Lagrangean multipliers of the incentive-compatibility constraints. Capital demand is a function of the tax rates in both types of regions and is given by Eqs. (3.20) and (3.21). Differentiating the Lagrange function with

respect to t^h , t^l , s^h , and s^l yields

$$\begin{aligned}
(t^l) : \quad & -n^l k^l + v'(g^l) \left(k^l + t^l \frac{\partial k^l}{\partial t^l} \right) (\theta^l n^l + \theta^l \mu^l - \theta^h \mu^h) \\
& + v'(g^h) t^h \frac{\partial k^h}{\partial t^l} (\theta^h n^h + \theta^h \mu^h - \theta^l \mu^l) \\
& + (\mu^h - \mu^l) \left[f''(k^l) \frac{\partial k^l}{\partial t^l} k^l - f''(k^h) \frac{\partial k^h}{\partial t^l} k^h \right] = 0,
\end{aligned} \tag{3.46}$$

$$\begin{aligned}
(t^h) : \quad & -n^h k^h + v'(g^l) t^l \frac{\partial k^l}{\partial t^h} (\theta^l n^l + \theta^l \mu^l - \theta^h \mu^h) \\
& + v'(g^h) \left(k^h + t^h \frac{\partial k^h}{\partial t^h} \right) (\theta^h n^h + \theta^h \mu^h - \theta^l \mu^l) \\
& + (\mu^h - \mu^l) \left[f''(k^l) \frac{\partial k^l}{\partial t^h} k^l - f''(k^h) \frac{\partial k^h}{\partial t^h} k^h \right] = 0,
\end{aligned} \tag{3.47}$$

and

$$(s^h) : \quad -n^h + v'(g^h) (n^h \theta^h + \mu^h \theta^h - \mu^l \theta^l) = 0, \tag{3.48}$$

$$(s^l) : \quad -n^l + v'(g^l) (n^l \theta^l + \mu^l \theta^l - \mu^h \theta^h) = 0. \tag{3.49}$$

Using these first-order conditions Bucovetsky, Marchand, and Pestieau (1998) prove the following proposition.

Proposition 3.5 [Bucovetsky, Marchand, and Pestieau (1998)]: *If the central government has access to a transfer system, the incentive-compatibility constraint is only binding on θ^l -type regions. Furthermore, the equilibrium is separating, i.e. $t^h > t^l$, and local public goods are underprovided in θ^h -type regions and overprovided in θ^l -type regions.*

The proof of this proposition is given in Bucovetsky, Marchand, and Pestieau (1998, p. 380). Proposition 3.5 shows that the first-best allocation is not incentive compatible. Recall, the implementation of the first-best allocation requires uniform capital taxation and, thus, private consumption which is equalized across regions. However, since $\theta^h > \theta^l$ local public good provision in θ^h -type regions exceeds the level of g in θ^l -type regions. With asymmetric information θ^l -type regions have an incentive to misrepresent their type if the central government offers the first-best contracts to the regions. For this reason, the center deviates from the efficient allocation to restore incentive compatibility. This is done by distorting both levels of local public goods

and the interregional capital allocation ($t^h > t^l$). The result can be motivated by the theory of second best which states that it is optimal to have multiple instead of only one distortion in the economy. Applied to this model the theory of second best predicts that a distortion, e.g., only in g^h would require a higher welfare loss than a simultaneous distortion in g^h, g^l as well as in the interregional capital allocation. Exactly this result is implied by proposition 3.5.

In partial equilibrium principal-agent models, e.g., analyzed in Laffont and Tirole (1993), the optimal deviation from the first-best contract would be different. There is no gain in distorting the contract of the mimicker in a partial equilibrium model. In general, the contract of that agent is distorted which is susceptible to being mimicked. In this model, θ^l -type regions are the mimickers. That is, the contract of θ^h -type regions would have to be distorted to make it less attractive to θ^l -type regions. In contrast, the contract designed for θ^l -type regions would remain unchanged. However, in a general equilibrium setting a modification of one contract implies a change in the other contract. For instance, starting from the first-best contracts (g^{l*}, c^{l*}) and (g^{h*}, c^{h*}) a rise in t^h induces a reallocation of capital since k^h decreases and k^l increases. Consequently, g^l rises above the first-best level g^{l*} which translates into an overprovision of local public goods in θ^l -type regions. Therefore, the optimal behavior derived in partial equilibrium models does not apply here. Both contracts have to be adjusted though only θ^l -type regions have to be prevented from mimicking.

The resulting allocation is depicted in figure 3.4. The first-best contracts are not incentive compatible. Given by proposition 3.5 the optimal response is to allow for a tax differential $t^h - t^l > 0$ implying a lower private consumption in θ^h - than in θ^l -type regions. Additionally, local public goods are underprovided in θ^h -type regions and overprovided in θ^l -type regions. Accordingly the optimal contract for θ^l -type regions lies north-east of the first-best contract. Conversely, the contract designed for θ^h -type regions moves south-west until both contracts lie on the same θ^l -type regions' indifference curve. The latter is required by the fact that the incentive-compatibility constraint of θ^l -type regions is binding at the optimum ($\mu^l > 0$).

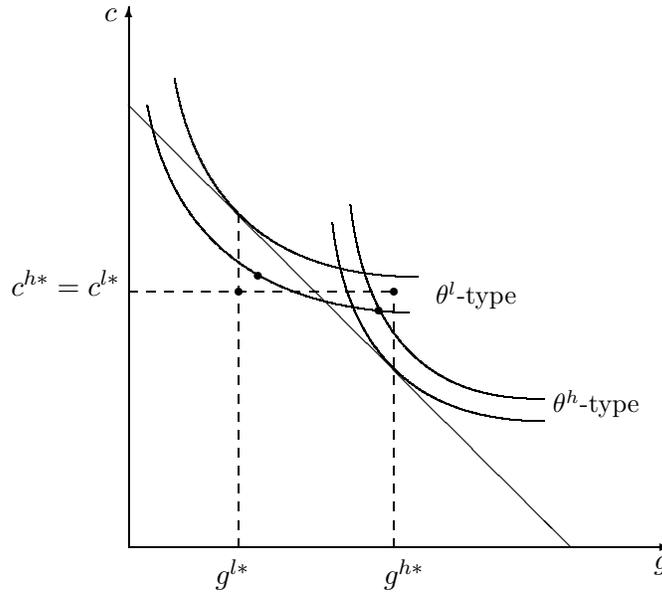


Figure 3.4: Resource allocation with a transfer scheme: asymmetric information and capital mobility.

3.4.6 Conclusion

In this section, the allocative implications of centralized source-based capital taxation with asymmetric information are analyzed. This institutional setting is chosen for two reasons. First, models of tax competition typically result in an inefficient outcome. As discussed in the literature one solution to circumvent the inefficiency is to coordinate capital tax rates. Here, tax coordination is modeled as centralization of capital taxation. Second, in the traditional literature on decentralization, decentralized decision making is favored due to different information structures. It is assumed that local decision makers have more information relevant for decision making than a central authority. Here, this approach is adopted by assuming an information asymmetry between regional and central decision makers.

The analysis characterizes the implementable tax coordination policy with respect to the tax rates and the level of local public good provision. Specifically, the analysis shows that local public goods can be overprovided, underprovided, and efficiently provided. The results are summarized in table 3.1. One can give more structure

	ICC	θ^h -type	θ^l -type	Tax rates
Capital mobility				
Symmetric information		$\theta^h_{v'} = 1$	$\theta^l_{v'} = 1$	$t^h = t^l$
Capital immobility				
Asymmetric information	$\mu^h = 0, \mu^l = 0$	$\theta^h_{v'} = 1$	$\theta^l_{v'} = 1$	$t^h > t^l$
Capital mobility				
Asymmetric information	$\mu^h = 0, \mu^l > 0$	$\theta^h_{v'} > 1$	$\theta^l_{v'} < 1$	$t^h > t^l$

Table 3.1: Tax coordination: local public good provision and tax rates.

to this general result by analyzing the impact of capital mobility on the specific equilibrium. With capital immobility and asymmetric information the first-best allocation is implementable. In this case incentive issues are of no concern. Each type of region reveals its private information if the central government offers first-best contracts.

To analyze the impact of the information asymmetry on tax coordination in the presence of capital mobility the optimal tax coordination policy under symmetric information has been derived first. The analysis shows that with full information centralized capital tax coordination yields the desirable efficient allocation. More specifically, since capital taxes are uniform across regions the allocation implies identical levels of private consumption for both types of regions. However, given by distinct preferences the efficient level of local public goods is higher for θ^h -type regions than for θ^l -type regions. Thus, the contract designed for θ^h -type regions is also preferred by θ^l -type regions. This property of the optimal contracts does not lead to incentive problems since information is symmetric and the contracts can be directly allocated to the regions without having to rely on reports from the regions to the center.

Crucial for the result is the availability of an interregional transfer system. Without such a transfer scheme the first-best allocation cannot be implemented. To see this, suppose $s^h = s^l \equiv 0$. Now, if the central government wants to achieve an efficient interregional capital allocation, capital taxes have to be uniform. However, uniform

capital taxes imply an inefficient local public good provision at least in one type of region. By contrast, an efficient allocation of local public goods in both types of regions requires distinct capital taxes and, hence, an inefficient interregional capital allocation. Consequently, in the absence of a transfer system the central government faces a trade off between distortions in local public good provision and a distorted interregional capital allocation.²⁵

The analysis reveals that asymmetric information in the presence of capital immobility and symmetric information in the presence of capital mobility do not involve inefficiencies. If capital mobility and asymmetric information are simultaneously analyzed the result no longer holds. The efficient allocation is not implementable since, as already noted above, θ^l -type regions prefer the first-best contract of θ^h -type regions to their own one. The optimal response of the central government is to distort local public good provision as well as the capital allocation up to the point where θ^l -type regions are indifferent between both contracts.

At this point it is useful to relate this outcome to that attainable under capital tax competition. As shown in chapter 1 capital tax competition with taste differences imply distinct equilibrium tax rates ($t^h > t^l$) and, consequently, an inefficient interregional capital allocation. Moreover, at least in one type of region local public goods are inefficiently provided. That is, both institutional arrangements yield similar qualitative results. However, more importantly, tax coordination as modeled in this section is at least equivalent, if not even superior to capital tax competition, since the outcome of the latter can be replicated by the central government. Therefore, welfare under tax coordination cannot be lower than welfare under capital tax competition. A more detailed treatment of this issue is relegated to the next section.

So far, efficiency considerations have been at the center of the analysis. However, distributional issues are of importance as well. To see this, note that the central government can always replicate the outcome under capital tax competition. Hence, each region's utility would be unaltered if the central government would do so. As implied by the objective function the central government weighs utility of θ^h -type regions against utility of θ^l -type regions. For this reason, optimality may require the central government to choose contracts, which gives one type of region a higher

²⁵A formal analysis of this institutional setting is provided in the next section.

utility level and the other a lower utility level than under decentralized capital taxation. This is of particular importance if the participation decision is endogenized since each type of region must benefit from tax coordination. Section 3.6 provides a brief analysis of tax coordination in the presence of an endogenous participation decision.

One further remark should be made here referring to the introduction of household mobility. One may be tempted to assume that an informational restriction on the central government's optimization problem is irrelevant. In the presence of household mobility, the self-sorting mechanism proposed by Tiebout (1956) is sufficient to reveal information about the preferences for local public goods. This is not a solution to the information asymmetry assumed here. The Tiebout mechanism only reveals information to the local governments among which the household can choose. If one allows for household mobility, local governments would know the preferences for local public goods. Exactly this is assumed here. Hence, the model in this section can be viewed as the allocation of households induced by the Tiebout mechanism.

3.5 Tax Coordination and Commitment

In the previous section centralized capital tax coordination was analyzed with respect to its efficiency properties. Though under asymmetric information and capital mobility an efficient allocation of resources cannot be achieved, tax coordination yields at least the same welfare level as capital tax competition. This section demonstrates that the unambiguous welfare ranking is closely connected to the Revelation Principle. In general, by dropping the assumptions underlying the Revelation Principle the welfare comparison becomes ambiguous. One of these assumptions is the commitment assumption which is relaxed in the subsequent section. The modification has two important implications. First, the absence of the full-commitment ability by the central government provides scope for decentralized capital taxation to outperform centralized tax coordination.²⁶ Second, a pooling equilibrium may

²⁶In this section, the result is derived in an asymmetric-information environment. However, tax coordination may be undesirable under symmetric information as well. Reasons for this result are credibility problems [Kehoe (1989)], a private agenda by politicians [Edwards and Keen (1996)], and the soft budget constraint syndrome [Qian and Roland (1998)]. See Maskin (1999) for a general discussion of the soft budget constraint syndrome.

occur which is more compatible with actual tax policies in federal states.

The section is organized as follows. Subsection 3.5.1 demonstrates the Revelation Principle. Different degrees of commitment are presented in subsection 3.5.2. The optimal coordinated tax policy is derived in subsection 3.5.3. The welfare implications of a missing commitment ability and a general welfare comparison of different institutional settings of capital taxation are provided in subsection 3.5.4. Finally, subsection 3.5.5 concludes.²⁷

3.5.1 Revelation Principle

As stated above, the information asymmetry itself does not hinder the central government to outperform capital tax competition. Crucial for the central government's ability is the Revelation Principle. In general, if the Revelation Principle holds, centralization can replicate allocations resulting from decentralized decision making.²⁸ That is, the performance under decentralization provides a lower bound for the performance of a centralized system. Hence, as long as the Revelation Principle holds a theory of decentralization cannot be developed. It is for this reason that the analysis in section 3.4 and in the last chapter cannot provide an argument for decentralization.

Due to the importance of the Revelation Principle for the welfare comparison of centralization and decentralization, the Revelation Principle is briefly summarized in the following paragraph. An emphasis is put on the commitment assumption which is relaxed in this section and, hence, generates scope for a theory of decentralization.

Revelation Principle: Results Consider a central level (principal) which faces multiple agents. The latter possess private information (their type). The center only knows the probability distribution of each agents' type. The center's objective is to assign an allocation to each agent which depends on the agent's type. In this setting the Revelation Principle is extremely helpful in solving the problem. To see this, note that in general, many mechanisms are available to the principal and some

²⁷The analysis in this section still rests on the assumption of benevolent governments. For a political economy approach to the issue of centralization versus decentralization see Bolton and Roland (1996, 1997) and Lockwood (1998).

²⁸To be more precise, the term "replication" indicates that the value of the principal's objective function is identical under both centralization and decentralization. In this vein, centralization outperforms decentralization if the value of the principal's objective function is higher under centralization than under decentralization.

of them can be quite complex. However, the Revelation Principle states that the center, as the designer of the mechanism, can restrict attention to a simple class of mechanisms. Specifically, the simple class of mechanisms is given by the class of direct mechanisms. With a direct mechanism the agents directly send type reports to the center and in turn receive an allocation based on their reports. Furthermore, among all direct mechanisms the designer of the mechanism can confine attention to those mechanisms which induce a truthful revelation of private information [see Myerson (1981)].²⁹ Given the general form of the Revelation Principle it is instructive to demonstrate the implication of this result within the model of centralized capital taxation.

The setting of section 3.4 is slightly modified to allow for continuous rather than discrete types. Suppose the optimal capital tax rate for a given type parameter $\theta \in \Theta$ is given by $t = t(\theta)$ where Θ denotes the set of all possible parameters. That is, for a given θ , $t = t(\theta)$ solves the optimization problem under asymmetric capital tax competition presented in section 1.2.3. Implied by the incentive compatibility of a Nash equilibrium

$$u(t(\theta), \theta) \geq u(t(\theta'), \theta) \quad \theta, \theta' \in \Theta \quad (3.50)$$

holds. At the optimal tax rate $t(\theta)$ utility of a θ -type region, $u(t(\theta), \theta)$, must be at least as high as $u(t(\theta'), \theta)$, where $t(\theta')$ is the tax rate which is optimal for a region of type θ' . Without knowing the regions' type, the central government can still compute the Nash equilibrium of the capital tax competition model. Let the Nash equilibrium be denoted by the function $t^* = t^*(\theta)$ which assigns each type of region θ its optimal tax rate. By offering this menu of contracts to regions the central government can induce a truthful revelation of preference types. If a region θ announces to be of type θ , the corresponding contract contains a tax rate which brings it to its unique optimum. Thus, implied by the nature of the Nash equilibrium, the contract is incentive-compatible [see Eq. (3.50)]. Consequently, though only knowing the distribution of types the central government can implement the allocation which is implemented by capital tax competition.

Observe, this result is independent of the specification of the central government's objective function. For any given specification, the value of the objective function at

²⁹For a text book treatment of the Revelation Principle see Fudenberg and Tirole (1991) and Laffont and Tirole (1993).

the tax competition outcome provides a lower bound for the value of the objective function under centralized capital taxation. This result follows from the optimizing behavior of the central government. If the central government decides to deviate from the contract $t^* = t^*(\theta)$, it can only be due to the fact that the value of the objective function at the optimal contract is higher than at the Nash-equilibrium allocation $t^* = t^*(\theta)$.

Summing up, given by the Revelation Principle and the incentive compatibility of a Nash equilibrium, the central government can replicate the tax-competition allocation by a direct mechanism. This property of the centralized solution is extremely helpful in analyzing the welfare performance of different institutional settings of capital taxation presented in this section.

Revelation Principle: Assumptions However, the Revelation Principle rests on a variety of assumptions. The most interesting one for the current analysis is the assumption of full commitment. Roughly speaking, it enables the central government to stick to the announced contract. To provide further insight into the importance of the assumption it is useful to recall the structure of the tax coordination game. At the first stage the central government announces a menu of contracts. At the second stage of the game regions choose a contract. Thereby, they reveal their types if the equilibrium is separating. At the third stage of the game the contracts are executed. In a separating equilibrium the central government has full information after the second stage of the game. Therefore, it could use the information and implement the full-information outcome. However, this behavior is ruled out by the assumption of full commitment. The central government does not change the contracts once information has been revealed. In this section, the assumption of full commitment is replaced by the assumption of no commitment. With no commitment technology the central government uses all information once it has been revealed. That is, the center cannot commit to not using the information. Full commitment and no commitment are only the extreme forms of commitment. Multiple forms of commitment exist in between. A short overview is provided in the next subsection.

Other assumptions underlying the Revelation Principle are (i) unlimited communication, (ii) no collusion, and (iii) costless information processing. The assumption of unlimited communication is necessary in order to report all possible prefer-

ence parameters from the regions to the center. For a model where agents cannot fully communicate their private information for contracting purposes see Melumad, Mookherjee, and Reichelstein (1992). The assumption of costless information processing implies that the center can compute the optimal contract regardless of the size of the computational task. Models with costly information processing are e.g. Radner (1993), Dewatripont and Bolton (1994), and Van Zandt (1999).

Additionally, if agents are allowed to collude, the Revelation Principle does not hold either. Under the Revelation Principle agents act noncooperatively. That is, they do not merge to undermine the mechanism offered by the center. The issue of collusion is studied, e.g., in Tirole (1986) and Laffont and Martimort (1998). However, in contrast to the principal-agent model studied in Tirole (1986) and Laffont and Martimort (1998) the principal's objective and the agents' objectives are not strictly opposing in the model considered here. For this reason, the principal cannot be exploited by collusion. Any form of collusion enhances rather than undermines efficiency. Moreover, if collusion occurs at the regional level, decentralized capital taxation does not result in fiscal externalities. Thus, no externalities have to be internalized and the purpose of the central level vanishes. Stated differently, collusion implies that noncooperative decision making at the decentralized level is turned into cooperative decision making at the lower level. Consequently, any gains from capital tax coordination are already realized in a decentralized system.

3.5.2 Degrees of Commitment

So far, most of the literature has analyzed the commitment issue in a multi-period model. Different degrees of commitment are distinguished [see Salanié (1997) for a survey]. To illustrate different forms of commitment consider a T -period relationship between a principal and an agent. With full commitment the principal can pledge to stick to a contract. Therefore, a contract can be written at the beginning of the relationship, which holds for all T periods. Any information revealed by the agent after signing the contract is not used to alter the conditions of the contract. Thus, the agent enjoys an information rent in all T periods.³⁰ With full commitment the

³⁰In a partial equilibrium model of the Laffont-Tirole type [see Laffont and Tirole (1993)] agents receive a nonnegative information rent due to private information. In a general equilibrium model this does not hold in all cases if information rent is computed as the difference between the agent's utility in the asymmetric information and the full information outcome [see e.g. Raff and Wilson

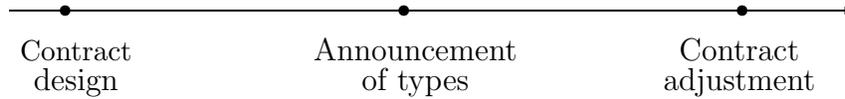


Figure 3.5: Coordination game: no commitment.

optimal dynamic contract is a T -fold repetition of the optimal one-period contract.

The second form of commitment is no commitment. In this case the principal cannot commit to a contract, which covers more than one period. At the beginning of each period a new contract has to be signed. More importantly, any information revealed by the agent in previous periods enters the contract in subsequent periods. Suppose in the first period the principal offers the optimal contract with full commitment and the agent reveals its private information. Then the agent receives the information rent only in the first period. In all subsequent periods the principal offers the full information contract. Thus, the information rent is reduced to 0. Therefore, the agent is subject to the so called *ratchet effect*. The contract is adjusted (i.e. ratcheted) to new information. This behavior is ex-post efficient. However, when a principal cannot commit to ignoring public information, the agent will be cautious in revealing information. This in turn causes ex-ante efficiency problems.³¹

A third form of commitment is an intermediate case between the above mentioned two extreme forms of commitment. If the principal is able to stick to a contract whose duration is longer than one period but shorter than T periods, the principal's commitment ability is referred to as limited commitment.³²

In contrast to the above cited literature, the current analysis restricts attention to a static contracting environment. However, even within a one period model the degree of commitment does not become irrelevant. To see this, note that with full commitment the model presented in subsection 3.4.5 has the following structure. At the first stage of the game the contract is designed by the central government. At the second stage regions announce their types and contracts are executed. If the

(1997)].

³¹Optimal contracting with no commitment is analyzed among others by Freixas, Guesnerie, and Tirole (1985), Laffont and Tirole (1987) and Fudenberg, Holmström, and Milgrom (1990).

³²See Chiappori, Macho, Rey, and Salanié (1994) for a model with limited commitment.

central government is unable to restrict itself from using public information, a third stage is introduced (see figure 3.5). After regions announce their types the central government ratches the contract to incorporate the additional information into the contracts. Consequently, the optimal contracts under full information are allocated to the regions. However, anticipating this reaction, regions are reluctant to reveal their types. A truthful revelation of types, which arises with full commitment, may not occur with no commitment.³³ The incentives for regions in this modified tax coordination game are presented in the remainder of this section.

3.5.3 Optimal Tax Coordination

Before turning to the welfare implications of the missing commitment ability, it is useful to derive the optimal uniform tax policy and the optimal tax policy under symmetric information and in the absence of an interregional transfer system first.

Optimal Tax Coordination under Uniform Capital Taxation The uniform policy becomes only effective in this setting if regions do not truthfully reveal their types to the central government. Thus, without truthful preference revelation the central government is forced to impose uniform tax rates even though it knows there are two types of regions. In this case $t^i = t$ and, thus, capital employment equals capital endowment, $k^i = \tilde{k}$. Consequently, private consumption and public consumption are identical in both types of regions, i.e. $c^i = c$ and $g^i = g$. With these modifications the objective function of a government with full commitment

$$\begin{aligned}
& n^l f(k^l) + n^h f(k^h) - n^l t^l k^l - n^h t^h k^h + n^l \theta^l v(t^l k^l) + n^h \theta^h v(t^h k^h) \\
& + \mu^h \left\{ f(k^h) - f'(k^h) k^h - f(k^l) + f'(k^l) k^l + \theta^h \left[v(t^h k^h) - v(t^l k^l) \right] \right\} \\
& + \mu^l \left\{ f(k^l) - f'(k^l) k^l - f(k^h) + f'(k^h) k^h + \theta^l \left[v(t^l k^l) - v(t^h k^h) \right] \right\}
\end{aligned}$$

³³A welfare comparison of centralization and decentralization in a static environment with limited commitment of the central government is given in Klibanoff and Poitevin (1999). Common to the assumption in this subsection, the central government cannot commit to ex-post inefficient allocations in their setting. Additionally, see Strausz (1997) for a justification of the no-commitment assumption. Specifically, unlike Klibanoff and Poitevin (1999) and the analysis in this subsection, the government is not restricted in its commitment ability by assumption. In Strausz (1997) the no-commitment ability is endogenously determined.

reduces to $f(\tilde{k}) - t\tilde{k} + n^l\theta^l v(t\tilde{k}) + n^h\theta^h v(t\tilde{k})$. Hence, the central government chooses the optimal contract (c, g) by solving the optimization problem

$$\max_t \mathcal{L} = f(\tilde{k}) - t\tilde{k} + n^l\theta^l v(t\tilde{k}) + n^h\theta^h v(t\tilde{k}). \quad (3.51)$$

The first-order condition is

$$(t) : \quad -\tilde{k} + n^l\theta^l v'(g)\tilde{k} + n^h\theta^h v'(g)\tilde{k} = 0. \quad (3.52)$$

Dividing the first-order condition by \tilde{k} and rearranging yields

$$\left[n^l\theta^l + n^h\theta^h \right] v'(g) = 1. \quad (3.53)$$

The optimal policy of the government is summarized in proposition 3.4.

Proposition 3.4: *With uniform capital taxation local public goods are underprovided in θ^h -type regions and overprovided in θ^l -type regions.*

Proof: First, the underprovision result in θ^h -type regions is proved. Eq. (3.53) can be rewritten to $\theta^h v'(g) \left[n^l \frac{\theta^l}{\theta^h} + n^h \right] = 1$. As $\theta^h > \theta^l$ and $n^l + n^h = 1$, the term in brackets is lower than unity. Hence, $\theta^h v'(g) > 1$. To prove the second assertion of proposition 3.4, Eq. (3.53) is rewritten to $\theta^l v'(g) \left[n^l + n^h \frac{\theta^h}{\theta^l} \right] = 1$. $\theta^h > \theta^l$ and $n^l + n^h = 1$ ensure that the term in brackets is greater than unity. Thus, $\theta^l v'(g) < 1$. \square

If a government is forced to implement uniform policies, it offers a contract to the regions, which implies an inefficient provision of local public goods. From the perspective of the central government it is optimal to distort local public good provision in both types of regions. A contract which implies an efficient provision of local public goods in one type of region and an inefficient provision of local public goods in the other type of region leads to a welfare loss relative to the contract described in proposition 3.4. The welfare gain by providing local public goods efficiently in one type of region does not outweigh the welfare loss due to an even more inefficient level of g in the other type of region. Thus, it is too costly for the central government to have only one distortion rather than two distortions in the economy. Note, this rationale is consistent with the theory of second best. In contrast, the allocation of mobile capital is efficient. Uniform capital taxation results in an equalization of the marginal productivities of capital in both types of regions.

Optimal Tax Coordination Under Symmetric Information If regions truthfully announce their types, the center has full information. Since it cannot commit to not using the information the truthful reports immediately enter contract design. Thus, tax coordination occurs under symmetric information.

With symmetric information and an interregional transfer system optimality requires to offer contracts which contain the efficient levels of g^i and equal quantities of private consumption. The latter follows from the fact that capital taxes are uniform across regions which induces an efficient interregional allocation of capital. This result has already been derived in section 3.4.

In the following, it is also allowed for the possibility that the central government has no access to an interregional transfer system. With this modification the optimal coordinated tax policy changes, which is subsequently shown.

Without an interregional transfer system capital taxes raised in each region must be sufficient to finance the optimal amount of local public goods, i.e. $g^i = t^i k^i$. The other parts of the model presented in section 3.4 remain intact. Thus, the central government's optimization problem is

$$\max_{t^h, t^l} \mathcal{L} = n^l f(k^l) + n^h f(k^h) - n^l t^l k^l - n^h t^h k^h + n^l \theta^l v(t^l k^l) + n^h \theta^h v(t^h k^h). \quad (3.54)$$

Capital demand is a function of the tax rates in both types of regions as given by Eqs. (3.20) and (3.21). Differentiating the Lagrange function with respect to t^h and t^l yields

$$\begin{aligned} (t^h) : \quad & n^h f'(k^h) \frac{\partial k^h}{\partial t^h} + n^l f'(k^l) \frac{\partial k^l}{\partial t^h} - n^h k^h - n^h t^h \frac{\partial k^h}{\partial t^h} - n^l t^l \frac{\partial k^l}{\partial t^h} \\ & + n^l \theta^l v'(g^l) t^l \frac{\partial k^l}{\partial t^h} + n^h \theta^h v'(g^h) \left(k^h + t^h \frac{\partial k^h}{\partial t^h} \right) = 0 \end{aligned} \quad (3.55)$$

$$\begin{aligned} (t^l) : \quad & n^h f'(k^h) \frac{\partial k^h}{\partial t^l} + n^l f'(k^l) \frac{\partial k^l}{\partial t^l} - n^l k^l - n^h t^h \frac{\partial k^h}{\partial t^l} - n^l t^l \frac{\partial k^l}{\partial t^l} \\ & + n^l \theta^l v'(g^l) \left(k^l + t^l \frac{\partial k^l}{\partial t^l} \right) + n^h \theta^h v'(g^h) t^h \frac{\partial k^h}{\partial t^l} = 0. \end{aligned} \quad (3.56)$$

which gives proposition 3.5.

Proposition 3.5: *Under symmetric information and in the absence of an interregional transfer system local public goods are either*

(i) *overprovided in θ^h -type regions and underprovided in θ^l -type regions, i.e. $\theta^h v'(g^h) <$*

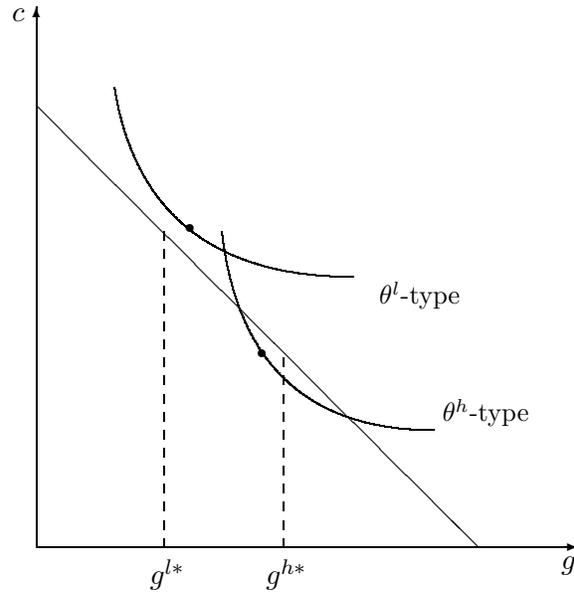


Figure 3.6: Resource allocation without a transfer scheme: symmetric information and capital mobility.

1 and $\theta^l v'(g^l) > 1$, or

(ii) underprovided in θ^h -type regions and overprovided in θ^l -type regions, i.e. $\theta^h v'(g^h) >$

1 and $\theta^l v'(g^l) < 1$.

A proof of proposition 3.5 is given in appendix A.2.

Proposition 3.5 reveals that in none of the regions local public goods are efficiently provided. Local public goods are either overprovided in θ^h -type regions and underprovided in θ^l -type regions or vice versa. That is, in the absence of an interregional transfer scheme the central government is forced to distort the local public good provision since the remaining policy variables are not sufficient to realize an efficient allocation.³⁴

³⁴If $t^h = t^l$, local public good provision is distorted at least in one type of region. By contrast, an efficient local public good provision in both types of regions requires $t^h \neq t^l$ and, thus, an inefficient allocation of capital.

		θ^l	
		h	l
	h	P/P	A/B
θ^h	l	B/A	P/P

Figure 3.7: Preference revelation: no commitment.

A possible equilibria is depicted in figure 3.6 where local public goods are underprovided in θ^h -type regions and overprovided in θ^l -type regions. With this type of equilibrium private consumption is not identical in both types of regions unless $t^h = t^l$ which, however, does not correspond to figure 3.6, but cannot be excluded on the basis of the first-order conditions (3.55) and (3.56).³⁵ Recall, with an interregional transfer system at hand the central government equalizes private consumption in both types of regions. The allocations depicted in figure 3.6 underlie a positive tax differential $t^h - t^l$. Consequently, $c^l > c^h$.

3.5.4 Welfare Implications

In this subsection, the impact of a lack of commitment on the policy outcome is characterized. As shown in the last subsection, the uniform capital taxation results in an underprovision of g in θ^h -type regions and an overprovision of g in θ^l -type regions. However, this policy only becomes effective if regions do not reveal their type. If they do reveal their preference type, the center has full information and is able to implement the full information outcome. Hence, the revelation decision of regions has to be analyzed in more detail. The purpose of the subsequent analysis is to identify model constellations for which regions separate or pool.

The revelation decision of regions is depicted in figure 3.7. In the revelation game

³⁵To see this, insert $\theta^h v'(g^h) > 1$ and $\theta^l v'(g^l) < 1$ in the modified first-order conditions presented in appendix A.2 which yields $\theta^l v'(g^l) t^l - \theta^h v'(g^h) t^h < 0$. Thus, the Nash equilibrium at the second stage of the game is compatible with $t^h = t^l$, $t^h > t^l$, as well as $t^h < t^l$. However, subgame perfection requires $t^h \geq t^l$. The latter is an immediate implication of the condition $u^i(c^i, g^i) \geq u^i(c^j, g^j)$ which must hold in any subgame perfect equilibrium.

the strategy space of each region is given by $\{h, l\}$. Either they announce to be of type θ^h or θ^l . The utility of different strategy combinations is determined by the resulting allocation. Let A (B) denote the allocation a region receives if it pretends to be of type θ^h (θ^l) and the other region of type θ^l (θ^h). P denotes the outcome if regions do not separate.

If θ^l -type regions reveal to be of type θ^l and θ^h -type regions to be of type θ^h , the central government has full information. With no commitment technology the central government uses this information and computes the optimal contracts under full information. As shown in section 3.5.3 the optimal contract under full information depends on whether or not the central government has access to a transfer system. If the former applies, optimality requires to choose the efficient levels of g^h and g^l , respectively. However, if the latter applies, g^h and g^l are set at an inefficient level. By contrast, if both regions claim to be of the same type, the central government has no additional information concerning regions' types. In this case, the only piece of information available to the central government is n^h and n^l . Consequently, incentive-compatibility constraints are not imposed on the optimization problem. Optimization of the Benthamite welfare functional subject to capital mobility constraints yields the outcome described in proposition 3.4.

By anticipating the reaction of the central government to their announcement regions choose the best response. Hence, the strategy choice, i.e. the regions' announcement of types, depends on the utility levels associated with different type announcements. Therefore, the impact of the missing commitment technology is reduced to the question of whether the utility of the no-commitment outcome is sufficient to induce truthful revelation. As it will be shown below the availability of a transfer system plays a crucial role in answering this question. First, the revelation game is solved in the absence of a transfer scheme, which is done in the next paragraph.

Tax Coordination without a Transfer Scheme For illustration, consider the allocation depicted in figure 3.8 where P denotes the optimal allocation in the case that both regions pool. The optimal allocation under full information is given by B (for θ^l -type regions) and A_i (for θ^h -type regions). B and A_i are only specific outcomes compatible with proposition 3.5. However, what matters for the subsequent analysis is the fact that at least one type of region is better off under full information

relative to the pooling outcome.³⁶

The Nash equilibrium of the announcement game depicted in figure 3.7 depends on whether θ^h -type regions prefer allocation A to allocation P or vice versa. If the former holds ($A = A_1 \succ P$), the Nash equilibrium of the game is that both regions truthfully reveal their types. To see this, suppose θ^h -type regions announce their true type. The best response of θ^l -type regions is to announce θ^l since allocation B is strictly preferred to allocation P . For the given strategy of θ^l -type regions it is optimal for θ^h -type regions to announce θ^h ($A_1 \succ P$). Therefore, the central government can induce truthful revelation though not being able to commit to its policy.

In contrast, if P is preferred to A ($P \succ A = A_2$) by θ^h -type regions, the optimal strategy for θ^l -type regions is to still reveal their type. But for θ^h -type regions it is optimal to pretend to be of type θ^l . Again, if θ^h -type regions announce θ^h , it is optimal for θ^l -type regions to choose θ^l . However, for given announcement θ^l it is a best response for θ^h -type regions to choose θ^l ($P \succ A_2$). A best response of θ^l -type regions to this announcement is still θ^l as $P \succ A_2$ by θ^l -type regions. In this case, the central government cannot induce truthful revelation. Thus, tax rates cannot be differentiated across regions. Uniform capital taxation results in allocation P .

The analysis reveals that with no commitment the outcome of centralized capital taxation depends on the allocations A and P . Specifically, the utility for θ^h -type regions associated with both allocations is the decisive factor for the outcome of the game. At this general level of the model one cannot determine a priori whether $A \succ P$ holds or the contrary. However, one can analyze the responsiveness of the interregional capital allocation to an increase in the tax differential $t^h - t^l$. To do this, consider $P \succ A$ holds at a low degree of capital responsiveness. A rise in the latter implies a lower level of private and public consumption for θ^h -type regions.³⁷ Hence, the allocation A moves south-west. That is, A becomes less favorable to θ^h -type regions. However, this change does not affect the preference relation as P

³⁶This must be the case for any allocation underlying proposition 3.5. Otherwise, it would be optimal to choose the pooling equilibrium even under full information. In this case, the central government does not try to induce truthful information revelation and the revelation game does not have to be played.

³⁷For a given tax differential $t^h - t^l > 0$, a rise in the responsiveness of the interregional capital allocation implies a rise in k^l and a reduction in k^h . Accordingly, c^h and g^h are lowered.

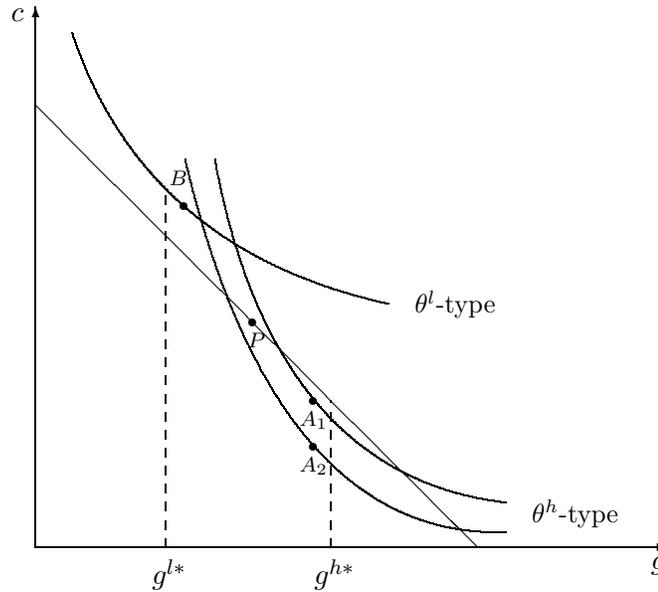


Figure 3.8: Tax coordination without a transfer scheme: no commitment.

is already preferred to A .

Things change if $A \succ P$ at the initial degree of responsiveness. As mentioned above, a higher responsiveness makes allocation A less attractive to θ^h -type regions. For this reason, there is some degree of capital responsiveness for which the preference relation $A \succ P$ is turned into $P \succ A$. Consequently, the higher the capital responsiveness the more likely the preference relation $P \succ A$.

Tax Coordination with a Transfer Scheme With an interregional transfer system the outcome of the announcement game is unambiguous. The resulting allocations are illustrated in figure 3.9. If regions separate, the full information outcome can be implemented which entails equal private consumption and the efficient level of g^i for both types of regions (bundle B for θ^l -type regions and bundle A for θ^h -type regions). The pooling equilibrium P remains unaffected by the modification of the game. Returning to the announcement game depicted in figure 3.7, the Nash equilibrium is given by the pooling equilibrium. θ^h -type regions reveal their type. However, θ^l -type regions benefit from mimicking and, thus, do not truthfully reveal their type. More specifically, if θ^h -type regions pretend to be of type θ^l , a best

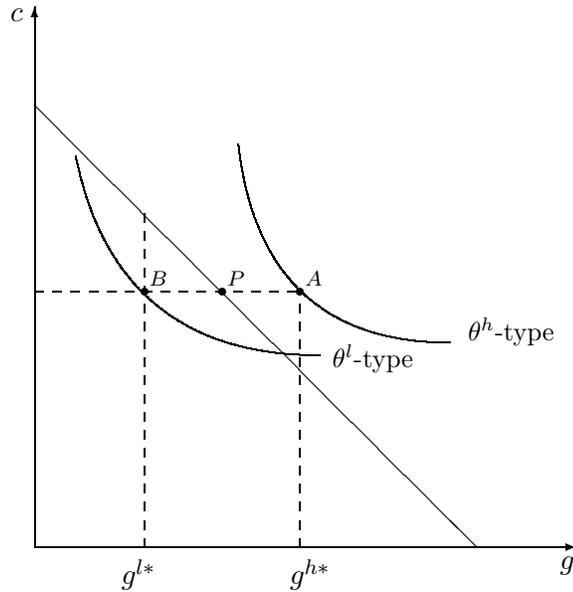


Figure 3.9: Tax coordination with a transfer scheme: no commitment.

response of θ^l -type regions is to mimic θ^h -type regions since $A \succ P$. Now, it is optimal for θ^h -type regions to reveal their true type ($P \succ B$). Given this strategy choice of θ^h -type regions, θ^l -type regions do not change their strategy ($P \succ B$) and, therefore, continue to mimic θ^h -type regions.

Analogously, starting with truthful revelation by θ^l -type regions a best response of θ^h -type regions is to reveal their type truthfully as well. However, since $P \succ B$ it is optimal for θ^l -type regions to deviate from the initial strategy and to mimic θ^h -type regions. For θ^h -type regions being mimicked it is still optimal to reveal their true type. Thus, the allocation P constitutes a Nash equilibrium in the game.

In contrast to a situation without a transfer scheme, the introduction of this policy instrument unambiguously implies a pooling equilibrium. If regions separate, θ^l -type regions would have to transfer resources to θ^h -type regions which makes θ^l -type regions worse off. Anticipating this behavior θ^l -type regions pretend to be of type θ^h . In this case the loss of commitment forces the central government to choose uniform capital tax rates. The transfer scheme cannot be used to implement a differentiated policy.

	$W_{nc}^c - W_{fc}^c$	$W_{nc}^c - W^d$
Transfer	<	ambiguous
No Transfer		
$A \succ P$	≥ 0	> 0
$P \succ A$	≤ 0	ambiguous

Table 3.2: Welfare comparison: full commitment versus no commitment.

A Welfare Comparison To complete the welfare analysis it is necessary to derive the welfare implications of the commitment inability. This is done in two ways. First, the sign of the welfare difference between full and no-commitment outcomes is derived. In both cases the capital tax rate is coordinated at the central level. It is also instructive to compare welfare under centralized capital taxation with no commitment and decentralized capital taxation. This welfare comparison is conducted in the second part of this section. All results are summarized in table 3.2.

First, the welfare change due to commitment inability is derived. Formally, the sign of the term $W_{nc}^c - W_{fc}^c$ is analyzed where W_{nc}^c denotes welfare under centralized capital taxation with no commitment and W_{fc}^c denotes welfare under centralized capital taxation with full commitment.³⁸ The welfare analysis is conducted separately for each institutional setting (with or without a transfer scheme).

In the absence of a transfer system the implementable allocations under full commitment and asymmetric information have not been characterized in this analysis. However, some reflections are sufficient to sign $W_{nc}^c - W_{fc}^c$. If $A \succ P$, the absence of a commitment technology enables the central government to implement the full information outcome. With a commitment technology two cases can be distinguished. If both incentive-compatibility constraints are not binding, the asymmetry of information imposes no restriction on the central government's decision problem ($\mu^h = \mu^l = 0$). The optimization problem is equivalent to that under no commitment. Consequently, the solutions to both problems are identical and $W_{nc}^c - W_{fc}^c = 0$. In contrast, if at least one incentive-compatibility constraint is

³⁸The superscript c refers to centralized capital taxation whereas the subscript represents the form of commitment (fc for full commitment and nc for no commitment).

binding ($\mu^h > 0$ and/or $\mu^l > 0$), the central government is constrained by the asymmetry of information implying a lower welfare level, i.e. $W_{nc}^c - W_{fc}^c > 0$. Thus, in general $W_{nc}^c - W_{fc}^c \geq 0$.

If $P \succ A$, regions pool due to the lack of commitment and the uniform policy is implemented. Since the latter satisfies the incentive-compatibility constraints for both types of regions as an equality it also belongs to the set of implementable allocations under full commitment and asymmetric information. Provided the central government chooses the pooling equilibrium under asymmetric information and full commitment, welfare is identical in both settings, i.e. $W_{nc}^c - W_{fc}^c = 0$. However, if it deviates from the pooling equilibrium, welfare under a separating equilibrium must exceed welfare under the pooling equilibrium. For this reason, $W_{nc}^c - W_{fc}^c < 0$. Combining both cases yields the welfare ranking $W_{nc}^c - W_{fc}^c \leq 0$.

With a transfer system the welfare comparison is unambiguous. In the absence of a commitment technology the central government cannot separate regions. It is forced to apply uniform policies. By contrast, with full commitment and asymmetric information the equilibrium is separating since $t^h > t^l$ [see proposition 3.3]. However, using the fact that a pooling equilibrium belongs to the set of implementable allocations under asymmetric information and full commitment, but is not chosen by the central government, yields $W_{nc}^c - W_{fc}^c < 0$.

Thus, the welfare analysis reveals that with a transfer the lack of commitment decreases welfare. Without an interregional transfer system the welfare ranking is ambiguous. The absence of a commitment technology can improve as well as lower welfare. The decisive factor is whether only one type of region or both types of regions are worse off under a pooling equilibrium.

In the remaining part of this subsection the sign of $W_{nc}^c - W^d$ is analyzed, where W^d denotes welfare under decentralized capital taxation. This welfare comparison is of interest since the aim of the whole analysis is to approach the issue whether other institutional settings, different from decentralized capital taxation, are superior in terms of welfare. As already mentioned above, under asymmetric information and full commitment the central government can replicate the outcome under capital

tax competition. However, with no commitment the welfare ranking is less obvious in advance.

If $A \succ P$ and a transfer system is not available, the full information outcome is realized, which is chosen by taking all effects of capital taxation into account. In contrast, decentralized capital taxation is subject to fiscal externalities. Using this information and the fact that the central government can at least replicate welfare under capital tax competition gives $W_{nc}^c - W^d > 0$.

If $P \succ A$, the welfare comparison cannot be conducted at this general level of analysis. With decentralized capital taxation regions can choose distinct capital tax rates, but the tax decision causes fiscal externalities. In contrast, the central government internalizes all effects of capital taxation but is restricted to uniform policies.³⁹ Accordingly, the sign $W_{nc}^c - W^d$ is ambiguous. A similar line of reasoning applies if an interregional transfer system is available. The additional policy instrument does not result in higher welfare under tax coordination since, due to the occurrence of a pooling equilibrium, the transfer system is not used. Consequently, with a transfer system the welfare comparison $W_{nc}^c - W^d$ is still ambiguous.

3.5.5 Conclusion

In this section, the model of section 3.4 is restricted by not allowing the central government to credibly commit to its policy. This modification has striking implications for the set of implementable policies and, consequently, affects welfare under centralized capital taxation.

The welfare performance of centralized tax coordination can be summarized as follows. With full commitment the central government can replicate the outcome under capital tax competition. However, if the full commitment assumption is relaxed, this ability may be lost. Centralized capital taxation does not necessarily yield a welfare improvement relative to decentralized capital taxation. Therefore, from a pure welfare-theoretic point of view this may create a demand for decentralized capital taxation. The welfare comparison between both forms of commitment crucially depends on whether the central government can induce a truthful revelation of preferences though not being able to commit to any policy. If it can do so, the full-information

³⁹As shown in chapter 1 a replication of the capital tax competition allocation requires $t^h > t^l$.

levels of g are implemented. In general, this requires differentiated tax rates across regions. However, if truth telling does not occur, the central government is forced to apply uniform tax policies.

With truthful preference revelation the loss of commitment does not result in a welfare loss. Either it stays constant or rises. The intuition for the result is that the central government implements the uniform allocation if regions do not separate. Thus, this allocation can be interpreted as a default option, which becomes effective if separation does not occur. In contrast, with full commitment the central government is able to induce truthful revelation. However, once it receives private information it cannot be used to implement the optimal policy under full information unless it is incentive compatible.

In the absence of commitment the central government can credibly threaten regions with this default option. Hence, if both regions are better off under truthful revelation than under the default option, they reveal their types. Since the central government cannot commit to not using the information, the full-information policy is implemented. If one region is better off under pooling than under separation, the uniform policy is applied. In this case the analysis shows that welfare cannot exceed the level achieved under full commitment. That is, the policy can at best achieve the same welfare level. Specifically, if the full commitment policy calls for a differentiated policy, the loss of commitment decreases welfare. In contrast, if the full commitment policy is uniform, welfare is identical.

Furthermore, the welfare comparison between centralized capital taxation with no commitment and decentralized capital taxation demonstrates that the superiority of the centralized solution does not necessarily hold in the absence of commitment. With truthful revelation it still holds. But if regions pool, the welfare difference becomes ambiguous unless optimality under full commitment also requires pooling.

There is one result worth receiving special attention. In the existing literature a centrally-mandated transfer system is welfare enhancing relative to a situation without such a policy variable given the benevolent behavior of the central government. Under full commitment this finding can be recovered in the analysis presented in this

section. With full commitment the introduction of a transfer system either leaves welfare unaffected (if the transfer system is not used by the central government) or enhances welfare (if the central government makes use of the transfer system). However, a transfer system available to a government not being able to commit to its policy is no longer welfare improving. As shown in this subsection, welfare either stays constant (in the case of a pooling equilibrium in the absence of a transfer system) or even deteriorates (in the case of a separating equilibrium in the absence of a transfer system). Thus, reducing the set of policy variables at the central level is weakly welfare increasing if a commitment technology is not available to the center.

Uniform capital taxation seems to be consistent with actual tax policies in federal states. In federal systems with centralized taxation, tax rates are not differentiated across regions to reflect, e.g., taste differences. This empirical observation is probably the reason why in most of the literature on government decision making centralized policy is uniform by assumption. The analysis in this section demonstrates that the issue of uniform taxation is closely connected to the Revelation Principle. By dropping the assumption of full commitment non-differentiated capital tax rates can be endogenously derived. Accordingly, the results obtained with capital taxes being coordinated by a central government which has access to a transfer scheme but is unable to commit to its policy are supported by the empirics of federal taxation. Therefore, the analysis provides an explanation of actual tax policy.

3.6 Extension: Tax Coordination and Participation

Section 3.4 analyzes how contracts have to be designed to be implementable, i.e. to satisfy the incentive-compatibility constraints. In general, the resulting allocation is characterized by distinct utility levels for each type of region. At the general level of analysis it cannot be excluded that one type of region is worse off under coordination relative to the non-cooperative outcome analyzed in chapter 1. This observation plays an important role for the outcome under centralized capital taxation for the following reason. So far, the analysis has been conducted by assuming that regions can either be forced or have already agreed to participate in the tax coordination game. However, in practice this assumption is hardly fulfilled. For instance, in the

European Union tax coordination is decided unanimously. Hence, each member of the European Union must be better off due to tax coordination, otherwise it will not participate. In this section, the assumption of compulsory participation is relaxed and an endogenous-participation decision in tax coordination is considered. The problem is not solved here. The purpose of this section is solely to provide some intuition why an endogenous participation decision may affect the outcome of tax coordination and, therefore, why this is a useful extension of the model analyzed in section 3.4.

Participation Constraint With compulsory participation the only restrictions which have to be imposed on the central government's optimization problem are the incentive-compatibility constraints. However, if local governments are initially independent, they cannot be forced to participate in tax coordination. Regions are free to join or not to join a tax coordination agreement. The regional autonomy can be formalized by the introduction of a participation (individual rationality) constraint which the central authority must respect. Put differently, in addition to incentive-compatibility constraints, participation constraints restrict the central government's optimization problem. The constraints ensure that regions have an incentive to participate in tax coordination activities regardless of their type. Formally, the participation constraint takes the form

$$u^i(c^i, g^i) \geq \bar{u}^i \quad i = h, l. \quad (3.57)$$

The l.h.s. shows the utility a θ^i -type region can attain under centralized capital taxation. The r.h.s. gives the reservation utility of a θ^i -type region, i.e. the utility a θ^i -type region can attain if all regions reject the tax coordination proposal. In this case the capital tax competition outcome is realized. Eq. (3.57) differs from those participation constraints used in standard adverse-selection models⁴⁰ since the reservation utility \bar{u}^i is type dependent. This difference makes it difficult to derive clear-cut conditions for Eq. (3.57) to be satisfied or not.

As given by proposition 3.3, local public goods are inefficiently provided in both types of regions if capital taxes are coordinated, whereas under capital tax competition local public goods are inefficiently provided at least in θ^h -type regions.⁴¹ Thus,

⁴⁰See, e.g., Fudenberg and Tirole (1991), ch. 7.

⁴¹From the discussion of asymmetric tax competition in chapter 1 it is known that an overprovision or even efficient provision of local public goods in θ^l -type regions cannot be excluded. Note,

in general the allocations under both institutional settings are distinct. Recall, the outcome of uncoordinated tax competition is incentive compatible and, therefore, belongs to the set of incentive-compatible allocations which can be implemented by the central government. Thus, if the uncoordinated tax policy is chosen, utility for each type of region is identical under both regimes. In this case, the participation constraint (3.57) is binding for both types of regions. However, it cannot be excluded that a different implementable allocation exists, which is preferred by the central government as it yields a higher value of the welfare functional. The fact that a higher weighted sum of utilities can be achieved by deviating from the capital tax competition outcome is compatible with a higher utility in one type of region but a lower utility in the other type of region. Note, the central government weighs utilities of both types of regions in its objective function. Therefore, at least at this general level of analysis, it cannot be excluded that the participation constraint is binding for one type of region and, thus, constitutes an effective constraint for centralized policy implementation in the presence of voluntary participation.⁴² This observation does not violate the Revelation Principle which merely states that the central level can replicate the non-coordinated outcome. The Nash equilibrium of the tax competition game is incentive compatible as well as individually rational.

Informational Rent One important concept in information economics is that of an informational rent. The informational rent measures the impact of privately held information on the agent's utility. More precisely, it is defined as the difference between the agent's utility under asymmetric information and under symmetric information. In the standard principal-agent model the agents' utility under symmetric information is given by the reservation utility. This is due to the fact that the principal and the agents have strictly opposing interests in the standard framework. Thus, under symmetric information the principal offers a contract to the agent which gives agents only the reservation utility. In contrast, under asymmetric information some types of agents enjoy a utility level higher than their reservation utility. That is, the principal cannot suppress utility of all types of agents to their reservation

the tax rate t^h and t^l are too low compared with the case of capital immobility. However, $t^h > t^l$ and, consequently, $k^l > k^h$. Therefore, it is still possible that tax revenues in θ^l -type regions are sufficient to finance an efficient level or even a higher level of local public goods g^l .

⁴²There are different papers emphasizing the crucial role of the participation constraint in hindering efficient allocations. See, e.g., Myerson and Satterthwaite (1983), Buchanan and Faith (1987), Klibanoff and Morduch (1995), Grüner (1999), and Klibanoff and Poitevin (1999).

utility. Consequently, some types of agents receive an informational rent. From the perspective of the principal the informational rent enjoyed by the agent are costs due to asymmetric information.

The rest of this section draws a parallel between the standard principal-agent model and the model analyzed in this chapter. The purpose of this comparison is to analyze whether the above outlined results carry over to capital tax coordination.

In the general equilibrium setting considered here the sign of the informational rent is ambiguous. With compulsory participation the informational rent can even be negative. However, unlike the standard principal-agent framework the introduction of the participation constraint does not restrict the informational rent to be non-negative. The informational rent may increase. But it can still be negative. The underlying reason is the following. The interests between the center as the principal and the regions as agents are not perfectly opposed. The center cares about both types of regions whereas regions only care about their own well-being. This accounts for the fact that under symmetric information a region's utility does not necessarily equal its reservation utility, i.e. the full information outcome may not be identical to the capital tax competition outcome. Both the utility level under full information and under asymmetric information can exceed the reservation utility. Thus, the difference between the latter and the former can be positive as well as negative and is not restricted to be non-negative by the participation constraint. In the general equilibrium setting the constraint only ensures that one type of region is not worse off under centralized tax coordination relative to capital tax competition. Therefore, in contrast to the standard model the endogenous participation decision does not exclude the possibility that one type of region is worse off due to privately held information.⁴³

The Full Optimization Problem With voluntary participation the optimization problem becomes

$$\max_{t^h, t^l} W(t^h, t^l) = n^l [c^l + \theta^l v(g^l)] + n^h [c^h + \theta^h v(g^h)] \quad (3.58)$$

subject to

$$(ICC^h) : c^h + \theta^h v(g^h) \geq c^l + \theta^h v(g^l) \quad (3.59)$$

⁴³This observation is also made in Raff and Wilson (1997).

$$(ICC^l) : c^l + \theta^l v(g^l) \geq c^h + \theta^l v(g^h) \quad (3.60)$$

$$(PC^h) : c^h + \theta^h v(g^h) \geq \bar{u}^h \quad (3.61)$$

$$(PC^l) : c^l + \theta^l v(g^l) \geq \bar{u}^l. \quad (3.62)$$

The endogenous participation decision enters the optimization problem through the participation constraint for θ^h -type regions PC^h and for θ^l -type regions PC^l . As mentioned above, the purpose of this section is only to motivate one extension of the tax coordination model rather than to solve the extended model. Such an analysis is left to future research.

3.7 Summary

The discussion in this chapter tries to evaluate the potential of capital tax coordination to mitigate the inefficiency of capital tax competition. Two forms of capital tax coordination are considered. The first approach assumes that capital taxes are still determined at the regional level. In this case, regions agree to change their tax rates simultaneously where the starting situation is the capital tax competition equilibrium. With symmetric regions the decentralized form of tax coordination unambiguously improves global welfare as well as welfare in each region. The regional welfare change becomes ambiguous if one allows for asymmetric regions. The reason for this result is that in the initial equilibrium distinct levels of local public goods are provided. Thus, a higher level of local public goods due to an increase in the capital tax rate is evaluated differently by distinct types of regions. For this reason, capital tax coordination in the presence of asymmetric regions does not yield clear cut results. The finding has important implications for actual tax coordination since the asymmetry of regions may imply that at least some regions have no incentive to participate in tax coordination though being globally welfare enhancing.

The second form of capital tax coordination requires a reassignment of capital taxes to the central level. That is, regions lose their tax autonomy and capital taxes are chosen at the central level. This approach to tax coordination seems to be a promising alternative as the inefficiency of capital tax competition rests on fiscal externalities. Thus, a centralized tax coordination is an appropriate institutional setting to internalize fiscal externalities (at least fiscal externalities among regions within a federation). In chapter 2 a central government was also introduced. How-

	$W_{nc}^c - W_{fc}^c$	$W_{nc}^c - W^d$	$W_{fc}^c - W^d$
Transfer	<	ambiguous	> 0
No Transfer			
$A \succ P$	≥ 0	> 0	> 0
$P \succ A$	≤ 0	ambiguous	> 0

Table 3.3: Welfare comparison: summary.

ever, in that setting capital is still taxed at the regional level. The central level can only indirectly influence the regions' decision by taxing labor income and paying unconditional grants to the regions. With centralized tax coordination the capital tax rate is under direct control of the central government.

Welfare under centralized tax coordination and full commitment is at least as high as under tax competition. If information is symmetrically distributed between the center and the regions, centralized tax coordination results in an efficient allocation of resources. However, the efficient allocation is not incentive compatible inducing an inefficient local public good provision under asymmetric information.

So far, the central government is assumed to have full commitment. If one drops this fundamental assumption, the comparative performance of centralized capital tax coordination and capital tax competition becomes ambiguous. A summary of the results is presented in table 3.3. With full commitment the Revelation Principle applies. For this reason, capital tax coordination is preferable to capital tax competition. By contrast, with no commitment welfare can be lower relative to tax competition. However, it can also outperform the full commitment outcome. Thus, centralized capital coordination may lose its desirable property to outperform capital tax competition once the central government cannot credibly commit to its policy. In particular, the comparative performance is negatively affected by the presence of a centrally-mandated interregional transfer system.

With compulsory participation it cannot be excluded that some regions are worse off due to tax coordination. If participation is compulsory, this finding is of no further consequence. However, if regions are initially autonomous, capital tax coor-

dination must be utility enhancing for each region. The regions' autonomy results in a participation constraint. In this case tax coordination is restricted by the participation constraint only to the extent to which compulsory participation implies a lower utility level at least for one region relative to the tax competition outcome.

Appendix A

Appendix to Chapter 3

A.1 Proof of Proposition 3.2

Depending on which incentive-compatibility constraint is binding, four cases can be distinguished:

(1): Both incentive-compatibility constraints are binding ($\mu^h > 0$ and $\mu^l > 0$).

(2): ICC^h is binding and ICC^l is not binding ($\mu^h > 0$ and $\mu^l = 0$).

(3): ICC^h is not binding and ICC^l is binding ($\mu^h = 0$ and $\mu^l > 0$).

(4): Both incentive-compatibility constraints are not binding ($\mu^h = 0$ and $\mu^l = 0$).

Case 1: By lemma 3.1 $t^h \geq t^l$. If $t^h > t^l$, $c^l > c^h$ and $g^h > g^l$. However, due to the Spence-Mirrlees condition, both incentive-compatibility constraints do not simultaneously hold as an equality for these allocations. The remaining case is $t^h = t^l$ and, therefore, $c^h = c^l$ and $g^h = g^l$. For this allocation Eq. (3.41) reduces to

$$v'(g) = \frac{-(n^h + \mu^h) + \mu^l}{-\theta^h(n^h + \mu^h) + \theta^l \mu^l}. \quad (\text{A.1})$$

Since $\theta^h > \theta^l$ this can only hold if $\theta^l v'(g^l) < 1$ and $\theta^h v'(g^h) > 1$. However, for a given (c^h, g^h) a marginal reduction in g^l relaxes both incentive-compatibility constraints and increases $u^l(c^l, g^l)$ and lowers $u^h(c^l, g^l)$ while leaving $u^h(c^h, g^h)$ and $u^l(c^h, g^h)$ unaffected. Therefore, the central state will not choose the pooling equilibrium and case 1 can be ruled out as an optimal policy.

Case 2: With $\mu^l = 0$ and $\mu^h > 0$ the first-order condition (3.41) becomes

$$(n^h + \mu^h) [-1 + \theta^h v'(g^h)] = 0, \quad (\text{A.2})$$

which only holds for $\theta^h v'(g^h) = 1$. The first-order condition (3.42) changes to

$$n^l [-1 + \theta^l v'(g^l)] = \mu^h [-1 + \theta^h v'(g^l)] \quad (\text{A.3})$$

which implies $\theta^l v'(g^l) > 1$. With capital immobility ($k^i = \tilde{k}$) and $\theta^h v'(g^h) = 1$, ICC^h can only be binding if $c^h = c^l$ and $g^h = g^l$. This contradicts $\theta^l v'(g^l) > 1$.

Case 3: If $\mu^h = 0$ and $\mu^l > 0$ the first-order condition (3.42) yields

$$(n^l + \mu^l) [-1 + \theta^l v'(g^l)] = 0. \quad (\text{A.4})$$

The equation only holds for $\theta^l v'(g^l) = 1$. Eq. (3.41) becomes

$$n^h [-1 + \theta^h v'(g^h)] = \mu^l [-1 + \theta^l v'(g^h)] \quad (\text{A.5})$$

which gives $\theta^h v'(g^h) < 1$. Again, with capital immobility ($k^i = \tilde{k}$) and $\theta^h v'(g^h) = 1$, ICC^l can only be binding if $c^h = c^l$ and $g^h = g^l$. This contradicts $\theta^h v'(g^h) < 1$.

Case 4: With $\mu^h = 0$ and $\mu^l = 0$ Eqs. (3.41) and (3.42) reduce to

$$n^h [-1 + \theta^h v'(g^h)] = 0 \quad \text{and} \quad n^l [-1 + \theta^l v'(g^l)] = 0. \quad (\text{A.6})$$

Therefore, $\theta^h v'(g^h) = 1$ and $\theta^l v'(g^l) = 1$.

A.2 Proof of Proposition 3.5

In this part of the appendix proposition 3.5 is proved. First, the first-order conditions (3.55) and (3.56) are rewritten to

$$t^h [\theta^h v'(g^h) - 1] - \epsilon_{k^h, t^h} [\theta^l v'(g^l) t^l - \theta^h v'(g^h) t^h] = 0 \quad (\text{A.7})$$

$$t^l [\theta^l v'(g^l) - 1] + \epsilon_{k^l, t^l} [\theta^l v'(g^l) t^l - \theta^h v'(g^h) t^h] = 0 \quad (\text{A.8})$$

where Eqs. (3.20) and (3.21) have been inserted and $\epsilon_{k^i, t^i} := \frac{\partial k^i}{\partial t^i} \frac{t^i}{k^i} < 0$.

If $\theta^h v'(g^h) = 1$ and $\theta^l v'(g^l) = 1$, Eq. (A.7) reduces to $-\epsilon_{k^h, t^h} (t^l - t^h) = 0$ which can only hold for $t^h = t^l$. Since, $\theta^h > \theta^l$ and, thus, $g^h > g^l$ the regional budget constraints cannot hold simultaneously for $t^h = t^l$.

If $\theta^h v'(g^h) = 1$, Eq. (A.7) implies $\theta^l v'(g^l) t^l = t^h$. Inserting the result in Eq. (A.8) yields $t^h = t^l$ and, therefore, $\theta^l v'(g^l) = 1$. However, this violates the regional budget constraints. The same line of argument can be applied for $\theta^l v'(g^l) = 1$. Hence, neither level of local public goods is efficient.

If $\theta^h v'(g^h) < 1$ and $\theta^l v'(g^l) < 1$, Eq. (A.7) implies $\theta^l v'(g^l) t^l - \theta^h v'(g^h) t^h > 0$. However, using Eq. (A.8) implies $\theta^l v'(g^l) t^l - \theta^h v'(g^h) t^h < 0$ which is a contradiction.

The same holds for $\theta^h v'(g^h) > 1$ and $\theta^l v'(g^l) > 1$.

If $\theta^h v'(g^h) > 1$ and $\theta^l v'(g^l) < 1$, both Eqs. (A.7) and (A.8) require $\theta^l v'(g^l)t^l - \theta^h v'(g^h)t^h < 0$. Thus, $\theta^h v'(g^h) > 1$ and $\theta^h v'(g^h) < 1$ satisfy the first-order conditions. An analogous argument holds for $\theta^h v'(g^h) < 1$ and $\theta^l v'(g^l) > 1$.

Concluding Remarks

The question of the current study, whether the negative effects of capital tax competition can be mitigated in a federal system, cannot be answered unambiguously. As shown in chapter 2, a federal system with capital taxation at the lower level and labor taxation at the upper level yields higher welfare than purely decentralized source-based capital taxation. The exact welfare improvement in turn depends on the behavioral assumptions (Stackelberg or Nash) underlying federal and regional decision making. However, chapter 3 showed that capital tax coordination may not yield the desired welfare improvement. More specifically, the analysis in chapter 3 revealed that with decentralized capital taxation regions may not have an incentive to agree to tax coordination unless regions are symmetric. Furthermore, with centralized tax coordination the efficient allocation cannot be implemented even if a transfer is available to the central government to distribute the benefits of tax coordination among regions. More importantly, however, if the central government can commit to its policy, welfare is unambiguously higher than under capital tax competition. By contrast, if the central government cannot credibly commit to its policy, the unambiguous welfare ranking no longer holds. In this case capital tax competition may even outperform centralized capital tax coordination.

In sum, even with benevolent governments tax coordination may not always yield the desirable effects, which are attributed to this policy measure in practice. With respect to the European Union the following policy implications can be derived. First, decentralized capital tax coordination may not work since member countries are asymmetric rather than symmetric. The finding that the asymmetry among regions is critical to the success of policy coordination is supported by the latest efforts to agree on a minimum tax on capital income or only an exchange of tax relevant information among the member states of the European Union. In particular, Great Britain and Luxembourg with the common characteristic of being important

European financial markets have been opposed to these policy measures. They fear that given the asymmetry they will be worse off due to the tax reform.

Second, in general a fully centralized European capital tax system cannot be recommended. Only if the European level has full commitment can centralized capital taxation be supported by welfare theoretic considerations. However, implied by the nonnegligible influence of national interests on European policy formation, the assumption of full commitment is questionable. If the European level cannot credibly commit to its policy, member states will be reluctant to reveal information (for instance to have a low preference for public goods) which may be used to adjust European policy against their national interest. In particular, this holds if the European level has access to a transfer system. In this situation, a delegation of capital taxes to the member states may be preferable, which is the current form of capital taxation within the European Union.

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