The Effectiveness of Partial Coordination among Decentralized Institutions

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Sven Wehke

Contents

Chapter 1

Motivation and Outline

1.1 Introduction

1.1.1 Systems competition

In principle, economists should not be worried about the economic forces of competition. Under symmetric information, in the absence of increasing returns to scale, market power, externalities and public goods, competition produces an outcome that does not waste scarce resources. The first theorem of welfare economics allows us to conclude that the result will be Pareto-efficient and a social planer cannot do better in terms of efficiency. In contrast, if one of the abovementioned preconditions is not fulfilled, we have at least a theoretical justification for government intervention. The public economics literature has dealt with these issues in length and has described how governments can intervene when private markets fail to provide a Pareto-efficient allocation. If we take the optimistic view that governments are benevolent and are able to correct market failures given the constraints it faces, what can then be said about the competition between governments? Is this form of competition innocuous since potential market failures have already been taken into account by benevolent policy makers? Or does it introduce a distortion again?

If countries are connected by mobile factors of production, such as capital, the answer is that the 'systems competition' will (at least to some extent) reintroduce the distortion which the government initially aimed to correct. As has been described by Sinn (2003), systems competition can take several forms. The most prominent type in the recent literature is the case of fiscal competition, which reintroduces a distortion in the following way. Given that a government is benevolent, it corrects a market failure by providing public goods instead of leaving it to the private market. In doing so, it collects tax revenue in a way that prevents the private sector to easily avoid the tax liability. In its simplest form, we may think of the fact that taxes are not designed to be a voluntary payment. Competition between countries for tax revenue, i.e. opening up the borders between jurisdictions, now enables private agents to avoid domestic contributions to the public good, which, in turn, weakens the government's position to provide a Pareto-efficient allocation. In this sense, competition between countries bears some resemblance to an attempt to provide public goods by a private market.

However, financing a public good by means of a tax on a mobile tax base, e.g., capital income, does not mean that the public good is not provided at all. Instead, we would rather observe an underprovision of public goods in the presence of fiscal competition. This can be seen by interpreting a capital tax as a tax that imposes an external effect on other jurisdictions (Wildasin 1989, DePater and Myers 1994). A single country recognizes a capital tax to be harmful to domestic production since mobile capital leaves the country seeking for an alternative investment abroad. This outflow of capital represents an inflow to the rest of the world. The latter effect is not part of the single country's calculus.

The theoretical literature on tax competition has bulked in the 1990s. The first presumption on the harmful effects of tax competition on public good provision, however, goes back to Oates (1972, p. 143):

> "The result of tax competition may well be a tendency towards less than efficient levels of output of local services. In an attempt to keep taxes low to attract business investment local officials may hold spending below those levels for which marginal benefits equal marginal costs, particular for those programs that do not offer direct benefits to local business."

In the mid-eighties, Wilson (1986) and Zodrow and Mieszkowski (1986) were the first to provide a formal treatment on these concerns. At that time, the academic interest in tax competition has been a reaction to publicly discussed cases of tax competition within the United States. To attract production plants, states and lower level jurisdictions offered sizeable subsidies to domestic and foreign automobile companies (see Wilson 1999). The main contributions of these seminal works are to explicitly pronounce the repercussions mobile tax bases have on the efficiency of public good provision and to characterize simple conditions for which tax competition emerges. In a nutshell, the basic ingredients for tax competition comprise a mobile tax base such as capital and a tax instrument that is required for raising public funds but drives out the tax base.

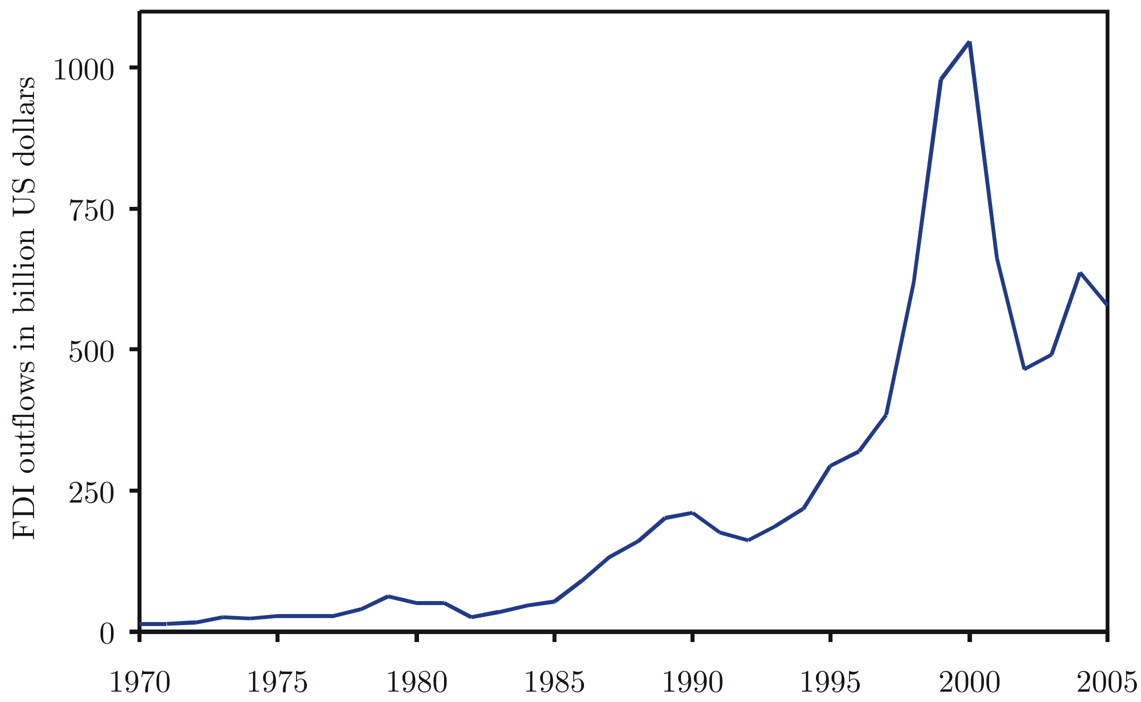

Figure 1.1: Total FDI outflow from selected OECD countries from 1970 to 2005
Source: UNCTAD (2007).
Legend: The Figure shows gross FDI flows in current billion US dollars. The figure only includes OECD countries for which data are available from 1970. It excludes the Czech Republic, Greece, Hungary, Iceland, Ireland, Mexico, the Slovak Republic, Switzerland and Turkey.

1.1.2 Some stylized facts

As indicated earlier, a fundamental requirement for initiating a tax competition game between governments is the existence of a mobile tax base. Indeed, capital as a factor of production is considered to be sufficiently mobile to set off such fiscal competition. In the academic literature, the Feldstein-Horioka-approach (Feldstein and Horioka 1980) has gained some attention in measuring the degree of capital mobility by looking at the correlation of a country's savings and investments. However, the explanatory power of this measure has been subject to some doubts since a missing correlation between savings and investments correctly indicates capital mobility but a positive correlation might as well be associated with gross capital flows between a country and the rest of the world. In the light of the potential defect the Feldstein-Horioka-approach might show, we take an even simpler view and argue that capital did become more mobile in recent years, making tax competition more likely to occur. Figure 1.1 depicts the gross foreign direct investment

(FDI) outflows from selected OECD countries from 1970 to 2005. In fact, starting in the mid-eighties, FDI flows experienced an enormous increase. Even if we neglect the spike around 2000, the data indicate a strong long-term increase in the degree of capital mobility during the last 20 years. This sheds some light on the grown possibilities of capital when seeking for the best after-tax investment opportunity throughout the world.

In view of the development in capital flows during nineties, we might expect that countries have reacted with their tax policy. To get an impression of the way governments have responded to a tax base that became more mobile, consider Table 1.1. It presents the statutory corporate income tax rates for all OECD countries in 2006 and allows us to compare these numbers with the year 2000. Even though the statutory tax rates as given in the table are not fully conclusive since policies that affect the tax base, i.e. depreciation allowances, are important for the effective tax burden as well, two things become apparent. First, there is no country in the OECD that decided to increase the statutory corporate income tax rate. Second, and even more important, within only six years, from 2000 to 2006, a large majority of OECD members (24 out of the 30) has even reduced the corporate income tax rate.

On the other hand, empirical research has shown that tax policy is indeed effective to influence the volume and location of FDI. In his survey, Hines (1999) reports a tax rate elasticity of FDI of about -0.6. Thus, from an empirical perspective, countries are able to engage in tax competition and, in fact, we should expect that they do so.

1.1.3 The basic argument

In subsection 1.1.1, we interpreted the outcome of tax competition as (i) a re-introduction of a market failure that the government has already corrected before and (ii) the consequence of imposing an external effect on other jurisdictions. Yet another way to characterize the economic consequence of tax competition is to describe it as augmenting the welfare cost of taxation. In turn, higher costs of shifting resources to the public sector imply a lower level of welfare enhancing public policy that requires spending public funds, e.g., public good provision, redistribution (see Sinn 1990, 1997) or subsidization of external effects. From that perspective, the consequences of tax competition may appear to be 'invisible' in a similar manner as is the case with the excess burden of taxation. However, the channel through which it works, i.e. capital/firms relocating from a high tax to a low tax country, are well recognized and heavily discussed in the public and in policy-making.

	Combined corporate income tax rate		
	2000	2006	+/−
Australia	34.0	30.0	−4.0
Austria	34.0	25.0	−9.0
Belgium	40.2	34.0	−6.2
Canada	44.6	36.1	−8.5
Czech Republic	31.0	24.0	−7.0
Denmark	32.0	28.0	−4.0
Finland	29.0	26.0	−5.0
France	37.8	34.4	−3.4
Germany	52.0	38.9	−13.1
Greece	40.0	29.0	−11.0
Hungary	18.0	16.0	−2.0
Iceland	30.0	18.0	−12.0
Ireland	24.0	12.5	−11.5
Italy	37.0	33.0	−4.0
Japan	40.9	39.5	−1.4
Korea	30.8	27.5	−3.3
Luxembourg	37.5	30.4	−7.1
Mexico	35.0	29.0	−6.0
Netherlands	35.0	29.6	−5.4
New Zealand	33.0	33.0	±0.0
Norway	28.0	28.0	±0.0
Poland	30.0	19.0	−11.0
Portugal	35.2	27.5	−7.7
Slovak Republic	29.0	19.0	−10.0
Sweden	28.0	28.0	±0.0
Spain	35.0	35.0	±0.0
Switzerland	24.9	21.3	−3.6
Turkey	33.0	30.0	−3.0
United Kingdom	30.0	30.0	±0.0
United States	39.3	39.3	±0.0

Table 1.1: Statutory corporate income taxes for OECD countries in 2000 and 2006.
Source: OECD (2007).
Legend: The tax rates shown in the table are combined corporate income tax rates. They include each country's central and sub-central (state and local) statutory corporate income tax rate. Surtaxes (if any) as well as potential deduction of the central governments against sub-central taxes have also been taken into account. For countries with a progressive tax schedule, the top marginal rate is reported.

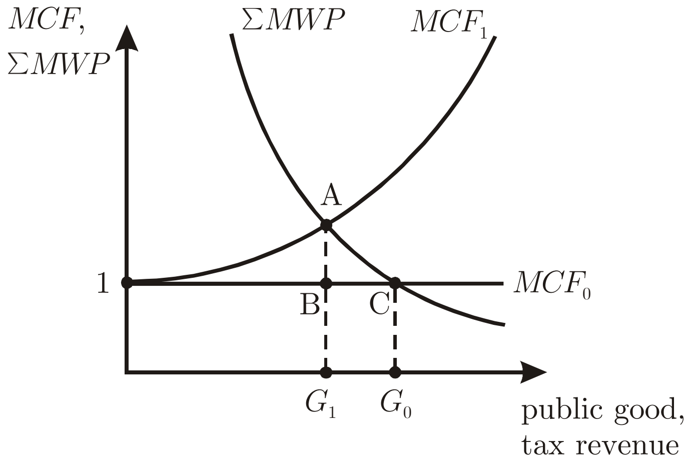

Figure 1.2: The (modified) Samuelson rule of optimal public good provision

In order to shed more light on the basic problem of fiscal competition, it is useful to employ a simple version of the basic tax competition model. Suppose that the worldwide capital stock is fixed in supply and a capital tax would be non-distortionary from a worldwide perspective, whereas capital taxation is distortionary from a single country's point of view.

Since we assume the government to be benevolent, it provides the public good in an efficient manner by expanding public good provision until its total marginal benefits are equal to the marginal costs of its production. As for public consumption goods, the marginal benefits are given by the marginal willingness to pay for the public good for all consumers. The total marginal costs then comprise two components. The first are the marginal production costs MC of transforming public funds into public goods. Without loss of generality, we can normalize $MC = 1$. As a second component, we have to incorporate that, in general, raising public funds is costly in terms of welfare. Since taxation is associated with an excess burden, each Euro of tax revenue collected by the government induces a loss in the private sector of more than one Euro. These costs are captured by the *marginal costs of public funds* (MCF). Hence, in such a second-best environment, the condition for optimal public good provision becomes

$$\sum MWP = MCF,$$

which is referred to as the modified Samuelson rule (see Atkinson and Stern 1974). The public good provision is on its first-best level if the sum of the marginal willingness to pay is equal to the pure production cost of the public good. This can only be the case for fully non-distortionary taxation, i.e. $MCF_0 = 1$, where G_0 is the first-best level of the public good; see Figure 1.2. In contrast, if taxation is distortionary,

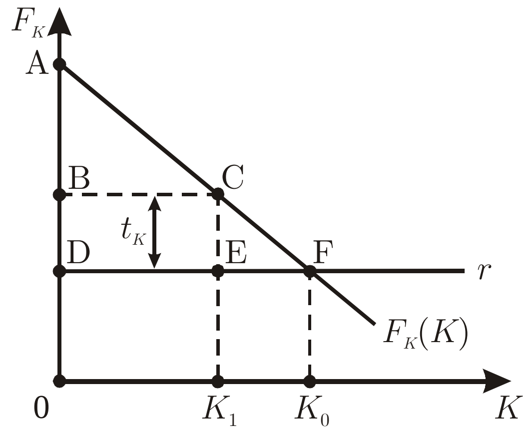

Figure 1.3: The welfare cost of capital taxation

$MCF_1 > 1$ public good provision is second-best at G_1. Clearly, the resulting welfare loss of distortionary taxation is the area ABC. The magnitude of the welfare loss therefore depends on how distortionary the tax system is (at the margin) and how strong the preferences are regarding the public activity. In an attempt to quantify the welfare costs by calculating the size of the area ABC in Figure 1.2, Parry (2003a) argues that the efficiency cost of tax competition are between five and ten percent of tax revenue.

To see the welfare cost of capital tax competition and the shape of the above MCF-curve in more detail, it proves convenient to have a closer look at the way in which a mobile factor is employed in a small country. In its simplest version, we make use of a representation that goes back to MacDougall (1960). This standard approach is to consider a homogenous good that is produced in a small open country. Mobile capital enters domestic production as the only variable input factor and exhibits decreasing returns since we assume the existence of a fixed factor such as land. Output is therefore produced according to the production function $F(K)$, with $F_K(K) > 0$ and $F_{KK}(K) < 0$. For the government, we assume that pure profits can be taxed at a rate t_π. A source-based capital tax t_K is the only distortionary tax available.

Figure 1.3 then depicts the capital employment from the small country's point of view. Capital supply is perfectly elastic at a constant net return r per unit. The demand for domestic capital employment is given by the marginal product of capital $F_K(K)$ which is decreasing in K. The linear shape of the F_K-curve has been chosen for the sake of convenience when interpreting the figure. Also note that the output price is normalized to one.

To begin with, we first consider the scenario without any tax on domestic capital

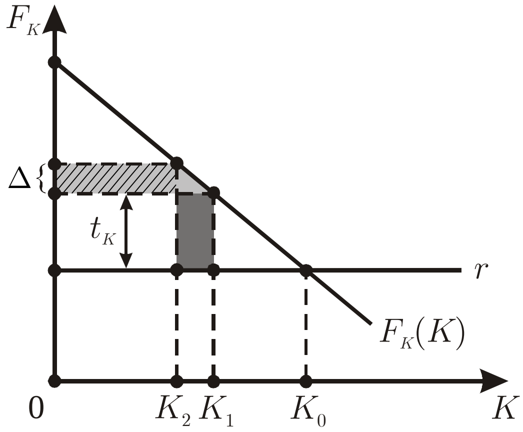

Figure 1.4: A unilateral increase in the capital tax

employment. In this case, the country employs capital until the last unit of capital exactly earns the net world interest rate, i.e. the country chooses point F, where $F_K = r$ and K_0 units of capital are used in domestic production. Total output is then given by the area AF$K_0$0, with AFD being profits, i.e. the rent of the fixed, country-specific factor. Profit taxation, as a means to collect non-distortionary tax revenue, is supposed to be restricted to a maximum rate $\bar{t}_\pi$. First, it cannot exceed 100 percent since it would violate a participation constraint. Second, we even allow for further (legal or constitutional) restrictions which aim at protecting property rights and might therefore restrict profit taxation to less than 100 percent. If the profit tax suffices to provide the public good at its first-best level, other taxes are not necessary and the problem of tax competition becomes irrelevant. Let us therefore assume that the first-best level of the public good is not attainable by solely using the restricted profit tax revenue, i.e. $\Sigma MWP > 1$ for $t_\pi = \bar{t}_\pi$. Thus, depending on its welfare costs, introduction capital taxation might improve welfare by spending its revenue on additional public good provision.

As will be explained in more detail below, a small country might wish to levy a strictly positive (source-based) capital tax on capital used in domestic production. In this case, the gross price of capital is $r + t_K$ and only K_1 units of capital are employed in the country. Output is reduced to the area AC$K_1$0, where capital tax revenue is $t_K \cdot K_1$ =BCED and profits are ABC. Since capital owners earn the world interest rate r on their endowment, their income remains unchanged.

Should a single country then tax capital at a strictly positive rate, imposing an externality on all other countries? To answer that question, we consider an increase in the capital tax, starting from a pre-existing capital tax rate t_K (which might be zero), and its repercussions on private consumption and total tax revenues. For illustrative purpose, we will first discuss a tax increase by the discrete amount Δ in Figure 1.4 and then translate our analysis to marginal steps ($\Delta \to 0$) to show the marginal costs of public funds in Figure 1.3. Since capital income cannot be altered by a small country's policy, changes in private consumption can only stem from changes in net profit income. In Figure 1.4, raising the capital tax rate by Δ, starting from a tax rate of t_K, reduces domestic capital employment from K_1 to K_2 which reduces profits by the trapezoid shaded in light gray. A fraction of $(1 - t_\pi)$ of that is reduced consumption, whereas the fraction t_π represents a loss in profit tax revenue. For capital tax revenue, two mechanisms are at work. First, the striped area in Figure 1.4 describes that after the tax increase each unit capital employed in the country contributes to higher capital tax revenue. Second, there a counteracting effect since what is lost in terms of domestic capital employment does no longer generate capital tax revenue at the old tax rate. This is illustrated by the area shaded in dark gray. Formally, this loss in capital tax revenue is given by $t_K \cdot (K_1 - K_2)$ in absolute terms, where the slope of the F_K-curve determines the extent to which capital employment is reduced. For a linear approximation of the marginal product curve, we can write $K_1 - K_2 = -\Delta \cdot F_{KK}$.

Turning to a marginal capital tax increase ($\Delta \to 0$), the areas presented above in Figure 1.4 now reduced to distances which can easily be shown in Figure 1.3. Starting from a tax wedge $t_K =$CE, consider a marginal increase in the capital tax rate. On the one hand, the damage to the private sector amounts to the loss in net rent income $(1 - t_\pi)\cdot$BC, where the distance BC is the loss in pure profits. On the other hand, tax revenue is changed. Total marginal tax revenues are given by $(1 - t_\pi)\cdot$BC+CE$/F_{KK}$, where the first term captures that (i) capital tax revenues increase by BC, given the level of capital employment, and (ii) profit tax revenues are reduced by $t_\pi\cdot$BC. The second term represents the common countervailing effect as capital is driven out of the jurisdiction and capital tax revenues are therefore reduced. The extent to which domestic capital employment must be reduced to earn its new gross price depends on the slope of the marginal product curve. Using the linear approximation of the F_K-curve, we can write the latter effect as CE$/F_{KK}$ =EF. Consequently, for a marginal increase of the capital tax, the private damage per unit of tax revenue is

$$MCF = \frac{(1 - t_\pi)\text{BC}}{(1 - t_\pi)\text{BC} + \text{CE}/F_{KK}}, \tag{1.1}$$

where CE is the pre-existing tax wedge, e.g., due to a unit source-based capital tax.

The above measure of the marginal cost of public funds allows us to study the optimal tax policy in more detail. First, we can shed more light on a small country's desire to tax mobile capital at source. Starting from a zero tax rate, $t_K =$CE$= 0$,

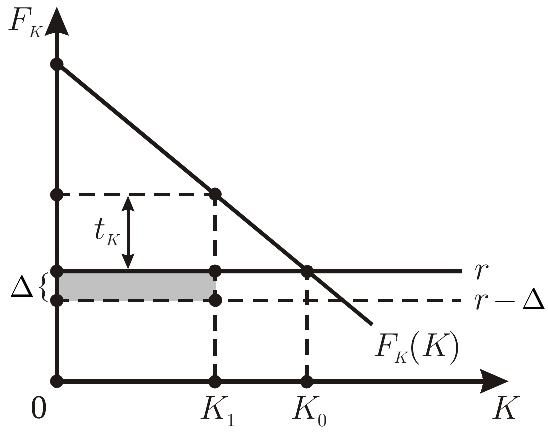

Figure 1.5: A coordinated increase in the capital tax

equation (1.1) reveals that this crucially depends on the admissible maximum profit tax rate. If profits are taxed at 100 percent, a marginal introduction of a capital tax does not change total tax revenue since what is gained in terms of capital tax revenue is lost in terms of profit tax revenue. Thus, public good provision remains unchanged and there is no reason to deviate from a zero tax rate on capital. In contrast, for less than 100 percent profit taxation, a marginal introduction of a capital tax is able to generate additional tax revenue. The loss in profit tax revenue is more than compensated by additional capital tax revenue since for $t_K = 0$ we do not have to incorporate a negative tax base effect due to the reduction in the capital employment. In the absence of such negative tax base effect, the loss in private consumption exactly equals the gain in total tax revenue. Thus, a marginal introduction of a capital tax is lump-sum ($MCF = 1$) and unambiguously contributes to welfare as the additional revenue is spent on public good provision with $\Sigma MWP > 1$. For less than 100 percent profit taxation, a positive capital tax rate is therefore optimal from a single (small) country's perspective. As a second insight from equation (1.1) we can infer that the marginal cost of public fund increase more than proportionally with the capital tax rate. Together with the concave relationship between the capital tax and total tax revenues, this produces a MCF-curve as depicted in Figure 1.2.

What can then be gained from coordination in the capital tax rate? As our starting point, let us assume that all countries are symmetric, having a tax wedge of t_K =CE, employ K_1 units of capital in their country (see Figure 1.5) and provide the public good at G_1, where the modified Samuelson rule is fulfilled (refer back to Figure 1.2). Now consider a coordination agreement between all countries that commits them to jointly raise their capital tax rate by Δ units. Assuming that the worldwide supply of capital is fixed and all countries are symmetric, this agreement does not change the capital employed in each country. It remains fixed at K_1. Rather, the worldwide net interest rate is reduced by the additional tax wedge to balance worldwide capital demand and supply. In Figure 1.5, the additional capital tax revenue is then given by the area shaded in light gray. Since the net capital remuneration is reduced by the additional tax wedge, capital owners' consumption is reduced as well. Assuming a symmetric distribution of capital endowments, this loss is also given by the gray area. Consequently, the capital tax coordination amounts to a lump-sum transfer from the private to the public sector. Translating this procedure to marginal tax coordination, both the additional tax revenue as well as the loss in private consumption are given by the distance DE; see Figure 1.3. The marginal costs of public funds are equal to one for a marginal coordination agreement in the capital tax rate.

To sum up, in the simple setting presented above, any coordination of the capital tax rate translates into a coordination of overall tax revenue and thus coordination in public good provision. As has been pointed out before, it is the underprovision of public goods that characterizes the welfare loss of fiscal competition. A major contribution of this thesis is that this one-to-one-relationship must break down in more realistic scenarios with more than just a capital tax instrument. In turn, this entails several important consequences. The more elaborated analysis, which is provided in chapters 2 to 4, then allows for an additional tax instrument which is distortionary even from a worldwide perspective. To be more specific, we make use of a tax on immobile labor, where we treat labor input as a price complement to domestic capital employment. If capital tax coordination is carried out in the presence of another tax rate, which is not part of the international agreement, a welfare improvement is no longer ensured.

If tax coordination is considered as an instrument to avoid the excess burden of taxation, it may be instructive to take a look at the (marginal) welfare cost of pre-existing tax systems. In fact, empirical estimates on the excess burden of taxation suggest that at the margin the welfare costs are quite substantial. For capital income taxes, the marginal cost of public funds range from 1.463 (Ballard et al. 1985) to 1.675 (Jorgenson and Yun 1991). For taxation of labor income, these numbers are lower and range from 1.2 to 1.469 (see, e.g., Browning 1985, Fullerton and Henderson 1989 and Parry 2003b).

1.1.4 Related literature

Since the literature on international fiscal competition is huge, we have to be restrictive in some respects. In particular, in the main contributions of the thesis we ignore the following fields that have been discussed in the theoretical literature.

1. If, in a dynamic setting, benevolent governments cannot commit to future policies, problems of time inconsistency may arise, where competition between countries may act as a welfare improving commitment device when deciding on tax policy (Kehoe 1989).

2. In the light of public choice theory, tax competition may also act as a discipline device. This offers another possibility of tax competition being welfare enhancing as it puts an additional constraint on revenue-maximizing governments (see, e.g., Edwards and Keen 1996, Rauscher 1998 or Eggert 2001).

3. In a more general setting, competition between countries has also been seen as welfare enhancing since mobile factors (households) 'vote with their feet' in the spirit of Tiebout (1956). Each household thereby chooses its most preferred tax and public service bundle.

4. There is only a thin literature capturing the obvious fact that the jurisdictions playing the Nash game are asymmetric in size and factor endowments, respectively (see Bucovetsky 1991, Wilson 1991, Kanbur and Keen 1993, Eggert and Haufler 1998). Among the main results, these contributions show that small countries can actually benefit from tax competition. However, as has been pointed out by Baldwin and Krugman (2004), asymmetric countries may also be the result of agglomeration forces. In this case, the country with industrial concentration can tax mobile capital more heavily due to the existence of 'agglomeration rents'.

5. Even without the physical mobility of capital or firms, countries might face a tax competition game since multinational firms may engage in profit-shifting activities (see, e.g., Haufler and Schjelderup 1999, 2000 or Mansori and Weichenrieder 2001).

6. Instead of playing a Nash game in the tax rates, where each jurisdiction chooses its own tax policy taking the tax rates of all other countries as given, 'expenditure competition' might also be a form of fiscal interaction between countries (see, e.g., Bayindir-Upmann 1998). As has first been pointed out by Wildasin (1988, 1991) expenditure competition is even more severe in terms of the corresponding welfare losses than competition in tax rates.

7. For a realistic view, we should bear in mind that the number of interacting jurisdictions is finite with each player having a small impact on common variables. Rather, we assume that each player of the Nash game treats common

variables, e.g., the net interest rate, as given instead of taking into account that unilateral actions will have a $1/N$-effect on these measures, with N denoting the number of jurisdictions (see Hoyt 1991). Analogously, we do not follow any concepts of intermediated cases of less than perfect (capital) mobility (Lee 1997).

8. Even though the literature on tax competition usually assumes unit taxes, we will employ ad valorem taxes on income as is done in reality. Lockwood (2004) shows that, although the qualitative result is unaltered, tax competition is fiercer when countries use ad valorem taxes instead of unit taxes. However, this quantitative difference becomes negligible when the number of countries becomes large.

9. One of the most important ingredients regarding the welfare effects of tax competition concerns the principles of capital taxation. Income stemming from an internationally mobile factor can either be taxed according to the place of residence of the factor owner (*residence principle*) or the origin of the factor income (*source principle*). As for efficiency, countries should adopt residence-based capital taxation to avoid that domestic capital owners can evade domestic taxation by simply investing abroad. Under the pure residence principle, international capital allocation is not distorted which promotes international production efficiency (Homburg 1999). In fact, most countries have implemented a combination of both, where residents are taxed according to the residence principle and non-residents according to the source principle. The resulting double taxation is then frequently avoided by bilateral tax treaties, where the foreign-earned income is either exempted from domestic taxation or credited against domestic tax liabilities. In both cases, however, there is a role of a country's source-based tax rate to influence the investment decision of a mobile factor (see, e.g., Zee 1998, Haufler 2001 or de Mooij and Ederveen 2003). Pure residence-based capital taxation is seen as administratively infeasible (Tanzi 1995). Consequently, we restrict our analysis to source-based taxes only.

1.1.5 Coordination

On the basis of the figures in subsection 1.1.3, it became apparent that the gain from coordination arises because it enables all participants to change a variable that has been perceived as fixed from an individual perspective. In the case of countries engaging in tax competition, this amounts to a (potential) source of lump-sum tax revenue. As a consequence, we cannot expect welfare gains from tax coordination if two small countries cooperate in their tax policy (Razin and Sadka 1991). Similarly, coordination is not able to do a better job if countries have unrestricted access to a lump-sum tax while capital may nevertheless be taxed in the uncoordinated equilibrium to strategically influence a domestic distortion (Huber 1999).

In a framework with multiple tax instruments available to local governments, a fundamental distinction concerns the magnitude of coordination that is potentially carried out. Most importantly, this thesis distinguishes between *complete* and *partial* coordination, where the former describes a coordination agreement that covers *all* policy instruments that have been used as strategic variables in the Nash game. In our tax competition example, complete coordination ensures that *tax revenue* (and thus public good provision) is actually under joint control. This is the procedure employed by, e.g., Bucovetsky and Wilson (1991) and Fuest and Huber (1999b) who analyze a coordinated increase in the capital (wage) tax, where it is implicitly assumed that governments also agree not to change the remaining wage (capital) tax rate. In contrast, partial coordination is less restrictive. It covers only one policy instrument, where the other one can be freely chosen after the coordination is carried out. The notion of such partial cooperation has first been studied by Copeland (1990) in the context of trade policy. In a two-stage game, governments first agree upon a negotiable trade barrier (tariffs) cooperatively, taking into account that, in a second stage, they can choose a non-negotiable trade barrier (subsidies) non-cooperatively. Fuest (1995) has been the first to apply this idea to tax coordination. He shows that, after capital tax coordination is carried out, countries compete for mobile capital by spending public funds on productive public input goods. Fuest and Huber (1999a) employ a model with four policy instruments available to governments and demonstrate that jointly introducing a minimum tax rate is completely ineffective. The remaining three policy instruments can be used to exactly restore the uncoordinated Nash equilibrium again. The contribution by Marchand et al. (2003) is closest to the approach of the present thesis. They study in which way countries react to capital tax coordination by adjusting a tax on the factor labor, which might be complementary with or substitutable for capital. In contrast to the present thesis, however, Marchand et al. focus on the direction of the labor tax adjustment and do not discuss the welfare consequences. The welfare effects of partial coordination are therefore analyzed in detail in this thesis. In doing so, we will also examine whether the underlying labor market organization is important for the effectiveness of (partial) coordination. In addition, the last chapter translates the idea of partial coordination to the labor market, where, instead of small countries, small trade unions might wish to coordinate their policy.

Another distinction can be made between *marginal* and *global* coordination agreements. In the present thesis, we restrict our attention to marginal steps, i.e. if coordination is carried out it comprises a marginal change starting from the uncoordinated Nash equilibrium. In Figure 1.2, this translates into a welfare gain of the distance AB weighted with the additional tax revenue collected from a joint marginal increase in the tax rate. On the other hand, global coordination implies that all countries fix their policy instruments on the optimal level without any scope for welfare improving joint marginal changes. Referring back to Figure 1.2, this is associated with a welfare gain as given by the area ABC. Admittedly, restricting our analysis to marginal agreements might seem arbitrary. In fact, if we allow all countries to coordinate, we might as well suppose that they agree upon more than just marginal projects by directly choosing the first-best optimum. Evaluating welfare effects from non-marginal changes, however, requires detailed knowledge of the shape of the objective function. In the present case, the preferences with respect to the public good are important. Such information is not necessary for marginal steps starting from the uncoordinated equilibrium, where we can simply use the fact that $\Sigma MWP = MCF$.

Finally, to avoid confusion, we should note that the literature on tax competition also uses the term 'partial coordination' when only a subgroup of countries chooses its policy cooperatively to alleviate the consequences of international tax competition (see, e.g., Konrad and Schjelderup 1999 or, more recently, Conconi et al. 2007). One basic result of such partial coordination is that, even if not all countries participate in the coordination agreement, this form of arrangement is nevertheless beneficial to the countries involved.

1.2 Tax Competition and Partial Coordination

Clearly, policy coordination offers a potential device to counteract the consequences of harmful fiscal competition. However, the design of the coordination agreement matters. The discussion above has pointed out that fiscal competition among benevolent governments leads to an underprovision of public goods. Consequently, the most promising form of coordination would comprise a jointly increase the level of public good provision, where the additional tax revenue is captured from capital owners. Indeed, if the capital tax instrument is the only (distortionary) source of tax revenue for each individual country, any capital tax coordination must translate into public good coordination. Due to this one-to-one relation through the government budget constraint, the welfare effect is clear-cut in this case. However, the welfare implications are less straightforward if we restrict to tax coordination and each government is allowed to use not only a tax on mobile capital but also a tax on immobile and elastically supplied labor. In order to ensure that a joint increase in capital tax coordination also results in higher tax revenues, certain assumptions on the labor tax are necessary. So far, the literature often dealt with this problem by either neglecting a second tax instrument or assumed the labor tax to remain constant during capital tax coordination is carried out (Bucovetsky and Wilson 1991, Fuest and Huber 1999b). However, this requires that the labor tax has also been part of the coordination agreement in the sense that adjustments in this tax instrument are ruled out. Such an 'all-inclusive' coordination agreement that covers all possible policy instruments, which might be able to influence domestic capital employment, seems to be rather unrealistic.

Chapter 2, which draws on Wehke (2006), therefore takes a more realistic view by analyzing the welfare effects of partial tax coordination. Since coordination is likely to cover only one tax rate, we take into account that countries will adjust another tax rate to optimally respond to coordination. To be more specific, we set up a model with mobile capital and immobile labor, where the labor market is assumed to be competitive and the government can levy taxes on both factors to spend the revenues on a public consumption good.

First, the chapter derives well-known results for the uncoordinated Nash equilibrium, i.e. underprovision of the public good, distortionary taxation if profits are not fully taxed away and a wage tax that depends on the labor supply elasticity.

As a point of reference, the chapter then determines the welfare effect of complete tax coordination as is known from the previous literature, i.e. starting from the Nash equilibrium we marginally raise one tax rate and assume implicitly that the other tax rate is kept constant. For a coordinated increase in the capital tax at a constant wage tax, we only observe a reduction in the net of tax interest rate for capital owners. The additional tax revenue which is spend is on the public good unambiguously increases welfare. The same holds true for a coordinated increase in the wage tax rate at a given level of capital taxation. Although all factor prices are altered in this case, for a marginal tax coordination starting from the Nash equilibrium only the reduction of the net of tax interest is relevant in terms of welfare as all other effect are already 'optimized out' by the first-order conditions of the uncoordinated Nash equilibrium.

To analyze partial tax coordination, we first consider the case that all countries agree to marginally increase their capital tax rate while the labor tax rate is still free to be adjusted by all countries. It is shown that a coordinated increase in the capital tax reduces the marginal tax revenue of the wage tax thereby increasing its marginal costs of public funds. Thus, each country faces an incentive to lower its wage tax in order to equate the marginal costs of public funds between both tax rates again. As every country is confronted with the same incentive, an uncoordinated but symmetric change in tax rates is triggered: a 'joint' reduction in the wage tax at a given capital tax. However, the (negative) welfare effect of this joint adjustment is, in general, not able to overcompensate the initial (positive) welfare effect of the capital tax coordination (at a given wage tax). The intuition runs as follows. After the marginal coordination of the capital tax has taken place, all countries are still allowed to compete for mobile capital by using the wage tax instrument. A joint change in the capital tax rate is not able to alter the real allocation, since the tax wedge on the labor market remains constant and capital, which is fixed in supply from a worldwide perspective, as well as labor employment must remain constant. For a joint change in the wage tax, however, a higher tax wedge is introduced on the labor market, thereby reducing labor employment and gross factor prices in each country. Hence, the wage tax is not a perfect substitute to the capital tax in terms of competing for mobile capital. Therefore, it is not possible for all countries to restore the welfare of the (uncoordinated) Nash equilibrium, i.e. the overall welfare effect is positive. Only for the special case of a zero elasticity of substitution between capital and labor, a joint change in the wage tax does not affect the labor employment. In this case of capital and labor being perfect complements, the wage tax is a perfect substitute to the capital tax and the initial (inefficient) Nash equilibrium will be restored if all countries enter the tax competition game after the partial coordination of the capital tax.

However, if all countries jointly increase their wage tax, the welfare effect becomes ambiguous. For a constant labor supply elasticity, the opportunity to adjust the capital tax enables all countries to engage in a tax competition game that exactly restores the initial Nash equilibrium. In this case, coordination has no welfare impact. If the labor supply elasticity is increasing (decreasing) in the course of a joint increase of the wage tax, the existing distortion on the labor market is augmented (attenuated) such that the overall welfare effect after the joint capital tax adjustment is negative (positive).

As a main policy implication from the present analysis, we can first conclude that coordination with respect to one policy instrument is welfare enhancing if other policy instruments are not perfect substitutes in attracting mobile capital to the one that is subject to coordination. To be more specific, following a capital tax coordination, which is non-distortionary, a joint adjustment of the wage tax is, in general, distortionary from a global perspective and is therefore not able to perfectly mimic the capital tax. As a second result, we find that even in the existence of a perfect mimicry marginal coordination improves welfare, if - starting from the Nash equilibrium - the distortion of the tax system is reduced.

1.3 Public Goods, Unemployment and Policy Coordination

Government expenditures are not only used for public consumption goods which solely enter the household's utility function. Rather, they are also used to increase the productivity of domestic factors (capital, labor) and thus - in the light of increasing international competition - to promote the attractiveness of domestic investments. First empirical studies by Ratner (1983) and Aschauer (1989) have shown that 'public capital' has a positive impact on a country's output level. Later studies (see, e.g., Berndt and Hansson 1992, Seitz 1994 or Batina 1999) were even able to distinguish between the types of public expenditure. Nevertheless, the empirical literature is rather mixed with respect to the magnitude of the impact, especially compared to private capital; see Romp and de Haan (2007) for a recent survey. The productive nature of public expenditures may therefore be captured by the term public input goods, which are provided by the government.

The first theoretical contribution is Kaizuka (1965) followed by a number of subsequent interpretations by Sandmo (1972), Hillman (1978), McMillan (1979) and Feehan (1989). Analogous to the famous Samuelson rule (Samuelson 1954) for public consumption goods, these authors derive a condition for a country's first-best provision of a public input good.

We should note that it might be impossible to strictly distinguish between public expenditures which are exclusively used for consumption purposes, on the one hand, or for raising local productivity, on the other hand. While public parks can be seen as for pure consumption purposes, things are less clear-cut with the famous lighthouse example or even with social security. The latter, for instance, might be interpreted as a welfare enhancing insurance against certain risks that are not insurable on a private market. Clearly, this is a property that directly affects private utility and can thus be seen as a public consumption good. By contrast, social security can also be productive in the sense that it stimulates risk-taking behavior (Sinn 1996). In this chapter, however, we restrict our attention to the extreme case, where such a distinction is possible.

While earlier literature dealing with fiscal competition has focused on tax policy, less attention has been paid to the mix of public expenditures. An important exception is Keen and Marchand (1997), who make a distinction between a public consumption good and a public input good. Chapter 3 of the present thesis follows Keen and Marchand in this respect. In addition, however, we take into account another important institutional detail to be found in many (especially European) countries - unemployment due to union-firm wage negotiations. In doing so, this chapter contributes to the literature in two ways. The first is by characterizing the uncoordinated equilibrium, which is based on the assumption that each small country treats the world interest rate as well as the policies chosen by other countries as exogenous. The second is by considering policy coordination, where we first examine the welfare effects of an increase in the capital or the wage tax rate, while allowing the additional tax revenues to be spent either on the public consumption good or the public input good. As a second option of policy coordination, we study the welfare effects of a revenue neutral reallocation of public expenditures.

Regarding the uncoordinated Nash equilibrium, we characterize the optimal tax rates on labor and capital, where both tax rates are used to influence the outcome of the wage bargain and the wage tax is, in addition, used to correct for the imperfection on the labor market. With respect to optimal public spending, we present the way in which the respective public good provision deviates from its optimality rule as it is used to change the bargained wage and to boost employment in the presence of unemployment.

Turning to policy coordination, we first investigate the case of a joint increase in the capital or the wage tax rate. In both cases, the only effect that is relevant in terms of welfare is the repercussion of the coordination on the net of tax interest rate. Even if the tax coordination alters the remaining factor prices, i.e. the net wage and the gross factor prices, these effects were also present in the uncoordinated case. Thus, as a consequence of the envelope theorem, they cannot have welfare consequences since the starting point of coordination is the uncoordinated Nash equilibrium.

Given the knowledge that it is solely the net interest rate response which affects welfare by coordination agreements, the total welfare effect of tax coordination comprises two effects. The first effect stems from the ability of a joint increase in one tax rate to lower the net interest rate, neglecting that additional revenue is raised, which must be spend on any of the public goods. The second effect arises since the additional tax revenue is spent on the public input or the public consumption good, which, in turn, affects the net interest rate.

Since the interest rate response is crucial for the welfare impact, we need to determine the channels through which a change in the net interest rate is able to improve welfare. First, a reduction in the net interest rate is unambiguously welfare enhancing as it captures resources from capital owners in a lump-sum manner. This has not been possible for a small country and therefore increases welfare in a second-best environment, where raising public revenue is costly in terms of welfare. Second, a reduction in the net interest rate gives rise to an income effect for the trade union. Depending on the shape of the utility function, the bargained wage rate can be reduced or increased, which will either reinforce or dampen the first welfare effect. As an important result, we do not find a crucial influence of the labor demand elasticity on the direction of the welfare effect, as has been put forward by Fuest and Huber (1999b).

In contrast to earlier literature, we also allow the individual countries to spend the additional tax revenue on their preferred alternative and compare the result with the spending decision that yields the higher welfare gain for all countries, collectively. In this sense, we follow the idea of partial coordination and demonstrate that the individual spending decision will, in general, be wrong seen from a world-wide perspective. For example, it turns out that if it is socially optimal to spend the additional revenue on the public input good, then each country will inevitable face the wrong incentive and spend it on the public consumption good, if the influence of the public input good on the tax revenue is non-negative.

Finally, the chapter shows that the Keen-Marchand result of relative overprovision of the public input good does not necessarily carry over to the case of non-competitive labor markets. In their model, only the public input good is able to attract mobile capital from abroad since it raises the marginal product of capital directly and, indirectly, via the higher labor employment due to the increased marginal product of labor. There are two reasons for the ambiguity in the presence of wage bargaining. First, and in contrast to Keen and Marchand, the public consumption good will influence the wage rate if it is determined in a Nash bargain. This, in turn, affects the attractiveness of domestic capital employment. In detail, this depends on (i) whether the public consumption good is complementary with or substitutable for private consumption and (ii) whether the trade union's rent from bargaining is increased or reduced. Second, the impact of the public input good on the domestic capital employment is ambiguous and differs from the case of a fully competitive labor market. In particular, if the wage rate is increasing in the public input the indirect effect via the labor employment might change the direction of the result.

1.4 Fighting Tax Competition in the Presence of Unemployment: Complete versus Partial Tax Coordination

The fourth chapter of this thesis utilizes the framework already chosen in chapter 2. The basic modification is made with respect to the determination of the wage rate. Instead of equalizing labor supply and labor demand within a fully competitive environment, this chapter assumes that the wage rate is the outcome of a bargaining process between small trade unions and firms. In contrast to the second chapter, we therefore analyze the interaction between two institutional arrangements. On the one hand, countries are characterized by an additional distortion, i.e. involuntary unemployment, with the governments designing their policy instruments accordingly. On the other hand, the only way to fight tax competition is to partially coordinate with respect to the capital or wage tax, respectively.

Since the resulting equilibrium is characterized by involuntary unemployment, the optimal usage of the tax structure is now different to the one described in chapter 2. Even though a rather general description of the optimal tax rates in the presence of wage bargaining will already be given in chapter 3, the present chapter can be more detailed for two reasons. First, instead of a general production function, we choose a CES-specification. Second, and in contrast to the standard approach in the literature on taxation in the presence of wage bargaining (including chapter 3), we follow chapter 2 by incorporating a non-constant marginal disutility of supplying labor. This allows us to distinguish between the ability (of the wage tax) to capture intra-marginal rent from labor suppliers and the possibility (of both tax rates) to strategically influence the outcome of the wage bargaining. The latter crucially depends on the elasticity of substitution between capital and labor.

Again, as a point of reference, it is shown that full tax coordination is unambiguously welfare improving when one tax is marginally increased and the other one is kept constant. A coordinated change in the capital tax simply amounts to shifting resources between the private and the public sector in a one-to-one relationship without affecting the real allocation. In contrast, a joint change in the wage tax alters worldwide labor employment and thus the real allocation. For marginal changes, however, the envelope theorem ensures that only the impact on worldwide net interest rate contributes to welfare. Thus, the desirability of full tax coordination does not depend on whether the labor markets are competitive or unionized with involuntary unemployment being the consequence.

Analogous to the procedure in the second chapter, partial tax coordination is analyzed, starting from the uncoordinated Nash equilibrium. Following chapter 2, we first discuss a joint marginal increase in the capital tax, whereupon all countries respond with a reduction in the wage rate. Second, we also study a coordinated increase in the wage tax with the capital tax remaining at discretion of competing countries.

The welfare consequences of partial tax coordination then comprise two effects. First, similar to the flexible labor market, the tax rate that is free to be adjusted will be used to go back towards the initial Nash equilibrium, depending on how costly this adjustment is. Second, an additional effect on welfare emerges since the pre-existing distortion, for which the tax rates accounted, could either be augmented or alleviated due to the coordination or the joint adjustment, respectively. In contrast to chapter 2, however, the usage of taxation is now different due to wage bargaining. This constitutes the main difference of the welfare effects compared with competitive labor markets.

1.5 Union Wages, Hours of Work and the Effectiveness of Partial Coordination Agreements

The notion of partial coordination among decentralized institutions is not restricted to the scenario of jurisdictions that compete for mobile capital. Coordination due to external effects is a potential remedy in other settings as well. Chapters 3 and 4 of the present thesis already deal with decentralized trade union behavior, but rather focus on the interaction between wage setting, the corresponding tax system and the effects of tax coordination. By contrast, chapter 5 abstracts from a government sector and analyzes in more detail the external effects which are at work among decentralized trade unions.

While chapter 3 and 4 are less detailed in describing the way union behavior leads to unemployment, this chapter provides a more elaborate analysis on this issue. Unemployment caused by decentralized union behavior is not only a result of market power on the labor market but also a consequence of externality generating behavior of individual trade unions. The latter gives rise to a joint desire to cooperate. It shows a similar prisoners' dilemma structure as is the case with the tax competition game. In fact, the externality at work here, is even more direct than with the tax competition literature, where the impact runs through both a reduction in private production and a loss in tax revenues if capital is withdrawn from a foreign country in response to a domestic tax cut.

In the case of decentralized trade union behavior, each small union simply ignores

	Average unemployment rates		
	Decentralized	Intermediately centralized	Highly centralized
1960-1975	3.04	3.14	1.49
1976-1995	6.99	8.46	3.17

Table 1.2: Unemployment rates categorized by the level of wage bargaining
Source: Mares (2006), p. 9.
Legend: The distinction between highly decentralized (Britain, Unites States, France), intermediately centralized (Belgium, Denmark, Finland, Germany, Italy, The Netherlands, Switzerland) and highly centralized (Austria, Norway, Sweden) has been made according to an average of existing indices (see Mares 2006, chapter 2).

that a wage increase adds to the overall pool of unemployed within a country which, in turn, reduces the probability of re-employed for union members in the rest of the economy. The resulting unemployment is therefore higher compared to scenario in which a single countrywide trade union determines the wage rate and working conditions. Table 1.2 illustrates this point. It shows the average unemployment rates for selected countries depending on whether unions are decentralized, highly centralized or intermediately centralized. Obviously, countries with centralized wage bargaining have much lower unemployment rates than those with a highly decentralized union structure.

The fifth chapter therefore analyzes whether decentralized trade unions can effectively cooperate to internalize the externalities they impose on each other. In doing so, we suppose small monopoly trade unions and allow them to influence employment not only via the wage rate but also by choosing the hours of work. In contrast to chapter 3 and 4, we are able to distinguish more precisely between unemployment and underemployment. Since each union treats the re-employment possibilities in the rest of the country as given, the resulting uncoordinated equilibrium is characterized by 'excess' unemployment compared to the outcome of a centralized union.

The basic question of this chapter is then the following. If a country shows such a decentralized union structure, can we expect that cooperation among trade unions is a promising attempt provided that such cooperation is able to include only one policy instrument? As potential coordination agreements we then consider two different forms. First, we analyze a joint wage cut of all unions with autonomy retaining in the choice of the hours of work. Indeed, many European countries have established social pacts which comprised wage moderation (Mares 2006) but disregarded working time on the agenda. Second, we study a coordinated reduction in working time with the unions still being free to adjust the wage rate. The German *Alliance for Jobs* (Bündnis für Arbeit) can be interpreted as such an experiment, where some unions refused to make the wage rate part of the negotiations.

The chapter demonstrates that a positive welfare effect for union members only emerges when the partial coordination agreement is associated with a beneficial overall employment effect. Whether or not such imperfect cooperation among trade unions can constitute a positive employment effect, depends on similar mechanisms already described in the previous chapters. First, trade unions will use the instrument that has not been covered by the cooperation to mimic the variable which has been jointly changed due to the agreement. This will tend to offset the initial employment effect of coordination since unions try to go back to the Nash equilibrium. Second, the Nash equilibrium is characterized by the optimal choice of the unions' policy instruments depending on the marginal benefit and marginal cost of the instruments. In the course of the coordination agreement, this trade off may be changed and call for choosing the instruments on a different level. This may further change employment and welfare in either direction.

1.6 Preliminary conclusion

When decentralized decision-making is associated with externalities, the equilibrium will be inefficient, which, in principle, calls for coordination to internalize the external effects. In the present thesis, we analyze two institutions, small countries and trade unions, that might wish to coordinate their policy for that reason. However, we introduce an 'obstacle' to effective coordination in the following sense. The competing institution typically have more than one policy instrument available to maximize their well-being thereby imposing external effects on others. Hence, coordination that covers only one of the instruments leaves door open for the competition to continue. The welfare effects of such partial coordination are analyzed in the context of small countries competing for mobile capital and in a framework of decentralized union behavior. The basis message of the thesis will be rather pessimistic regarding the effectiveness of partial coordination. In general, they are less effective than the more unrealistic scenario of full coordination of all policy instruments. We also identify special cases in which they are not effective at all or are even counterproductive.

What are the implications of the present thesis? Should we be satisfied with the result that is obtained by partial coordination? Are we better off by not even wasting any effort to establish a (partial) coordination agreement? Obviously, the answer to the first question depends on (i) how much welfare is lost when comparing full coordination with partial coordination and (ii) how much effort it actually takes to form a joint agreement on *all* policy instruments instead of just one. In order to answer the second question, we need to compare the effort that is necessary to partially coordinate with the effectiveness of partial coordination (compared with no coordination). In fact, given that cooperation fails to capture all possible instruments and is therefore most likely doomed to be ineffective, then even any effort that is taken to form a partial agreement is a waste of resources.

Chapter 2

Tax Competition and Partial Coordination

Abstract

To determine the welfare effects of tax coordination, it is often assumed that one tax is jointly increased and all other policy instruments are held constant. This chapter, in contrast, analyzes partial coordination in the sense that each country can still adjust another tax, which is not subject to coordination. In a model with capital and labor taxation, we show that under plausible assumptions the welfare effect of coordinating the capital tax only is then still non-negative. For a partial coordination of the labor tax, however, results become ambiguous and depend on the labor supply elasticity.

JEL Classification: H21, H87

Keywords: factor taxation, fiscal competition, partial coordination

2.1 Introduction

Starting with the seminal contributions by Wilson (1986) as well as Zodrow and Mieszkowski (1986), there exists a vast literature on tax competition pointing out that the level of provision of local public consumption goods by small countries is too low compared to that expected under the famous Samuelson rule (Samuelson 1954).[1] The reason for the underprovision result is that a tax base (capital) which is immobile and thus a source of lump-sum tax revenue for the whole world is perceived as perfectly elastic by a small country and therefore gives rise to distortions in taxation. In changing domestic capital employment with policy instruments, each individual jurisdiction ignores the external effect capital movements have on other countries (see Wildasin 1989). It is therefore beneficial for all countries to raise their tax rates jointly in order to capture resources from capital owners in a lump-sum manner. In doing so, it is generally assumed that coordination is complete in the sense that the countries involved do not adjust other tax rates or other policy variables. However, such an 'all-inclusive' coordination agreement that covers all possible policy instruments that might be able to influence domestic capital employment seems to be rather unrealistic. Therefore, this chapter analyzes how overall welfare is affected by partial coordination agreements that leave open the possibility for each country to adjust some non-coordinated tax instruments.

So far only a few theoretical models have explicitly analyzed the possibility of countries responding to coordination agreements by adjusting other available policy instruments in order to increase their own welfare. In a seminal paper by Copeland (1990), two governments are involved in negotiations with respect to trade policy. In a first stage, both governments jointly choose a negotiable trade barrier, while, in a second stage, a non-negotiable trade barrier is chosen non-cooperatively. As a result, negotiations aimed at reducing a trade barrier nevertheless enhance welfare as long as the second instrument of trade protection is not a perfect substitute for the first one. The case of government spending decisions that might not be affected by international coordination is considered in Fuest (1995). Since a government can increase domestic investment by supplying a public infrastructure good that raises the marginal product of capital, this instrument will be used if the capital tax is jointly increased. Starting from a positive capital tax rate, each country tries to further benefit from capital taxation by enlarging its tax base. Due to the assumption that the worldwide supply of public input is constant, however, this adjustment leads to an increase in the price of the public input good so that the overall welfare effect is ambiguous and depends on the shape of the production technology. In a

[1] See Wilson (1999) for a survey.

rather broad context with a capital tax and a labor tax as well as a public consumption good and a public input good, Keen and Marchand (1997) emphasize that the case of partial tax coordination is of practical importance in policy making, but they do not analyze this topic further. Fuest and Huber (1999a) set up a two period model with four policy instruments: a corporate tax, a withholding tax on interest income, a value-added tax and depreciation allowances. They show that the joint introduction of a minimum tax rate, letting the countries choose the other policy parameters without any constraint, is neutral with respect to overall welfare. In their model, it is always possible to completely undo the change in capital costs caused by a minimum tax rate agreement so that the uncoordinated equilibrium is restored. Cremer and Gahvari (2000) combine the standard tax competition result with the possibility of tax evasion and auditing activities by the government. They show, in a two-country model with a tax on a private good as well as an audit rate, that harmonizing the tax rates only cannot completely eliminate the fiscal externality of tax competition, as long as each country retains national autonomy in the choice of the audit rate. Recently, Marchand et al. (2003) address capital and labor taxes in a model of partial tax coordination. However, their model considers capital as well as labor to be perfectly mobile between countries and assumes rather *ad hoc* that when taxes are only used for redistributive purposes, redistribution from capital owners to workers enhances welfare. Moreover, they do not provide a comprehensive welfare analysis by considering the overall welfare implication but rather discuss the impact of tax adjustment after coordination.

This chapter explicitly discusses factor taxation of mobile capital and immobile labor in a model with public good provision and imperfect profit taxation. Partial coordination is incorporated by considering the effect of coordination of one tax instrument on the efficiency costs of the tax instrument that the government is free to adjust after coordination has taken place. We derive the overall welfare effect of partial coordination and show that a partial coordination of the capital tax - starting in the Nash-equilibrium - cannot be welfare worsening under plausible assumptions. For the labor tax, however, partial coordination has an ambiguous welfare effect in the sense that all countries will only benefit from such a joint increase in the labor tax if the labor supply elasticity is increasing in the net wage rate.

The chapter is organized as follows. In the next section, the basic model of the chapter is described. Section 2.3 then characterizes the Nash equilibrium. As a benchmark case, section 2.4 considers complete tax coordination. The welfare effects of partial tax coordination are then analyzed in section 2.5. The last section summarizes and concludes.

2.2 The model

We consider an economy that consists of many small and symmetric countries with a large number of homogenous households, where the number of households in each country is normalized to one. A representative household is endowed with a fixed amount of capital $\overline{K}$ that is perfectly mobile and can be invested in the home country or in the rest of the world to earn a constant net return r. In addition to capital income $r\overline{K}$, households obtain income by supplying labor, where we assume that labor is perfectly immobile and each household can decide on its labor supply L^S by maximizing the difference between net wage income wL^S and monetarized disutility of labor $e(L^S)$, where $e' > 0$.

Total household utility V then consists of two parts. The first one is linear and includes capital earnings $r\overline{K}$, the net benefit from labor supply in monetary units, $wL^S - e(L^S)$, as well as net of tax profits, $(1 - t_\pi)\pi$, from firm ownership. The second part is utility derived from public good consumption $U(G)$, with $U' > 0$ and $U'' < 0$. Hence,

$$V = r\overline{K} + wL^S - e(L^S) + (1 - t_\pi)\pi + U(G). \tag{2.1}$$

Each household chooses labor supply by equating the net wage rate to marginal disutility of labor, $w = e'(L^S)$, which implicitly defines labor supply $L^S(w)$ with $dL^S/dw = 1/e''(L^S)$. The formulation of household utility allows for a labor supply that is independent of the public good provision.[2] Following Keen and Marchand (1997) and Fuest and Huber (1999b), we assume $e'' > 0$ so that labor supply is increasing in the net of tax wage rate.[3]

The government provides the public good G and raises revenue R with a non-distortionary profit tax t_π levied on the rent of a third (non-specified) factor,[4] a source-based capital tax t_r on net capital income from domestic capital input and a wage tax t_w on net labor income. We will assume that profit tax revenue does not suffice to provide the public good at the first-best level. Thus, the government

[2] Note that this is due to the specification of the disutility of labor supply as part of the linear consumption term. The assumption of separability in the public good consumption is made for notational convenience and could be dropped without changing the results since the labor supply decision will be unaffected.

[3] From a theoretical perspective, labor supply may also be declining with the wage rate. Early empirical literature (see Pencavel 1986) even finds some evidence for this ambiguity, especially with respect to men. Recent empirical findings, as summarized by Blundell and MaCurdy (1999), however, tend to support the assumption that labor supply is increasing in the wage rate.

[4] Since we assume firms to be immobile, a tax on profits is indeed non-distortionary. This is a standard assumption in the existing literature. For models with firm mobility see, e.g., Richter and Wellisch (1996) or Eggert and Goerke (2004).

budget constraint is given by

$$G = t_\pi \pi + t_r r K + t_w w L = R, \tag{2.2}$$

where the marginal cost of the public good is normalized to one, implying a marginal rate of transformation of one between private output and the public good.

Turning to the production side of the small economy, a homogenous output good Y is produced by using capital K and labor L as inputs. To keep the model manageable, we use a production function with a constant elasticity of substitution between labor and capital and decreasing returns to scale:

$$Y = F(K, L) = \left[\left(K^{\frac{\sigma-1}{\sigma}} + L^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \right]^{1-\frac{1}{\varepsilon}}, \tag{2.3}$$

where the parameter $\varepsilon > 1$ indicates decreasing returns to scale and $\sigma \geq 0$ denotes the elasticity of substitution between capital and labor. Both factor markets as well as the output market are characterized by perfect competition. The price of output is normalized to one.[5]

Taking gross factor prices $\tilde{r} = (1+t_r)r$ and $\tilde{w} = (1+t_w)w$ as given, firms maximize profits and thereby choose capital and labor inputs according to $\partial F(K, L)/\partial K = \tilde{r}$ and $\partial F(K, L)/\partial L = \tilde{w}$. Together with the above production function, this allows us to derive unconditional factor demands $L(\tilde{w}, \tilde{r})$ and $K(\tilde{w}, \tilde{r})$ with corresponding elasticities that solely depend on the parameters σ and ε as well as on the cost share of labor s (see Hamermesh 1993 or, e.g., Koskela and Schöb 2002a,b):

$$\eta_{L,\tilde{w}} = -(1-s)\sigma - s\varepsilon < 0, \tag{2.4}$$

$$\eta_{K,\tilde{r}} = -s\sigma - (1-s)\varepsilon < 0, \tag{2.5}$$

$$\eta_{L,\tilde{r}} = (1-s)(\sigma - \varepsilon), \tag{2.6}$$

$$\eta_{K,\tilde{w}} = s(\sigma - \varepsilon), \tag{2.7}$$

where s is given by

$$s = \frac{\tilde{w}^{1-\sigma}}{\tilde{w}^{1-\sigma} + \tilde{r}^{1-\sigma}}. \tag{2.8}$$

As is usual in the literature, we assume that capital and labor are price complements ($F_{KL} > 0$), which is equivalent to $\sigma - \varepsilon < 0$, so that both cross-price elasticities, (2.6) and (2.7), are negative. By assuming $\sigma - \varepsilon > 0$, however, we could easily incorporate the case of factors being substitutes.

[5] Note that we can also interpret equation (2.3) as being a linear-homogenous production function, where output faces imperfect competition on the world product market due to monopolistic competition (see Dixit and Stiglitz 1977). In this case, ε represents the price elasticity of output demand.

2.3 Nash equilibrium

2.3.1 Comparative static results

Since the net factor price of capital is constant at r under our small country assumption, we only need to determine how wages change as a reaction to changes in tax rates. This is done under the Nash assumption that each country takes the policy variables of all other countries as given.

By totally differentiating the labor market equilibrium

$$L^S(w) - L(\tilde{w}, \tilde{r}) = 0, \tag{2.9}$$

we get $w = w(t_w, t_r)$ with

$$w_{t_w} = \frac{w}{(1+t_w)} \frac{\eta_{L,\tilde{w}}}{\eta^S - \eta_{L,\tilde{w}}} < 0, \;\; \tilde{w}_{t_w} = w \frac{\eta^S}{\eta^S - \eta_{L,\tilde{w}}} > 0, \tag{2.10}$$

$$w_{t_r} = \frac{w}{(1+t_r)} \frac{\eta_{L,\tilde{r}}}{\eta^S - \eta_{L,\tilde{w}}} < 0, \;\; \tilde{w}_{t_r} = \frac{\tilde{w}}{(1+t_r)} \frac{\eta_{L,\tilde{r}}}{\eta^S - \eta_{L,\tilde{w}}} < 0, \tag{2.11}$$

where η^S denotes the labor supply elasticity $\eta^S \equiv w/\left[L^S e''(L^S)\right] > 0$. Increasing the labor tax reduces the net of tax wage rate while raising the gross wage rate. In contrast, if labor and capital are complements in production, taxing domestic capital income more heavily reduces labor demand, which in turn lowers both the net and gross wage rate.

2.3.2 Welfare maximization

The government maximizes the utility of domestic private households given the government budget constraint (2.2), wage reactions $w = w(t_w, t_r)$ and a restriction on the maximum profit tax rate $t_\pi \leq \bar{t}_\pi$. The corresponding Lagrangian, to be maximized with respect to G, t_π, t_w and t_r, is given by

$$\max_{G,t_\pi,t_w,t_r} \begin{array}{l} \mathcal{L} = r\overline{K} + wL - e(L) + (1-t_\pi)\pi + U(G) + \lambda\left(t_\pi \pi + t_w wL + t_r rK - G\right) \\ \quad + \mu\left(\bar{t}_\pi - t_\pi\right), \end{array} \tag{2.12}$$

where λ and μ are Lagrangian multipliers.

The first-order conditions with respect to the public good and the profit tax rate are as follows:

$$\frac{\partial \mathcal{L}}{\partial G} = 0 \Rightarrow U'(G) = \lambda, \tag{2.13}$$

$$\frac{\partial \mathcal{L}}{\partial t_\pi} = 0 \Rightarrow (\lambda - 1)\pi = \mu. \tag{2.14}$$

According to equation (2.13), public good provision should be expanded until total marginal utility of public good consumption equals marginal costs of its provision. In our case, the latter is equal to the marginal costs of public funds λ since by assumption the marginal rate of transformation between Y and G is equal to one. This is referred to as the modified Samuelson rule (see Atkinson and Stern 1974).

Given the complementary slackness condition

$$\mu\,(\bar{t}_\pi - t_\pi) = 0, \tag{2.15}$$

we can distinguish two cases. Firstly, if the restriction on profit taxation is not binding ($\bar{t}_\pi > t_\pi$), we have $\mu = 0$ and we can infer from (2.14) that $\lambda = 1$, i.e. tax revenue is raised non-distortionarily by the profit tax and public good provision is, according to (2.13), already first-best since $U'(G) = 1$. Secondly, if the restriction is binding, then $t_\pi = \bar{t}_\pi$ and $\mu > 0$ so that $\lambda > 1$ and we are in the more relevant scenario of a second-best world, i.e. because of (at the margin) distortionary taxation the public good provision is inefficiently low, $U'(G) > 1$. In what follows, we restrict our attention to the more relevant scenario of second-best taxation, i.e. the case with $\mu > 0$ and $\lambda > 1$.

After some manipulations and using $w - e'(L) = 0$, we obtain the following first-order conditions with respect to labor and capital tax rates:

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial t_w} = 0 \Rightarrow \quad & (\lambda - 1)\left[-\frac{\eta_{L,\tilde{w}}}{1+t_w} + (1-\bar{t}_\pi)\eta^S\right] \\ & +\lambda\left[\frac{t_w}{1+t_w}\eta^S\eta_{L,\tilde{w}} + \frac{t_r}{1+t_r}\eta^S\eta_{L,\tilde{r}}\right] = 0\end{aligned} \tag{2.16}$$

and

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial t_r} = 0 \Rightarrow \quad & (\lambda - 1)\left[-\frac{\eta_{K,\tilde{w}}}{1+t_w} + (1-\bar{t}_\pi)\left(\eta^S - \eta_{L,\tilde{w}} + \eta_{K,\tilde{w}}\right)\right] \\ & +\lambda\left[\frac{t_w}{1+t_w}\eta^S\eta_{K,\tilde{w}} + \frac{t_r}{1+t_r}\eta^S\eta_{K,\tilde{r}} - \frac{t_r}{1+t_r}\varepsilon\sigma\right] = 0.\end{aligned} \tag{2.17}$$

Each given level of overall tax revenue is raised efficiently by the available tax instruments if marginal costs of public funds are equal for all tax rates. Equality of λ in (2.16) and (2.17) requires

$$\left[\frac{t_w}{1+t_w} - \frac{t_r}{1+t_r}\right](1-\bar{t}_\pi)\eta^S = \frac{t_r}{1+t_r}\frac{\varepsilon}{1+t_w}, \tag{2.18}$$

or, equivalently,

$$(t_w - t_r)(1-\bar{t}_\pi)\eta^S = t_r\varepsilon. \tag{2.19}$$

Effective tax rates on capital and labor income in the Nash equilibrium are then given by

$$\frac{t_r}{1+t_r} = \frac{(\lambda-1)}{\lambda\varepsilon}(1-\bar{t}_\pi) \geq 0 \tag{2.20}$$

and

$$\frac{t_w}{1+t_w} = \frac{(\lambda-1)\left[\varepsilon+(1-\bar{t}_\pi)\eta^S\right]}{\varepsilon\left[\lambda\eta^S+(\lambda-1)\right]} \geq \frac{t_r}{1+t_r}. \tag{2.21}$$

If profits can be completely taxed away ($\bar{t}_\pi = 1$), capital should be tax exempted. This result is well known in the literature and is often referred to as the production efficiency theorem of Diamond and Mirrlees (1971).[6] The intuition is straightforward. As long as capital owners do not obtain rent income beyond the constant world net return r, i.e. their supply is perfectly elastic, they cannot bear any tax burden and consequently the immobile factor, for which suppliers receive a rent for intra-marginal units (as long as labor supply is not perfectly elastic as well), bears the whole tax burden. A direct distortion of the labor market is therefore preferable to an indirect labor market distortion of equal size caused by a previous distortion of the capital allocation. The case of a 100 percent profit tax also offers a suitable point of reference to grasp the intuition for the following sections.

At this point, it is worth noting that for this case the optimal wage tax solely depends on the marginal costs of public funds λ, which are determined by (2.13), and on the labor supply elasticity as $t_w = (\lambda-1)/(\lambda\eta^S)$. To explain this, let us first consider a perfectly elastic labor supply such that neither factor owner loses in terms of net remuneration. Both factor taxes would then be zero since, starting from zero tax rates, a marginal increase in the labor tax reduces profit tax revenue by the same amount as labor tax revenue is increased. For a finite labor supply elasticity, all intra-marginal units of L obtain a rent which now can be captured additionally using a wage tax by reducing the net of tax wage rate w. This allows to raise additional positive revenue - though again associated with an excess burden which is traded off against the utility of public good consumption. A changing labor demand elasticity is not able to alter the way of capturing this labor supply rent, i.e. this trade off; rather it influences the excess burden in the same way as additional tax revenue at the margin such that the wage tax rate at the optimum does not depend on labor demand elasticity, but only on η^S.

For situations in which $0 \leq \bar{t}_\pi < 1$, it is optimal to have a positive tax on mobile capital since it enables the government to indirectly tax pure profits (see Huizinga and Nielsen 1997). The extent of additional capital taxation then depends on the

[6] See, e.g., Razin and Sadka (1991). Eggert and Haufler (1999) further discuss the production efficiency theorem in an open economy.

size of profits available and thus on the parameter ε.[7] Note that labor taxation also increases as the maximum value of permissible profit taxation $\bar{t}_\pi$ declines.

2.4 Complete tax coordination

Complete coordination applies when all countries agree to marginally alter one of the tax rates and at the same time to leave the other tax rate unchanged (see, e.g., Bucovetsky and Wilson 1991, Fuest and Huber 1999b and Wilson 1995).[8]

The crucial point with a coordinated increase in one tax rate is the fact that induced factor price changes are different to the ones perceived by the single countries in the uncoordinated scenario. In particular, from the viewpoint of all countries the net interest rate is no longer given and capital supply is no longer perfectly elastic, but now fixed and the net interest rate becomes endogenous. Formally, the reactions of r and w in response to coordinated steps are, on the one hand, given by the equalization of labor supply and labor demand as before [see equation (2.9)] and, on the other hand, by the condition that, after coordination has taken place, capital employed in each country is constant and in the symmetric case must be equal to the capital endowment, i.e.

$$\overline{K} = K(\tilde{w}, \tilde{r}). \tag{2.22}$$

2.4.1 Coordinated increase in the capital tax

If all countries increase their capital tax while (implicitly) leaving their labor tax at its previous level, the worldwide allocation of capital does not change and the real allocation remains unaltered. Since labor taxation is by assumption not changed, the net of tax wage rate is unchanged as well. The only effect is a reduced worldwide net return on capital, as the whole tax burden of the coordinated increase in the capital tax falls on capital owners. We have:

$$\left.\frac{\partial \tilde{r}}{\partial t_r}\right|_{dK=0}^{dt_w=0} = \left.\frac{\partial \tilde{w}}{\partial t_r}\right|_{dK=0}^{dt_w=0} = \left.\frac{\partial w}{\partial t_r}\right|_{dK=0}^{dt_w=0} = 0 \tag{2.23}$$

and

$$\left.\frac{\partial r}{\partial t_r}\right|_{dK=0}^{dt_w=0} = -\frac{r}{1+t_r} < 0. \tag{2.24}$$

[7] Note that for the production function chosen we have a constant profit share, $\pi = Y/\varepsilon$.

[8] We may distinguish between complete *explicit* and complete *implicit* coordination, where the former describes a coordination agreement that in fact alters *both* tax rates, while in the latter, the other tax rate is kept constant. In what follows, we use the term complete coordination, but we restrict our analysis to complete *implicit* coordination.

Given these coordinated factor price reactions, we can determine the welfare effects of a (complete) coordinated increase in the capital tax starting from the Nash equilibrium:

$$\left.\frac{\partial \mathcal{L}}{\partial t_r}\right|_{dK=0}^{dt_w=0} = \overline{K}\left.\frac{\partial r}{\partial t_r}\right|_{dK=0}^{dt_w=0} + \lambda\overline{K}\left.\frac{\partial\left[t_r r\right]}{\partial t_r}\right|_{dK=0}^{dt_w=0},$$

which simplifies to

$$\left.\frac{\partial \mathcal{L}}{\partial t_r}\right|_{dK=0}^{dt_w=0} = -(\lambda-1)\overline{K}\left.\frac{\partial r}{\partial t_r}\right|_{dK=0}^{dt_w=0}. \tag{2.25}$$

Since a coordinated increase in the capital tax rate does not alter the real allocation on the labor and capital market and thus keeps marginal products as well as the output level constant, the only change is a reduction in capital income which, however, is fully offset by additional lump-sum tax revenue accruing to the government. The welfare effect consists of that additional revenue $\partial R/\partial t_r|_{dK=0}^{dt_w=0} = \overline{K}\,\partial r/\partial t_r|_{dK=0}^{dt_w=0}$, weighted by the net welfare gain that arises if one Euro of lump-sum tax revenue is used to increase public good provision by one (monetary) unit, which amounts to $\lambda - 1 > 0$ at the second-best optimum.[9]

2.4.2 Coordinated increase in the labor tax

As has been pointed out by Bucovetsky and Wilson (1991), a coordination of a tax rate on an immobile factor can also enhance welfare from a theoretical point of view, since it also able to reduce the rent accruing to capital owners. However, their result crucially depends on the assumption that countries are not allowed to adjust their capital tax. As we analyze in section 2.5 whether this welfare effect holds true if countries adjust their capital tax rate, we also consider complete labor tax coordination in our setting as a point of reference.

With regard to the repercussions on factor prices, a coordinated increase in the wage tax for a given capital tax rate has to fulfill the same two conditions as in the case of a coordinated increase in the capital tax rate, i.e. equations (2.9) and (2.22) still hold after such a joint policy. However, the result of the previous subsection cannot be carried over to the present analysis exactly since, although in the course of a labor tax coordination the capital employed within each country is still constant, a higher tax wedge is now introduced on the labor market thereby reducing worldwide equilibrium employment. Consequently, the gross wage rate increases, the net of tax wage rate declines and, if labor and capital are complements in production, the gross

[9] Of course, $\lambda - 1$ also measures the net welfare gain if one Euro of lump-sum revenue is spent on reducing the level of existing distortionary taxation. However, this is excluded in our setting by implicitly keeping the (distortionary) wage tax constant.

and net remunerations of capital are reduced, i.e.

$$\left.\frac{\partial \tilde{w}}{\partial t_w}\right|_{dK=0}^{dt_r=0} = w \cdot \frac{\eta^S \eta_{K,\tilde{r}}}{\eta^S \eta_{K,\tilde{r}} - \varepsilon\sigma} > 0, \tag{2.26}$$

$$\left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0} = \frac{w}{1+t_w} \cdot \frac{\varepsilon\sigma}{\eta^S \eta_{K,\tilde{r}} - \varepsilon\sigma} < 0, \tag{2.27}$$

$$\left.\frac{\partial \tilde{r}}{\partial t_w}\right|_{dK=0}^{dt_r=0} = -\frac{\tilde{r}}{1+t_w} \cdot \frac{\eta^S \eta_{K,\tilde{w}}}{\eta^S \eta_{K,\tilde{r}} - \varepsilon\sigma} < 0, \tag{2.28}$$

$$\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0} = -\frac{r}{1+t_w} \cdot \frac{\eta^S \eta_{K,\tilde{w}}}{\eta^S \eta_{K,\tilde{r}} - \varepsilon\sigma} < 0. \tag{2.29}$$

For these factor price reactions in the case of a coordination, the effect of a (complete) joint increase in the labor tax on welfare, starting from the uncoordinated Nash equilibrium, is given by

$$\begin{aligned}\left.\frac{\partial \mathcal{L}}{\partial t_w}\right|_{dK=0}^{dt_r=0} = {} & \overline{K}\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0} + [1 - t_\pi(1-\lambda)]\left(\pi_{\tilde{r}}\left.\frac{\partial \tilde{r}}{\partial t_w}\right|_{dK=0}^{dt_r=0} + \pi_{\tilde{w}}\left.\frac{\partial \tilde{w}}{\partial t_w}\right|_{dK=0}^{dt_r=0}\right) \\ & + (1+\lambda t_w)L\left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0} + \lambda\left(wL + t_w w\left.\frac{\partial L}{\partial t_w}\right|_{dK=0}^{dt_r=0} + t_r K\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0}\right),\end{aligned}$$

where all terms, except for the first one, reduce to $-\lambda\overline{K}\ \partial r/\partial t_w|_{dK=0}^{dt_r=0}$ when inserting the tax rates that characterize a Nash equilibrium. The welfare effect can therefore be written as

$$\left.\frac{\partial \mathcal{L}}{\partial t_w}\right|_{dK=0}^{dt_r=0} = -(\lambda - 1)\overline{K}\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0}. \tag{2.30}$$

If capital and labor are assumed to be price complements, a marginal coordination is welfare enhancing although, in this case, it implies an increase in a global distortionary tax. This is because such a policy enables all countries to reduce the net interest rate, which was constant from the perspective of a single jurisdiction, thereby shifting resources from the private to the public sector at lower welfare costs. However, the intuition is slightly different to the case above. Although a *marginal* increase in the labor tax by all countries reduces employment and thus output, due to a higher tax wedge on the labor market, the same was true for the uncoordinated choice of the labor tax. Hence, starting from the Nash equilibrium, such a coordinated increase has a first-order effect without any welfare consequences. The only relevant effect with respect to welfare is a second-order effect, which is $\partial r/\partial t_w|_{dK=0}^{dt_r=0} < 0$, i.e. the possibility of reducing the marginal product of capital in all countries at constant capital employment and thus transferring net capital income from the private towards the public sector.[10] Note, however, that there is

[10] Of course, the result would change if we drop our assumption of factors being price complements; see equations (2.7) and (2.29).

no direct transfer from capital owners to the government. In fact, the first channel is profit taxation (if possible) since a declining gross remuneration of capital *ceteris paribus* increases profits for a constant capital employment. As a second channel, notice that a reduced gross interest rate *ceteris paribus* also raises employment and thus the tax base of t_w.

The welfare effects of complete coordination, where the respective other tax rate is kept constant, crucially depend on the extent to which such a policy can extract rents from capital owners. The same mechanisms as in Bucovetsky and Wilson (1991) are at work in this section. This basic incentive will also carry over to the next section. However, it will be shown that the overall effect on the net of tax interest rate changes in the case of a partial coordination.

2.5 Partial tax coordination

In contrast to a complete (implicit) coordination agreement, partial tax coordination is less restrictive. In this case, marginal coordination indeed concerns only one of the tax rates so that the respective other tax rate can be freely adjusted by each country.

2.5.1 Partial coordination of the capital tax

Based on the analysis in subsection 2.4.1, only one additional effect must be determined. If the capital tax was marginally increased by all countries, starting from the uncoordinated Nash equilibrium and leaving the wage tax constant, which yields the welfare gain discussed above, we now have to examine how each individual country reacts to such an 'exogenous coordination' if it is free to adjust the wage tax optimally. The choice with respect to the capital tax rate t_r is fixed both by the first-order condition in the Nash equilibrium, i.e. $\partial\mathcal{L}/\partial t_r = 0$ [see equation (2.17)], and its marginal coordination starting from the uncoordinated equilibrium. However, all countries are now free to adjust their wage tax t_w, which was determined in the Nash equilibrium by $\partial\mathcal{L}/\partial t_w = 0$, so as to reestablish this condition again. In doing so, each country aims at equalizing marginal revenue costs between tax instruments available to reach a second-best tax system.

However, with regard to the new equilibrium one crucial point deserves attention. Each country has an incentive to adjust its wage tax individually under the Nash assumption, thereby perceiving capital supply to be perfectly elastic with a constant net interest rate, and will thus consider factor price reactions to be as calculated in subsection 2.3.1, including the perception of influencing domestic investment by the choice of t_w. Thus, all countries play a Nash game in the wage tax in order to again attract mobile capital. However, in the new equilibrium no country will succeed, since *all countries* face the same incentives regarding this wage tax adjustment, thereby triggering a joint change in the wage tax rate at a constant capital tax that finally leaves capital employment in each country unaffected. The welfare effect of this joint change has already been calculated in the previous section. Thus, to determine the new equilibrium, we need know the extent to which the wage tax rate is jointly altered. In doing so, we consider what effect a coordinated increase in the capital tax rate, as discussed in subsection 2.4.1, has on the marginal costs of public funds of the wage tax and which worldwide (i.e. joint) change in the labor tax rate will equate these marginal costs of public funds again to the ones of the capital tax rate. Formally, equation (2.16), which gives us the optimal choice with respect to the wage tax in the Nash equilibrium, can be rearranged to

$$\frac{(\lambda - 1)}{\lambda} = -\frac{\frac{t_w}{1+t_w}\eta^S \eta_{L,\tilde{w}} + \frac{t_r}{1+t_r}\eta^S \eta_{L,\tilde{r}}}{(1-\bar{t}_\pi)\eta^S - \frac{\eta_{L,\tilde{w}}}{1+t_w}} \tag{2.31}$$

in order to facilitate calculations. Equation (2.31) is then totally differentiated with respect to both tax rates, in each case taking into consideration the factor price reactions for the case that the *tax rates are changed by all countries jointly.* Thus, for the labor tax reaction, we obtain

$$\left.\frac{dt_w}{dt_r}\right|_{dK=0} = -\frac{(1+t_w)}{(1+t_r)} \cdot \frac{\eta^S \frac{\eta_{L,\tilde{r}}}{\eta_{L,\tilde{w}}}}{\eta^S + (t_w - t_r)\left.\frac{\partial \eta^S}{\partial t_w}\right|_{dK=0}^{dt_r=0}}, \tag{2.32}$$

where

$$\left.\frac{\partial \eta^S}{\partial t_w}\right|_{dK=0}^{dt_r=0} = \frac{d\eta^S}{dw} \cdot \left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0}. \tag{2.33}$$

Note that equation (2.32) cannot be signed *a priori* as the net wage rate may have a positive, a negative or no impact on labor supply elasticity.

Thus, starting from the Nash equilibrium, the total effect of a partial coordination on welfare consists of

1. the initial welfare effect of a coordinated increase in the capital tax for a constant wage tax as given by equation (2.25), plus

2. the welfare effect of a joint change in the wage tax for a constant capital tax as given by equation (2.30), weighted by the extent to which all countries will finally change their labor tax in the new Nash equilibrium according to equation (2.32):

$$\left.\frac{d\mathcal{L}}{dt_r}\right|_{dK=0}^{part.} = \left.\frac{\partial \mathcal{L}}{\partial t_r}\right|_{dK=0}^{dt_w=0} + \left.\frac{dt_w}{dt_r}\right|_{dK=0} \left.\frac{\partial \mathcal{L}}{\partial t_w}\right|_{dK=0}^{dt_r=0}. \tag{2.34}$$

Consequently, by using the results from (2.25), (2.30) and (2.32), and after rearranging, we get

$$\left.\frac{d\mathcal{L}}{dt_r}\right|_{dK=0}^{part.} = (\lambda-1)\frac{r\overline{K}}{(1+t_r)}\left[1-\frac{\frac{\eta_{K,\tilde{w}}\eta_{L,\tilde{r}}}{\eta_{L,\tilde{w}}\eta_{K,\tilde{r}}}}{1-\frac{\varepsilon\sigma}{\eta^S\eta_{K,\tilde{r}}}\frac{\lambda\eta^S+(\lambda-1)\left(1-\frac{d\eta^S}{dw}\frac{w}{\eta^S}\right)}{\lambda\eta^S+(\lambda-1)}}\right]. \tag{2.35}$$

In order to sign the overall welfare impact, we need to determine whether the second term in brackets exceeds or falls short of unity. Firstly, the numerator does not exceed unity since

$$\frac{\eta_{K,\tilde{w}}\eta_{L,\tilde{r}}}{\eta_{L,\tilde{w}}\eta_{K,\tilde{r}}} = \frac{s(1-s)(\sigma-\varepsilon)^2}{s(1-s)(\sigma-\varepsilon)^2+\varepsilon\sigma} \leq 1.$$

Secondly, as we are not able to sign the second term of the denominator *a priori,* we have to conclude that the overall welfare effect of a partial capital tax coordination is theoretically ambiguous.

Imposing an additional assumption on the disutility of labor, however, enables us to sufficiently sign the overall welfare impact. Since the labor supply elasticity is given by $\eta^S \equiv w/\left(Le''\right)$ and

$$1-\frac{d\eta^S}{dw}\frac{w}{\eta^S} = \eta^S + \frac{e'''e'}{e''},$$

the assumption $e''' \geq 0$ sufficiently ensures that the denominator in (2.35) cannot fall short of unity and the whole term in brackets is non-negative. In this case, overall welfare cannot be reduced by a partial coordination of the capital tax. In the light of the importance for this result, the assumption $e''' \geq 0$ deserves a detailed interpretation. As the slope of the labor supply curve is given by $dL^S/dw = 1/e''$, this assumption is equivalent to assuming that the slope of the labor supply curve is non-decreasing in labor supply and non-increasing in the net wage rate, $d^2L^S/dw^2 = -e'''/\left(e''\right)^3 \leq 0$, respectively. Considering a labor supply curve that is non-convex in the net wage rate seems to be rather restrictive. On the one hand, however, note that this is only a sufficient condition to sign the welfare effect. On the other hand, this assumption is also in line with standard microeconomic theory, as it mirrors the standard labor-leisure choice if leisure is a normal good. In this case, the labor supply has a similar shape as the income effect becomes stronger relative to the substitution effect as the net wage rate increases.[11]

[11] To see this, suppose for simplicity that preferences are linear-homogenous in private consumption and leisure. Note, however, that we exclude the possibility of a backward-bending labor supply curve, as we maintain the assumption $e'' > 0$, i.e. $\eta^S > 0$.

Comparing this welfare effect with the one derived for a complete coordination of the capital tax, we can infer that the (relative) welfare loss due to the inability to keep the wage tax constant in the course of coordination is given by

$$\frac{\frac{\eta_{K,\tilde{w}}\eta_{L,\tilde{r}}}{\eta_{K,\tilde{r}}\eta_{L,\tilde{w}}}}{1-\frac{\varepsilon\sigma}{\eta^S\eta_{K,\tilde{r}}}\frac{\lambda\eta^S+(\lambda-1)\left(1-\frac{d\eta^S}{dw}\frac{w}{\eta^S}\right)}{\lambda\eta^S+(\lambda-1)}} \geq 0, \tag{2.36}$$

provided that $e''' \geq 0$. Note that for the extreme case of $\sigma = 0$ the term in (2.36) is unity, indicating that a partial coordination of the capital tax rate has no overall effect on welfare.

To shed some light on the basic intuition and the mechanisms at work, we consider how optimal taxation and coordination interact with the marginal costs of public funds of the wage tax instrument. First, a coordinated increase in the capital tax will increase the marginal costs of public funds. To see this, consider that according to (2.16) they are given by the marginal utility loss of private households per unit of additional tax revenue from t_w, i.e.

$$\lambda^{t_w} = \frac{-Lw_{t_w} + (1-\bar{t}_\pi)L\tilde{w}_{t_w}}{-Lw_{t_w} + (1-\bar{t}_\pi)L\tilde{w}_{t_w} + Lt_w\eta^S w_{t_w} + t_r rK_{t_w}}, \tag{2.37}$$

since we have $w = e'(L)$ at the household's optimum and $\pi_{\tilde{w}} = -L$ by Hotelling's lemma. Note that the last two terms of the denominator in (2.37) indicate the excess burden caused by wage taxation, i.e. the extent to which additional tax revenue falls short of the damage incurred by private households. By inspecting (2.37), two things are important:

1. The marginal utility loss of the private sector due to a marginal increase in the wage tax, i.e. the numerator of (2.37), is not affected by capital tax coordination.[12]

2. Marginal tax revenue of the wage tax rate is affected by coordination. The last term of the denominator, which represents the reaction of capital tax revenue to a change in wage taxation, declines, i.e. although $K_{t_w} = K\eta_{K,\tilde{w}}\tilde{w}_{t_w}/\tilde{w} < 0$ remains unchanged, $t_r r$ is increased by a coordinated increase in the capital tax, since $\partial[t_r r]/\partial t_r|_{dK=0}^{dt_w=0} = r/(1+t_r) > 0$. Consequently, marginal tax revenue of the wage tax is reduced.

Thus, as a coordinated increase in the capital tax 'exogenously' renders the wage tax more distortionary at the margin, each country now seeks to lower λ^{t_w} by changing

[12] Note that as gross factor prices are unaffected by coordination in t_r, the same is true for all factor demand elasticities (see equation (2.8) and the expressions for demand elasticities). Also, recall equation (2.10) to see that w_{t_w} and $\tilde{w}_{t_w}$ are indeed unaltered.

t_w. For the second part of the intuition, note that the marginal costs of public funds of a tax rate are increasing in this tax instrument, irrespective of whether the tax is increased unilaterally or collectively.[13] Thus, to counteract the above-mentioned effect on λ^{t_w}, each country has an incentive to lower its wage tax. However, the change in the wage tax by all countries still alters the allocation on the labor market, which is not the case for a joint change in the capital tax. This implies that the wage tax adjustment in the new equilibrium has to be rather small, leading to a rather low weighting being given to the welfare effect of the joint wage tax reaction. Consequently, the negative welfare impact of the induced worldwide wage tax cut will not outweigh the welfare gain caused by a coordinated increase in capital taxation, imposing rather mild assumptions on the disutility of labor. In a nutshell, as a joint change in the wage tax affects the allocation on the labor market, it is not a perfect substitute for the capital tax in terms of competing for mobile capital and the initial Nash equilibrium cannot be restored. Only for the extreme case $\sigma = 0$, i.e. for capital and labor being perfect complements in production, does a joint change in t_w not alter capital and labor employment in each country and all countries will compete back to the initial Nash equilibrium by using the wage tax instrument. In this case, both the initial capital tax coordination and the joint adjustment of the wage tax are non-distortionary.

2.5.2 Partial coordination of the labor tax

In contrast to the studies of Bucovetsky and Wilson (1991) and Fuest and Huber (1999b), where complete wage tax coordination is examined as a means to improve welfare, we now consider a coordinated increase in the wage tax when countries can freely adjust the capital tax rate. Although wage tax coordination is not on the agenda of potential international coordination agreements, it may be an important issue in countries with federal structures. In particular, the wage tax rate is often centralized at the federal level while local business taxes can be freely chosen by local jurisdictions.

In the case of partial wage tax coordination, the decision with respect to the wage tax is fixed by the combination of the behavior in the Nash equilibrium according to $\partial\mathcal{L}/\partial t_w = 0$ and the coordination agreement. Thus, we have to determine the

[13]The former must hold as a result of a second-order condition for each country's optimization. The latter is required for stability of the Nash equilibrium. Intuitively, assume that all countries start from a tax rate that is slightly lower than in the Nash equilibrium. As all countries increase their tax rate, the Nash equilibrium can only be reached, if the marginal revenue costs increase as well. Indeed, the assumption $e''' \geq 0$ is sufficient to ensure both conditions.

reaction of the capital tax using $\partial\mathcal{L}/\partial t_r = 0$ [see equation (2.17)]. This optimal choice with respect to the capital tax rate for each government can be rearranged to

$$\frac{(\lambda-1)}{\lambda} = -\frac{\frac{t_w}{1+t_w}\eta^S\eta_{K,\tilde{w}} + \frac{t_r}{1+t_r}\eta^S\eta_{K,\tilde{r}} - \frac{t_r}{1+t_r}\varepsilon\sigma}{(1-\bar{t}_\pi)(\eta^S+\sigma) - \frac{\eta_{K,\tilde{w}}}{1+t_w}}. \tag{2.38}$$

Analogously to the procedure above, by implicitly differentiating this condition and taking into account that all countries face the same incentive to adjust their capital tax, we get the following tax response in the new equilibrium:

$$\left.\frac{dt_r}{dt_w}\right|_{dK=0} = -\frac{(1+t_r)}{(1+t_w)} \cdot \frac{\eta_{K,\tilde{w}}\left[\eta^S + (t_w - t_r)\left.\frac{d\eta^S}{dt_w}\right|_{dK=0}^{dt_r=0}\right]}{\eta^S\eta_{K,\tilde{r}} - \varepsilon\sigma}. \tag{2.39}$$

The overall welfare effect of such a partial coordination agreement is again determined by the sum of two effects: the welfare effect of a marginal coordinated increase in the wage tax for a given level of capital taxation, plus the welfare effect of a joint change in the capital tax rate for a given wage tax weighted by the actual change of the capital tax that emerges in the new equilibrium:

$$\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{part.} = \left.\frac{\partial\mathcal{L}}{\partial t_w}\right|_{dK=0}^{dt_r=0} + \left.\frac{dt_r}{dt_w}\right|_{dK=0}\left.\frac{\partial\mathcal{L}}{\partial t_r}\right|_{dK=0}^{dt_w=0}. \tag{2.40}$$

Inserting the corresponding equations (2.25), (2.30) and (2.39) enables us to write the total welfare effect of a partial wage tax coordination as

$$\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{part.} = -(\lambda-1)r\overline{K}\frac{1}{(1+t_w)}\frac{\eta_{K,\tilde{w}}(t_w-t_r)\left.\frac{\partial\eta^S}{\partial t_w}\right|_{dK=0}^{dt_r=0}}{\eta^S\eta_{K,\tilde{r}} - \varepsilon\sigma}. \tag{2.41}$$

From equation (2.19) we know that the labor tax rate is always larger in the Nash equilibrium than the capital tax rate. If we assume capital and labor to be complements in production, we are able to sign this expression as follows:

$$sign\left\{\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{part.}\right\} = -sign\left\{\left.\frac{\partial\eta^S}{\partial t_w}\right|_{dK=0}^{dt_r=0}\right\}, \tag{2.42}$$

or, recalling equation (2.33),

$$sign\left\{\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{part.}\right\} = sign\left\{\frac{\partial\eta^S}{\partial w}\right\}. \tag{2.43}$$

Consequently, a coordinated increase in the labor tax with national autonomy concerning the choice of the capital tax rate is associated with a positive (negative) total welfare effect for all countries in the case of an increasing (decreasing) labor supply elasticity in the net of tax wage rate.[14] For a constant labor supply elasticity, such a coordination agreement has no welfare consequences at all.

For the simple special case in which disutility of labor is characterized by $e''' = 0$, the above condition reduces even further since we then have

$$\frac{d\eta^S}{dw} = \left(1 - \frac{e'}{e''L}\right)\frac{1}{e''L} = (1-\eta^S)\frac{\eta^S}{w}. \tag{2.44}$$

Thus, whether a partial increase in the wage tax by all countries is beneficial or not can be judged by means of the absolute value of the labor supply elasticity:[15]

$$\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{part.} \left\{\begin{array}{c} > \\ = \\ < \end{array}\right\} 0 \quad \text{as} \quad \eta^S \left\{\begin{array}{c} < \\ = \\ > \end{array}\right\} 1. \tag{2.45}$$

In order to gain an intuition for the result, it is instructive for the time being to restrict our attention to a constant labor supply elasticity. Recalling (2.17), the marginal revenue costs of the capital tax are given by

$$\lambda^{t_r} = \frac{-Lw_{t_r} + (1-\bar{t}_\pi)L\tilde{w}_{t_r} + (1-\bar{t}_\pi)Kr}{-Lw_{t_r} + (1-\bar{t}_\pi)L\tilde{w}_{t_r} + (1-\bar{t}_\pi)Kr + t_w L\eta^S w_{t_r} + t_r r K_{t_r}}, \tag{2.46}$$

where the last two terms of the denominator represent the excess burden of capital taxation. Similarly to the preceding subsection, we need to explore how a marginal coordination in the wage tax affects this measure and to what extent t_r is adjusted jointly in order to again equalize efficiency costs of taxation, $\lambda^{t_r} = \lambda^{t_w}$, as each country aims at equalizing the marginal revenue costs of each tax instrument. First, it is not straightforward to determine the impact of wage tax coordination on (2.46), since both the marginal utility loss and the marginal tax revenue of a capital tax increase are affected. However, by considering the special case of $\bar{t}_\pi = 1$ we know that at the optimum the welfare costs of capital taxation reduce to $\lambda^{t_r} = 1/(1-t_w\eta^S)$ since the capital tax is not used in the Nash equilibrium. Thus, λ^{t_r} unambiguously rises in the course of a coordinated increase in t_w. Second, marginal costs of public funds of the capital tax increase in t_r itself, implying that each government *ceteris paribus* faces an incentive to lower t_r as its welfare costs increase 'exogenously'. A reduction in the capital tax rate carried out by *all countries* will also reduce λ^{t_r}.

[14] Note that the direction of the welfare effect again reverses if capital and labor are substitues so that $\eta_{K,\tilde{w}}$ is positive.

[15] Considering the special case $e''' = 0$ does not change the theoretical ambiguity of our result. However, it allows us to assess the welfare impact by means of the absolute value of the labor supply elasticity, for which there exits a wide empirical literature. The labor supply elasticity suggested by that literature is, in general, smaller than one (see, e.g., the survey by Blundell and MaCurdy 1999).

Analogously to the previous subsection, this must hold as a stability condition of the Nash equilibrium (see footnote 13). By differentiating (2.46), this can be shown to be fulfilled without resorting to restricting assumptions. It is not straightforward to see this directly by inspecting (2.46) since w_{t_r} and $\tilde{w}_{t_r}$ are increasing in absolute terms as the capital tax is jointly reduced [see equation (2.11)] and r is increased as well. Consequently, the marginal utility loss as well as marginal tax revenues are changed. However, for the case of $\bar{t}_\pi = 1$ again, it is easy to see that (2.46) reduces to $\lambda^{t_r} = 1/(1 - t_w \eta^S)$ and is unchanged as a joint change in the capital tax does not alter the net of tax wage rate and thus the labor supply elasticity. However, as (negative) capital taxation is introduced by the joint capital tax adjustment, the impact on capital tax revenue has to be taken into account, i.e. the effect covered by the last term of the denominator in (2.46) additionally increases marginal tax revenue. Thus, λ^{t_r} is reduced as all countries lower their capital tax. As it turns out, the coordinated increase in the wage tax has a rather large impact on λ^{t_r} compared to the subsequent joint capital tax adjustment so that the decline in t_r, which is necessary to equate $\lambda^{t_r} = \lambda^{t_w}$, is strong enough to exactly neutralize the initial welfare effect of wage tax coordination - given that the labor supply elasticity remains constant. The intuitive reason for this result is straightforward. First, recall that the Nash equilibrium is characterized by a certain level of distortion that each government is willing to accept. This translates to a wage tax that only depends on the distortion, given by λ, and the absolute value of η^S, which measures the degree of the existing wage tax distortion. Thus, if a joint increase in the wage tax does not change the labor supply elasticity, all countries can restore the initial Nash equilibrium by engaging in tax competition by using t_r after wage tax coordination. This is due to the fact that a joint change in the capital tax does not affect the real allocation and has no impact on η^S either. The joint adjustment is non-distortionary and perfectly enables all countries to go back to the initial Nash equilibrium. Hence, for constant labor supply elasticity, the overall effect on the interest rate is zero, implying that welfare is unchanged.

Once we know that the total effect on welfare is zero for the case of a constant labor supply elasticity, the point for a changing η^S is easily made. If η^S is increasing as t_w is jointly raised, i.e. η^S is declining in the net wage rate w, capital taxation becomes more costly in terms of welfare and the coordinated increase in the wage tax increases the marginal costs of public funds of t_r more heavily.[16] This in turn calls for a greater reduction in the capital tax by all countries, which now raises the net interest rate by more than the initial decline due to wage tax coordination.

[16] Recall that the burden of the capital tax is fully shifted to the labor market.

Thus, overall welfare is reduced in the new equilibrium since coordination of t_w increases the preexisting distortion of the tax on the labor market. If, on the contrary, the labor supply elasticity decreases as wage taxation is jointly increased, capital taxation will now become less distortionary and t_r has to be reduced by a smaller amount to again equalize marginal costs of public funds so that this time the second round of coordination is not able to overcompensate the initial one. In this case, the coordinated increase in wage taxation mitigates the distortion of the tax system which is welfare enhancing.

2.6 Concluding remarks

The present chapter extends the existing tax competition literature by focusing on partial tax coordination which only covers one tax rate or a subset of tax instruments while other policy instruments can still be chosen independently by the countries involved. We consider the case of two distortionary tax instruments, a capital and a labor tax rate, one of which is subject to coordination and the other is free to be adjusted by all countries individually. As it is shown, the adjustment of the free tax instrument, which is carried out by all countries in the same way, triggers a joint adjustment which will always counteract the initial coordination step with respect to its welfare gain. The welfare effect of a coordinated increase in the capital tax becomes smaller but remains positive under plausible assumptions. In contrast, with respect to the immobile factor labor, the welfare effect of a coordination of wage taxation now becomes ambiguous. This depends on whether the labor supply elasticity is increasing or decreasing. The crucial point in judging the welfare impact is, in both cases, whether coordination allows the governments to lower the net interest rate.

Qualitatively, our outcomes are not affected by the degree of maximum profit taxation. As a limitation to the analysis, however, one should keep in mind that some assumptions, in particular with regard to the disutility of supplying labor are rather restrictive from a theoretical point of view. Furthermore, one should be aware of the fact that the results may change if non-homogeneous production functions are considered. Also note that it is not possible to reach the first-best level of the public good by cooperatively choosing the global optimum with respect to the capital tax only. Countries will still engage in tax competition by using the tax on the immobile factor.

As a main policy implication from the present analysis, we can first conclude that coordination with respect to one policy instrument is welfare enhancing if other policy instruments are not perfect substitutes in attracting mobile capital to the one that is subject to coordination. This is the case when the capital tax, which is non-distortionary from a worldwide perspective, is jointly increased and a wage tax, which is distortionary even in a global sense, is available for adjustment. As a second result, we find that even with the existence of a perfect substitute marginal coordination improves welfare if - starting from the Nash equilibrium - the distortion of the tax system is reduced. This is true for a partial coordination of the wage tax, which has no welfare consequences only if the labor supply elasticity remains constant as the capital tax is used to exactly restore the Nash equilibrium.

Interesting fields of future research include the extension of the model to allow for firm mobility which renders the profit tax distortionary as well. The analysis may also be enriched by distinguishing between low-skilled and high-skilled labor supply, where both differ with respect to their complementarity to capital. Furthermore, the question arises whether the results derived in the present chapter change if labor markets are not competitive but organized by collective wage bargaining, giving rise to involuntary unemployment. We will discuss the latter point in detail in chapter 4 of this thesis.

Chapter 3

Public Goods, Unemployment and Policy Coordination

Abstract

Earlier literature on tax competition and policy coordination typically assumes that the labor market is competitive, a description less suitable for Europe, where trade unions have had a strong position in the labor market for a long time. This chapter concerns factor income taxation and public good provision in small open economies characterized by capital mobility and imperfect competition in the labor market. We assume that each national government collects public revenues via taxes on labor, capital and profit income, and that the revenues are spent on a public consumption good and a public input good, where the latter enters the economic system in terms of an 'externality production factor'. The overall purposes are to characterize the tax and expenditure policies, if decided upon at the national level, and analyze the welfare effects of policy coordination with respect to taxes and public expenditures. Among the results, we show that tax coordination contributes to higher welfare if it reduces the net interest rate and the wage rate, and that the relative overprovision of the public input good derived by Keen and Marchand (1997) in the context of a competitive economy may no longer hold, if the labor market is non-competitive.

JEL Classification: H21, H41, J51

Keywords: optimal taxation, wage bargaining, public goods, policy coordination

3.1 Introduction

As productive capital is mobile across countries, it has been recognized that independent national governments have incentives to adjust their public policies in order to compete for mobile capital. Earlier literature dealing with fiscal competition and/or policy coordination (in order to internalize the associated externalities) has focused much attention on tax policy (see, e.g., Mintz and Tulkens 1986, Wilson 1986 and Zodrow and Mieszkowski 1986). A major result is that tax competition leads to undertaxation of capital (at least if the economies are characterized by competitive markets) which may, in turn, give rise to underprovision of public goods relative to the first-best allocation.[1] However, much less attention has been paid to the related issue of how the tax revenues are spent, i.e. the mix of public expenditures. This is somewhat surprising given that first empirical studies by Ratner (1983) and Aschauer (1989) have show that 'public capital' has a positive impact on a country's output level. Later studies (see, e.g., Berndt and Hansson 1992, Seitz 1994 or Batina 1999) were even able to distinguish between the types of public expenditure.

An important exception is Keen and Marchand (1997), who make a distinction between a public consumption good, which enters the economic system via the utility function, and a public input good entering as an 'externality production factor'. In their study, the set of tax instruments contains linear taxes on labor and capital and a (nondistortionary) profit tax. If, as they assume, the nondistortionary tax instrument does not raise enough revenues (meaning that distortionary taxes must be used), the results show that the public input good will be inefficiently large relative to the public consumption good in an uncoordinated equilibrium, where each national government behaves as a Nash competitor. The intuition in terms of their model is that the public consumption good does not, itself, give rise to externalities, whereas the public input good strengthens the externality caused by the competition for mobile capital.

Based on the Keen and Marchand approach, Matsumoto (2000) incorporates labor mobility which enables the public consumption good to impose external effects on other countries as well. As a consequence, it is *a priori* unclear in which way the relative public spending is distorted. For the special case of factor-augmenting public inputs and a CES-production technology regarding the remaining factors, there is no relative distortion between public consumption goods and public inputs. A distinction between two types of public inputs is made by Matsumoto (2004). In his framework, one public input is complementary with immobile labor while the

[1] Bucovetsky and Wilson (1991) show that also labor taxes tend to be too low in an uncoordinated equilibrium.

other is complementary with mobile capital. With regard to the relative spending decision, the result now depends on the elasticity of substitution between capital and labor. There is relative overprovision of the public input that is a complement to capital when the elasticity of substitution exceeds unity.

The literature discussed above is based on the assumption of competitive markets. In this chapter, we relax the assumption that the labor market is competitive and assume, instead, that the wage rate is decided upon by bargaining between unions and firms, meaning that the equilibrium is characterized by involuntary unemployment. Given this description of the labor market, our chapter deals with factor income taxation and public good provision in small open economies competing for mobile capital. To be able to address the mix of public expenditures, we follow Keen and Marchand in the sense of distinguishing between a public consumption good and a public input good, while the set of tax instruments contains linear taxes on labor and capital and a nondistortionary profit tax. The overall purposes are to characterize the tax and expenditure policies, if decided upon at the national level, and analyze the welfare effects of policy coordination with respect to taxes and public expenditures.

There are several reasons for considering imperfect competition in the labor market in the context of optimal taxation and public goods. First, unions are important institutions, at least in a European context, suggesting that the introduction of imperfect competition in the labor market provides additional realism to the study of taxation, public goods and policy coordination. Considering that many countries have experienced high rates of unemployment for a long time, it is clearly relevant to extend the theory of fiscal competition accordingly. Second, by analyzing the mix of public goods more thoroughly in the context of fiscal competition, our study provides a complement to the literature developed so far on optimal taxation and public provision (of public and private goods) in economies with involuntary unemployment (see, e.g., Marceau and Boadway 1994, Fuest and Huber 1997, Koskela and Schöb 2002a, Aronsson and Sjögren 2004a and Aronsson et al. 2005).

Policy coordination under imperfect competition in the labor market has been addressed by Lejour and Verbon (1996) and Fuest and Huber (1999b). Lejour and Verbon analyze social insurance financed by labor income taxation in a two-country economy. In their study, where a monopoly union characterizes the labor market, capital mobility leads to undertaxation in an uncoordinated equilibrium. As a consequence, a coordinated tax increase leads to higher welfare. Fuest and Huber consider fiscal competition and policy coordination in small open economies with right-to-manage wage formation. They assume that the set of tax instruments facing each national government consists of linear taxes on labor and capital and a

100 per cent profit tax, while the expenditure side includes a public consumption good. In their model, coordinated labor and capital tax increases do not necessarily increase the welfare, if the labor market is characterized by right-to-manage wage formation, even though coordinated increases in the labor and capital taxes would increase welfare in their model, if the labor market were competitive.[2]

Our chapter differs from the aforementioned studies in several ways. One such difference is that we pay more attention to the expenditure side by considering the mix of public goods; as such this chapter is connected to the study by Keen and Marchand (1997). In addition, the distinction between two types of public goods also enables us to address the interesting issue of how the additional tax revenues, following a coordinated increase in each of the tax instruments, are spent. To be more specific, we contribute to the literature in two ways. The first is by characterizing the uncoordinated equilibrium, which is based on the assumption that each small country treats the world interest rate as well as the policies chosen by other countries as exogenous. The second is by considering policy coordination, where we examine the welfare effects of (i) an increase in each of the tax rates, while allowing the additional tax revenues to be spent either on the public consumption good or the public input good, and (ii) a revenue neutral reallocation of the public expenditures. Among the results, we show that tax coordination contributes to higher welfare if it reduces the net interest rate and the wage rate, and that the relative overprovision of the public input good derived by Keen and Marchand may no longer hold, if the labor market is non-competitive.

The chapter is organized as follows. In section 3.2, we describe the model and analyze the outcome of private optimization. Section 3.3 characterizes the uncoordinated Nash equilibrium from the perspective of public policy. The welfare effects of policy coordination are analyzed in section 3.4. Section 3.5 summarizes and concludes.

3.2 The model

Since our analysis does not address redistribution, we simplify by considering a representative-agent economy, where the agent (or household) is rationed in the

[2] There are other possible reasons for policy coordination in open economies characterized by right-to-manage wage formation. For instance, firms might move abroad in case the bargain fails. This means that the wage formation system gives rise to an international externality (as the reservation profit is determined abroad and treated as exogenous in the context of domestic public policy) which, in turn, motivates policy coordination; see Aronsson and Sjögren (2004b).

labor market. The utility function is written

$$U = U(C, G), \tag{3.1}$$

where C is a private consumption good and G a public consumption good. We assume that $U(\cdot)$ is increasing in both arguments and strictly quasiconcave. The budget constraint is given by

$$C = r\overline{K} + wL + (N - L)b + (1 - t_\pi)\pi, \tag{3.2}$$

in which r is the net interest rate, $\overline{K}$ the capital endowment, w the net wage rate, L employment, b the monetary value attached to leisure by the consumer,[3] π the profit income and t_π the profit tax rate. If N is thought of as 'the number of household members', then L is interpretable as the number of household members who are in employment. The gross wage rate and interest rate are defined as $\tilde{w} = w(1 + t_w)$ and $\tilde{r} = r(1 + t_r)$, respectively, where t_w is the labor tax rate and t_r the capital tax rate.

Turning to the production side of the economy, the representative firm produces a homogenous good by using labor, capital and the public input good, P. The public input good works as an 'externality production factor' in the sense that it is exogenous to the firm. We assume that the public input good raises the productivity of private factors and does not itself generate profits, meaning that the number of firms in each country is not important for the analysis and can be normalized to one (see, e.g., McMillan 1979 and Matsumoto 1998). However, in order to formalize the wage bargaining part of the model (see below), we also require that the firms produce rents to bargain over. Therefore, the production function, $F(K, L, P)$, exhibits decreasing returns to scale in the private production factors, so $F_{KK}F_{LL} - (F_{KL})^2 > 0$. The objective function of the firm is written as

$$\pi = F(K, L, P) - \tilde{w}L - \tilde{r}K, \tag{3.3}$$

where the output price has been normalized to one for notational convenience. The firm chooses labor and capital to maximize profits, which gives the factor demand functions,

$$K = K(\tilde{w}, \tilde{r}, P), \tag{3.4}$$

$$L = L(\tilde{w}, \tilde{r}, P), \tag{3.5}$$

[3] An alternative interpretation of b would be in terms of an unemployment benefit. However, in order to avoid unnecessary structure, unemployment benefits are not part of the choice set facing the government. This simplification is not important for the qualitative results to be derived below.

and the profit function

$$\pi = \pi(\tilde{w}, \tilde{r}, P). \tag{3.6}$$

The net wage rate is determined by bargaining between unions and firms, and wage formation is decentralized. The latter is interpreted to mean that each union is small enough to treat economy-wide aggregates as well as the government's decision variables as exogenous, which is a reasonable description of the wage formation system in many countries. By analogy to the treatment of the production sector, the number of unions will be normalized to one. If we define $C^0 = r\overline{K} + Nb + (1 - t_\pi)\pi$ and $U^0 = U(C^0, G)$ to be the consumption and utility, respectively, of the household in case the bargain fails, the rent for the union from the bargain becomes $\Upsilon = U - U^0$. The profit income accruing to each household is its share of the aggregate (economy-wide) profit, and we assume that this measure of profit income is treated as exogenous in the context of a single firm-union bargain. The rent for the firm is equal to the net profit it earns in the production since its reference profit (which applies in case the bargain fails) is equal to zero. The outcome of the bargain will be the net wage rate which maximizes the generalized Nash product

$$\Omega = \Upsilon^{\beta} \left[(1 - t_\pi)\pi\right]^{1-\beta}, \tag{3.7}$$

where β is the bargaining power of the union. Following earlier literature on optimal taxation under imperfect competition in the labor market, we assume that firms retain the 'right to manage', i.e. they choose labor and capital employment given the result of the wage bargaining process. By substituting equations (3.2), (3.5) and (3.6) into equation (3.7), we can use the resulting first-order condition to write the net wage rate as a function of the policy variables, t_w, t_r, G and P, and of the net interest rate,

$$w = w(t_w, \tilde{r}, r, P, G). \tag{3.8}$$

Note that the profit tax vanishes from the first-order condition and is, therefore, not an argument in the wage equation. For later use, note also that the net interest rate, r, influences the net wage rate via two channels; (i) as a separate argument that captures a pure income effect on the rent Υ due to changes in capital income and (ii) as an indirect effect via the gross interest rate, $\tilde{r} = (1 + t_r)r$. The parameters β and b have been suppressed for notational convenience.

3.3 The non-cooperative Nash equilibrium

Let us begin by considering the tax and expenditure policies in a non-cooperative Nash equilibrium, where each national government treats the policy instruments of the other countries as exogenous. The order of decision-making is such that the government is first mover and recognizes how the private sector (including the union) responds to its policies, while the private sector is follower. The objective function of the national government is the indirect utility function of the representative household, which is obtained by substituting equations (3.2), (3.4), (3.5) and (3.6) into equation (3.1);

$$V = U(r\overline{K} + w(t_w, \tilde{r}, r, P, G)L(\tilde{w}, \tilde{r}, P) + (N - L(\tilde{w}, \tilde{r}, P))b \\ + (1 - t_\pi)\pi(\tilde{w}, \tilde{r}, P), G), \tag{3.9}$$

in which we also recognize that the net wage rate is endogenous from the perspective of the government and given by equation (3.8). In addition, recall that $\tilde{w} = (1+t_w)w$ and $\tilde{r} = (1 + t_r)r$, where the government treats r as constant as we are considering a small open economy. The government's budget constraint can be written as

$$t_\pi\pi(\tilde{w}, \tilde{r}, P) + t_w w(t_w, \tilde{r}, r, P, G)L(\tilde{w}, \tilde{r}, P) + t_r rK(\tilde{w}, \tilde{r}, P) - G - P = 0, \tag{3.10}$$

where we assume that the marginal rates of transformation between the private and the public goods are equal to one. Furthermore, following earlier literature on factor income taxation (see, e.g., Koskela and Schöb 2002a), we also recognize the possibility that profit taxation is restricted. Let $0 \leq \bar{t}_\pi \leq 1$ be the upper limit of the profit tax and write the constraint on the profit tax as follows:

$$\bar{t}_\pi - t_\pi \geq 0. \tag{3.11}$$

The decision problem of the national government is to choose t_w, t_r, t_π, G and P in order to maximize the indirect utility function given by equation (3.9) subject to the budget constraint and the maximum restriction on the profit tax. By using the short notation

$$R = t_\pi\pi(\tilde{w}, \tilde{r}, P) + t_w w(t_w, \tilde{r}, r, P, G)L(\tilde{w}, \tilde{r}, P) + t_r rK(\tilde{w}, \tilde{r}, P), \tag{3.12}$$

the Lagrangian can be written as

$$\mathcal{L} = V + \lambda[R - P - G] + \mu[\bar{t}_\pi - t_\pi]. \tag{3.13}$$

Each country maximizes this expression with respect to the tax rates t_π, t_r and t_w and the public expenditures G and P. For each policy instrument, we assume that the second-order condition is fulfilled.

The tax policy implications following from a simplified version of the decision-problem (where the utility function is linear in private consumption) has been addressed by Koskela and Schöb (2002a). It is, nevertheless, instructive to begin by briefly discussing the tax structure chosen by the national government, since the characteristics of this tax structure will be used in the analysis of policy coordination in the next section. Define $\hat{\lambda} = \lambda/U_C$ to be the marginal cost of public funds in real terms, where $U_C = U_C(C,G) = \partial U(C,G)/\partial C$ is the marginal utility of consumption, and let $\hat{\mu} = \mu/U_C$ be the shadow price of the profit tax in real terms. We also introduce the short notations $w_{t_w} = \partial w/\partial t_w$, $w_{t_r} = \partial w/\partial t_r$ and $\tilde{w}_{t_w} = \partial \tilde{w}/\partial t_w$. Consider Proposition 1;

Proposition 1 *In the non-cooperative Nash equilibrium, which is characterized by unemployment, the tax structure is given by*

$$(\hat{\lambda}-1)\pi - \hat{\mu} = 0,$$

$$t_w = \frac{(\hat{\lambda}-1)}{\hat{\lambda}}\left[\frac{w_{t_r}}{\tilde{w}_{t_w}}\frac{L}{r}F_{KL} + \frac{w_{t_w}}{\tilde{w}_{t_w}}\frac{L}{w}F_{LL} - (1-\bar{t}_\pi)\frac{KF_{KL}+LF_{LL}}{w}\right] - \frac{(w-b)}{\hat{\lambda}w}$$

and

$$t_r = \frac{(\hat{\lambda}-1)}{\hat{\lambda}}\frac{1}{r}\left[\frac{w_{t_r}}{\tilde{w}_{t_w}}\frac{wL}{r}F_{KK} + \frac{w_{t_w}}{\tilde{w}_{t_w}}LF_{LK} - (1-\bar{t}_\pi)(KF_{KK}+LF_{LK})\right],$$

where $F_{LL}, F_{KK} < 0$ and $F_{LK} = F_{KL} > 0$ are second-order partial derivatives of the production function.

Proof: see Appendix 1.

Note first that, if the constraint on the profit tax is binding, so $\hat{\mu} > 0$, it follows that $t_\pi = \bar{t}_\pi$ and $\hat{\lambda} > 1$. In other words, if the government must use distortionary taxes, then the marginal cost of public funds exceeds one. Except for the final term in the expression for t_w, which reflects the incentive for the government to subsidize labor due to the presence of involuntary unemployment, the expressions for t_w and t_r share a similar structure. In each tax formula, the terms within the bracket reflect the desire to raise revenues by means of distortionary taxes in an efficient way; the first two terms appear because the two tax rates affect the net wage rate, and the third arises because labor and capital taxes constitute indirect means of taxing profit as long as $\bar{t}_\pi < 1$. On the other hand, if $\bar{t}_\pi = 1$ (and, of course, provided that the constraint on the profit tax is binding), the third term within the bracket of each formula vanishes. These effects are well understood from earlier research - let be in a slightly different framework than ours - and are also discussed in more detail in chapter 4 of this thesis, where the specification of the production function allows us to provide a more intuitive interpretation.

Given the choice of tax structure, what factors characterize the optimal mix of public goods from the perspective of each individual country? Let subindices attached to $\tilde{w}(\cdot)$, $w(\cdot)$, $\pi(\cdot)$, $U(\cdot)$, $L(\cdot)$, $K(\cdot)$ and $F(\cdot)$ denote partial derivatives and consider Proposition 2;

Proposition 2 *In the non-cooperative Nash equilibrium, which is characterized by unemployment, the provision of public goods is given by*

$$F_P - 1 = \frac{(\hat{\lambda}-1)}{\hat{\lambda}}[w_P L + (1-\bar{t}_\pi)(\pi_P + \pi_{\tilde{w}}\tilde{w}_P)] - \frac{(w-b)}{\hat{\lambda}}[L_P + L_{\tilde{w}}\tilde{w}_P] - t_w w[L_P + L_{\tilde{w}}\tilde{w}_P] - t_r r[K_P + K_{\tilde{w}}\tilde{w}_P]$$

and

$$\frac{1}{\hat{\lambda}}\frac{U_G}{U_C} - 1 = \frac{(\hat{\lambda}-1)}{\hat{\lambda}}[w_G L + (1-\bar{t}_\pi)\pi_{\tilde{w}}\tilde{w}_G] - \frac{(w-b)}{\hat{\lambda}}L_{\tilde{w}}\tilde{w}_G - t_w w L_{\tilde{w}}\tilde{w}_G - t_r r K_{\tilde{w}}\tilde{w}_G.$$

The proof is analogous to the proof of Proposition 1. Each formula in Proposition 2 is written in terms of the way in which it deviates from the corresponding optimality rule, which applies when public expenditures have no impact on the domestic real variables. The main difference between the two formulas is that, whereas the public input good gives rise to direct effects on the profit and factor employment ($\pi_P = F_P$, L_P and K_P in the equation for the provision of P), the public consumption good only affects the profit and factor employment indirectly via the wage rate.[4] Note that, in the absence of these effects, the public input good would obey the first-best policy rule, $F_P = 1$, while the public consumption good would be characterized by a modified second-best rule, $U_G/U_C = \hat{\lambda}$ (which is equivalent to the first-best rule if $\hat{\lambda} = 1$). This difference can be interpreted as an application of the production-efficiency theorem according to which production decisions should remain undistorted in a second-best optimum.

The first term on the right hand side of each expression is due to the use of distortionary taxes. Since $\hat{\lambda} > 1$, it follows that the marginal benefit of lump-sum income for the private sector, U_C, falls short of the marginal cost for society if the government were to claim these additional resources via distortionary taxation, λ. This necessitates, in turn, that the public good is adjusted, if it affects the private income and tax revenues to the same extent. It is this adjustment that the first term on the right hand side accomplishes. If, for instance, higher public input provision would increase private wage income, $w_P L > 0$, this contributes to an underprovision of P, *ceteris paribus,* since the necessary revenue is costly to raise, ($\hat{\lambda} > 1$). The second part of the first row is due to the presence of involuntary unemployment.

[4]See Appendix 2 for a discussion of how P and G affect the bargained wage rate.

If public provision gives rise to increased (decreased) employment, *ceteris paribus*, this constitutes an incentive for the government to provide more (less) of the public good than it would otherwise have done. Note also that this effect becomes less important, relative to the other components, the higher the marginal cost of public funds. In other words, the greater the cost for society of raising additional tax revenues, the weaker will be the incentive to adjust the provision of the public good in order to increase the employment. The second row of each formula reflects tax base effects, which are defined conditional on the tax rates. The intuition is that increased public provision may either exacerbate or counteract the preexisting tax distortions, depending on how the public provision affects the tax base. Since the public revenues are costly to raise, this constitutes an incentive for the government to modify the public provision. Therefore, if the provision of public goods increases (decreases) the tax revenues, then the government spends more (less) on public provision than it would otherwise have done.

3.4 Policy Coordination

Since the countries compete for a fixed worldwide capital stock, the policy outcome of the non-cooperative Nash equilibrium described in Section 3.3 is not optimal from the perspective of society as a whole, defined as the group of countries. The intuition is, of course, that each national government treats the net interest rate as given, whereas it is an endogenous variable for society as a whole. In this section, we analyze the welfare effects of policy coordination with respect to tax and expenditure policies. Note, however, that we are not discussing how such agreements are formed, but only their welfare effects if they are agreed upon and carried out. However, we restrict our analysis to *marginal* coordination, i.e. starting from the uncoordinated Nash-equilibrium we suppose that all countries change one of their policy instruments by a marginal unit. This is a weaker form compared with global coordination. The latter seems to be difficult to implement as it would require all jurisdictions to choose their policy variables to achieve an optimum from the worldwide perspective. To simplify the analysis, we assume that the initial equilibrium is symmetric.

3.4.1 Tax coordination

We analyze tax coordination in the sense that the capital tax rate (labor tax rate) is marginally increased by all countries, while the labor tax rate (capital tax rate) is held constant, i.e. $dt_i > 0$ and $dt_j = 0$, $i, j = r, w$ and $i \neq j$.[5] To begin with, let us consider the factor price changes in response to such a joint increase in t_i without taking into account how the resulting increase in expenditures affect the factor prices. This enables us to better distinguish the differential welfare effects of public expenditures to be discussed later. If all countries jointly increase their tax on factor i, t_i, worldwide capital allocation is not affected. In a symmetric equilibrium, each country must still employ its capital endowment

$$\overline{K} = K(\tilde{w}, \tilde{r}, P). \tag{3.14}$$

Differentiating equations (3.8) and (3.14) with respect to the factor prices and the tax rate t_i, while holding G and P (as well as the other tax instruments) constant, we obtain the following factor price reactions

$$r_{t_i}\big|_{dK=0} = -\frac{dK/dt_i}{dK/dr}, \tag{3.15}$$

$$\tilde{r}_{t_i}\big|_{dK=0} = \tilde{r}_{t_i} + (1 + t_r) \cdot r_{t_i}\big|_{dK=0}\,, \tag{3.16}$$

$$w_{t_i}\big|_{dK=0} = w_{t_i} + \frac{dw}{dr} \cdot r_{t_i}\big|_{dK=0}\,, \tag{3.17}$$

$$\tilde{w}_{t_i}\big|_{dK=0} = \tilde{w}_{t_i} + \frac{d\tilde{w}}{dr} \cdot r_{t_i}\big|_{dK=0}\,, \tag{3.18}$$

where $dK/dr = K_{\tilde{r}}\tilde{r}_r + K_{\tilde{w}} d\tilde{w}/dr < 0$. Consequently, and in contrast to the uncoordinated case, a joint increase in tax rate t_i alters the net interest rate according to equation (3.15). Equations (3.16)-(3.18) show that the impact on each of the other factor prices can be decomposed into two effects. The first term on the right hand side represents the factor price change that is also present in case of a unilateral tax increase, i.e. at a constant r, which will be referred to as the 'autarky effect'. The second term is the additional effect due to the change in the net interest rate, i.e. the 'coordination effect'.

A joint tax increase carried out by all countries generates additional tax revenues for each government, which are to be spent on public goods. This causes, in turn, a change in the net interest rate. From equations (3.8) and (3.14), we can derive for the public consumption good

$$r_G\big|_{dK=0} = -\frac{K_{\tilde{w}}\tilde{w}_G}{dK/dr}, \tag{3.19}$$

while the associated changes in the gross interest rate and the wage rate are derived in the same way as equations (3.16)-(3.18). If, on the other hand, the additional tax

[5] The analysis of partial tax coordination in the presence of unemployment is postponed to chapter 4, since the focus of the present chapter is on the expenditure decision.

revenues are spent on the public input good, we have

$$r_P|_{dK=0} = -\frac{K_P + K_{\tilde{w}}\tilde{w}_P}{dK/dr}, \tag{3.20}$$

again affecting the remaining factor prices in the same principal way.

We are now in the position to analyze the welfare effects of a marginal tax coordination. Let W be the national welfare function for any of the countries involved, so $W = U(C, G)$, where all entities are evaluated at the non-cooperative Nash equilibrium described in the previous section. In addition, note that the welfare function equals the Lagrangian at the non-cooperative Nash equilibrium, so $W = \mathcal{L}$. We can derive the following result.

Proposition 3 *Starting in the non-cooperative Nash equilibrium, which is characterized by unemployment, and holding tax rate t_j constant, the welfare effect of a joint increase in tax t_i, $i = r, w$, $i \neq j$, is given by*

$$\left.\frac{dW}{dt_i}\right|_{dK=0}^{dP=0} = (V_r + \lambda R_r)\, r_{t_i}|_{dK=0} + (V_r + \lambda R_r)\, r_G|_{dK=0} \cdot R_{t_i}|_{dK=0}\,, \tag{3.21}$$

if the additional tax revenue is spent on the public consumption good, and by

$$\left.\frac{dW}{dt_i}\right|_{dK=0}^{dG=0} = (V_r + \lambda R_r)\, r_{t_i}|_{dK=0} + (V_r + \lambda R_r)\, r_P|_{dK=0} \cdot R_{t_i}|_{dK=0}\,, \tag{3.22}$$

if the additional tax revenue is spent on the public input good.

According to Proposition 3, the welfare effect following tax coordination crucially depends on how the net interest rate responds to the policy variables. Each formula in the proposition is a straightforward consequence of the envelope theorem: although a coordinated increase in one of the tax rates (with the other tax instruments held constant) causes a change in the real allocation by altering the gross factor prices, there are no welfare changes associated with the autarky effect mentioned above. This is so because each national government has already made an optimal policy choice conditional on the net interest rate. Therefore, as the change in the net interest rate is the only additional effect in case of policy coordination, it is the only source of welfare change in this framework. In particular, the impact of the tax rates on the bargained net wage rate is not crucial for the welfare effects.

We show in Appendix 4 that the welfare effect of an increase in the net interest rate can be written as

$$V_r + \lambda R_r = -U_C(\hat{\lambda} - 1)[K + \frac{w_r}{\tilde{w}_{t_w}} wL]. \tag{3.23}$$

The right hand side of this expression is decomposable into two parts. First, since $\hat{\lambda} > 1$, we have $-U_C(\hat{\lambda} - 1)K < 0$. The intuition is that, to the extent that policy coordination reduces the net interest rate, this is associated with a lump-sum transfer from the capital owners to the government, which unambiguously increases welfare. Second, a change in the net interest rate affects the union's rent from bargaining which, in turn, influences the net wage rate. To provide some intuition behind the latter effect, notice that $\tilde{w}_{t_w} > 0$, so $-U_C(\hat{\lambda} - 1)wL/\tilde{w}_{t_w} < 0$. Therefore, the second part of the expression for $V_r + \lambda R_r$ is negative (positive) if $w_r > 0$ (< 0); we derive an expression for w_r in the appendix (see Appendix 5). We show that the sign of the expression

$$\frac{U_{CC}}{U_C} - \frac{U_C - U_C^0}{\Upsilon} \tag{3.24}$$

determines how the net wage rate responds an increase in the net interest rate (with the gross interest rate held constant). The second term in the above expression is the change in the union's rent from bargaining, whereas the first reflects that the value the union attaches to a higher net wage rate decreases with the level of private consumption (conditional on the rent). If the second term dominates, then $w_r > 0$. The intuition is that a lower wage rate contributes to increased employment which, in turn, increases welfare in an economy with involuntary unemployment. Therefore, if $w_r > 0$, we have unambiguously $V_r + \lambda R_r < 0$, implying that a decrease in the net interest rate is welfare improving. The same result will, of course, apply in the special case where the utility is linear in private consumption, as this case means that the net wage rate does not depend directly on r. Yet another way to have a wage rate that is unaffected by the net interest rate is to define a separate group of households, called capital owners, the members of which receive all capital and profit income. In this case, trade unions only take into account the wage income and employment status of their members.

Note once again that the first term on the right hand side of equations (3.21) and (3.22), respectively, denotes the welfare effect of a joint increase in t_i ($i = r, w$), with the other tax instruments held constant, irrespective of whether the additional tax revenue is spent on G or P. The second term, on the other hand, shows the additional welfare effect caused by increased provision of public goods. As such, the latter effect must be weighted by the additional tax revenues, which determines the extent to which the public provision can be increased. Indeed, provided that all countries use Laffer-efficient tax rates in the uncoordinated case, we must also have $R_{t_i}|_{dK=0} > 0$ since a negative tax base effect vanishes.

Let us start with the case where the additional tax revenues are spent on the public consumption good. According to equations (3.19) and (3.21), two mechanisms determine how increased provision of the public consumption good influences welfare; (i) the relationship between welfare and the net interest rate, i.e. $V_r + \lambda R_r$ (which we discussed at some length above), and (ii) the impact of the public consumption good on the wage rate, $\tilde{w}_G = w_G(1 + t_w)$. The sign of $\tilde{w}_G$ is ambiguous in general. On the one hand, increased provision of the public consumption good will change the union's rent from bargaining, as it affects both the utility of the bargaining outcome and the fall-back utility. On the other hand, it also affects the marginal valuation of wage increases, as the public consumption good may be either complementary with, or substitutable for, private consumption.[6] In a similar way, the sign of the second term on the right hand side of equation (3.22) is also ambiguous. Although it is common to have $K_P > 0$,[7] increasing the public input good has an ambiguous effect on the net wage rate. From the perspective of society, therefore, which public good that should be increased is determined by comparing (3.19) and (3.20). The incentives underlying public good provision are further discussed in subsection 24.

The result presented in Proposition 3 appears to stand in contrast to Fuest and Huber (1999b), who consider labor and capital tax coordination in case the additional tax revenues are spent on a public consumption good. They argue that, in the presence of unemployment, a coordinated increase the labor or capital tax reduces welfare, if the labor demand is inelastic with respect to the gross wage rate. Although the wage rate will change as a consequence of policy coordination also in our framework, we do not find such a crucial influence of the labor demand elasticity. Our results show that the welfare effect is driven solely by the ability to reduce the net interest rate, which captures rents from (i) the capital owners and (ii) the union members (if $w_r > 0$). The reason for the difference is that Fuest and Huber normalize the union's outside option to zero, i.e. union members do not receive capital income when bargaining breaks down. In turn, this implies a strong income effect when the net interest rate falls due to the coordination and renders their results ambiguous.

Coordination of the capital tax rate

So far, we have discussed the general cost benefit rule for coordination with respect to any of the two distortionary tax instruments. The coordination agreement most frequently analyzed in earlier literature is a marginal increase in the capital tax rate,

[6] See Appendix 2 for a derivation.

[7] This is ensured by assuming that the public input good is a complement to private factors ($F_{LP} > 0$, $F_{KP} > 0$) and both private factors are complements as well ($F_{KL} > 0$).

which is carried out by all countries simultaneously. A coordinated increase in the capital tax rate, with the labor tax rate held constant, means that

$$r_{t_r}|_{dK=0} = -\frac{K_{\tilde{r}}\tilde{r}_{t_r} + K_{\tilde{w}}\tilde{w}_{t_r}}{K_{\tilde{r}}\tilde{r}_r + K_{\tilde{w}}d\tilde{w}/dr}, \tag{3.25}$$

while the associated changes the gross interest rate and wage rate are given by equations (3.16)-(3.18). Therefore, the sign of $r_{t_r}|_{dK=0}$ is ambiguous *a priori*.

In the special case where the utility function is linear in private consumption,[8] we have as a benchmark

$$r_{t_r}|_{dK=0} = -\frac{r}{1+t_r} < 0 \tag{3.26}$$

and

$$\tilde{w}_{t_r}|_{dK=0} = \tilde{r}_{t_r}|_{dK=0} = w_{t_r}|_{dK=0} = 0. \tag{3.27}$$

Consequently, as all countries increase their capital tax rate, the entire tax burden falls on the capital owners, since the capital endowment cannot evade worldwide taxation, whereas $d\tilde{w}/dr = \tilde{w}_{\tilde{r}}\tilde{r}_r$ and $\tilde{w}_{t_r}$ are proportional, since this special case implies that $w_r = 0$. As the tax wedge on the labor market is not affected, the real allocation is not altered. Therefore, a joint increase in the capital tax rate unambiguously contributes to higher welfare; the total welfare change is positive in case the additional tax revenues are spent on the public consumption good (since $w_G = 0$), and ambiguous if the additional tax revenues are spent on the public input good (since w_P is ambiguous).

Public expenditures, partial coordination and quasi-linear utility

In order to introduce the notion of partial coordination, we discuss each country's individual spending decision following a joint increase in the capital tax and compare it with the decision that is optimal from a social point of view. To simplify, we consider the special case where the utility function is linear in private consumption. The corresponding factor price reactions are given by equations (3.26) and (3.27). Following Schöb (1994), we denote by $MBF(G)$ and $MBF(P)$ the marginal benefit of public funds associated with the public consumption good and the public input good, respectively. These expressions can be derived by using the first-order conditions for G and P, i.e.

$$MBF(G) = \frac{dV/dG}{1 - dR/dG} = \frac{V_G + V_w w_G}{1 - R_w w_G},$$

[8] It has been common in earlier literature on optimal linear taxation under wage bargaining to assume a constant marginal utility of private consumption; see, e.g., Boeters and Schneider (1999), Koskela and Schöb (2002a) and Richter and Schneider (2001).

$$MBF(P) = \frac{dV/dP}{1 - dR/dP} = \frac{V_P + V_w w_P}{1 - R_P - R_w w_P}.$$

Note that the special case with a quasi-linear utility function implies $w_G = 0$, so $MBF(G) = V_G$. Since the policy choices already made at the national level mean $MBF(G) = MBF(P) = \lambda$, the government will be indifferent between G and P in the uncoordinated equilibrium.

However, when all countries have agreed to marginally increase their capital tax and face the abovementioned reduction in the net interest rate, they may, nevertheless, strictly prefer to spend the additional tax revenue either on G or P, depending on how the MBF measures change due to capital tax coordination. The additional tax revenue is used to increase the provision of the public input good instead of the public consumption good if

$$\left.\frac{\partial MBF(P)}{\partial t_r}\right|_{dK=0} > \left.\frac{\partial MBF(G)}{\partial t_r}\right|_{dK=0},$$

which can be rewritten as[9]

$$(K_P + K_{\tilde{w}}\tilde{w}_P)\,(1 - dR/dP) > 0. \tag{3.28}$$

Inequality (3.28) suggests that the individual spending decision of each country following a capital tax coordination deviates from the spending decision that is rational for *all* countries, collectively. Since $V_r + \lambda R_r < 0$, combining equations (3.19) to (3.22) shows that it is welfare superior for all countries to increase the public input good instead of public consumption good provision if

$$K_P + K_{\tilde{w}}\tilde{w}_P < 0. \tag{3.29}$$

Consequently, for the special case where the public input good has no impact on the tax revenues, i.e. $dR/dP = 0$, each country's incentive regarding the composition of additional public expenditures is exactly the opposite to the spending decision that gives the largest welfare gain for all countries.

Intuitively, it is not surprising that the individual countries may face incorrect incentives (from the perspective of society as a whole) with respect to additional public good provision. Since the tax coordination forces each government to deviate from its individually most preferred allocation, there is an incentive for the national government to use the pattern of public spending in order to again engage in fiscal competition by attracting mobile capital.[10] By inspecting equation (3.29) and the

[9] See Appendix 6 for a derivation.

[10] Theoretically, countries may also react by adjusting the wage tax in order to attract capital again. However, we exclude this possibility in this chapter.

counterpart to equation (3.28), i.e. the national decision rule to spend revenues on G, we can conclude the following as a more general result. If it is socially optimal to spend the additional tax revenues on the public input good, then each country will inevitably face the wrong incentive and spend it on the public consumption good, if the influence of the public input good on the tax revenue is non-negative. An analogous conclusion holds if the socially optimal decision is to spend the revenue on G.

Coordination of the wage tax rate

Instead of jointly increasing the capital tax rate, let us consider a coordinated change in the labor tax with the capital tax held constant. As has been pointed out by Bucovetsky and Wilson (1991), a joint increase in the labor tax will also affect the capital demand, which calls for an adjustment in the net interest rate. In contrast to the coordinated change in the capital tax, however, a joint increase in the labor tax adds to the tax wedge in the labor market. This, in turn, raises the gross wage and reduces employment. Therefore, the worldwide allocation is altered (even if we were to assume that the utility function is linear in private consumption).

Formally, from equations (3.8) and (3.14), we obtain the corresponding factor price changes, where the impact on the net interest rate is given by

$$r_{t_w}|_{dK=0} = -\frac{K_{\tilde{w}}\tilde{w}_{t_w}}{dK/dr}. \tag{3.30}$$

If capital and labor are price complements, a coordinated increase in the labor tax reduces the worldwide capital demand, which calls for a reduction in the net interest rate to fully employ capital again. Therefore, given that $V_r + \lambda R_r < 0$, this effect contributes to higher welfare.

3.4.2 A coordinated reform of government spending

Following Keen and Marchand (1997), let us consider a revenue-neutral change in the composition of government spending by all countries. Keen and Marchand assume a competitive labor market, and a utility function in which the disutility of labor enters the private consumption term additively. Given these assumptions, the public consumption good does not affect the labor market equilibrium, and the result is clear-cut: the Nash equilibrium is characterized by a relative overprovision of the public input good. The intuition is that each country has an incentive to increase the domestic capital stock by increasing the provision of the public input good. The mechanisms emphasized are (i) a direct positive effect on the marginal product of capital and (ii) complementarity between labor and capital. Therefore, since there is no such link between the public consumption good and the marginal product of capital, each country will excessively use the public input good to attract capital at the expense of other countries.

Assuming the tax rates to be constant, we use our setting to analyze a joint increase in the public consumption good and reduction in the public input good, $dG = -dP > 0$. The corresponding welfare change becomes

$$\left.\frac{dW}{dG}\right|_{dK=0}^{dG=-dP} = \left.\frac{dW}{dG}\right|_{dK=0}^{dP=0} + \left.\frac{dW}{dP}\right|_{dK=0}^{dG=0}\frac{dP}{dG} = W_G|_{dK=0} - W_P|_{dK=0}\,.$$

By analogy to the analysis carried out above, we can use the envelope theorem to determine

$$W_P|_{dK=0} = (V_r + \lambda R_r)\, r_P|_{dK=0}$$

and

$$W_G|_{dK=0} = (V_r + \lambda R_r)\, r_G|_{dK=0}\,.$$

Therefore, by using $V_r + \lambda R_r = -U_C(\hat{\lambda} - 1)\,(K + w_r wL/\tilde{w}_{t_w})$, we can derive the following result;

Proposition 4 *Starting at the non-cooperative Nash equilibrium, which is characterized by unemployment, the welfare effect of a joint revenue-neutral increase in the public consumption good and corresponding reduction in the public input good is given by*

$$\left.\frac{dW}{dG}\right|_{dK=0}^{dG=-dP} = U_C(\hat{\lambda} - 1)\,(K + w_r wL/\tilde{w}_{t_w})\,(r_P|_{dK=0} - r_G|_{dK=0})\,.$$

To interpret Proposition 4, let us assume that $V_r + \lambda R_r < 0$. Then, by using equations (3.19) and (3.20), the welfare effect can be signed as follows:

$$sign\left\{\left.\frac{dW}{dG}\right|_{dK=0}^{dG=-dP}\right\} = sign\left\{K_P + K_{\tilde{w}}\,(\tilde{w}_P - \tilde{w}_G)\right\}.$$

Therefore, the sign of the welfare effect depends not only on whether the public consumption good is complementary with, or substitutable for, private consumption, which crucially determines the sign of $\tilde{w}_G$. It also depends on the shape of the production function. The properties of the production function determine to what extent the wage rate responds to increased provision of the public input good as well as the magnitudes of the terms K_P and $K_{\tilde{w}}$.

Turning to the intuition of the result, it is instructive to bear in mind that coordination agreements are aimed at correcting the externalities of unilateral fiscal policy decisions due to capital mobility. In which direction the public consumption good G is *ceteris paribus* inefficiently used in the uncoordinated Nash equilibrium depends on whether it attracts or expels mobile capital from the rest of the world. If one unit of tax revenue is spent on the public consumption good, this may have a positive, negative or no external effect on the rest of the world, since

$$\frac{dK}{dG} = K_{\tilde{w}} \tilde{w}_G \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} 0 \quad \text{as} \quad \tilde{w}_G \left\{ \begin{array}{c} < \\ = \\ > \end{array} \right\} 0.$$

If, for instance, higher provision of the public consumption good has a wage moderating effect, $\tilde{w}_G < 0$, countries will, *ceteris paribus*, provide too much of it since attracts capital at the expense of other countries. The possibility that $\tilde{w}_G \neq 0$ was assumed away by Keen and Marchand due to their choice of functional form of the utility function. For the public input good, on the other hand, there are two channels of influence on the capital employment:

$$\frac{dK}{dP} = K_P + K_{\tilde{w}} \tilde{w}_P.$$

The direct effect, K_P, is positive due to the complementarity between the public input good and the private production factors, whereas the indirect effect via the wage rate can go in either direction. Therefore, in contrast to a competitive labor market, this may offset the direct effect of higher public input provision.

3.5 Concluding remarks

In this chapter, we consider factor income taxation and public good provision in small open economies, which compete for mobile capital and are characterized by involuntary unemployment due to wage bargaining between unions and firms. Each national government can spend its tax revenues on a public consumption good and a public input good. The chapter contributes to the literature in two ways; (i) by characterizing the Nash equilibrium, which is based on the assumption that each country treats the world interest rate as well as the policies chosen by other countries as exogenous, and (ii) by considering policy coordination. We examine the welfare effects of a coordinated increase in each distortionary tax, where the additional tax revenues are spent either on the public consumption good or the public input good, and a revenue neutral reallocation of the public expenditures.

We would like to emphasize two distinct results. First, tax coordination contributes to higher welfare, if it reduces the net interest rate (which counteracts the incentives associated with tax competition for mobile capital) and the net wage rate. Therefore, the welfare effects of coordination is interpretable in terms of the possibility to capture rents from the private sector. Second, the relative overprovision of the public input good derived by Keen and Marchand (1997) in the context of a competitive economy needs not necessarily carry over to an economy with wage bargaining. The reason is that increased provision of the public consumption good and the public input good may change the wage rate in either direction.

To further address the consequences of tax and expenditure policies in small open economies, as well as analyze the effects of policy coordination, there are several possible ways to extend the analysis carried out in this chapter. For instance, it is not difficult to address centralized wage bargaining instead of decentralized wage formation. For that purpose, the union objective function must adjusted accordingly. It should take into account that the union's outside utility does not any longer contain profit income and the public good provision since domestic output is zero in case of bargaining breaks down. In addition, a change in the wage rate now affects countrywide variables. The latter modification will render unemployment less severe in the uncoordinated equilibrium. The former will only slightly change our results regarding coordination since the rent from bargaining is now altered. Other extensions would require to change the setup to a larger extent. One possibility is to allow for a choice of work hours among the employed, which means an additional margin relevant for public policy. This is particularly interesting from the perspective of the labor income tax, as the employed individuals may not (themselves) choose the hours of work in an optimal way from society's point if view in an economy with involuntary unemployment (see Aronsson and Sjögren 2004a). Another is to incorporate heterogeneity and redistribution into the analysis. This would also provide a natural framework for analyzing nonlinear tax instruments (instead of the linear instruments used in this chapter).

Appendix

1. Proof of Proposition 1

Noting that $\tilde{w}_{t_w} = w + (1+t_w)w_{t_w}$, the first-order condition with respect to the labor tax, i.e. $\mathcal{L}_{t_w} = 0$, can be written as

$$(\hat{\lambda}-1)\left[-Lw_{t_w} + (1-t_\pi)L\tilde{w}_{t_w}\right] + (w-b)L_{\tilde{w}}\tilde{w}_{t_w} + \hat{\lambda}\left[t_w w L_{\tilde{w}}\tilde{w}_{t_w} + t_r r K_{\tilde{w}}\tilde{w}_{t_w}\right] = 0. \tag{3.31}$$

The corresponding condition for the capital tax is $\mathcal{L}_{t_r} = 0$ and yields the following:

$$\begin{aligned}&(\hat{\lambda}-1)\left[-Lw_{t_r} + (1-t_\pi)\left(L\tilde{w}_{t_r} + rK\right)\right] + (w-b)(L_{\tilde{w}}\tilde{w}_{t_r} + L_{\tilde{r}}r)\\ &+\hat{\lambda}\left[t_w w(L_{\tilde{w}}\tilde{w}_{t_r} + L_{\tilde{r}}r) + t_r r(K_{\tilde{w}}\tilde{w}_{t_r} + K_{\tilde{r}}r)\right] = 0.\end{aligned} \tag{3.32}$$

Multiplying equation (3.31) by w_{t_r} and equation (3.32) by w_{t_w} enables us to combine both expressions to get

$$\begin{aligned}&(\hat{\lambda}-1)(1-t_\pi)\left(wLw_{t_r} - rKw_{t_w}\right) + (w-b)\left(L_{\tilde{w}}ww_{t_r} - L_{\tilde{r}}rw_{t_w}\right)\\ &+\hat{\lambda}\left[t_w w(L_{\tilde{w}}ww_{t_r} - L_{\tilde{r}}rw_{t_w}) + t_r r\left(K_{\tilde{w}}ww_{t_r} - K_{\tilde{r}}rw_{t_w}\right)\right] = 0.\end{aligned} \tag{3.33}$$

After plugging in $L_{\tilde{w}} = F_{KK}/\Sigma < 0$, $K_{\tilde{r}} = F_{LL}/\Sigma < 0$ and $L_{\tilde{r}} = K_{\tilde{w}} = -F_{LK}/\Sigma < 0$, where $\Sigma = F_{LL}F_{KK} - (F_{LK})^2 > 0$, and substituting equation (3.33) into (3.31) and (3.32), respectively, we arrive at the optimal tax formulas as given in the Proposition.

2. Wage bargaining and the wage response to public expenditure

The first-order condition for the net wage rate can be written as

$$\Omega_w = 0 \Rightarrow \widetilde{\Omega}_w = \beta\frac{\Upsilon_w}{\Upsilon} + (1-\beta)\frac{\pi_w}{\pi} = 0, \tag{3.34}$$

where

$$\pi_w = -L(1+t_w) < 0 \tag{3.35}$$

and

$$\Upsilon_w = U_C \cdot \left[L + (w-b)L_{\tilde{w}}(1+t_w)\right] > 0. \tag{3.36}$$

The sign restriction on expression (3.36) follows from expressions (3.34) and (3.35). In deriving (3.36), we think of the net profit accruing to the union members as the average profit in the economy as a whole, which cannot be influenced by a small union's wage setting.

The wage reaction to a change in i, $i = t_r, t_w, G, P$, is given by

$$w_i = -\frac{\widetilde{\Omega}_{wi}}{\widetilde{\Omega}_{ww}},$$

where $\widetilde{\Omega}_{ww} < 0$ according to the second-order condition. Furthermore,

$$\widetilde{\Omega}_{wi} = \beta \frac{\partial}{\partial i}\left(\frac{\Upsilon_w}{\Upsilon}\right) + (1-\beta)\frac{\partial}{\partial i}\left(\frac{\pi_w}{\pi}\right).$$

The influence of the public consumption good on the wage rate

Since $sign(w_i) = sign(\widetilde{\Omega}_{wi})$, and π_w/π is unaffected by a change in the public consumption good, we are left with

$$\begin{aligned}\widetilde{\Omega}_{wG} &= \beta \frac{\partial}{\partial G}\left(\frac{\Upsilon_w}{\Upsilon}\right)\\ &= \frac{\beta \Upsilon_w}{U_C \Upsilon}\left[U_{CG}\left(U - U^0\right) - U_C \cdot \left(U_G - U_G^0\right)\right],\end{aligned}$$

where U^0 and U_G^0 are evaluated at C^0. The first term in brackets is positive (negative) if the public consumption good is complementary with (substitutable for) private consumption, i.e. $U_{CG} > (<)\ 0$, implying that an increase in G increases (decreases) the marginal benefit of a wage increase. The second term is the increased (decreased) rent from bargaining facing the union if $U_G - {U_G}^0 > (<)\ 0$, which works to reduce (increase) the wage claims.

The influence of the public input good on the wage rate

Following the above procedure, we have

$$\widetilde{\Omega}_{wP} = \beta \frac{\partial}{\partial P}\left(\frac{\Upsilon_w}{\Upsilon}\right) + (1-\beta)\frac{\partial}{\partial P}\left(\frac{\pi_w}{\pi}\right). \tag{3.37}$$

The first term on the right hand side of equation (3.37) can be written as

$$\frac{\partial}{\partial P}\left(\frac{\Upsilon_w}{\Upsilon}\right) = \frac{1}{\Upsilon^2}\left[\Upsilon_{wP}\Upsilon - \Upsilon_w \Upsilon_P\right],$$

where Υ_w is given by equation (3.36) and

$$\begin{aligned}\Upsilon_P &= U_C \cdot (w-b)L_P + \left(U_C - U_C^0\right)(1-t_\pi)\pi_P,\\ \Upsilon_{wP} &= U_C\left[L_P + (w-b)L_{\tilde{w}P}(1+t_w)\right]\\ &\quad + U_{CC}\underbrace{\left[L + (w-b)L_{\tilde{w}}(1+t_w)\right]}_{=\Upsilon_w/U_C}\left[(w-b)L_P + (1-t_\pi)\pi_P\right]\\ &= U_C\left[L_P + (w-b)L_{\tilde{w}P}(1+t_w)\right] + \frac{U_{CC}}{U_C}\Upsilon_w\left[(w-b)L_P + (1-t_\pi)\pi_P\right].\end{aligned}$$

Therefore,

$$\begin{aligned}\frac{\partial}{\partial P}\left(\frac{\Upsilon_w}{\Upsilon}\right) = \frac{1}{\Upsilon^2}\Bigg\{ & U_C\left[L_P + (w-b)L_{\tilde{w}P}(1+t_w)\right]\Upsilon + (w-b)L_P\frac{\Upsilon_w}{U_C}\left[U_{CC}\Upsilon - U_C^2\right]\\ & +(1-t_\pi)\pi_P\frac{\Upsilon_w}{U_C}\left[U_{CC}\Upsilon - U_C\left(U_C - U_C^0\right)\right]\Bigg\}.\end{aligned} \tag{3.38}$$

The first term in the upper line of equation (3.38) reflects the union's incentives to alter its wage claim, as an increase in the public input good changes the marginal benefit of a higher wage rate. On the one hand, the union will *ceteris paribus* demand higher wages as the public input good increases labor demand. On the other hand, the union wants the reduce (increase) the wage rate, if the additional public good provision increases (decreases) the wage responsiveness of labor demand. The second term in the upper line shows that the union has an incentive to *ceteris paribus* call for lower wages as the marginal utility of private consumption is decreasing, and the total rent from bargaining is increasing in the public input good. The term in the lower line of (3.38) will vanish if the utility is linear in consumption, and is ambiguous for $U_{CC} < 0$ as this also implies $U_C - U_C^0 < 0$. Inspecting the second term on the right hand side of equation (3.37), we are able to write

$$\frac{\partial}{\partial P}\left(\frac{\pi_w}{\pi}\right) = \frac{\partial}{\partial P}\left(\frac{-L(1+t_w)}{\pi}\right) = \frac{L(1+t_w)}{\pi}\left[\frac{\pi_P}{\pi} - \frac{L_P}{L}\right].$$

Thus, higher public input provision contributes to a higher wage rate, *ceteris paribus*, if its relative impact on profits is higher than its relative impact on labor demand, i.e. $\pi_P/\pi > L_P/L$.

3. Derivation of $\tilde{w}_{t_w} > 0$

From $\tilde{w} = w(1+t_w)$, we have

$$\begin{aligned} \tilde{w}_{t_w} &= (1+t_w)w_{t_w} + w \\ &= \frac{-\widetilde{\Omega}_{wt_w}(1+t_w) + \widetilde{\Omega}_{ww}w}{\widetilde{\Omega}_{ww}}, \end{aligned} \tag{3.39}$$

For $\tilde{w}_{t_w} > 0$, the numerator of equation (3.39) must be is negative. Inspecting that numerator, we first observe that

$$-(1-\beta)\frac{\partial}{\partial t_w}\left(\frac{\pi_w}{\pi}\right)(1+t_w) + (1-\beta)\frac{\partial}{\partial w}\left(\frac{\pi_w}{\pi}\right)w = 0,$$

implying that we only need to analyze the sign of

$$-\frac{\partial}{\partial t_w}\left(\frac{\Upsilon_w}{\Upsilon}\right)(1+t_w) + \frac{\partial}{\partial w}\left(\frac{\Upsilon_w}{\Upsilon}\right)w.$$

Therefore,

$$\begin{aligned} \frac{\partial}{\partial t_w}\left(\frac{\Upsilon_w}{\Upsilon}\right)(1+t_w) = \frac{1}{\Upsilon^2}\Big\{ & \tilde{w}\Upsilon U_C\left[L_{\tilde{w}} + (w-b)(1+t_w)L_{\tilde{w}\tilde{w}} + \frac{(w-b)}{w}L_{\tilde{w}}\right] \\ & + \tilde{w}\Upsilon U_{CC}\left[L + (w-b)L_{\tilde{w}}(1+t_w)\right]\left[(w-b)L_{\tilde{w}} - (1-t_\pi)L\right] \\ & - \tilde{w}\Upsilon_w U_C\left[(w-b)L_{\tilde{w}} - (1-t_\pi)L\right]\Big\} \end{aligned}$$

and

$$\frac{\partial}{\partial w}\left(\frac{\Upsilon_w}{\Upsilon}\right)w = \frac{1}{\Upsilon^2}\left\{\tilde{w}\Upsilon U_C\left[L_{\tilde{w}} + (w-b)(1+t_w)L_{\tilde{w}\tilde{w}} + L_{\tilde{w}}\right]\right.$$
$$+\,\tilde{w}\Upsilon U_{CC}\left[L + (w-b)L_{\tilde{w}}(1+t_w)\right]\left[(w-b)L_{\tilde{w}} + \frac{L}{(1+t_w)}\right]$$
$$\left.-\tilde{w}\Upsilon_w U_C\left[(w-b)L_{\tilde{w}} - (1-t_\pi)L\right]\right\}.$$

Consequently, we can write the numerator of equation (3.39) as follows:

$$-\widetilde{\Omega}_{wt_w}(1+t_w) + \widetilde{\Omega}_{ww}w$$
$$= \frac{1}{\Upsilon}\left\{\tilde{w}U_C L_{\tilde{w}}\left[1 - \frac{(w-b)}{w}\right] + \tilde{w}L\frac{U_{CC}\Upsilon_w}{U_C}\left[\frac{1}{(1+t_w)} + (1-t_\pi)\right]\right\}.$$

Thus, as $\Upsilon, U_C, \Upsilon_w, [1-(w-b)/w], (1+t_w), (1-t_\pi) > 0$ and $U_{CC}, L_{\tilde{w}} < 0$ we can also conclude that $\tilde{w}_{t_w} > 0$.

4. Derivation of $V_r + \lambda R_r = -U_C(\hat{\lambda}-1)\left(K + w_r w L/\tilde{w}_{t_w}\right)$

We have

$$\begin{aligned}
&V_r + \lambda R_r \\
&= U_C K + \lambda t_r K \\
&+ \tilde{r}_r\left\{U_C\cdot\left[(w-b)(L_{\tilde{r}} + L_{\tilde{w}}\tilde{w}_{\tilde{r}}) + Lw_{\tilde{r}} + (1-t_\pi)(-K - L\tilde{w}_{\tilde{r}})\right]\right. \\
&\left.+\lambda\left[t_\pi(-K - L\tilde{w}_{\tilde{r}}) + t_w L w_{\tilde{r}} + t_w w\left(L_{\tilde{r}} + L_{\tilde{w}}\tilde{w}_{\tilde{r}}\right) + t_r r\left(K_{\tilde{r}} + K_{\tilde{w}}\tilde{w}_{\tilde{r}}\right)\right]\right\} \\
&+ w_r\left\{U_C\cdot\left[(w-b)L_{\tilde{w}}(1+t_w) + L - (1-t_\pi)L(1+t_w)\right]\right. \\
&\left.+\lambda\left[-t_\pi L(1+t_w) + t_w L + t_w w L_{\tilde{w}}(1+t_w) + t_r r K_{\tilde{w}}(1+t_w)\right]\right\},
\end{aligned} \tag{3.40}$$

where $\tilde{r}_r = (1+t_r)$. By inserting the optimal tax rates the last term in curly brackets can be rearranged to

$$-\frac{U_C w L(\hat{\lambda}-1)}{\tilde{w}_{t_w}}.$$

The first-order condition for the capital tax, $V_{t_r} + \lambda R_{t_r} = 0$, can be written as

$$0 = \lambda r K + \tilde{r}_{t_r}\left\{U_C\cdot\left[(w-b)(L_{\tilde{r}} + L_{\tilde{w}}\tilde{w}_{\tilde{r}}) + Lw_{\tilde{r}} + (1-t_\pi)(-K - L\tilde{w}_{\tilde{r}})\right]\right.$$
$$\left.+\lambda\left[t_\pi(-K - L\tilde{w}_{\tilde{r}}) + t_w L w_{\tilde{r}} + t_w w\left(L_{\tilde{r}} + L_{\tilde{w}}\tilde{w}_{\tilde{r}}\right) + t_r r\left(K_{\tilde{r}} + K_{\tilde{w}}\tilde{w}_{\tilde{r}}\right)\right]\right\},$$

where $\tilde{r}_{t_r} = r$, and the term in curly brackets exactly coincides with the first term in curly bracket in equation (3.40). Thus, by inserting $\{\cdot\} = -\lambda K$ into the (3.40), we arrive at

$$\begin{aligned}
V_r + \lambda R_r &= U_C K + \lambda t_r K - \lambda K(1+t_r) \\
&+ w_r\left\{U_C\cdot\left[(w-b)L_{\tilde{w}}(1+t_w) + L - (1-t_\pi)L(1+t_w)\right]\right. \\
&\left.+\lambda\left[-t_\pi L(1+t_w) + t_w L + t_w w L_{\tilde{w}}(1+t_w) + t_r r K_{\tilde{w}}(1+t_w)\right]\right\}.
\end{aligned} \tag{3.41}$$

In order to simplify this expression, we make use of the first-order condition for the labor tax, $V_{t_w} + \lambda R_{t_w} = 0$, i.e.

$$\begin{aligned} 0 &= U_C[w_{t_w} L + (w-b)L_{\tilde{w}}\tilde{w}_{t_w} - (1-t_\pi)L\tilde{w}_{t_w}] \\ &\quad + \lambda\left[-t_\pi L\tilde{w}_{t_w} + wL + t_w L w_{t_w} + t_w w L_{\tilde{w}}\tilde{w}_{t_w} + t_r r K_{\tilde{w}}\tilde{w}_{t_w}\right] \end{aligned}$$

which can be rearranged to

$$\begin{aligned} & w_{t_w}\left\{U_C\left[L + (w-b)L_{\tilde{w}}(1+t_w) - (1-t_\pi)L(1+t_w)\right]\right. \\ & \left.+\lambda\left[-t_\pi L(1+t_w) + t_w L + t_w w L_{\tilde{w}}(1+t_w) + t_r r K_{\tilde{w}}(1+t_w)\right]\right\} \\ & = U_C\left[-(w-b)L_{\tilde{w}}w + (1-t_\pi)Lw\right] + \lambda\left[t_\pi Lw - wL - t_w w L_{\tilde{w}} w - t_r r K_{\tilde{w}} w\right], \end{aligned}$$

Inserting this formula into equation (3.41), we have

$$\begin{aligned} V_r + \lambda R_r &= -U_C K(\hat{\lambda}-1) \\ &\quad -\frac{w_r w U_C}{w_{t_w}}\left[(w-b)L_{\tilde{w}} + (\hat{\lambda}-1)(1-t_\pi)L + \hat{\lambda}\left(t_w w L_{\tilde{w}} + t_r r K_{\tilde{w}}\right)\right]. \end{aligned} \tag{3.42}$$

Finally, using the optimal tax rates in the Nash equilibrium in equation (3.42), we find that

$$-(w-b)L_{\tilde{w}} - (\hat{\lambda}-1)(1-t_\pi)L - \hat{\lambda}\left(t_w w L_{\tilde{w}} + t_r r K_{\tilde{w}}\right) = -(\hat{\lambda}-1)L w_{t_w}/\tilde{w}_{t_w}$$

so

$$\begin{aligned} V_r + \lambda R_r &= -U_C K(\hat{\lambda}-1) - \frac{w_r}{\tilde{w}_{t_w}} w U_C(\hat{\lambda}-1)L \\ &= -(\hat{\lambda}-1)U_C\left[K + \frac{w_r}{\tilde{w}_{t_w}} wL\right]. \end{aligned}$$

as given in the text, where the only term whose sign is ambiguous is w_r [see equation (3.43) below].

5. Factor price changes in response to capital tax coordination

By totally differentiating $\overline{K} = K(\tilde{w}, \tilde{r}, P)$ and taking $w = w(t_w, \tilde{r}, r, P, G)$ from the Nash bargaining result into account, we have

$$\begin{aligned} r_{t_r}\big|_{dK=0} &= -\frac{dK/dt_r}{dK/dr} \\ &\quad -\frac{K_{\tilde{r}}\tilde{r}_{t_r} + K_{\tilde{w}}(1+t_w)w_{\tilde{r}}\tilde{r}_{t_r}}{K_{\tilde{r}}\tilde{r}_r + K_{\tilde{w}}(1+t_w)w_{\tilde{r}}\tilde{r}_r + K_{\tilde{w}}(1+t_w)w_r} \\ &= -\frac{r}{(1+t_r)}\frac{K_{\tilde{r}} + K_{\tilde{w}}(1+t_w)w_{\tilde{r}}}{K_{\tilde{r}} + K_{\tilde{w}}(1+t_w)w_{\tilde{r}} + K_{\tilde{w}}(1+t_w)w_r/(1+t_r)} \\ &= -\frac{r}{(1+t_r)}\left[1 - \frac{K_{\tilde{w}}(1+t_w)w_r/(1+t_r)}{K_{\tilde{r}} + K_{\tilde{w}}(1+t_w)w_{\tilde{r}} + K_{\tilde{w}}(1+t_w)w_r/(1+t_r)}\right]. \end{aligned}$$

For the wage response to a change in the net interest rate (at a constant $\tilde{r}$), we need $w_r = -\widetilde{\Omega}_{wr}/\widetilde{\Omega}_{ww}$. In detail, we have the following for $\widetilde{\Omega}_{wr}$:

$$\frac{\partial}{\partial r}\left(\frac{\pi_w}{\pi}\right) = 0$$

and

$$\frac{\partial}{\partial r}\left(\frac{\Upsilon_w}{\Upsilon}\right) = \frac{K\Upsilon_w}{\Upsilon}\left(\frac{U_{CC}}{U_C} - \frac{U_C - U_C^0}{\Upsilon}\right),$$

The wage response can, therefore, be written as

$$w_r = -\frac{\beta}{\widetilde{\Omega}_{ww}}\frac{K\Upsilon_w}{\Upsilon}\left(\frac{U_{CC}}{U_C} - \frac{U_C - U_C^0}{\Upsilon}\right). \tag{3.43}$$

Thus, for a joint increase in the capital tax, the net interest rate changes according to

$$r_{t_r}\big|_{dK=0} = -\frac{r}{(1+t_r)}\left[1 + \frac{\beta(\Upsilon_w/\Upsilon)\cdot\left(K/\widetilde{\Omega}_{ww}\right)\left[U_{CC}/U_C - (U_C - U_C^0)/\Upsilon\right]}{K_{\tilde{r}} + K_{\tilde{w}}(1+t_w)w_{\tilde{r}} + K_{\tilde{w}}(1+t_w)w_r/(1+t_r)}\right].$$

6. Derivation of equation (3.28)

The marginal tax revenues from higher public spending are given by

$$R_w w_G = 0, \tag{3.44}$$

since we restrict our example to a quasi-linear utility function, and

$$\begin{aligned} R_P + R_w w_P = {} & (1-t_\pi)\pi_P + t_r r K_P + t_w w L_P + (1-t_\pi)\pi_{\tilde{w}}(1+t_w)w_P \\ & + t_r r K_{\tilde{w}}(1+t_w)w_P + t_w L w_P + t_w w L_{\tilde{w}}(1+t_w)w_P, \end{aligned} \tag{3.45}$$

respectively. For the special case where the utility function is linear in private consumption, a joint increase in the capital tax does not affect the real allocation. Consequently, in equation (3.45) only the terms that contain $t_r r$ will change due to a capital tax coordination. Since $V_G = U_G$ and $V_P + V_w w_P = U_C[Lw_P + (w-b)L_P + (1-t_\pi)\pi_P] + U_C[L + (w-b)L_{\tilde{w}}(1+t_w)]w_P$ are not altered by a joint increase in the capital tax and the subsequent change in r, we have the following:

$$\left.\frac{\partial MBF(G)}{\partial t_r}\right|_{dK=0} = 0$$

and

$$\begin{aligned} \left.\frac{\partial MBF(P)}{\partial t_r}\right|_{dK=0} &= \frac{(V_P + V_w w_P)\cdot\left(\left.\frac{\partial R_P}{\partial t_r}\right|_{dK=0} + \left.\frac{\partial R_w}{\partial t_r}\right|_{dK=0} w_P\right)}{(1 - R_P - R_w w_P)^2} \\ &= \frac{MBF(P)\cdot[K_P + K_{\tilde{w}}(1+t_w)w_P]}{(1 - R_P - R_w w_P)}\left.\frac{\partial(t_r r)}{\partial t_r}\right|_{dK=0}. \end{aligned}$$

Using $MBF(P) > 0$, the expression $\partial(t_r r)/\partial t_r|_{dK=0} = r/(1+t_r) > 0$ as well as the assumption that the model is stable in the sense that $1 - dR/dP > 0$, yields the inequality (3.28) as given in the text.

Chapter 4

Fighting Tax Competition in the Presence of Unemployment: Complete versus Partial Tax Coordination

Abstract

In this chapter, we analyze the welfare consequences of tax coordination agreements which cover taxes on mobile capital and immobile labor, respectively. In doing so, we take into account two important institutional details. First, we incorporate decentralized wage bargaining, giving rise to involuntary unemployment. Second, we distinguish between complete tax coordination, which effectively covers both tax instruments, and the more plausible case of partial tax coordination, where one tax is marginally increased by all countries, while the other tax rate can still be freely chosen by all countries. It is shown that complete tax coordination remains welfare enhancing in the presence of unemployment. In contrast, for partial tax coordination, the welfare effects become ambiguous and are different to the case of competitive labor markets.

JEL Classification: H21, H87, J51

Keywords: factor taxation, (partial) tax coordination, wage bargaining, unemployment

4.1 Introduction

Fiscal competition among countries has received increasing attention as jurisdictions are connected by mobile capital. This has created an extensive literature on the (un)desirability of international tax competition.[1] As one basic result, it has been pointed out that benevolent governments ignore the external effect their tax policy has on the tax base of other countries via capital mobility (Wildasin 1989). Thus, each policy instrument that is able to increase the attractiveness of domestic capital employment, e.g., tax cuts, will be excessively used by all countries. Consequently, the resulting equilibrium is inefficient from a worldwide perspective as the public good provision is too low compared with the Samuelson rule (Samuelson 1954). Theoretically, all countries would be better off by jointly increasing their level of taxation in order to capture resources from capital owners since the latter cannot escape a worldwide tax increase.

However, this standard tax competition result of undertaxation in the uncoordinated Nash equilibrium has been challenged by incorporating various existing institutional characteristics pointing out that a joint tax increase may even be welfare worsening. The level of taxation may even be too high in the uncoordinated equilibrium if, e.g., non-benevolent governments are taken into account (Edwards and Keen 1996), federal structures are considered, which give rise to vertical fiscal externalities (Keen and Kotsogiannis 2002, 2003), or public input goods are incorporated (Noiset 1995).

In this chapter, we take a different view by analyzing whether a coordinated tax increase may be welfare worsening even if the Nash equilibrium is characterized by undertaxation. In doing so, we allow for two institutional details to be found in many countries and analyze the way they interact if tax coordination is carried out. First, we incorporate that labor markets are frequently characterized by wage bargaining, giving rise to involuntary unemployment. Second, and in contrast to parts of the previous literature, we take into account that an international coordination agreement is unlikely to cover all policy instruments available to local governments. In fact, it is more plausible that tax coordination is carried out with regard to *one* tax rate only, whereas all governments are nevertheless free to choose their remaining tax instrument(s) afterwards. This approach can also be motivated by the existence of federal structures, where one tax rate is (jointly) determined on a federal level while local states can nevertheless choose another tax rate non-cooperatively.

So far, the literature that combines optimal taxation with unemployment mostly

[1] This branch of literature was initiated by the seminal contributions of Wilson (1986) and Zodrow and Mieszkowski (1986). For a survey, see Wilson (1999).

concentrated on characterizing the structure of optimal taxation in a small open economy by incorporating wage bargaining (see, e.g., Richter and Schneider 2001 and Koskela and Schöb 2002a) or efficiency wages (Eggert and Goerke 2004). One exception is the contribution by Fuest and Huber (1999b), where tax coordination is addressed explicitly. Their analysis is motivated by the presumption that, as tax competition puts a downward pressure on tax rates, this may be desirable if involuntary unemployment calls for a reduced level of taxation. Fuest and Huber put forward that in the presence of involuntary unemployment due to decentralized wage negotiations, tax competition might be welfare enhancing. In particular, they argue that, for a labor demand elasticity which is smaller than one in absolute terms, a coordinated increase in the capital tax and the wage tax, respectively, reduces welfare. However, they discuss complete coordination only, i.e. they consider a coordinated increase in one tax rate while keeping the respective other tax rate constant.

On the other hand, the existing literature on partial policy coordination has not yet taken into account imperfections on the labor market. Starting with the seminal contribution by Copeland (1990) with respect to trade policy, several authors have analyzed how countries might react to tax coordination if other policy instruments are available which have *not* been subject to the coordination agreement. In response to a joint tax increase, governments may adjust their provision of a public input good (Fuest 1995), other tax rates or depreciation allowances (Fuest and Huber 1999a), tax auditing activities (Cremer and Gahvari 2000) or a tax on a complementary factor (Marchand et al. 2003). Intuitively, in all cases, countries try to compete back to their initial Nash equilibrium. However, as has been shown in chapter 2 for the case of a fully competitive labor market, the total welfare effect of partial tax coordination not only depends on the extent to which all countries are able to compete back to the initial Nash equilibrium. In addition, there may also be positive or negative welfare effects if the distortion of the pre-existing tax system is altered.

The aim of the present chapter is to contribute to the literature of tax coordination by taking into account labor market imperfections due to decentralized wage bargaining as well as incomplete, i.e. partial, tax coordination agreements. In doing so, a similar model setup is used as in chapter 2, where partial tax coordination is analyzed in the presence of a fully competitive labor market. In detail, we allow for less than 100 percent profit taxation and, in contrast to many other models of wage negotiations (see, e.g., Koskela and Schöb 2002a), we assume the marginal disutility of supplying labor to be non-constant (see, e.g., Keen and Marchand 1997 or Fuest and Huber 1999b). It is first shown that, in the presence of unemployment due to wage bargaining, the usage of distortionary taxation deviates from the case of fully competitive labor markets. However, unemployment does not justify different policy conclusions with respect to complete tax coordination. The welfare effect is always positive and qualitatively similar to the scenario of perfect labor markets. In contrast, for partial tax coordination, the welfare effects are shown to become ambiguous and are different to the case of a flexible labor market.

The chapter is organized as follows. The basic model of a small unionized country is set up in section 4.2. Section 4.3 presents each country's optimal behavior in the uncoordinated equilibrium. Complete tax coordination is considered in section 4.4, where one tax rate is jointly increased and the respective other tax rate is kept constant. This assumption is then relaxed in section 4.5, where we study the welfare consequences of partial tax coordination. Finally, the last section summarizes and concludes.

4.2 The model

We consider an economy that consists of many small and symmetric countries. Each country is inhabited by a large number of (homogenous) households, the number of which we normalize to one. The (representative) household is endowed with a fixed amount of capital $\overline{K}$ and earns a net profit $(1 - t_\pi)\pi$ from national firm ownership. Capital is assumed to be perfectly mobile and can be invested in the home country or in the rest of the world to earn a constant net return r per unit. The profit income accruing to private households is interpreted as the average net profit in the country. In addition to capital income $r\overline{K}$ and net profit income, households obtain income by supplying labor, where we treat labor as perfectly immobile between countries.[2] Each household has a fixed total time endowment of which L units are labor supply. Following Keen and Marchand (1997) as well as Fuest and Huber (1999b), we capture the disutility from supplying labor by the term $e(L)$, with $e(0) = 0$, $e'(L) > 0$ as well as $e''(L) > 0$. For a fully flexible labor market, as considered in chapter 2, we would have $w = e'(L)$ as the optimal choice of each household's labor supply. However, as we will assume that the net wage rate w is determined by decentralized wage bargaining, each household will be underemployed in the sense that her choice of labor supply is rationed by labor demand. This implies that the bargained net wage rate w exceeds the marginal disutility $e'(L)$ of labor.[3]

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[2] The results would not change if we define two separate groups of households, called capitalists and workers.

[3] Alternatively, we may think of unemployment instead of underemployment. To do so, we should think of the households to be heterogeneous and divided into L employed households and $(1-L)$ unemployed households. In this case, we should also reinterpret $e(L)$ to be a measure of the

Total private utility V is assumed to be additive and consists of two parts. The first one is assumed to be linear in income and represents the net benefit from supplying labor plus capital and net profit income. The second part is utility derived from public good consumption $u(G)$, where $u' > 0$ and $u'' < 0$. Hence,

$$V = wL - e(L) + r\overline{K} + (1 - t_\pi)\pi + u(G). \tag{4.1}$$

In the following, we will assume that the disutility from labor supply is quadratic, i.e. $e'''(L) = 0$, for algebraic convenience.[4]

Each country's government provides the public good G and raises revenue R with a non-distortionary profit tax t_π levied on the rent of a third (non-specified) factor,[5] a source-based capital tax t_r on net capital income from domestic capital input, and a wage tax t_w on net labor income. We will assume that the profit tax is restricted to a maximum level $\bar{t}_\pi$, where $0 \leq \bar{t}_\pi \leq 1$, and its revenue does not suffice to ensure a first-best solution, i.e. to provide the public good at the first-best level as well as designing the tax system in order to fully correct for the labor market distortion. The government budget constraint is given by

$$G = t_\pi \pi + t_r rK + t_w wL = R, \tag{4.2}$$

where the marginal cost of the public good is normalized to one, implying a linear marginal rate of transformation of one between private output and the public good. In what follows, the government will be treated to be a Stackelberg leader towards the private sector behavior, including the wage negotiations between firms and trade unions.

Turning to the production side of the small jurisdiction, a homogenous output good Y is produced by a large number of identical firms, whose number we can normalize to one. The (representative) firm utilizes capital K and labor L as the only variable factor inputs to production. To keep the model manageable, we use a production function with a constant elasticity of substitution between labor and

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aggregate disutility of supplying labor for the whole country and $w > e'(L)$ indicates involuntary unemployment of the $(1 - L)$ households. The term $e'(L)$ then denotes the disutility of the L-th household being employed.

[4] The literature on tax policy in the presence of wage bargaining often treats the marginal disutility of labor as a constant term, i.e. $e''(L) = 0$. See, e.g., Boeters and Schneider (1999) or Koskela and Schöb (2002a). Thus, our assumption of a quadratic disutility is even more general than the previous literature. Note that $e''(L) > 0$ implies that the household's preferred labor supply is increasing the net wage rate.

[5] A tax on profits is indeed non-distortionary in this setting, as we assume firms to be immobile. This is a standard assumption in the existing literature on capital mobility. For models with firm mobility see, e.g., Richter and Wellisch (1996), Janeba (1998) or Aronsson and Sjögren (2004b).

capital as well as decreasing returns to scale in both factors:

$$Y = F(K,L) = \left[\left(K^{\frac{\sigma-1}{\sigma}} + L^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}\right]^{1-1/\varepsilon}, \tag{4.3}$$

where $\varepsilon > 1$ indicates decreasing returns to scale in capital and labor due to the existence of a third (fixed) factor such as land. The parameter $\sigma \geq 0$ denotes the elasticity of substitution between capital and labor. Let the output good be the numeraire.[6]

Taking gross factor prices $\tilde{r} = (1+t_r)r$ and $\tilde{w} = (1+t_w)w$ as given, firms maximize profits and thereby choose capital and labor inputs according to $\partial F(K,L)/\partial K = \tilde{r}$ and $\partial F(K,L)/\partial L = \tilde{w}$. Together with the above production function, this allows us to derive unconditional factor demands $L(\tilde{w},\tilde{r})$ and $K(\tilde{w},\tilde{r})$ with corresponding elasticities that solely depend on the parameters of the productions function, i.e. σ and ε, as well as on the cost share of labor s (see Hamermesh 1993 or, e.g., Koskela and Schöb 2002a,b):

$$\eta_{L,\tilde{w}} = -(1-s)\sigma - s\varepsilon < 0, \tag{4.4a}$$

$$\eta_{K,\tilde{r}} = -s\sigma - (1-s)\varepsilon < 0, \tag{4.4b}$$

$$\eta_{L,\tilde{r}} = (1-s)(\sigma - \varepsilon), \tag{4.4c}$$

$$\eta_{K,\tilde{w}} = s(\sigma - \varepsilon), \tag{4.4d}$$

where s is given by

$$s = s(\tilde{w},\tilde{r}) = \frac{\tilde{w}^{1-\sigma}}{\tilde{w}^{1-\sigma} + \tilde{r}^{1-\sigma}}.$$

As is common in the literature, we assume capital and labor to be price complements, which is equivalent to suppose $F_{KL} > 0$ as a property of the production function. Consequently, we have $\sigma - \varepsilon < 0$ and the cross-price elasticities (4.4c) and (4.4d) are negative in sign as the substitution effect does not outweigh the scale effect.

4.3 The non-cooperative Nash equilibrium

4.3.1 Wage bargaining

The small country's net of tax wage rate is supposed to be the outcome of a decentralized union-firm bargain. In particular, we adopt the right-to-manage approach

[6] Equation (4.3) can also be interpreted as being a linear-homogenous production function in capital and labor, where the output good faces imperfect competition on the world product market due to monopolistic competition (see Dixit and Stiglitz 1977). In this case, $\varepsilon > 1$ represents the constant price elasticity of output demand.

in which the firm can choose employment conditional on the bargained wage rate. For each country, we assume many small and symmetric trade unions that treat government policy, i.e. t_w, t_r and G, as well as the net interest rate r as given. For simplicity, let the total number of trade unions be normalized to one.

Turning to the objective function of the representative trade union, we first assume that all households are trade union members and membership is not subject to changes. The trade union is then interested in maximizing the utility of households as given by equation (4.1). If the wage negotiation fails, union members receive the outside utility V^o which is, for a small union, given by the member's capital income, average profit income from total domestic firm ownership as well as the utility derived from public good consumption, since these numbers are not affected by the outcome of a decentralized wage negotiation:

$$V^o = r\overline{K} + (1 - t_\pi)\pi + u(G).$$

Consequently, the trade union's rent from bargaining with the firm is given by

$$\Lambda = V - V^o = wL - e(L).$$

For the representative firm, we assume, as usual, that the outside option is given by zero profits, $\pi^o = 0$.[7] Hence, the rent from bargaining with the trade union is determined by the net of tax profits, $(1 - t_\pi)\pi$.

The Nash maximand of the wage bargaining problem can be written as

$$\Omega = \Lambda^\beta \left[(1 - t_\pi)\pi\right]^{1-\beta},$$

where β denotes the relative bargaining power of the union. The net of tax wage rate w is then implicitly defined by the first-order condition $\Omega_w = 0$ which balances the percentage change in both parties' rents, weighted by their respective bargaining power. This can be rearranged to

$$\widehat{\Omega}_w = \beta \left[w + (w - e')\eta_{L,\tilde{w}}\right] + (1 - \beta)(1 - \varepsilon)s \left(w - \frac{e(L)}{L}\right) = 0. \qquad (4.5)$$

Note that in equation (4.5) the labor demand elasticity $\eta_{L,\tilde{w}}$, the cost share of labor s as well as the labor demand L, in turn, depend on the gross factor prices $\tilde{w} = w(1 + t_w)$ and $\tilde{r} = r(1 + t_r)$. In what follows, we assume that the trade union's bargaining power β is sufficiently large such that $w - e' > 0$ is fulfilled, indicating involuntary unemployment.

[7] This requires firms to be immobile as supposed above. This assumption is frequently made in the literature (see, e.g., Koskela and Schöb 2002a,b or Aronsson 2005). With firm mobility, the outside option is given by foreign net of tax profits (see Aronsson and Sjögren 2004b).

Since the government acts as a Stackelberg leader vis-à-vis the private sector, we need to determine how the bargained wage is altered as a reaction to changes in the policy instruments. Our specification of private utility does not allow for an influence of the public good on the wage rate. However, the net wage reactions in response to changes in the tax rates are given by

$$w_i = \frac{\partial w}{\partial i} = -\frac{\widehat{\Omega}_{wi}}{\widehat{\Omega}_{ww}}, \quad i = t_w, t_r,$$

where $\widehat{\Omega}_{ww} < 0$ must hold as a second-order condition of the Nash bargain. Thus, to determine how the wage rate is affected by tax policy, the sign of $\widehat{\Omega}_{wi}$ is important. In detail, we have for the impact of the wage tax rate

$$\widehat{\Omega}_{wt_w} = xs_{t_w} - \frac{\beta\eta^2_{L,\tilde{w}}e''(L)L}{1+t_w} - (1-\beta)(1-\varepsilon)s\frac{\eta_{L,\tilde{w}}}{1+t_w}\left(e' - \frac{e(L)}{L}\right), \tag{4.6}$$

where $x = \beta(w-e')(\sigma-\varepsilon) + (1-\beta)(1-\varepsilon)\left(w - e(L)/L\right) < 0$ and $e'(L) > e(L)/L$ due to our assumption that $e(0) = 0$ and $e''(L) > 0$. In equation (4.6), the first term indicates that an increase in the cost share of labor *ceteris paribus* leads to a reduction in the bargained wage for two reasons. Firstly, the labor demand elasticity increases in absolute terms thereby increasing the union's marginal cost from a wage increase in terms of laid-off workers. Secondly, the reduction in profits following a wage increase becomes more pronounced which, in turn, increases the marginal damage to a firm. According to the second term in (4.6), an increase in the wage tax lowers employment which, in turn, reduces the marginal disutility of labor and renders an increase in employment through a wage cut more interesting for the trade union. Finally, the last term denotes that an increase in wage taxation will lower employment and thus, in turn, the worker's rent from being employed. Furthermore, we have

$$\widehat{\Omega}_{wt_r} = xs_{t_r} - \frac{\beta\eta_{L,\tilde{w}}\eta_{L,\tilde{r}}e''(L)L}{1+t_r} - (1-\beta)(1-\varepsilon)s\frac{\eta_{L,\tilde{r}}}{1+t_r}\left(e' - \frac{e(L)}{L}\right), \tag{4.7}$$

$$\widehat{\Omega}_{ww} = xs_w - \frac{\beta\eta_{L,\tilde{w}}\eta_{L,\tilde{w}}e''(L)L}{w} - (1-\beta)(1-\varepsilon)s\frac{\eta_{L,\tilde{w}}}{w}\left(e' - \frac{e(L)}{L}\right) + \beta(1+\eta_{L,\tilde{w}}) + (1-\beta)(1-\varepsilon)s. \tag{4.8}$$

The interpretation of equation (4.7) is analogous to the one with respect to the wage tax rate. The change in the cost share of labor, however, differs among both tax rates and depends on the elasticity of substitution:

$$s_{t_w} = \frac{(1-\sigma)(1-s)s}{1+t_w}, \tag{4.9}$$

$$s_{t_r} = -\frac{(1-\sigma)(1-s)s}{1+t_r}. \tag{4.10}$$

For the impact of the wage tax on the gross wage rate $\tilde{w}_{t_w} = w + (1+t_w)w_{t_w}$ we obtain

$$\tilde{w}_{t_w} = \frac{w\left[\beta(1+\eta_{L,\tilde{w}}) + (1-\beta)(1-\varepsilon)s\right]}{\widehat{\Omega}_{ww}}. \tag{4.11}$$

Signing this expression, requires to take a closer look at the first-order condition of the Nash maximand. Solving equation (4.5) for the net wage rate yields

$$w = \frac{\beta e'(L)\eta_{L,\tilde{w}} + (1-\beta)(1-\varepsilon)se(L)/L}{\beta\left(1+\eta_{L,\tilde{w}}\right) + (1-\beta)(1-\varepsilon)s}. \tag{4.12}$$

As the numerator of (4.12) is strictly negative due to $\eta_{L,\tilde{w}} < 0$ and $\varepsilon > 1$, we must have

$$\beta\left(1+\eta_{L,\tilde{w}}\right) + (1-\beta)(1-\varepsilon)s < 0 \tag{4.13}$$

to ensure that the bargained wage rate is positive. Together with $\widehat{\Omega}_{ww} < 0$, the inequality in (4.13) then allows us to conclude from (4.11) that increasing the wage tax will unambiguously increase the gross wage (and hence reduce employment).

4.3.2 Welfare maximization

Assuming a benevolent government, the Lagrangian, to be maximized with respect to G, t_π, t_w and t_r, comprises the total private utility (4.1), the government budget constraint (4.2) and a restriction on the maximum level of admissible profit taxation. Hence,

$$\mathcal{L} = wL - e(L) + r\overline{K} + (1-t_\pi)\pi + u(G) + \lambda\left(t_\pi\pi + t_w wL + t_r rK - G\right) + \mu\left(\bar{t}_\pi - t_\pi\right),$$

where we keep in mind that $w = w(t_w, t_r, r)$ and $L(\cdot), K(\cdot)$ as well as $\pi(\cdot)$ depend on both gross factor prices $\tilde{r} = r(1+t_r)$ and $\tilde{w} = (1+t_w)w(t_w, t_r, r)$. The parameters λ as well as μ denote Lagrangian multipliers on the government budget constraint and the maximum level of profit taxation, respectively. The first-order conditions with respect to the public good G and the profit tax rate t_π are as follows:

$$u'(G) = \lambda, \tag{4.14}$$

$$(\lambda - 1)\pi = \mu. \tag{4.15}$$

According to condition (4.14), public good provision should be expanded until the marginal utility of public good consumption equals the marginal costs of its provision. In our case, the latter is given by the marginal costs of public funds λ since by assumption the marginal rate of transformation between the private and the public good is equal to one. This is referred to as the modified Samuelson rule (see Atkinson and Stern 1974).

Given the complementary slackness condition $\mu\left(\bar{t}_\pi - t_\pi\right) = 0$,we can distinguish two cases. Firstly, if the restriction on profit taxation is not binding, $\bar{t}_\pi > t_\pi$, we have $\mu = 0$ and we can infer from (4.15) that $\lambda = 1$. Tax revenue is then raised non-distortionarily by the profit tax and public good provision is first-best. Secondly, if the restriction is binding, then $t_\pi = \bar{t}_\pi$ and $\mu > 0$ so that $\lambda > 1$ and we are in the more relevant scenario of a second-best world. Public good provision is then inefficiently low, $u'(G) > 1$, because taxation is distortionary (at the margin). In what follows, we restrict our attention to the scenario of second-best taxation, i.e. the case with $\mu > 0$ and $\lambda > 1$.

Turning to the first-order conditions with respect to the tax rates, we have $\partial\mathcal{L}/\partial t_w = 0$ which can be written as

$$0 = \frac{w - e'}{\tilde{w}}\eta_{L,\tilde{w}}\tilde{w}_{t_w} + (\lambda - 1)\left[(1 - \bar{t}_\pi)\tilde{w}_{t_w} - w_{t_w}\right] + \tilde{w}_{t_w}\left(\frac{\lambda t_w}{1 + t_w}\eta_{L,\tilde{w}} + \frac{\lambda t_r}{1 + t_r}\eta_{L,\tilde{r}}\right) \tag{4.16}$$

and $\partial\mathcal{L}/\partial t_r = 0$ which yields

$$\begin{aligned} 0 \;=\; & (w - e')\left(\frac{\eta_{L,\tilde{w}}\tilde{w}_{t_r}(1 + t_r)}{\tilde{w}} + \eta_{L,\tilde{r}}\right) \\ & +(\lambda - 1)\left[(1 - \bar{t}_\pi)\left(\tilde{w}_{t_r}(1 + t_r) + \tilde{w}\frac{1 - s}{s}\right) - w_{t_r}(1 + t_r)\right] \\ & +\frac{\lambda t_w}{1 + t_w}\left(\eta_{L,\tilde{w}}\tilde{w}_{t_r}(1 + t_r) + \tilde{w}\eta_{L,\tilde{r}}\right) + \frac{\lambda t_r}{1 + t_r}\left(\eta_{L,\tilde{r}}\tilde{w}_{t_r}(1 + t_r) + \tilde{w}\frac{1 - s}{s}\eta_{K,\tilde{r}}\right). \end{aligned} \tag{4.17}$$

Each of the two first-order conditions defines the marginal costs of public funds for the respective tax instrument, defined as the utility loss in absolute terms per unit of additional tax revenue. Any level of tax revenue is then raised efficiently by the available tax instruments if the marginal costs of public funds are equalized among the tax rates.

After some manipulation of the above first-order conditions we can derive the following expression for the (effective) capital tax rate (see Appendix 1):

$$\frac{t_r}{1 + t_r} = \frac{\lambda - 1}{\lambda}\left[\frac{1 - \bar{t}_\pi}{\varepsilon} + \frac{\eta_{L,\tilde{w}}}{\sigma\varepsilon}\frac{w_{t_r}}{\tilde{w}_{t_w}}\frac{wL}{rK} - \frac{\eta_{K,\tilde{w}}}{\sigma\varepsilon}\frac{w_{t_w}}{\tilde{w}_{t_w}}\right], \tag{4.18}$$

Thus, there are only two mechanisms at work for the optimal usage of the capital tax rate. The first term on the right hand side of (4.18) captures how capital taxation is used as a means to indirectly tax pure profits if the maximum level of the admissible profit tax is less than 100 percent (see Huizinga and Nielsen 1997). It is important to note that the parameter $\varepsilon > 1$ determines the extent to which pure profits are available since $1/\varepsilon = \pi/Y$ represents the profit share of domestic production. The two remaining terms on the right hand side of (4.18) then indicate that capital taxation is used strategically depending on the interaction between taxation and the wage bargaining result. On the one hand, if an increase in the capital tax is associated with a higher net wage, this provides an incentive to *ceteris paribus* use the capital tax as a subsidy in order to lower the wage rate. If, on the other hand, a higher *wage tax* is associated with a higher net wage, the capital tax will be chosen to be positive *ceteris paribus* in order to provide funds that allow for a reduction in the wage tax. Due to our specification of the production function and private utility, we are able to write the combined effect in a more convenient way so that the capital tax rate becomes

$$\frac{t_r}{1+t_r} = \frac{\lambda - 1}{\lambda}\left[\frac{1-\bar{t}_\pi}{\varepsilon} - \frac{s}{1-s}\frac{x(1-\sigma)(1-s)s}{\sigma\tilde{w}\left[\beta(1+\eta_{L,\tilde{w}}) + (1-\beta)(1-\varepsilon)s\right]}\right]. \tag{4.19}$$

where $x < 0$ is as defined above. This term would vanish for a competitive labor market without involuntary unemployment, where the labor market outcome is solely determined by $w = e'$. Consequently, the component of the capital tax that enters due to the presence of unemployment (i.e. the second term in brackets) contributes to a positive (negative) capital tax *ceteris paribus* if σ is greater (less) than one. For instance, if capital and labor are close substitutes ($\sigma > 1$), a higher capital tax will boost the cost share of labor s. As a consequence, labor demand becomes more elastic and firm profits become more sensitive to wage increases. Both effects will induce the bargaining parties to moderate their wage claims. This interaction between capital taxation and wage setting is not present in a competitive labor market.

The effective wage tax rate is given by

$$\frac{t_w}{1+t_w} = \frac{\lambda - 1}{\lambda}\left[\frac{1-\bar{t}_\pi}{\varepsilon} + \frac{\eta_{K,\tilde{r}}}{\sigma\varepsilon}\frac{w_{t_w}}{\tilde{w}_{t_w}} - \frac{\eta_{L,\tilde{r}}}{\sigma\varepsilon}\frac{w_{t_r}}{\tilde{w}_{t_w}}\frac{wL}{rK}\right] - \frac{w-e'}{\lambda\tilde{w}}. \tag{4.20}$$

The interpretation of the wage tax is now different from both the capital tax derived above and the wage tax in a competitive environment. In the presence of a flexible labor market, the government would use distortionary taxation only to indirectly tax pure profits and intra-marginal rents accruing to labor suppliers. This is changed in the presence of wage bargaining since additional mechanisms enter the optimal tax formula. The first part of equation (4.20) shows a similar pattern as the optimal capital tax rate. Wage taxation is also used to indirectly capture pure profits and the wage tax is *ceteris paribus* higher if an increase in the wage tax or reduction in the capital tax is able to reduce the bargained wage rate. The last term entering the optimal wage tax equation (4.20), represents the ability of the wage tax to directly reduce the distortion on the (monopolized) labor market by subsidizing labor. This effect goes back to Guesnerie and Laffont (1978) who show that, in a first-best scenario, the price maker's output should be subsidized in order to restore Pareto-efficiency. In the second-best setup discussed here, the subsidy, however, must be weighted by $1/\lambda$ to take into account the welfare costs of distortionary taxation. Combining the two terms which comprise the wage responses of tax policy, we can express the optimal wage tax as follows:

$$\begin{aligned}\frac{t_w}{1+t_w} &= \frac{\lambda-1}{\lambda}\frac{1-\bar{t}_\pi}{\varepsilon} + \frac{\lambda-1}{\lambda}\frac{x(1-\sigma)(1-s)s}{\sigma\tilde{w}\left[\beta(1+\eta_{L,\tilde{w}})+(1-\beta)(1-\varepsilon)s\right]} \\ &+ \frac{\lambda-1}{\lambda}\frac{\left[\beta\eta_{L,\tilde{w}}e''(L)L+(1-\beta)(1-\varepsilon)s\left(e'(L)-\frac{e(L)}{L}\right)\right]}{\tilde{w}\left[\beta(1+\eta_{L,\tilde{w}})+(1-\beta)(1-\varepsilon)s\right]} - \frac{w-e'}{\lambda\tilde{w}}.\end{aligned} \tag{4.21}$$

The combined effect as given in equation (4.21), reveals that the impact running through a change in the cost share of labor has the opposite sign to the capital tax rate since the overall level of taxation is not used to strategically influence the bargaining outcome. Additionally, however, it turns out that the wage tax is used to tax rents accruing to intra-marginal labor suppliers. Even if we fully abstract from trade union wage setting and the corresponding rent accruing to employed workers beyond the competitive wage level $w = e'(L)$, intra-marginal labor suppliers obtain rents which give rise to taxation since the marginal disutility of supplying labor is increasing, i.e. $e'(L), e''(L) > 0$.[8] The latter mechanism is present in a competitive labor market as well. Summing up, the tax structure presented above resembles the results derived by Koskela and Schöb (2002a) and extends them to the case of $e''(L) > 0$.

4.4 Complete tax coordination

Turning to tax coordination, we first analyze *complete* tax coordination in the sense that coordination is effectively carried out with respect to *both* the capital tax as well as the wage tax rate. In doing so, we consider a special case of complete tax coordination, where one tax rate is marginally increased by all countries and the respective other tax rate is agreed to remain constant throughout. This (rather restrictive) procedure is employed by, e.g., Bucovetsky and Wilson (1991) and Wilson (1995) for the case of perfect labor markets as well as Fuest and Huber (1999b) for imperfect labor markets.

[8] In fact, it is easy to show that the level of distortionary taxation, i.e. $t_r rK + t_w wL$, is solely used to extract rents from the private sector (from private production if $\bar{t}_\pi < 1$ and from labor suppliers as $e''(L) > 0$) and to correct for the labor market imperfection (as $w - e' > 0$).

4.4.1 Complete coordination of the capital tax

For a joint increase in the capital tax rate at a constant wage tax, we first have to determine the repercussions on factor prices and allocation. After the marginal coordination has been implemented, capital employed in each country is still equal to the country's fixed capital endowment due to our assumption of symmetric jurisdictions:

$$\overline{K} = K(\tilde{w}, \tilde{r}), \tag{4.22}$$

where the net interest rate r is now subject to changes if capital demand is altered by a joint policy action. Furthermore, on the labor market both bargaining parties still choose their optimal wage rate in the new equilibrium, so that after coordination we still have

$$\widehat{\Omega}_w = 0. \tag{4.23}$$

Totally differentiating the equations (4.22) and (4.23) with respect to t_r, w and r yields the factor price reactions for a joint increase in the capital tax rate. We have

$$\begin{aligned} \left.\frac{\partial r}{\partial t_r}\right|_{dK=0}^{dt_w=0} &= -\frac{r\left(w\eta_{K,\tilde{r}}/\eta_{K,\tilde{w}} + w_{t_r}(1+t_r)\right)}{(1+t_r)\left(w\eta_{K,\tilde{r}}/\eta_{K,\tilde{w}} + w_r r\right)} \\ &= -\frac{r}{1+t_r} < 0, \end{aligned}$$

since $w_{t_r}(1+t_r) = w_r r$ and[9]

$$\left.\frac{\partial \tilde{r}}{\partial t_r}\right|_{dK=0}^{dt_w=0} = \left.\frac{\partial w}{\partial t_r}\right|_{dK=0}^{dt_w=0} = \left.\frac{\partial \tilde{w}}{\partial t_r}\right|_{dK=0}^{dt_w=0} = 0.$$

As a consequence, the real allocation is unchanged and capital owners have to bear the full burden of the joint increase in the capital tax as their net remuneration is reduced.[10]

Given the above factor price changes in the presence of (complete) capital tax coordination, the corresponding welfare effect is then easily determined. Using the Lagrangian as the welfare measure for any of the countries involved, we have

$$\begin{aligned} \left.\frac{d\mathcal{L}}{dt_r}\right|_{dK=0}^{dt_w=0} &= \overline{K}\left.\frac{\partial r}{\partial t_r}\right|_{dK=0}^{dt_w=0} + \lambda\overline{K}\left(r + t_r\left.\frac{\partial r}{\partial t_r}\right|_{dK=0}^{dt_w=0}\right) \\ &= -(\lambda - 1)\overline{K}\left.\frac{\partial r}{\partial t_r}\right|_{dK=0}^{dt_w=0} > 0. \end{aligned} \tag{4.24}$$

[9] Note that we have to assume for stability that

$$w\eta_{K,\tilde{r}}/\eta_{K,\tilde{w}} + w_{t_r}(1+t_r) \neq 0.$$

In fact, as is shown later, this term must be positive for the sake of stability of the Nash equilibrium.

[10] The allocation may change, however, if we drop the assumption of a linear private utility. See Aronsson and Wehke (2006).

Consequently, a marginal increase in the capital tax, carried out by all countries, is unambiguously welfare enhancing, given that the level of wage taxation remains constant. The intuition is analogous to the case of a fully flexible labor market. As capital is immobile from a worldwide perspective and the allocation of (immobile) labor is unchanged in the course of the coordination, the burden of a joint capital tax increase is fully born by worldwide capital owners and the additional tax revenue is captured lump-sum. Thus, the welfare effect consists of the additional lump-sum tax revenue weighted by the net welfare gain if one unit of tax revenue is spent on public good consumption in a second-best environment. The qualitative welfare effect does not depend on whether the labor market is governed by equalization of labor supply and labor demand or is organized by Nash wage bargaining. The principle insights from the tax competition literature with perfect labor markets thus also hold for countries with distorted labor markets.

4.4.2 Complete coordination of the wage tax

In this subsection, we now consider the case in which all countries agree to marginally increase their wage tax rate while keeping the capital tax fixed at the level determined in the Nash equilibrium. Theoretically, the possibility of capturing lump-sum resources by means of wage tax coordination is addressed by Bucovetsky and Wilson (1991) and Fuest and Huber (1999b). Depending on the respective labor market organization, however, they derive at different results.

In the present setting, complete wage tax coordination triggers factor price reactions that again have to fulfill equations (4.22) and (4.23). In detail, and defining $A \equiv w_r r + w\eta_{K,\tilde{r}}/\eta_{K,\tilde{w}} > 0$,[11] the factor price changes can be written as

$$\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0} = -\frac{r}{1+t_w}\frac{\tilde{w}_{t_w}}{A} < 0, \tag{4.25a}$$

$$\left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0} = \frac{w}{1+t_w}\frac{-w_r r + w_{t_w}(1+t_w)\eta_{K,\tilde{r}}/\eta_{K,\tilde{w}}}{A}, \tag{4.25b}$$

$$\left.\frac{\partial \tilde{w}}{\partial t_w}\right|_{dK=0}^{dt_r=0} = \frac{w}{A}\frac{\eta_{K,\tilde{r}}}{\eta_{K,\tilde{w}}}\tilde{w}_{t_w} > 0, \tag{4.25c}$$

$$\left.\frac{\partial \tilde{r}}{\partial t_w}\right|_{dK=0}^{dt_r=0} = -\frac{\tilde{r}}{1+t_w}\frac{\tilde{w}_{t_w}}{A} < 0. \tag{4.25d}$$

A marginal increase in the wage tax which is carried out by all countries has an ambiguous effect on the bargained net of tax wage rate. The gross wage rate,

[11] Assuming $A > 0$ is equivalent to suppose $dK/dr < 0$ (cf. footnote 9). This must hold as a stability condition of the Nash equilibrium. See the Appendix for details.

however, is unambiguously increased due to the higher tax wedge. Since labor demand falls in the gross wage, the marginal product of capital is reduced in each country which, in turn, calls for a worldwide reduction in the interest rate in order to fully employ capital again. In contrast to marginal capital tax coordination, the joint change in the wage tax will alter the worldwide allocation. In particular, each country's labor employment is, in general, reduced:

$$\left.\frac{\partial L}{\partial t_w}\right|_{dK=0}^{dt_r=0} = L_{\tilde{w}} \left.\frac{\partial \tilde{w}}{\partial t_w}\right|_{dK=0}^{dt_r=0} + L_{\tilde{r}} \left.\frac{\partial \tilde{r}}{\partial t_w}\right|_{dK=0}^{dt_r=0} = \frac{L\tilde{w}_{t_w}}{(1+t_w)A\eta_{K,\tilde{w}}}\varepsilon\sigma \leq 0. \tag{4.26}$$

Consequently, only for the special case of capital and labor being perfect complements in production, i.e. $\sigma = 0$, a joint change in the wage tax rate does not affect employment. Intuitively, if capital and labor are employed in a constant ratio and the capital employment must remain unchanged, the reduction in the interest rate will exactly suffice to compensate for the initial reduction in labor demand due to the increase in the gross wage rate.

Given the factor price reactions in (4.25) and keeping the capital tax constant, the welfare effect of (complete) wage tax coordination is then given by

$$\begin{aligned}\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{dt_r=0} &= -(\lambda-1)\overline{K} \left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0} - (\lambda-1)L \left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0} - (\lambda-1)(1-\bar{t}_\pi) \left.\frac{\partial \pi}{\partial t_w}\right|_{dK=0}^{dt_r=0} \\ &\quad +(w-e'+\lambda t_w w) \left.\frac{\partial L}{\partial t_w}\right|_{dK=0}^{dt_r=0}. \end{aligned} \tag{4.27}$$

As is shown in Appendix 2 all terms except of the first one cancel out since the first-order conditions of the initial Nash equilibrium serve as a starting point of coordination. Thus, the welfare effect reduces to

$$\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{dt_r=0} = -(\lambda-1)\overline{K} \left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0} > 0. \tag{4.28}$$

Similar to the case of the joint increase in the capital tax rate, the only effect that is relevant with respect to welfare is the ability to reduce the net of tax interest rate. Again, the intuition runs in an analogous way as in the case of a fully competitive labor market. Although a marginal increase in the wage tax alters the allocation by changing the wage rate and thus, in turn, employment and profits [see equation (4.27)], the same is true for the uncoordinated case. As coordination starts from the uncoordinated Nash equilibrium, the corresponding welfare effects are already 'optimized out'. Consequently, the only effect relevant for welfare stems from the reduction in the capital remuneration r, a factor price change that was not part of a small country's uncoordinated decision problem.

Both, the result with respect to complete capital tax coordination as well as the above result of a joint increase in the wage tax are in contrast to the one derived by Fuest and Huber (1999b), who conclude that in the presence of involuntary unemployment a coordinated increase in the capital tax or the labor tax will be welfare worsening if the labor demand elasticity is smaller than one in absolute terms. The reason for this difference is their misleading specification of the union's rent from bargaining (see, e.g., Layard and Nickel 1990, Creedy and McDonald 1991 and Layard et al. 1991). To be more detailed, Fuest and Huber normalize the union's fall-back utility to zero. This implies that, if the bargaining process breaks down, union members would no longer receive income from their capital endowment even if it invested outside the small country. The normalization is indeed innocuous as long as policies are analyzed that leave the fall-back utility constant. However, coordination changes the capital income accruing to union members which, in turn, changes the outside utility. The normalization is therefore inappropriate. In the Fuest-Huber case, coordination then introduces a negative income effect for the union since they neglect that capital income is reduced even if the bargaining fails. In turn, this will induce the union to call for a higher wage rate due to the reduction in capital income. The extent to which the wage rate is increased then depends on the labor demand elasticity. For rather inelastic values of the labor demand elasticity the wage increase will be rather large. To see why this may counteract the initial welfare gain, recall that coordination is effective because it captures rent from the private sector that could not be captured without coordination. On the one hand, we already discussed the rent from capital ownership. On the other hand, this loss in capital income can be counteracted since unions now react by raising the wage rate, thereby generating more rents from being employed. If labor demand is inelastic, the wage increase is high enough so that the private sector is left with even more rents after the coordination. This would be welfare worsening.

Summing up, we can state the following. If full tax coordination is possible, potential distortions on the labor market due to wage bargaining do not matter in terms of welfare. Coordination remains desirable, since in the Nash equilibrium each country ignores the externality of its tax policy on other countries. Therefore, we should not expect that tax competition is a distortion that alleviates another distortion, i.e. involuntary unemployment.

4.5 Partial tax coordination

As indicated earlier, the coordination agreement discussed in the previous section is highly restrictive. In fact, it requires that both policy instruments are jointly chosen. A more realistic approach would be to allow for a coordination of only *one* tax rate because coordination agreements are likely to be incomplete in this sense or tax rates are assigned to lower levels of government with the right to set them freely.

Analogous to the procedure in chapter 2, we therefore analyze how the results of the preceding section change if one tax rate is jointly increased but the respective other tax rate can still be freely chosen by all countries in order to maximize their own welfare. To keep the calculations manageable and reduce the complexity of the analysis in this section we restrict our attention to the extreme case of a monopoly trade union, i.e. we use $\beta = 1$ in what follows. Note that the simplifying assumption of monopoly trade unions does not conflict with decentralized bargaining. As has been shown by Binmore et al. (1986) the parameters of bargaining power, i.e. β and $(1-\beta)$, respectively, only capture the relative impatience during time-consuming negotiations or the relative break down probabilities of the bargaining parties, respectively. By contrast, decentralized wage bargaining refers to the situation where negotiation is made at the firm level. This means that the outcome of the bargaining is unable to influence countrywide variables such as tax revenue and total profit income. In a centralized bargaining, both parties would take into account that they are able to affect these values.

4.5.1 Partial coordination of the capital tax

After all countries have agreed to marginally increase their capital tax rate, we now assume that they can still make use of the wage tax in order to optimally respond to the coordination agreement. Since we know that, in the uncoordinated Nash equilibrium, the wage tax is determined by the first-order condition $\partial\mathcal{L}/\partial t_w = 0$ we have to find out to which extent *all* countries will adjust their wage tax if they face a coordinated increase in the capital tax in order to ensure that this condition still holds. Each country's first-order condition with respect to the wage tax rate yields its marginal costs of public funds for the wage tax instrument (λ^{t_w}). They are derived by rewriting (4.16) in a way to express the loss in private utility per unit of tax revenue raised by using t_w :

$$\lambda^{t_w} = \frac{\left(-\frac{w-e'}{\tilde{w}}\eta_{L,\tilde{w}} + (1-\bar{t}_\pi)\right)\tilde{w}_{t_w} - w_{t_w}}{\left(\frac{t_w}{1+t_w}\eta_{L,\tilde{w}} + \frac{t_r}{1+t_r}\eta_{L,\tilde{r}} + (1-\bar{t}_\pi)\right)\tilde{w}_{t_w} - w_{t_w}}. \tag{4.29}$$

By totally differentiating the right hand side of this expression with respect to both tax rates and taking into account the corresponding factor price reactions for joint changes in tax rates we have:

$$\left.\frac{dt_w}{dt_r}\right|_{dK=0} = -\frac{\partial\lambda^{t_w}/\partial t_r\big|_{dK=0}}{\partial\lambda^{t_w}/\partial t_w\big|_{dK=0}}. \tag{4.30}$$

Equation (4.30) gives us the magnitude by which *all* countries have eventually adjusted their wage tax in the new Nash equilibrium if the capital tax has been marginally increased by all countries so that each country's capital employment remains constant in both cases. The sign of (4.30) can easily be determined, even without discussing its explicit expression. First, note that stability of the Nash equilibrium requires that the marginal cost of public funds of a tax rate must be increasing in this tax rate, if the tax is changed jointly by all countries, i.e. $\partial\lambda^{t_w}/\partial t_w\big|_{dK=0} > 0$.[12] Second, a worldwide increase in the capital tax rate reduces the marginal tax revenue of the wage tax instrument, thereby increasing the marginal costs of public funds of the wage tax, so that $\partial\lambda^{t_w}/\partial t_r\big|_{dK=0} > 0$. This can easily be seen by inspecting (4.29) and recalling that a joint increase in t_r does not affect the real allocation and thus, in turn, the values of w_{t_w}, $\tilde{w}_{t_w}$ as well as the factor demand elasticities. Since the denominator of (4.29) is negatively affected by a coordinated increase in the capital tax rate, each country perceives its wage tax to be more distortionary at the margin and is therefore willing to reduce its level of wage taxation. Consequently, in the new Nash equilibrium, we observe that *all* countries have lowered their wage tax as a response to the coordinated increase in the capital tax so that we can sign equation (4.30) as $dt_w/dt_r|_{dK=0} < 0$.

The overall welfare effect of such partial capital tax coordination is then given by the sum of two effects. First, welfare is increased since the capital tax rate is jointly raised at a constant wage tax and additional lump-sum tax revenue is captured from capital owners; see subsection 4.4.1. Second, welfare is reduced as all countries will react by lowering their wage tax at a given capital tax and tax revenues are shifted back to capital owners in a lump-sum manner; to see this, recall (the counterpart of) the discussion in subsection 4.4.2 that a joint reduction in the wage tax, at a constant capital tax, unambiguously reduces welfare even in the presence of unemployment. Thus, the net welfare effect crucially depends on the magnitude of the worldwide reaction in the wage tax rate:

$$\left.\frac{d\mathcal{L}}{dt_r}\right|_{dK=0}^{part.} = \left.\frac{d\mathcal{L}}{dt_r}\right|_{dK=0}^{dt_w=0} + \left.\frac{dt_w}{dt_r}\right|_{dK=0} \left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{dt_r=0}, \tag{4.31}$$

[12] The explanation is straightforward. Suppose that in all countries the wage tax is slightly higher (lower) than the one in uncoordinated Nash equilibrium. As *all* countries have an incentive to lower (increase) their wage tax, this joint reduction (increase) must lower (increase) the marginal costs of public funds of this tax instrument in order to reach a stable Nash equilibrium.

where both welfare effects on the right hand side of (4.31) have already been determined in subsections 4.4.1 and 4.4.2, respectively.

Before we turn to an expression of the welfare effect in algebraic terms, let us first set out an intuition about the mechanisms at work. To begin with, we should bear in mind that the starting point is a joint increase in the capital tax which does not change the worldwide allocation. However, this coordination agreement disturbs the initial (uncoordinated) Nash equilibrium as it fixes the capital tax rate on a higher level than preferred by each country individually. As a consequence, all countries now engage in tax competition by solely using the wage tax instrument. Each jurisdiction tries to attract mobile capital from the rest of the world by lowering the wage tax but will fail in the new equilibrium as all (symmetric) countries face the same incentive. This may be characterized as an attempt to compete back to the initial Nash equilibrium which has been described in section 4.3 to be the most preferred allocation from a single country's point of view. The better all countries are able to compete back, the smaller *ceteris paribus* the remaining welfare gain of the marginal coordination of the capital tax. Intuitively, we should expect that the joint wage tax adjustment is not perfectly able to undo the initial coordination gain of the capital tax. To see this point, bear in mind that the initial joint increase in the capital tax does not change the real allocation. The joint wage tax adjustment, however, does alter the allocation on the labor market. Consequently, this joint adjustment is, in general, 'more costly' than the initial capital tax coordination. From a worldwide perspective, the wage tax is still distortionary, while the capital tax then reduces to a lump-sum instrument.

In other words, when trying to compete back to the initial Nash equilibrium, each country will realize that the employment level, in fact, deviates from the one that has been most preferred before. This costly adjustment will induce countries not to perfectly go back to their starting Nash equilibrium. Only if employment turns out to remain constant, the joint wage tax adjustment amounts to a lump-sum instrument that shifts resources from the government back to the private sector. The wage tax adjustment is then equally harmless to allocation as is the joint increase in the capital tax. In fact, Appendix 3 shows that this is the case for capital and labor being perfect complements in production. As a consequence, the wage tax can then be used to perfectly mimic the capital tax so that the initial welfare gain of coordination can be wiped out completely, *ceteris paribus.*

On the other hand, overall welfare might also be affected through a second channel since the pre-existing distortion of the tax system may be altered. To see this intuitively, recall that the starting point of coordination is the Nash equilibrium as has been presented in section 4.3. In this uncoordinated equilibrium, each government chooses its tax instruments by balancing the trade-off between the corresponding distortions in the private sector with the gain of spending the public revenue. In doing so, each benevolent government is willing to accept a certain distortion (at the margin) in return for the additional benefit from public good consumption. If this pre-existing tax distortion is changed after the coordination agreement has been implemented, we have a second mechanism through which welfare might be affected. In the present case, the initial joint increase in the capital tax does not affect employment as well as gross factor prices. Consequently, we cannot expect to observe a change in the pre-existing distortion due to the initial coordination agreement. Once the capital tax has been fixed on a higher level than preferred by each country individually, however, it is the joint reduction in the wage tax that triggers a change in gross factor prices and employment. In particular, this will have repercussions on the cost share of labor and thus, in turn, on the distortion of the tax system.

Returning to the detailed welfare effect of equation (4.31) and inserting equations (4.24), (4.28) and (4.30), we obtain after some cumbersome manipulations:

$$\left.\frac{d\mathcal{L}}{dt_r}\right|_{dK=0}^{part.} = -\left.\frac{dt_w}{dt_r}\right|_{dK=0} \frac{(\lambda-1)\tilde{r}\overline{K}}{\eta_{L,\tilde{r}}\tilde{w}(1+\eta_{L,\tilde{w}})}\Upsilon.$$

Since $\eta_{L,\tilde{r}} < 0$ and $(1+\eta_{L,\tilde{w}}) < 0$,[13] the sign of the term Υ also determines the direction of the total welfare effect. This term becomes

$$\frac{\lambda-1}{\lambda}\frac{1-s}{s}\sigma\tilde{w}(1+\eta_{L,\tilde{w}})\,\frac{\partial}{\partial t_w}\left[\frac{s}{1-s}\frac{(w-e')(\sigma-\varepsilon)(1-s)(1-\sigma)s}{\tilde{w}(1+\eta_{L,\tilde{w}})\sigma}\right]\Bigg|_{dK=0} \tag{4.32a}$$

$$-\;\frac{\lambda-1}{\lambda}(\sigma-\varepsilon)\left.\frac{\partial s}{\partial t_w}\right|_{dK=0}^{dt_r=0}\left[(w-e')\left[1-\frac{s(\sigma-\varepsilon)}{\varepsilon}\right]+\frac{e''(L)L\eta_{L,\tilde{w}}}{(1+\eta_{L,\tilde{w}})}\right] \tag{4.32b}$$

$$+\;\left.\frac{\partial L}{\partial t_w}\right|_{dK=0}^{dt_r=0}\frac{\eta_{L,\tilde{w}}}{\lambda L}\left[Le''\left[\lambda(1-2\eta_{L,\tilde{w}})+\eta_{L,\tilde{w}}-2\right]+(\lambda-1)\,e'+\frac{(e')^2}{w}\right], \tag{4.32c}$$

where $\tilde{w}_{t_w} > 0$, $A > 0$ and $\eta_{K,\tilde{w}} < 0$.

The last line in (4.32) is non-negative in sign which *ceteris paribus* indicates that a non-negative overall welfare effect remains even after the wage tax adjustment has taken place. Only for the special case where $\partial L/\partial t_w|_{dK=0}^{dt_r=0} = 0$ this expression reduces to zero. Referring back to equation (4.26), this is the benchmark case of capital and labor being perfect complements in production ($\sigma = 0$). The joint adjustment of the wage tax then does not alter each country's labor employment since capital and labor are employed in constant proportions and each country's capital employment will remain unchanged in a symmetric equilibrium. It is important to

[13] Note that for $\beta = 1$ the condition $\widehat{\Omega}_w = 0$ reads $w(1+\eta_{L,\tilde{w}}) = e'\eta_{L,\tilde{w}}$ which implies that the monopoly trade union will choose a wage rate where labor demand is elastic.

keep in mind that each individual country perceives its wage tax to be an instrument that unambiguously changes domestic employment. As all countries follow the same incentive, however, the resulting change in the interest rate will finally restore the initial employment level for $\sigma = 0$. Since all countries will find their employment level unchanged, the wage tax can, in fact, be used as an instrument that is equally non-distortionary as has been the case with the initial capital tax coordination (see Appendix 3). Consequently, for this benchmark case, the wage tax can *ceteris paribus* be used as a perfect mimicry to the capital tax as a means to compete for mobile capital. On the other hand, if the elasticity of substitution is strictly positive, the joint wage tax adjustment is 'costly', since it does change the employment level compared with each country's welfare maximizing choice. For this reason, countries are not willing to use the wage tax to perfectly undo the gain of the capital tax coordination and a positive welfare effect remains. Thus, in general, the last term in (4.32) may be interpreted as the extent to which all countries are able (or willing) to compete back to the initial Nash equilibrium. In fact, this mechanism is the only one that is at work for a flexible labor market, where partial capital tax coordination has a non-negative overall welfare effect given the setup of the present model (especially because of the assumption that $e'''(L) = 0$).

As indicated earlier, welfare is also affected through another channel. Since the uncoordinated Nash equilibrium is characterized by distortions due to wage negotiations, we might see welfare effects if the pre-existing distortions are altered due to the joint adjustment of the wage tax. In particular, the cost share of labor and the change of the cost share of labor, respectively, determine this distortion. In this context, another benchmark case is worth mentioning.

If the elasticity of substitution between capital and labor is unity, i.e. the production technology is Cobb-Douglas, the cost share of labor remains constant and the welfare effects in the first two lines of (4.32) vanish. Intuitively, we know from (4.19) that for $\sigma = 1$ the capital tax rate has not been used strategically to influence the outcome of the wage bargaining process. In this sense, the qualitative welfare effect is similar to competitive labor markets. However, things become more complex if we deviate from the Cobb-Douglas case.

The second line in (4.32) turns out to be positive (negative) if $\sigma < (>)1$. From section 4.3 it is already known that unilateral tax changes have repercussions on the factor demand elasticities through the cost shares of capital and labor, respectively. For joint tax changes, however, it is only the wage tax that is able to affect the factor's cost shares. More precisely, we obtain

$$\left.\frac{\partial s}{\partial t_w}\right|_{dK=0}^{dt_r=0} = -\frac{\tilde{w}_{t_w}\varepsilon(1-s)s(1-\sigma)}{A(1+t_w)\eta_{K,\tilde{w}}}, \tag{4.33}$$

i.e. a joint reduction in the wage tax increases (reduces) the cost share of labor if the elasticity of substitution is greater (less) than one which, in turn, is associated with a negative (positive) welfare impact. The influence of the factor cost shares runs through its impact on the factor demand elasticities [see the equations in (4.4)]. In particular, a reduction in the cost share of labor renders the labor demand elasticity $\eta_{L,\tilde{w}}$ less elastic.

According to the first line of equation (4.32), overall welfare is affected depending on how the term $\frac{s}{1-s}(w-e')(\sigma-\varepsilon)(1-s)(1-\sigma)s/\left[\tilde{w}(1+\eta_{L,\tilde{w}})\sigma\right]$ is altered due to a joint change in the wage tax. In fact, this term corresponds to the second term on the right hand side of the optimal capital tax formula for $\beta = 1$ [see equation (4.19)]. It captures the extent to which each country uses the capital tax unilaterally to influence the outcome of the wage bargain. Consider the case in which the expression $\frac{s}{1-s}(w-e')(\sigma-\varepsilon)(1-s)(1-\sigma)s/\left[\tilde{w}(1+\eta_{L,\tilde{w}})\sigma\right]$ becomes larger when all countries jointly *reduce* their wage tax rate, indicating that this is associated with a positive overall welfare effect. Referring back to equation (4.19), the right hand side of the optimal capital tax formula then becomes smaller, whereas the corresponding capital tax adjustment is excluded due to the international coordination agreement. In this case, the capital tax rate is again higher than the level that is individually preferred by each country which, in turn, contributes to higher welfare. Appendix 5 shows that $\frac{\partial}{\partial t_w}\left[\frac{s}{1-s}\frac{(w-e')(\sigma-\varepsilon)(1-s)(1-\sigma)s}{\tilde{w}(1+\eta_{L,\tilde{w}})\sigma}\right]\Big|_{dK=0}$ is negative in sign if the elasticity of substitution between capital and labor falls short of unity implying a positive welfare effect. In contrast, for $\sigma > 1$ this term cannot be signed. Again, for the special case of a Cobb-Douglas production function, this component of the welfare effect does not appear since the tax system is not used to strategically influence the bargaining outcome by altering the labor demand elasticity.

Summing up, if the elasticity of substitution is smaller than or equal to one, the overall welfare effect of partial capital tax coordination is unambiguously positive in the presence of wage bargaining. To an important extent this is due to the fact that the joint adjustment of the wage tax mitigates the pre-existing distortion of the tax system. This can best be illustrated by considering the extreme case of $\sigma = 0$ which gives a zero welfare effect for competitive labor markets but a strictly positive impact for the present setup with wage bargaining. In contrast, if capital and labor are close substitutes in the sense that the elasticity of substitution is larger than one, there are two opposing effects. On the one hand, welfare increases since the wage tax adjustment is costly and will not be used to completely undo the welfare gain of the capital tax coordination. On the other hand, the pre-existing distortion is augmented which is welfare worsening. Consequently, there might well be a critical value of the elasticity of substitution σ^{crit} [implicitly defined by equating to zero the expression in (4.32)] that results in a zero overall welfare effect. Welfare may even be reduced if the elasticity of substitution exceeds σ^{crit}. This would be in striking contrast to the case of competitive labor market, where any $\sigma > 0$ implies a positive overall welfare impact.

4.5.2 Partial coordination of the wage tax

Finally, let us turn to the question in which way a joint increase in the wage tax affects welfare if the capital tax is still free to be adjusted by each country. In fact, coordination agreements with respect to the wage tax rate are not a current issue in the political debate of tax competition. As mentioned above, it has rather been the theoretical literature on tax coordination that pointed out the link between the net remuneration of capital and the factor costs of a complementary factor. However, the analysis in this subsection may nevertheless be interesting since one often observes countries with federal structures, where the wage tax is determined on a federal level, which may be interpreted as tax setting on a coordinated level. On the other hand, local taxes, e.g., a business tax, can then be freely chosen by lower-level governments.

In the case of a fully competitive labor market, the labor supply elasticity plays a crucial role in determining the direction of the welfare effect when partial wage tax coordination is carried out. It has been demonstrated in chapter 2 that a joint change in the capital tax does not alter the allocation and all countries are therefore perfectly able to compete back to the allocation of the initial Nash equilibrium if the labor supply elasticity remains constant in the course of a joint wage tax increase. The total welfare effect of partial wage tax coordination is zero in this case. However, since the distortion of the tax system in the Nash equilibrium crucially depends on the absolute value of the labor supply elasticity, we observe welfare changes for a non-constant labor supply elasticity. If a coordinated increase in the wage tax increases (decreases) the labor supply elasticity, the pre-existing distortion of the tax system increases (decreases) and overall welfare effect is then negative (positive).

Returning to the case of a non-competitive labor market, we analyze whether a similar property carries over to a situation in which wages are determined by small monopoly trade unions ($\beta = 1$). If all countries agree only to marginally increase their wage tax and national autonomy is retained in the choice of the capital tax, we now have to determine to which extent all countries finally adjust their capital tax such that they still perceive this tax rate to be the best response from their small country perspective. The optimal choice regarding the capital tax rate is given by the first-order condition $\partial\mathcal{L}/\partial t_r = 0$ [see equation (4.17)], which can be restated to define the marginal costs of public funds for this tax instrument (λ^{t_r}):

$$\lambda^{t_r} = \frac{\left(-\frac{w-e'}{\tilde{w}}\eta_{K,\tilde{w}} + (1-\bar{t}_\pi)\right)\left(\tilde{w}_{t_r}(1+t_r) + \frac{1-s}{s}\tilde{w}\right) - w_{t_r}(1+t_r)\left(1 - \frac{w-e'}{w}\sigma\right)}{\left(\frac{t_w \eta_{K,\tilde{w}}}{1+t_w} + \frac{t_r \eta_{K,\tilde{r}}}{1+t_r} + (1-\bar{t}_\pi)\right)\left(\tilde{w}_{t_r}(1+t_r) + \frac{1-s}{s}\tilde{w}\right) - w_{t_r}(1+t_r)\left(1 + \frac{(t_w - t_r)\sigma}{1+t_r}\right)}.$$

Totally differentiating this expression at a constant capital employment yields the worldwide reaction of the capital tax rate following a coordinated marginal increase in the wage tax:

$$\left.\frac{dt_r}{dt_w}\right|_{dK=0} = -\frac{\partial\lambda^{t_r}/\partial t_w\big|_{dK=0}}{\partial\lambda^{t_r}/\partial t_r\big|_{dK=0}}, \tag{4.34}$$

where, for stability of the Nash equilibrium, we need to have $\partial\lambda^{t_r}/\partial t_r\big|_{dK=0} > 0$.[14] The overall welfare effect of the partial coordination in the wage tax rate is then again given by the sum of two effects, the initial welfare enhancing effect due to the joint increase in the wage tax at a constant capital tax (see subsection 4.4.2) and the subsequent welfare effect due to the worldwide adjustment of the capital tax at a given wage tax:

$$\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{part.} = \left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{dt_r=0} + \left.\frac{dt_r}{dt_w}\right|_{dK=0} \left.\frac{d\mathcal{L}}{dt_r}\right|_{dK=0}^{dt_w=0}. \tag{4.35}$$

Following the procedure of the previous subsection, we first describe the mechanisms that are able to affect welfare in this case before we turn to the detailed expression of the overall welfare effect.

For an intuitive explanation of the total welfare effect it proves convenient to again decompose the total effect into, first, a coordinated increase in the wage tax at a constant capital tax and, second, a joint change in the capital tax at a constant level of wage taxation. From our previous discussion we know that, starting from the Nash equilibrium, a joint increase in the wage tax changes the worldwide allocation, which has no first-order effect on welfare. The welfare impact solely stems from the availability to reduce the net interest rate which captures lump-sum tax revenue. On the other hand, any joint reaction in the capital tax does not affect employment and gross factor prices, but only the net remuneration of capital owners. Therefore, it should *ceteris paribus* be possible for all countries to exactly compete back to their individually preferred allocation which is given by the initial uncoordinated Nash equilibrium. This mechanism alone would enable all countries to exactly wash away the initial welfare gain of the coordination in the wage tax.

Similar to the preceding subsection, however, there is a second channel through which welfare is affected. The initial marginal increase in the wage tax rate, carried

[14] Note that $sign\{\partial\lambda^{t_r}/\partial t_r\big|_{dK=0}\} = sign\{A\}$ as is shown in Appendix 4. Thus, as indicated earlier, $A > 0$ must hold in the Nash equilibrium for the sake of stability.

out by all countries, will change the pre-existing distortion of the tax system. If this initial coordination step augments (alleviates) the pre-existing distortion, the overall welfare effect is negative (positive).

Inserting equations (4.24), (4.28) and (4.34) into the overall welfare effect (4.35), we derive at

$$\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{part.} = (\lambda-1)r\overline{K}\frac{1+t_r}{1+t_w}\frac{\tilde{w}_{t_w}}{A}\Phi.$$

Consequently, the sign of the total welfare effect is determined by the sign of the term Φ, which is equivalent to

$$\frac{1+\frac{e''(L)L}{e'(L)}\varepsilon}{(1-s)(\sigma-\varepsilon)}\left[\frac{\lambda-1}{\lambda}\frac{\partial}{\partial t_w}\left(\frac{(w-e')(\sigma-\varepsilon)(1-\sigma)(1-s)s}{w(1+\eta_{L,\tilde{w}})}\right)\bigg|_{dK=0} - \frac{\sigma}{\lambda}\frac{\partial}{\partial t_w}\left(\frac{w-e'}{w}\right)\bigg|_{dK=0}\right]$$
$$+\frac{\lambda-1}{\lambda}\left(1-\frac{(w-e')(\sigma-\varepsilon)(1-\sigma)(1-s)s}{w(1+\eta_{L,\tilde{w}})(1-s)(\sigma-\varepsilon)}\varepsilon\right)\frac{\partial}{\partial t_w}\left(\frac{e''(L)L}{e'(L)}\right)\bigg|_{dK=0}. \tag{4.36}$$

Turning to the interpretation of the above welfare effect, it is instructive to recall the expression for the optimal wage tax in the Nash equilibrium. For $\beta = 1$ and full profit taxation we have

$$t_w = \frac{\lambda-1}{\lambda}\frac{(w-e')(\sigma-\varepsilon)(1-\sigma)(1-s)s}{\sigma w(1+\eta_{L,\tilde{w}})} + \frac{\lambda-1}{\lambda}\frac{e''(L)L}{e'(L)} - \frac{w-e'}{\lambda w}. \tag{4.37}$$

Intuitively, the optimal usage of the wage tax depends on the availability of rents among labor suppliers (see the second term) as well as the existence of unemployment (see the first and third term, respectively). Welfare effects arise if the right hand side of this equation is changed by the marginal tax coordination, but the corresponding wage tax adjustment is excluded due to the international coordination agreement.

To begin with, note first that the change of the elasticity $e''(L)L/e'(L)$ is of crucial importance. In fact, for the special case of a Cobb-Douglas production function ($\sigma = 1$) it becomes the only component of the total welfare effect which can be seen by referring back to equation (4.36). Since in the Cobb-Douglas case the costs shares of labor and capital are constant in the uncoordinated setting, the wage tax is not used in the Nash equilibrium to strategically influence the net of tax wage rate by changing the labor demand elasticity. Moreover, for the special case of monopoly unions, as considered in this section, we known from (4.5) that $(w - e')/w = -1/\eta_{L,\tilde{w}}$ which remains unchanged for $\sigma = 1$. The direction of the overall welfare effect is then solely determined by the sign of $\partial[e''(L)L/e'(L)]/\partial t_w|_{dK=0}$. To shed some light on the intuition behind the result, bear in mind that a unilateral change in the wage tax always alters domestic employment. Thus, each government will make use of the wage tax in the uncoordinated Nash equilibrium depending on (the change of) the marginal disutility of labor. In particular, the absolute value of the elasticity $e''(L)L/e'(L)$ crucially determines the marginal welfare costs of wage taxation in the Nash equilibrium. To see this, note that for a rather inelastic value of $e''(L)L/e'(L)$ the labor supply curve is relatively flat. In turn, this implies rather high welfare costs of wage taxation (at the margin) since it becomes more difficult to capture intra-marginal rents from labor suppliers by marginally increasing the wage tax rate. In contrast, the corresponding increase in the gross wage rate is rather high implying a large reduction in employment and thus a higher welfare loss due to additional involuntary unemployment. The more elastic the marginal disutility the smaller is the reduction in employment that is necessary to capture rents from labor suppliers. Therefore, if a joint increase in the wage tax increases this elasticity, i.e. $\partial \left[e''(L)L/e'(L)\right]/\partial t_w|_{dK=0} > 0$, the pre-existing tax system becomes less distortionary at the margin which gives rise to a positive welfare effect. The opposite applies when a coordinated increase in the wage tax reduces the elasticity of the marginal disutility of labor.

For the more general setting in which the elasticity of substitution differs from unity, welfare is also affected through additional channels. On the one hand, the above effect running the change in the disutility of labor is modified. As can be seen from the lower line of (4.36), it is augmented (attenuated) if $\sigma < (>)1$.

On the other hand, for $\sigma \neq 1$, the upper line of equation (4.36) enters the total welfare effect. A partial coordination agreement regarding the wage tax then contributes to higher welfare if the initial joint increase in the wage tax reduces $(w-e')(\sigma-\varepsilon)(1-\sigma)(1-s)s/w(1+\eta_{L,\tilde{w}})$ and increases $(w-e')/w$, respectively. The former is sufficiently ensured if $s \geq 0.5$; the latter holds for $\sigma > 1$ (see Appendix 6). Both terms are also components of the optimal wage tax expression (4.37) above. The interpretation is analogous to that of the previous subsection. If the joint increase in the wage tax lowers the right hand side of the optimal wage tax formula, this contributes to higher welfare since the wage tax has been cooperatively chosen which, in turn, precludes a corresponding tax adjustment. As argued before, the whole economy is characterized by undertaxation so that all countries gain in terms of welfare if the wage tax is higher than individually preferred by each country.

4.6 Concluding remarks

Tax coordination is aimed at mitigating a worldwide tax distortion which emerges when countries ignore the fiscal externalities of unilateral changes in their policy instruments. The more policy instruments are included in a worldwide coordination agreement the more effective it is. This chapter analyzes this issue by employing taxes on immobile labor and mobile capital, taking into account that wage bargaining gives rise to involuntary unemployment. In particular, two (extreme) scenarios of tax coordination are discussed.

First, concerning complete tax coordination, imperfections on the labor market are not able to justify different policy conclusions with regard to coordination compared with the case of fully competitive labor markets as has been suggested by Fuest and Huber (1999b). We find that, starting from the uncoordinated Nash equilibrium, a joint increase in the capital tax is always welfare enhancing, if the wage tax is held constant. The same holds true for a coordinated increase in the wage tax at a constant capital tax, provided that capital and labor are complements in production. In both cases, marginal tax coordination is able to reduce the net remuneration of capital ownership, thereby shifting resources to the public sector in a lump-sum manner, a policy option that is not available to individual countries. Whether or not the underlying tax structure is designed for flexible labor markets or imperfect labor markets is not important for the welfare impact of coordination. Thus, even for Nash equilibria which are qualitatively different the desirability of (complete) tax coordination is the same.

With regard to partial tax coordination, however, the organization of the labor market does matter. In the presence of unemployment due to decentralized wage bargaining, the welfare results are more complex and become ambiguous. In general, there are two mechanisms at work. On the one hand, the tax instrument that is still free to be adjusted by each country after the tax coordination is used to mimic the tax rate that has been coordinated so that countries try to compete back to the initial Nash equilibrium. Taxes on labor and capital are different in that respect. While an uncoordinated but symmetric adjustment of the capital tax is non-distortionary and can be used to perfectly undo any gains of coordination, such an adjustment in the wage tax is, in general, distortionary from a global perspective. On the other hand, the pre-existing distortion of the tax system may be altered due to the coordination or the subsequent joint tax adjustment. Since the optimal usage of the available tax rates in the presence of unemployment differs from the case of competitive labor markets, we have a mechanism that introduces different welfare effects when comparing flexible and rigid labor markets.

Even under the rather restrictive assumptions made, the present chapter illustrates that if tax coordination fails to include all policy instruments the overall welfare effects become quite complex and are ambiguous *a priori.* An important benchmark case, that reduces this ambiguity, is the one of a Cobb-Douglas production technology. For this situation, a marginal coordination of the capital tax is welfare enhancing even if all countries can freely decide upon their wage tax rate. In contrast, a marginal coordination of the wage tax is then associated with a welfare gain if the elasticity of the marginal disutility of labor is augmented, provided that each country retains national autonomy in the choice of the capital tax.

Appendix

1. Derivation of the optimal tax rates in the Nash equilibrium

First, multiplying the first-order condition $\partial\mathcal{L}/\partial t_w = 0$ with $(1+t_r)\tilde{w}_{t_r}$ and $\partial\mathcal{L}/\partial t_r = 0$ with $\tilde{w}_{t_w}$ and combining both expressions yields

$$0 = \frac{\lambda-1}{\lambda}\left((1-\bar{t}_\pi)\frac{1-s}{s} - \frac{w_{t_r}}{\tilde{w}_{t_w}}\frac{1+t_r}{1+t_w}\right)+\left(\frac{w-e'}{\lambda\tilde{w}}+\frac{t_w}{1+t_w}\right)\eta_{L,\tilde{r}}+\frac{t_r}{1+t_r}\frac{1-s}{s}\eta_{K,\tilde{r}}.$$

Second, rearranging $\partial\mathcal{L}/\partial t_w = 0$ gives

$$0 = \frac{\lambda-1}{\lambda}\left(-(1-\bar{t}_\pi)+\frac{w_{t_w}}{\tilde{w}_{t_w}}\right) = \left(\frac{t_w}{1+t_w}+\frac{w-e'}{\lambda\tilde{w}}\right)\eta_{L,\tilde{w}}+\frac{t_r}{1+t_r}\eta_{L,\tilde{r}}.$$

Combining these two equations yields

$$\begin{aligned}&\frac{\lambda-1}{\lambda}\frac{1-\bar{t}_\pi}{\varepsilon}-\frac{\lambda-1}{\lambda}\frac{s}{\varepsilon\tilde{w}_{t_w}}\left(w_{t_r}\frac{1+t_r}{1+t_w}+w_{t_w}\right)-s\frac{w-e'}{\lambda\tilde{w}}\\ =\;& s\frac{t_w}{1+t_w}+(1-s)\frac{t_r}{1+t_r}.\end{aligned}$$

Inserting this expression into the first-order conditions $\partial\mathcal{L}/\partial t_w = 0$ and $\partial\mathcal{L}/\partial t_r = 0$, respectively, gives us the optimal tax rates:

$$\begin{aligned}\frac{t_r}{1+t_r} &= \frac{\lambda-1}{\lambda}\frac{1-\bar{t}_\pi}{\varepsilon}+\frac{\lambda-1}{\lambda}\frac{\eta_{L,\tilde{w}}}{\sigma\varepsilon}\frac{w_{t_r}}{\tilde{w}_{t_w}}\frac{s}{1-s}\frac{1+t_r}{1+t_w}-\frac{\lambda-1}{\lambda}\frac{\eta_{K,\tilde{w}}}{\sigma\varepsilon}\frac{w_{t_w}}{\tilde{w}_{t_w}},\\ \frac{t_w}{1+t_w} &= \frac{\lambda-1}{\lambda}\frac{1-\bar{t}_\pi}{\varepsilon}-\frac{\lambda-1}{\lambda}\frac{\eta_{K,\tilde{w}}}{\sigma\varepsilon}\frac{w_{t_r}}{\tilde{w}_{t_w}}\frac{1+t_r}{1+t_w}+\frac{\lambda-1}{\lambda}\frac{\eta_{K,\tilde{r}}}{\sigma\varepsilon}\frac{w_{t_w}}{\tilde{w}_{t_w}}-\frac{w-e'}{\lambda\tilde{w}}.\end{aligned}$$

2. The welfare effect of a joint increase in the wage tax ($dt_r = 0$)

Using equation (4.26) for the employment effect and applying Hotelling's lemma, i.e. $\pi_{\tilde{w}} = -L$ and $\pi_{\tilde{r}} = -K$, the effect on total welfare is given by

$$\begin{aligned}\left.\frac{d\mathcal{L}}{dt_w}\right|_{dK=0}^{dt_r=0} =\;& -(\lambda-1)\overline{K}\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0}-(\lambda-1)L\left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0}\\ &+(w-e'+\lambda t_w w)\left(L_{\tilde{w}}\left.\frac{\partial\tilde{w}}{dt_w}\right|_{dK=0}^{dt_r=0}+L_{\tilde{r}}\left.\frac{\partial\tilde{r}}{dt_w}\right|_{dK=0}^{dt_r=0}\right)\\ &-(\lambda-1)(1-\bar{t}_\pi)\left(-L\left.\frac{\partial\tilde{w}}{dt_w}\right|_{dK=0}^{dt_r=0}-K\left.\frac{\partial\tilde{r}}{dt_w}\right|_{dK=0}^{dt_r=0}\right).\end{aligned}$$

Rearranging the last three terms by inserting the joint factor price changes from (4.25) yields

$$\frac{1}{A}\left[(\lambda-1)wL\left(w_r r - w_{t_w}(1+t_w)\frac{\eta_{K,\tilde{r}}}{\eta_{K,\tilde{w}}}\right)+\frac{\tilde{w}L\tilde{w}_{t_w}\varepsilon\sigma}{\eta_{K,\tilde{w}}}\left(\frac{w-e'}{\tilde{w}}+\frac{\lambda t_w}{1+t_w}-\frac{(\lambda-1)(1-\bar{t}_\pi)}{\varepsilon}\right)\right].$$

After plugging in the optimal wage tax as given by equation (4.20), we have

$$(\lambda-1)\frac{wL}{A}\left[\left(w_r r - w_{t_w}(1+t_w)\frac{\eta_{K,\tilde{r}}}{\eta_{K,\tilde{w}}}\right)+\left(-w_{t_r}(1+t_r)+w_{t_w}(1+t_w)\frac{\eta_{K,\tilde{r}}}{\eta_{K,\tilde{w}}}\right)\right] = 0.$$

3. The distortion of a joint change in the wage tax rate ($dt_r = 0$)

To determine the extent to which a joint change in the wage tax is distortionary, we have to compare the corresponding effects on private utility and total tax revenue. Using Hotelling's lemma, the additional tax revenue amounts to

$$\begin{aligned}\left.\frac{dR}{dt_w}\right|_{dK=0}^{dt_r=0} &= t_\pi\left(-L\left.\frac{\partial\tilde{w}}{\partial t_w}\right|_{dK=0}^{dt_r=0} - K\left.\frac{\partial\tilde{r}}{\partial t_w}\right|_{dK=0}^{dt_r=0}\right)\\ &\quad +t_r K\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0} + wL + t_w L\left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0} + t_w w\left.\frac{\partial L}{\partial t_w}\right|_{dK=0}^{dt_r=0}. \quad (4.38)\end{aligned}$$

Private utility will be negatively affected by a joint increase in the wage tax. Thus, the change in private utility in absolute terms is given by

$$\begin{aligned}-\left.\frac{dV}{dt_w}\right|_{dK=0}^{dt_r=0} &= -(w-e')\left.\frac{\partial L}{\partial t_w}\right|_{dK=0}^{dt_r=0} - L\left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0} - K\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0}\\ &\quad -(1-t_\pi)\left(-L\left.\frac{\partial\tilde{w}}{\partial t_w}\right|_{dK=0}^{dt_r=0} - K\left.\frac{\partial\tilde{r}}{\partial t_w}\right|_{dK=0}^{dt_r=0}\right). \quad (4.39)\end{aligned}$$

Since $\tilde{w} = (1+t_w)w$ and $\tilde{r} = (1+t_r)r$, we have $\partial\tilde{w}/\partial t_w|_{dK=0}^{dt_r=0} = (1+t_w)\,\partial w/\partial t_w|_{dK=0}^{dt_r=0} + w$ and $\partial\tilde{r}/\partial t_w|_{dK=0}^{dt_r=0} = (1+t_r)\,\partial r/\partial t_w|_{dK=0}^{dt_r=0}$ which, in turn, simplifies the last term in (4.39) such that the change in private utility becomes

$$\begin{aligned}-\left.\frac{dV}{dt_w}\right|_{dK=0}^{dt_r=0} &= -(w-e')\left.\frac{\partial L}{\partial t_w}\right|_{dK=0}^{dt_r=0} + wL + t_w L\left.\frac{\partial w}{\partial t_w}\right|_{dK=0}^{dt_r=0} + t_r K\left.\frac{\partial r}{\partial t_w}\right|_{dK=0}^{dt_r=0}\\ &\quad +t_\pi\left(-L\left.\frac{\partial\tilde{w}}{\partial t_w}\right|_{dK=0}^{dt_r=0} - K\left.\frac{\partial\tilde{r}}{\partial t_w}\right|_{dK=0}^{dt_r=0}\right). \quad (4.40)\end{aligned}$$

Comparing expressions (4.38) and (4.40) reveals that they coincide only if employment remains unchanged, i.e. $\partial L/\partial t_w|_{dK=0}^{dt_r=0} = 0$. This holds irrespective of whether or not we start from the uncoordinated Nash equilibrium.

4. Joint factor price changes and the sign of A

Note first that the marginal costs of public funds for the capital tax are given by

$$\lambda^{t_r} = \frac{\left(-\frac{w-e'}{\tilde{w}}\eta_{K,\tilde{w}} + (1-\bar{t}_\pi)\right)\left(\tilde{w}_{t_r}(1+t_r)+\frac{1-s}{s}\tilde{w}\right) - w_{t_r}(1+t_r)\left(1-\frac{w-e'}{w}\sigma\right)}{\left(\frac{t_w\eta_{K,\tilde{w}}}{1+t_w}+\frac{t_r\eta_{K,\tilde{r}}}{1+t_r}+(1-\bar{t}_\pi)\right)\left(\tilde{w}_{t_r}(1+t_r)+\frac{1-s}{s}\tilde{w}\right) - w_{t_r}(1+t_r)\left(1+\frac{(t_w-t_r)\sigma}{1+t_r}\right)},$$

as given in the text (see subsection 4.5.2). For a joint increase in the capital tax, we have

$$\begin{aligned}\left.\frac{\partial\lambda^{t_r}}{\partial t_r}\right|_{dK=0}^{dt_w=0} &= -\frac{\lambda^{t_r}}{\Delta\left(1+t_r\right)^2}\left[\eta_{K,\tilde r}\left(\tilde w_{t_r}(1+t_r)+\frac{1-s}{s}\tilde w\right)+\tilde w_{t_r}(1+t_r)\sigma\right]\\ &= -\frac{\lambda^{t_r}(1+t_w)}{\Delta\left(1+t_r\right)^2}\eta_{K,\tilde w}\frac{1-s}{s}\left(w_{t_r}(1+t_r)+\frac{\eta_{K,\tilde r}}{\eta_{K,\tilde w}}w\right),\end{aligned}$$

where Δ is the denominator of λ^{t_r}, which must be positive for the sake of Laffer-efficiency, and the term in brackets is equivalent to A. Thus,

$$sign\left\{\left.\frac{\partial\lambda^{t_r}}{\partial t_r}\right|_{dK=0}^{dt_w=0}\right\}=sign\left\{A\right\}.$$

As already mentioned in the text, to reach a stable Nash equilibrium requires that the welfare cost of a tax instrument increase if this tax is increased by all countries jointly. Hence, $A>0$ ensures this stability.

5. Partial coordination of the capital tax

For a constant capital employment, the repercussion of a change in the wage tax on the right hand side of the optimal capital tax equation is given by

$$\begin{aligned}&\left.\frac{\partial}{\partial t_w}\left(\frac{s}{1-s}\frac{(w-e')(\sigma-\varepsilon)(1-\sigma)(1-s)s}{\tilde w(1+\eta_{L,\tilde w})}\right)\right|_{dK=0}=\\ &\frac{\tilde w_{t_w}}{(1+t_w)A\eta_{K,\tilde w}}\frac{s}{1-s}\frac{(\sigma-\varepsilon)(1-\sigma)(1-s)s}{\tilde w(1+\eta_{L,\tilde w})}\left\{-\frac{e''(L)\varepsilon\sigma}{1+\eta_{L,\tilde w}}\right.\\ &\left.+(w-e')\left[2(1-\sigma)(1-s)\varepsilon\left(\frac{s(\sigma-\varepsilon)}{1+\eta_{L,\tilde w}}-1\right)-\eta_{K,\tilde r}\right]\right\},\end{aligned}$$

where $s(\sigma-\varepsilon)/(1+\eta_{L,\tilde w})-1=(\sigma-1)/(1+\eta_{L,\tilde w})$. Since $1+\eta_{L,\tilde w}<0$ in the presence of monopoly trade unions, the whole expression becomes negative for $\sigma<1$ and ambiguous for $\sigma>1$.

6. Partial coordination of the wage tax

First, we have

$$\begin{aligned}&\left.\frac{\partial}{\partial t_w}\left(\frac{(w-e')(\sigma-\varepsilon)(1-\sigma)(1-s)s}{w(1+\eta_{L,\tilde w})}\right)\right|_{dK=0}=\\ &\frac{\tilde w_{t_w}\varepsilon}{(1+t_w)A\eta_{K,\tilde w}}\frac{(w-e')(\sigma-\varepsilon)(1-\sigma)^2(1-s)s}{w(1+\eta_{L,\tilde w})}\left[(\sigma-\varepsilon)(1-s)s\frac{1+2\eta_{L,\tilde w}}{(1+\eta_{L,\tilde w})\eta_{L,\tilde w}}-(1-2s)\right],\end{aligned}$$

which is unambiguously smaller than zero for $s\geq 1/2$. For $s<1/2$ it cannot be signed.

Secondly, we have

$$\frac{\partial}{\partial t_w}\left(\frac{w-e'}{w}\right)\Bigg|_{dK=0} = \frac{\tilde{w}_{t_w}}{(1+t_w)A\eta_{K,\tilde{w}}}\frac{(w-e')(\sigma-\varepsilon)(1-\sigma)(1-s)s}{w(1+\eta_{L,\tilde{w}})}\frac{e'(L)}{w}\varepsilon,$$

so that

$$sign\left\{\frac{\partial}{\partial t_w}\left(\frac{w-e'}{w}\right)\Bigg|_{dK=0}\right\} = sign\left\{\sigma-1\right\}.$$

Chapter 5

Union Wages, Hours of Work and the Effectiveness of Partial Coordination Agreements

Abstract

Small monopoly trade unions decide upon the wage rate per hour and the hours of work subject to firm's demand for union members. Since the resulting Nash equilibrium is characterized by excess unemployment, we study the employment and welfare effects when trade unions try to coordinate their policies. Firstly, we consider a joint agreement about marginal wage moderation, where trade unions remain free to choose the hours of work non-cooperatively. Secondly, we analyze in which way a joint change in the hours of work affects employment and welfare if trade unions are free to choose the wage rate.

JEL Classification: C72, J51

Keywords: unemployment, wage setting, hours of work, partial cooperation

5.1 Introduction

Among industrialized nations, especially European countries suffer from high and persistent unemployment rates caused by real wages that are above the market clearing level. As one basic reason, it has been emphasized that the existence of trade unions is, in general, not compatible with full employment. Since (involuntary) unemployment is traded off with the wage rate accruing to its members, this is the 'price' trade unions are willing to accept when maximizing the well-being of their members. The economic literature has therefore pointed out that redesigning the tax system might provide a potential remedy to such a distortion on the labor market (see, for instance, Richter and Schneider 2001 and Koskela and Schöb 2002a,b). In fact, tax policy can either be used to manipulate the labor demand elasticity or to directly subsidize the labor market to lower the wage rate and boost employment, respectively.

Within the well-known monopoly-union framework, the pure ability to exert market power on the labor market is the basic reason for excessive wage claims and involuntary unemployment. In addition, however, wages and unemployment might be even higher if a country comprises many sector-specific monopoly trade unions, each of which imposing an externality on the rest of the economy when deciding upon the wage rate unilaterally. The result of such a decentralized equilibrium might be referred to as *excess unemployment*. Prominent examples of such externalities are the interactions between trade unions and the government sector, which can be interpreted as a fiscal externality. To the extent unemployed union members receive unemployment benefits from a government-run insurance program, each individual trade union is not fully aware of the true costs of wage induced layoffs since the additional expenses for unemployment benefits are spread over all employees within the country. Thus, increasing each union's financial responsibility of running the unemployment benefit system of its members has a wage moderating effect (see Holmlund and Lundborg 1988 as well as Sinko 2004). Another example is the potential hump-shaped pattern of the real wage rate depending on the degree of centralization in the wage setting (Calmfors and Driffill 1988). For intermediate levels of centralization, an increase in the union's wage rate might raise the price level of the firms' output, representing a loss in real wage for all union members in other sectors. In contrast, for the extreme cases of fully decentralized and centralized wage setting, such a price increase is either not possible due to the existence of close substitutes or falls back on all union members as an increase in the general price level, respectively.[1] This hump-shaped relation, however, is alleviated the more

[1] See Calmfors (1993) for other types of externalities dealt with in the literature.

countries are integrated in a world market producing highly substitutable goods (Danthine and Hunt 1994).

Simple stylized facts support the view that the unemployment rate is considerably lower in countries with centralized bargaining (e.g., Austria, Norway and Sweden) than in economies with a very decentralized bargaining structure (United Kingdom, United States, France); see Mares (2006). In addition, there is also empirical evidence indicating that among the two extreme cases it is full centralization that performs better in terms of employment compared with decentralized bargaining structure (see, e.g., Belot and van Ours 2001). More detailed evidence by Belot and van Ours (2004) or Nickell et al. (2005) suggests that the interactions with other labor market institutions seem to matter. They find that in the presence of decentralized trade unions unemployment is higher when there is a high degree of employment protection or union density.

In the present chapter, we abstract from the potential externalities mentioned afore. Rather, we restrict our wage setting analysis to a quite fundamental form of a prisoners' dilemma situation among small decentralized (monopoly) trade unions. The basic externality at work in this chapter is as follows. When a trade union claims a higher wage, with the corresponding loss in employment being the cost of this additional wage income, it imposes an external effect on all other trade unions simply because the unemployed members of the latter now face a lower probability of getting re-employed. We choose this *unemployment externality* to be the driving force of excess unemployment in our setting. In addition, to draw a more realistic picture of trade union behavior, we also allow each trade union to decide upon both the wage rate per hour and the hours of work per employee in the sector. Since both union instruments affect the firm's labor demand, both are able to impose an externality on all other sectors. Obviously, the resulting equilibrium entails room for improvements in terms of welfare and employment. This is the starting point of the present chapter. Our basic question will then be the following. Even in the absence of any government intervention, can trade unions effectively benefit from coordination agreements that aim a internalizing this externality? Clearly, if all trade unions are perfectly able to agree on both available instruments, the answer is in the affirmative. But what happens when trade unions are unable to commit themselves to a joint agreement that captures *both* the wage rate and the hours of work? Can the internalization of external effects work if only *partial* coordination is possible in the sense that only one of the unions instruments is cooperatively chosen, whereas the respective other instrument can nevertheless be freely chosen by all trade unions involved?

The focus of the present chapter is therefore the following. Assume that a country cannot simply move from a very decentralized structure to a centralized one by installing a trade union that is common to all firms in the country. What is then the potential scope for cooperation among all decentralized trade unions? Is there a chance to mimic centralized trade unions by jointly agreeing on some projects but still retaining the decentralized structure as such?

As one example, we might refer to the German *Alliance for Jobs* (Bündnis für Arbeit), i.e. central negotiations between trade unions, employers' representatives and the government to boost employment, where the metal sector trade union (IG Metall) was the first to announce that it would leave the negotiations if the wage rate appears on the agenda. In fact, the main (and only) purpose of the trade union leaders was to negotiate on the working time by reducing overtime or weekly hours of work and promoting early retirement programs.

On the other hand, many European countries have undertaken some effort to establish social pacts between trade unions and the governments (see Mares 2006). These pacts often comprise wage moderation in return for changes in tax policy or social security regulation. In most cases, however, the hours of work are not explicitly on the agenda.[2]

Rather than analyzing a multi-party contract between trade unions and other potential bargaining parties such as the government or employers, we study the effectiveness of partial agreements among decentralized trade unions only. In particular, our approach differs from the previous literature primarily because it deals with decentralized trade unions. In contrast, Calmfors (1985), Booth and Schiantarelli (1987) as well as Booth and Ravallion (1993) simplify their analysis to some extent by assuming that all workers are members of a centralized trade union. However, as has been set out above, countries with a centralized union structure have remarkably lower unemployment rates since they do not suffer excess unemployment. This is an important difference since centralized unions have no intrinsic motivation to further use their instruments to change the employment level. Instead, these authors have to rely on exogenous reductions in working time and derive at ambiguous employment effect when taking the subsequent wage response into account.

To address this issue in the presence of decentralized unions, the chapter is organized in the following way. In section 5.2, we set up a simple model of decentralized monopoly trade unions deciding upon the wage rate per hour and the hours of work. Since the Nash equilibrium implies unemployment that is higher than under centralized wage setting, section 5.3 discusses different forms of cooperation among trade

[2]As one exception, the Dutch Wassenaar agreement explicitly stated that wage moderation was exchanged for a reduction in working time.

unions. In particular, we distinguish between full cooperation and the more realistic scenario of partial cooperation. Section 5.4 summarizes and concludes.

5.2 The model

We consider a single small open economy that consists of a fixed large number of identical firms or sectors producing a homogenous output good. The good is sold to the world market at a constant price.

Turning to the firm level first, we assume that each firm produces the homogenous output good X_i using 'labor' as the only variable input according the production function $X_i = F(L_i)$, where $F' > 0, F'' < 0$ and the index i refers to an individual sector. The production function is common to all firms within the country. For notational convenience, other factors are assumed to be fixed in supply and are therefore suppressed in our formulation. We define 'labor' L_i as effective labor input that comprises both the number of employed workers l_i in the sector and the hours of work per employed worker h_i. Following, e.g., Booth and Schiantarelli (1987) as well as Booth and Ravallion (1993), we allow working time and employment to be less than perfectly substitutable. Effective labor input is therefore specified as follows:

$$L_i = (h_i)^\alpha \, l_i, \tag{5.1}$$

where $0 \leq \alpha \leq 1$ in order to capture potential decreasing returns to scale of a longer working day, e.g., due to fatigue effects. This specification implies

$$\frac{\partial L_i}{\partial l_i} \frac{l_i}{L_i} = 1,$$

i.e. for given hours of work per employee, a one percentage increase in employment l_i always translates into a one percentage increase in effective labor input. In contrast, for the hours of work we have

$$\frac{\partial L_i}{\partial h_i} \frac{h_i}{L_i} = \alpha \leq 1,$$

i.e. for employment kept constant, a one percentage increase in working hours does not increase effective labor input by more than one percentage. In particular, note that $\alpha = 1$ is the special case of employment and working hours being 'perfect substitutes'. For this case, effective labor input is simply given by the total working hours of all employees. On the other hand, $\alpha < 1$ indicates that the hours of work are less than perfectly substitutable to employment l_i.

Since we suppose the wage rate w_i per hour as well as the hours of work h_i to be choice variables of a sector-specific monopoly trade union, each firm takes these variables as given. Normalizing the constant output price to one, each firm then has the right to manage, i.e. it chooses employment l_i so as to maximize its profit:

$$\max_{l_i} F(L_i) - w_i h_i l_i, \tag{5.2}$$

subject to (5.1). This yields

$$(h_i)^{\alpha} F'(L_i) = w_i h_i$$

and implicitly defines labor demand of firm i as $l_i = l_i(w_i, h_i)$.

Following a change in the wage rate or the hours of work, respectively, each firm will adjust employment according to:

$$\frac{\partial l_i}{\partial w_i} = \frac{h_i}{(h_i)^{2\alpha} F''} < 0, \tag{5.3}$$

$$\frac{\partial l_i}{\partial h_i} = \frac{w_i(1-\alpha)}{(h_i)^{2\alpha} F''} - \alpha \frac{l_i}{h_i} < 0. \tag{5.4}$$

In terms of elasticities, we are able to express the labor demand elasticity with respect to the hours of work as a weighted average of the labor demand with respect to the wage rate and -1, with α being the weight:

$$\frac{\partial l_i}{\partial h_i}\frac{h_i}{l_i} = (1-\alpha)\frac{\partial l_i}{\partial w_i}\frac{w_i}{l_i} - \alpha. \tag{5.5}$$

The interpretation of (5.5) is straightforward. For the extreme case $\alpha = 0$, the hours of work would collapse to a pure cost factor, equivalent to the wage rate. Both labor demand elasticities would therefore coincide. On the other hand, for the special case of $\alpha = 1$, the hours of work are perfectly substitutable to employment. It is only the total working hours, i.e. $L_i = l_i h_i$, that is relevant to the firm as the input factor of production. For a given factor price of the effective labor input, L_i, there is a one-to-one relation between l_i and h_i in terms of percentages. Since the working hours enter the production function, labor demand is more elastic with respect to the wage rate than the hours of work, the exception being $\alpha = 0$.

For later use, note that, in general, the labor demand elasticities are not constant in the level of effective labor input, but will change in response to changes in the union's policy instruments. Defining $\varepsilon_{l,w}$ and $\varepsilon_{l,h}$ as the elasticities of labor demand with regard to the wage rate and the hours of work,[3] respectively, we have

$$\frac{\partial \varepsilon_{l,h}}{\partial j} = (1-\alpha)\frac{\partial \varepsilon_{l,w}}{\partial j}, \quad j = w, h, \tag{5.6}$$

$$\frac{\partial \varepsilon_{l,w}}{\partial w} = \frac{\varepsilon_{l,w}}{w}\left[1 - \varepsilon_{l,w}\left(1 + \frac{F'''}{F''}L\right)\right] \lesseqgtr 0, \tag{5.7}$$

$$\frac{\partial \varepsilon_{l,w}}{\partial h} = (1-\alpha)\frac{\varepsilon_{l,w}}{h}\left[1 - \varepsilon_{l,w}\left(1 + \frac{F'''}{F''}L\right)\right] \lesseqgtr 0. \tag{5.8}$$

[3] The index i has been dropped for notational convenience.

Indeed, standard one-factor production functions produce $F''' > 0$ as a property and support the above ambiguity. According to (5.7) and (5.8), the elasticity of the above elasticities with regard to h and w are also connected by the parameter α, i.e.

$$\frac{\partial \varepsilon_{l,w}}{\partial h} \frac{h}{\varepsilon_{l,w}} = (1 - \alpha) \frac{\partial \varepsilon_{l,w}}{\partial w} \frac{w}{\varepsilon_{l,w}}. \tag{5.9}$$

The parameter α therefore has two impacts on the labor demand elasticities. On the one hand, it determines the extent to which the labor demand elasticity $\varepsilon_{l,h}$ can be influenced by either w or h compared with $\varepsilon_{l,w}$ [see equation (5.6)]. For the extreme case $\alpha = 1$, it is constant at $\varepsilon_{l,h} = -1$. On the other hand, according to (5.9), the impact of the hours of work on the labor demand elasticity $\varepsilon_{l,w}$ differs from the wage impact on this elasticity by the factor $(1 - \alpha)$. Intuitively, the change in the labor demand elasticity $\varepsilon_{l,w}$ crucially depends on the effective labor input L.[4] In turn, the hours of work have a positive direct effect on L given the number of employed workers, which is not the case for the wage rate. The negative indirect effect on L due to the reduction in employment can offset the former effect only for $\alpha = 1$. Otherwise a negative impact of effective labor input remains.

As mentioned above, both the hours of work in sector i as well as the wage rate in this sector are determined by a corresponding sector-specific monopoly trade union. Each union's membership is assumed to be fixed throughout. As is usual in the literature on trade union behavior, each small monopoly trade union acts as a Stackelberg leader towards the firm. Thus, when choosing w_i and h_i it takes into account that the firm retains the 'right to manage' according to labor demand $l_i = l_i(w_i, h_i)$. However, each sector-specific trade union is assumed to be sufficiently small and is therefore unable to influence the countrywide employment level and thus, in turn, the probability that unions members are employed in the rest of the economy.

Since trade unions represent the preferences of their members, we have to specify the utility of union members. Each member's utility function is assumed to be additive and linear in income. If employed in firm i, the household works h_i hours and receives a wage rate of w_i per hour, both variables being determined by the trade union the household is organized in. Since employment is associated with forgone leisure, we capture the disutility of supplying labor by the term $e(h_i)$, $e' > 0$, $e'' \geq 0$ with $e(0) = 0$.[5] Thus, an unemployed household receives a zero utility level.

The objective of the union i is to maximize the members' welfare which is given

[4] The labor demand elasticity with respect to the wage rate is given by $\varepsilon_{l,w} = F'(L)/[LF''(L)]$.

[5] See, e.g, Earle and Pencavel (1990) for a similar procedure.

by

$$\max_{w_i, h_i} V_i = l_i(w_i, h_i)\left[w_i h_i - e(h_i)\right] + \left[m_i - l_i(w_i, h_i)\right](1-u)\left[wh - e(h)\right], \qquad (5.10)$$

where m_i denotes the fixed number of union members of which l_i are employed in sector i and $m_i - l_i$ in the rest of the country. The subindex i refers to the individual union-firm relationship and variables without index denote countrywide averages which cannot be affected by a small trade union. In particular, u denotes the countrywide unemployment rate such that the probability of re-employment $(1-u)$ is therefore given by l/m. Since the number of trade unions and firms is fixed and we restrict our attention to symmetric outcomes, all variables without index i are a measure of countrywide values. In the objective function (5.10) we have assumed that union members are perfectly mobile between firms within the country under consideration (Hoel 1991). A union member who is not employed in firm i receives the average wage w and works for h hours since these numbers prevail in the rest of the country. On the other hand, if a union member is not employed outside firm i, which happens with probability u, her payoff is zero since $w = 0$ and $e(0) = 0$.[6]

Taking into account the firm's response to changes in trade union 'policy variables', each union's first-order conditions require, respectively,

$$\frac{\partial V_i}{\partial w_i} = 0 \Rightarrow l_i h_i + \frac{\partial l_i}{\partial w_i}\left\{w_i h_i - e(h_i) - \frac{l}{m}\left[wh - e(h)\right]\right\} = 0 \qquad (5.11)$$

and

$$\frac{\partial V_i}{\partial h_i} = 0 \Rightarrow l_i\left[w_i - e'(h_i)\right] + \frac{\partial l_i}{\partial h_i}\left\{w_i h_i - e(h_i) - \frac{l}{m}\left[wh - e(h)\right]\right\} = 0, \qquad (5.12)$$

i.e. for both instruments, the marginal benefit (at constant employment) must be equal to its marginal cost (due to the reduction in employment). For later use, note that the second-order conditions must satisfy

$$\frac{\partial^2 V_i}{\partial w_i^2} = 2h_i \frac{\partial l_i}{\partial w_i} + \frac{\partial^2 l_i}{\partial w_i^2}\left\{w_i h_i - e(h_i) - \frac{l}{m}\left[wh - e(h)\right]\right\} < 0$$

and

$$\frac{\partial^2 V_i}{\partial h_i^2} = \frac{\partial^2 l_i}{\partial h_i^2}\left\{w_i h_i - e(h_i) - \frac{l}{m}\left[wh - e(h)\right]\right\} + 2\left[w_i - e'(h_i)\right]\frac{\partial l_i}{\partial h_i} - l_i e''(h_i) < 0.$$

In a symmetric equilibrium, each union has solved the same problem. We are therefore able to write $w_i = w$ and $h_i = h$. For the analysis in section 5.3, it proves

[6] Recall that we fully ignore the government sector and therefore abstract from unemployment benefits accruing to unemployed union members.

convenient to express the first-order conditions in the symmetric Nash equilibrium in terms of elasticities. We obtain

$$\frac{wh}{[wh - e(h)]\left(1 - \frac{l}{m}\right)} + \varepsilon_{l,w} = 0 \tag{5.13}$$

and

$$\frac{h\,[w - e'(h)]}{[wh - e(h)]\left(1 - \frac{l}{m}\right)} + \varepsilon_{l,h} = 0, \tag{5.14}$$

i.e. for both 'policy' instruments of the trade union, a one percentage increase of this instrument must balance the percentage gain in utility with the percentage reduction in employment (see, e.g., Booth 2002). Union members are only willing to supply labor if they receive a positive rent from doing so. Hence, $wh - e(h) > 0$ and the resulting Nash equilibrium is characterized by unemployment, $l/m < 1$ [see equation (5.13)]. Since trade unions also determine the hours of work, each union member who is employed will be *under*employed in the Nash equilibrium, $w > e'(h)$ [see equation (5.14)]. Substituting (5.13) into (5.14) yields the following relation between the employment effects of the union's policy instruments

$$\frac{\varepsilon_{l,h}}{\varepsilon_{l,w}} = \frac{w - e'(h)}{w}, \tag{5.15}$$

i.e. the relative percentage employment effects of the union's instruments must be equal to the relative percentage benefits of the two policy instruments. As a common feature in the presence of monopoly power, the Nash equilibrium implies that labor demand is elastic in the wage rate, $\varepsilon_{l,w} < -1$. This follows from straightforward manipulation of expression (5.13). Recalling equation (5.5), a similar property applies to the labor demand elasticity regarding the hours work, i.e. $\varepsilon_{l,h} \leq -1$, where the case of $\varepsilon_{l,h} = -1$ holds for $\alpha = 1$. The expression in (5.5) then also allows us to infer that, in terms of percentages, the hours of work cannot have a stronger impact on labor demand that the wage rate, i.e. $\varepsilon_{l,h} \geq \varepsilon_{l,w}$.

Since we restrict our attention to symmetric equilibria we are able to rewrite the second-order conditions as

$$\frac{\partial^2 V}{\partial w^2} = \frac{\partial l}{\partial w} h \left(2 + \frac{F'''}{F''} L\right) < 0 \tag{5.16}$$

and

$$\frac{\partial^2 V}{\partial h^2} = \frac{\partial^2 l}{\partial h^2} [wh - e(h)] \left(1 - \frac{l}{m}\right) + 2\,[w - e'(h)]\,\frac{\partial l}{\partial h} - l e''(h) < 0.$$

Note that central wage setting, e.g., by a countrywide monopoly trade union, will also entail unemployment and a wage rate that exceeds the marginal disutility of labor. However, the unemployment rate will be lower compared with the decentralized scenario (see Appendix 1 for details). Consequently, there is room for improvement in terms of employment if all decentralized unions coordinate their policies. The next section examines to which extent such cooperation can be effective, depending on the policy instruments that are included in such an agreement.

5.3 Cooperation among decentralized unions

When discussing coordination, we restrict our analysis to marginal steps, starting from the symmetric uncoordinated Nash equilibrium. As a point of reference, we first discuss full cooperation in subsection 5.3.1, where all unions agree to jointly change one policy instrument while keeping the remaining variable constant. Subsections 5.3.2 and 5.3.3 then relax the latter assumption, i.e. we analyze the effectiveness of a joint change in the wage (hours of work) when all trade are still free to choose their hours of work (wage rate) non-cooperatively. Note that we do not attempt to explain why the one or the other form of cooperation is established. Our basic motivation is that it seems to be unrealistic that the participants of such a cooperation are able or willing to agree on several issues.

5.3.1 Full cooperation in the wage rate and the hours of work

We refer to the special case of full cooperation in w and h if all trade unions agree to jointly change one of their policy instruments while keeping the remaining instrument constant. Let us first consider a joint agreement that prescribes to marginally *reduce* the wage rate at constant hours of work. For notational clarity, we omit the index i if joint changes are considered, since all sectors are identical and face the same reactions. Such an agreement boosts employment in each sector:

$$\left.\frac{\partial l}{\partial w}\right|_{dh=0} = \frac{h^{1-2\alpha}}{F''} < 0,$$

and thus, in turn, output and profits according to, respectively,

$$\left.\frac{\partial X}{\partial w}\right|_{dh=0} = F' h^{\alpha} \left.\frac{\partial l}{\partial w}\right|_{dh=0} < 0$$

and

$$\left.\frac{\partial [X - whl]}{\partial w}\right|_{dh=0} = -hl < 0. \tag{5.17}$$

For each sector, these numbers are quantitatively identical to the effects of changes in the wage rate carried out by the respective trade union, unilaterally.

Most importantly, such coordination in the wage rate now affects each union's outside utility by lowering the countrywide probability of being unemployed. The welfare impact can therefore be written as

$$\left.\frac{\partial V}{\partial w}\right|_{dh=0} = \frac{m-l}{m}\left\{hl + [wh - e(h)]\left.\frac{\partial l}{\partial w}\right|_{dh=0}\right\} = -\frac{l}{m}hl < 0. \tag{5.18}$$

Hence, if all trade unions are able to commit on both a joint wage moderation and a given number of working hours, all unions are better off. As a consequence of the envelope theorem, all wage impacts which are present in the case of a unilateral change in w_i have no welfare impact, since the symmetric uncoordinated Nash equilibrium serves as the starting point. Thus, (in case of a joint wage cut) the only relevant effects are the reduction of wage income for the households not employed in firm i and the higher re-employment probability if not employed in sector i. Using the first-order condition (5.13), allows us to unambiguously sign this expression.

Correspondingly, a second form of cooperation comprises a joint change in the hours of work with the wage rate kept constant at its previous level. Again, a positive employment effect emerges if all unions reduce h :

$$\left.\frac{\partial l}{\partial h}\right|_{dw=0} = \frac{w(1-\alpha)}{h^{2\alpha}F''} - \alpha\frac{l}{h} < 0.$$

In turn, the output effect as well as the impact on firm profits depend on α since:

$$\left.\frac{\partial X}{\partial h}\right|_{dw=0} = \frac{w(1-\alpha)F'}{h^{\alpha}F''} \leq 0$$

and

$$\left.\frac{\partial[X - whl]}{\partial h}\right|_{dw=0} = -wl(1-\alpha) \leq 0. \tag{5.19}$$

Thus, we can only expect positive effects on output and profits, if employment and working hours are not perfectly substitutable to the firm. Intuitively, recall that for $\alpha = 1$ effective labor input is constant in the hours of work since the direct effect is exactly balanced by the indirect effect via reduced employment.

Finally, the joint change in the hours of work (at a constant w) yields the following welfare effect:

$$\left.\frac{\partial V}{\partial h}\right|_{dw=0} = \frac{m-l}{m}\left\{l\,[w - e'(h)] + [wh - e(h)]\left.\frac{\partial l}{\partial h}\right|_{dw=0}\right\} = -\frac{l}{m}l\,[w - e'(h)] < 0. \tag{5.20}$$

Trade unions will therefore be better off if they agree to reduce working time and can commit themselves to keep the wage rate constant. Again, the only relevant effects stem from households who are not employed in firm i. Even though the joint cut in the hours of work reinforces the underemployment of employed households, this loss in total income is exactly compensated by the gain in employment in this sector. In addition, however, the joint reduction in h increases employment in all other sectors and thus, in turn, the probability of employment outside sector i. Hence, using the first-order conditions of the symmetric Nash equilibrium, which serves as a starting point of coordination, the expression in (5.20) is unambiguously negative.

5.3.2 Partial cooperation in the wage rate

In contrast to the preceding subsection, we now reject the idea that unions are able to form an agreement on both the wage rate and the hours of work. Instead, we now suppose that trade unions are only able to agree on even smaller projects. In particular, we consider a joint change in only *one* of the two instruments (w or h), whereas the coordination arrangement does not cover the remaining variable. The latter can then freely be chosen by all trade unions.

In this subsection, we suppose that all trade unions have agreed to jointly reduce their wage rate to benefit from the subsequent reduction in the unemployment rate. Since the trade unions were assumed to be small, such a reduction in the unemployment rate (i.e. the probability that unions members earn no wage income at all) has not been possible for each union individually. However, since the hours of work are not a part of the agreement that stipulates the joint reduction in the wage rate, each union might now perceive its individual choice of h_i to be incorrect and aims at a corresponding adjustment.

To be more detailed, recall that the hours of work have been determined according to the first-order condition $\partial V_i/\partial h_i = 0$. Again, it is convenient to rewrite this condition in terms of elasticities, using the fact that the starting point (as well as the final equilibrium) is symmetric [see equation (5.14)]. In the uncoordinated (symmetric) optimum, the net benefit from changing the hours of work (by a marginal unit) can therefore be written as

$$NB(h) = h\left[w - e'(h)\right] + \varepsilon_{l,h}\left[wh - e(h)\right]\left(1 - \frac{l}{m}\right) = 0. \tag{5.21}$$

Since the wage coordination will, in general, alter this condition, each union has the incentive to use the hours of work to restore this condition again. In doing so, each single union will, again, treat the (un)employment rate as constant. However, as all unions face the same incentive to adjust their hours of work, the countrywide (un)employment rate will be subject to changes during this adjustment. Thus, to find out the extent to which all unions have finally adjusted their hours of work in response to the initial wage coordination, we need to determine

$$\frac{dh}{dw} = -\frac{\partial NB(h)}{\partial w} \cdot \left(\frac{\partial NB(h)}{\partial h}\right)^{-1}, \tag{5.22}$$

where, again, the changes in w and h are carried out by all countries and the index i is suppressed for clarity. Equation (5.22) then gives us the uncoordinated, but joint adjustment of h that is necessary to restore $\partial V_i/\partial h_i = 0$, if all unions face a coordinated change in the wage rate and the final equilibrium is symmetric again.

Note that joint changes in h or w, respectively, trigger the same employment reaction for each trade union as has been the case for unilateral changes; see the effects on l_i in (5.3) and (5.4). In addition, however, the employment level of the whole country, i.e. l, is changed. Due to our assumption of symmetric unions, these responses are equivalent to the ones given by (5.3) and (5.4).

In detail, we have

$$\begin{aligned}\frac{\partial NB(h)}{\partial h} &= (w - e')\left(1 + \varepsilon_{l,h}\right) - \varepsilon_{l,h}\frac{l}{m}\left[w - e' + \varepsilon_{l,h}\frac{wh - e(h)}{h}\right] \\ &\quad + \frac{\partial \varepsilon_{l,h}}{\partial h}\left[wh - e(h)\right]\left(1 - \frac{l}{m}\right) - he'',\end{aligned} \tag{5.23}$$

which must be negative in sign for the sake of stability of the initial Nash equilibrium. To see this, bear in mind that the expression $NB(h)$ stated in (5.21) gives each union's marginal net benefit from altering the hours of work (which must be zero to establish an optimum for the individual trade union). Now suppose that the hours of work for all unions are slightly lower than in the Nash equilibrium so that this net benefit is positive and each union has an incentive to increase its working hours. Since all unions face the same incentive to increase the hours of work, the corresponding *joint* increase must reduce the net benefit from increasing this variable to reach a stable Nash equilibrium, i.e. to eliminate the incentive to change the hours of work any further. Thus, whether unions choose higher or lower working hours following a wage coordination solely depends on the sign of the first term in (5.22):

$$sign\left\{\frac{dh}{dw}\right\} = sign\left\{\frac{\partial NB(h)}{\partial w}\right\}.$$

This term becomes

$$\frac{\partial NB(h)}{\partial w} = h + \varepsilon_{l,h}h\left(1 - \frac{l}{m}\right) - \varepsilon_{l,w}\varepsilon_{l,h}\frac{l}{m}\frac{wh - e(h)}{w} + \frac{\partial \varepsilon_{l,h}}{\partial w}\left[wh - e(h)\right]\left(1 - \frac{l}{m}\right), \tag{5.24}$$

where its sign is ambiguous *a priori*, depending on how a joint reduction in the wage rate affects the marginal benefit and marginal cost of changing the hours of work. For all employed union members, the joint wage cut lowers the additional rent from raising the working hours which *ceteris paribus* renders an increase in working hours less interesting for the trade union; see the first term on the right hand side of (5.24). On the other hand, a joint reduction in the wage rate also lowers the total rent from being employed. As a consequence of the lower opportunity cost for members being laid off (due to an increase in h), unions will call for more working hours, *ceteris paribus*; see the second term in (5.24). The third term then captures that the coordinated wage cut is able to reduce the countrywide unemployment rate. The cost of increasing the working hours are therefore reduced due to the higher re-employment probability for unemployed union members. Finally, the last term on the right hand side of (5.24) represents the way in which the trade union's marginal cost of increasing the hours of work are affected by a joint change in the wage rate. In particular, the impact on the labor demand elasticity is important, which is ambiguous in sign. Depending on whether the labor demand elasticity with respect to h is augmented (alleviated), in absolute terms, when a collective wage cut is carried out, increasing the hours of work becomes more (less) costly to the trade unions. In general, we are not able to conclude whether or not the trade unions' response is to have eventually raised their working hours in the new Nash equilibrium. A clear-cut statement can only be made if the labor demand elasticity with respect to the hours of work remains constant or becomes less elastic following the initial wage cut, i.e. $\partial\varepsilon_{l,h}/\partial w \leq 0$. For this case, we unambiguously find that trade unions have responded by increasing the hours of work; see Appendix 2 for details.

Employment effect

The overall effect on employment is given by the sum of the initial employment effect due to the joint reduction in the wage rate (at constant hours of work) and the subsequent joint change in the hours of work (at a constant wage rate), where the latter must be weighted with the extent to which all unions have finally adjusted h in the new Nash equilibrium:

$$\frac{dl}{dw} = \left.\frac{\partial l}{\partial w}\right|_{dh=0} + \frac{dh}{dw}\left.\frac{\partial l}{\partial h}\right|_{dw=0}. \tag{5.25}$$

For notational parsimony, we suppress the characterization $dh = 0$ and $dw = 0$ in what follows if the respective variable is kept constant. We solely use the partial derivative notation in what follows. Plugging (5.23) and (5.24) into (5.22) and substituting the result [together with (5.13) and (5.15)] into expression (5.25), we derive at (see Appendix 3):

$$\frac{dl}{dw} = \left(\frac{\partial NB(h)}{\partial h}\right)^{-1} \cdot \left(\frac{\partial\varepsilon_{l,h}}{\partial w} w \frac{\varepsilon_{l,h}}{\varepsilon_{l,w}} - \frac{\partial\varepsilon_{l,h}}{\partial h} h - \varepsilon_{l,w}\frac{h}{w}e''\right) l. \tag{5.26}$$

Obviously, the overall employment effect is ambiguous *a priori*. To provide an intuitive explanation for this result, a suitable starting point is to think of the zero employment effect as the benchmark scenario. Loosely speaking, if the hours of work were an instrument that perfectly mimics the wage rate, the trade union would be able to exactly return to where they started, i.e. the initial Nash equilibrium. The employment effect would be zero in this case. To the extent these instruments have different impacts on the first-order condition $NB(h) = 0$, a non zero employment effect emerges. Equation (5.26) can therefore be interpreted as describing the differential effect of w and h, respectively, that are able to constitute an employment effect. Since $\partial NB(h)/\partial h < 0$, the signs of the terms in brackets on the right hand side of (5.26) are important. A positive (negative) expression indicates that a joint wage cut boosts (reduces) total employment *ceteris paribus*.

Let us first turn to the last term in brackets which depends on the change of the marginal disutility of the hours of work. As $\varepsilon_{l,w} < 0$ and $e'' \geq 0$ this effect is *ceteris paribus* associated with a non-negative overall employment effect. It will vanish for the extreme case of a constant marginal disutility of labor ($e'' = 0$). What is the intuition behind this mechanism? The starting point of coordination is the symmetric Nash equilibrium which is characterized by each trade union's optimal choice of the wage rate and the hours of work (and thus, in turn, employment). The joint wage cut then disturbs this equilibrium such that each union perceives the allocation as no longer the individually most preferred one. Technically, the collective change in the wage rate changes the first-order condition which gives the optimality rule for the hours of work. Since all trade unions are still allowed to change the hours of work, they use this instrument to restore this condition again. Intuitively, trade unions try to use the hours of work to imperfectly mimic the initial equilibrium that has been most preferred from an individual point of view. In the course of the adjustment, the marginal disutility of the working hours is changed. This serves as one channel to partially restore $NB(h) = 0$. However, the initial joint change in the wage rate could not have an impact on the marginal disutility of working time. Thus, in an attempt to go back to the initial Nash equilibrium by increasing the hours of work in response to the joint wage cut, the marginal disutility of labor is increased. Since this mechanism already restores the first-order condition $NB(h) = 0$ to some extent, the total change in h is lower than what would have been necessary to perfectly undo the initial stimulus, i.e. the reduction in w.

Turning to the intuition of the first two terms in (the brackets of) equation (5.26), we should again be detailed in the interpretation of the effects which are at work. Let us first consider the impact on the elasticity of labor demand $\varepsilon_{l,h}$. Starting with the initial collective wage cut, the labor demand elasticity might become less elastic

($\partial\varepsilon_{l,h}/\partial w < 0$) or more elastic ($\partial\varepsilon_{l,h}/\partial w > 0$). In turn, this has repercussions on the way trade unions use their hours of work as an adjustment device. To be more specific, in the former case, where $\partial\varepsilon_{l,h}/\partial w < 0$, when competing back to the initial Nash equilibrium by raising h, trade unions use this adjustment too excessively. The reason is that the initial reduction in the wage rate 'distorts' the choice of h in a way that makes unions more aggressive in using the hours of work. This is a case in which, *ceteris paribus*, the overall employment effect is to have even lower employment after the joint wage cut. The opposite holds for $\partial\varepsilon_{l,h}/\partial w > 0$, where labor demand becomes more elastic so that unions do not use the hours of work to fully go back to the employment level that prevailed in the initial Nash equilibrium. An analogous interpretation applies when all unions use the working hours as an instrument to respond to wage agreement. This time it is the adjustment, i.e. the joint increase in h, that renders labor demand more or less elastic. For $\partial\varepsilon_{l,h}/\partial h < 0$, the joint adjustment (that is to say, the increase in h) implies that labor demand becomes more elastic with respect to the hours of work. As a consequence, the adjustment is not carried out to the 'full extent', i.e. to restore the initial Nash equilibrium, as it becomes more costly. For $\partial\varepsilon_{l,h}/\partial h > 0$, in contrast, the joint increase in h renders the labor demand elasticity less elastic which, in turn, induces the unions to raise the working hours even further.

The factor $\varepsilon_{l,h}/\varepsilon_{l,w} \leq 1$ then corrects for the following. First, as explained above the elasticity $\varepsilon_{l,h}$ is altered when employment changes due to both the initial coordination stimulus as well as the trade unions' response. Second, note that the impact of the wage rate on labor demand is larger than the impact of h (of equal size) on labor demand. Thus, the factor $\varepsilon_{l,h}/\varepsilon_{l,w} \leq 1$ scales down the $\partial\varepsilon_{l,h}/\partial w$-effect compared to the $\partial\varepsilon_{l,h}/\partial h$-effect.

Some special cases

In order to judge the direction of the employment effect, it might be interesting to examine some special cases. First, for $\alpha = 1$ and $e'' = 0$ there is no employment effect, i.e. the agreement which marginally changes the wage rate but fails to cover the hours of work is not able to affect employment. The former denotes the special case of employment and working hours being perfect substitutes in determining the effective labor input to production. It ensures that the labor demand elasticity $\varepsilon_{l,h}$ remains constant at $\varepsilon_{l,h} = -1$ and is therefore not affected by the collective wage cut nor the joint adjustment of the working hours. The latter may be the even more restrictive scenario of a constant marginal disutility of labor ($e'' = 0$), an assumption that is frequently used in the literature on union wage setting (see, for instance, Boeters and Schneider 1999 or Koskela and Schöb 2002a). As has been pointed out before, $e'' = 0$ eliminates one mechanism that prevents the trade unions to exactly return to the employment level of the initial Nash-equilibrium. Clearly, for $\alpha = 1$ and $e'' > 0$ the joint wage cut can effectively boost total employment even if trade unions engage in 'competition' by using the working hours as an instrument to maximize their well-being.

Turning to the more relevant scenario of labor and capital being less than perfectly substitutable ($\alpha < 1$), we now have a case where the repercussions on the labor demand elasticity $\varepsilon_{l,h}$ become important. The impact on $\varepsilon_{l,h}$ seems to be stronger the smaller is α; see equation (5.6). However, we have to take into account that this labor demand elasticity is not only affected by the joint wage cut, but also by the subsequent joint reaction in the hours of work. It is therefore important to examine in which direction this value is eventually influenced after the working time adjustment is carried out. First, inspecting equations (5.6) to (5.8) reveals that $h \cdot \partial\varepsilon_{l,h}/\partial h = (1-\alpha)w \cdot \partial\varepsilon_{l,h}/\partial w$. As has been set out before, the reason for the differential impact goes back to the different effects on effective labor input because the hours of work have a positive direct effect on L, which is not the case for the wage rate. Since the $h \cdot \partial\varepsilon_{l,h}/\partial h$-effect is smaller than the $w \cdot \partial\varepsilon_{l,h}/\partial w$-effect by the factor $(1-\alpha)$ and the $w \cdot \partial\varepsilon_{l,h}/\partial w$-effect itself is scaled down by the ratio $\varepsilon_{l,h}/\varepsilon_{l,w} \leq 1$, we are left with comparing $\varepsilon_{l,h}/\varepsilon_{l,w}$ and $(1-\alpha)$. Inspecting equation (5.5) then shows that $\varepsilon_{l,h}/\varepsilon_{l,w} - (1-\alpha) = -\alpha/\varepsilon_{l,w}$, i.e. the $w \cdot \partial\varepsilon_{l,h}/\partial w$-effect is stronger than the $h \cdot \partial\varepsilon_{l,h}/\partial h$-effect by a factor that is proportional to the parameter α. In fact, for $\alpha = 0$ (together with $e'' = 0$) again, a zero employment effect emerges. This time, the reason is twofold. First, both labor demand elasticities coincide so that the scaling factor in front of the $\partial\varepsilon_{l,h}/\partial w$-effect vanishes. Second, referring back to equations (5.6) to (5.8), a percentage change in the wage rate or the hours of work have an equal impact on the labor demand elasticity $\varepsilon_{l,h}$.

Summing up, for $e'' = 0$ and $0 < \alpha < 1$, the sign of the overall employment effect depends on whether the initial wage cut renders the labor demand elasticity $\varepsilon_{l,h}$ more or less elastic:

$$sign\left\{ \left.\frac{dl}{dw}\right|_{e''=0} \right\} = -sign\left\{ \frac{\partial\varepsilon_{l,h}}{\partial w} \right\}.$$

Thus, if the initial joint wage cut renders the labor demand elasticity with respect to the hours of work more elastic (less elastic), i.e. $\partial\varepsilon_{l,h}/\partial w > 0$ ($\partial\varepsilon_{l,h}/\partial w < 0$), the overall level of employment in each sector will be higher (lower) when trade unions have optimally responded to the reduction in w by using the hours of work.

Welfare effect

Since the collective reduction in the wage rate is associated with a joint adjustment in working hours and employment, a natural question is whether or not all union members eventually benefit from such a partial cooperation after the adjustment has taken place. The overall effect on union members' welfare is written as:

$$\frac{dV}{dw} = \frac{\partial V}{\partial w} + \frac{dh}{dw}\frac{\partial V}{\partial h}, \tag{5.27}$$

i.e. it comprises the initial welfare gain of a joint reduction in the wage rate (at a constant h), i.e. $\partial V/\partial w$, and the subsequent welfare effect of the joint adjustment of the hours of work (at a constant w), i.e. $\partial V/\partial h$, weighted with the magnitude of the adjustment. Both welfare terms on the right hand side of equation (5.27) have already been determined in subsection 5.3.1. Plugging (5.18), (5.20) and (5.22) into (5.27), the overall welfare effect is then given by (see Appendix 4):

$$\frac{dV}{dw} = \left(\frac{\partial NB(h)}{\partial h}\right)^{-1} \cdot \left(\frac{\partial \varepsilon_{l,h}}{\partial h}h - \frac{\varepsilon_{l,h}}{\varepsilon_{l,w}}\frac{\partial \varepsilon_{l,h}}{\partial w}w + \frac{h}{w}\varepsilon_{l,w}e''\right)\frac{whl}{\varepsilon_{l,w}}\frac{l}{m}. \tag{5.28}$$

Not surprisingly, the direction of the welfare effect is identical to the employment effect of partial wage coordination, i.e. boosting employment is welfare enhancing. Since the starting point of coordination is the uncoordinated Nash equilibrium and the wage rate, the hours of work and thus employment are optimally chosen by each individual trade union, welfare effects can only arise if collective marginal actions can influence the countrywide employment level as it determines the unions' outside option. Consequently, the interpretation of (5.26) also applies to the welfare effect of (5.28).

Repercussion on profit income

Even though the cooperation is among decentralized trade unions only, repercussion on each sector's profit income may be important in terms of a more comprehensive welfare analysis. Since employment is optimally chosen by each firm in the Nash equilibrium, any employment effects, which partial wage coordination might have, cannot affect profits. Following a joint wage cut with a subsequent adjustment in the hours of work, profit income is affected according to:

$$\frac{d[X - whl]}{dw} = -hl\left[\frac{dh}{dw}\frac{w}{h}(1-\alpha) + 1\right]. \tag{5.29}$$

Interestingly, for the extreme case of $\alpha = 1$, the impact on profit income is independent on whether the hours of work are kept constant during the wage coordination [see equation (5.17) in subsection 5.3.1] or can be freely chosen by trade unions afterwards. Note that the reason for this, somewhat surprising, result cannot be that trade unions voluntarily choose not to adjust their working hours. On the contrary, for employment and working hours being perfect substitutes ($\alpha = 1$), the labor demand elasticity $\varepsilon_{l,h}$ remains constant and trade unions will react to a wage cut by increasing the hours of work [see equation (5.24) and the discussion thereafter]. To be more specific, since $\varepsilon_{l,h} = -1$, the joint adjustment of the hours of work does not alter effective labor input $L = lh$, which, in turn, implies that profits remain unchanged in the course of the joint adjustment of the working hours. Thus, recipients of profit income should not be concerned whether the wage coordination agreement among trade unions covers the hours of work or not, given that employment and working hours are perfect substitutes.

5.3.3 Partial cooperation in the hours of work

As has been set out before, we observe that the hours of work are on the agenda of joint agreements (between trade unions and firms), while unions refuse to talk about the wage rate jointly. The German *Alliance for Jobs* is a prominent example. It may therefore be interesting to consider the consequences of a partial coordination in the hours of work.

From a theoretical perspective, Calmfors (1985) and Booth and Schiantarelli (1987) have analyzed a reduction in working time and its repercussion on employment when the wage rate is subject to changes afterwards. However, their starting point is a country-wide trade union that covers all workers so that unemployment is less severe than in countries with decentralized trade unions. The focus of these previous studies is therefore not on excess unemployment due to externalities among unions.

To make the scenario suitable to many other countries, let us therefore assume that, on a national level, all decentralized unions agree to marginally change (reduce) their working hours, whereas the choice of the wage rate is not subject to the joint agreement and can therefore be adjusted afterwards in an optimal manner from each union's perspective.

This time, each union is free to choose the wage rate such that in the new equilibrium the first-order condition $\partial V_i / \partial w_i = 0$ must be restored. Again, the net benefit from changing the wage rate by a marginal unit can be rewritten in terms of elasticities as [see equation (5.13)]:

$$NB(w) = wh + \varepsilon_{l,w} \left[wh - e(h) \right] \left(1 - \frac{l}{m} \right) = 0,$$

where we have used the property of a symmetric equilibrium. For the wage adjustment, we then need an expression for

$$\frac{dw}{dh} = -\frac{\partial NB(w)}{\partial h} \cdot \left(\frac{\partial NB(w)}{\partial w}\right)^{-1}, \tag{5.30}$$

with

$$\frac{\partial NB(w)}{\partial w} = h(1+\varepsilon_{l,w}) + \frac{\partial \varepsilon_{l,w}}{\partial w}\left[wh - e(h)\right]\left(1 - \frac{l}{m}\right) - \varepsilon_{l,w}\frac{l}{m}\left(h + \frac{wh - e(h)}{w}\varepsilon_{l,w}\right).$$

Note that for a similar stability reason as in the previous subsection we must have $\partial NB(w)/\partial w < 0$. Consequently, if a joint change in the hours of work raises (reduces) the net marginal benefit from a wage increase, all trade unions will react by increasing (lowering) the wage rate. The direction of the wage adjustment is then solely given by the sign of

$$\begin{aligned} \frac{\partial NB(w)}{\partial h} &= w + \varepsilon_{l,w}(w - e')\left(1 - \frac{l}{m}\right) - \frac{wh - e(h)}{h}\frac{l}{m}\varepsilon_{l,h}\varepsilon_{l,w} \\ &\quad + \frac{\partial \varepsilon_{l,w}}{\partial h}\left[wh - e(h)\right]\left(1 - \frac{l}{m}\right). \end{aligned} \tag{5.31}$$

Proceeding in an analogous way to the previous subsection, it is instructive to have a closer look at the impact of a joint *reduction* in the hours of work on the marginal benefit and marginal cost of increasing the wage rate. The first term in the upper line of equation (5.31) captures that a joint marginal reduction in the working hours also reduces the marginal benefit from raising the wage rate since all employed union members receive less total wage compensation. Since the reduction in the hours of work also lowers the total rent from being employed, wage moderation *ceteris paribus* becomes less interesting for the unions; see the second term in (5.31). Reducing the hours of work in all sectors will boost the countrywide employment level and therefore increase the re-employment probability of unemployed union members. Unions will *ceteris paribus* respond with more aggressive wage claims, see the third term in equation (5.31). Finally, we have to take into account that a joint cut in h has an impact on the labor demand elasticity with respect to the wage rate. This effect is captured by the last term in (5.31) and can go in either direction. If the collective reduction in the hours of work renders the labor demand elasticity $\varepsilon_{l,w}$ more (less) elastic, the wage rate becomes more (less) costly (at the margin) as a trade union instrument. For $\partial\varepsilon_{l,w}/\partial h \leq 0$, we can unambiguously infer that unions react to the cut in h by raising the wage rate (see Appendix 5 for details). This condition would be sufficient to conclude that the employment effect is smaller than the one under full cooperation.

In fact, Hunt (1999) presents empirical evidence that German unions claim higher wages following a reduction in standard hours of work to keep monthly earning almost unaffected. Similar evidence is reported for Sweden (see, e.g., Jacobson and Ohlsson 2000 or Skans 2004).

Employment effect

In the light of the trade unions' potential wage response, the overall impact of a reduction in working time on employment is ambiguous *a priori*. Formally, it is given by

$$\frac{dl}{dh} = \frac{\partial l}{\partial h} + \frac{dw}{dh}\frac{\partial l}{\partial w}.$$

As is shown in Appendix 6, we are able to write the overall employment effect of a joint cut in the hours of work, taking into account that all trade unions react by adjusting their wage rate as follows:

$$\frac{dl}{dh} = \left(\frac{\partial NB(w)}{\partial w}\right)^{-1} \cdot \left(\frac{\partial \varepsilon_{l,w}}{\partial h}h - \frac{\partial \varepsilon_{l,w}}{\partial w}w\frac{\varepsilon_{l,h}}{\varepsilon_{l,w}} + \varepsilon_{l,h} - \varepsilon_{l,w}\right) l. \tag{5.32}$$

When discussing the direction of the total employment effect, it is again necessary to interpret the terms in brackets of equation (5.32). This time, the change of the labor demand elasticity with respect to the wage rate becomes important. If it becomes more elastic, *ceteris paribus*, either due to the initial joint reduction in the working time ($\partial \varepsilon_{l,w}/\partial h > 0$) or the subsequent joint increase in the wage rate ($\partial \varepsilon_{l,w}/\partial w < 0$), the wage rate becomes a more costly instrument for the unions and is therefore not used to go all the way back to the initial equilibrium. This, in turn, contributes to a positive overall employment effect when working time is reduced. A second effect is relevant in terms of overall employment. Even if we fully abstract from the changes in the labor demand elasticity, there is, in general, a favorable employment effect since $\varepsilon_{l,w} \leq \varepsilon_{l,h}$; see the last two terms in brackets of equation (5.32).

In the light of the ambiguity of the overall employment effect so far, the term in brackets in equation (5.32) can be written as $-\alpha\varepsilon_{l,w}(2+F'''L/F'')$. Interestingly, from (5.16) we already know that we must have $2 + F'''lh^{\alpha}/F'' > 0$ in a symmetric Nash equilibrium. As $\partial NB(w)/\partial w < 0$ and $\varepsilon_{l,w} < 0$, the whole expression in (5.32) then becomes non-positive. The only possibility of a zero employment effect is the extreme case of $\alpha = 0$. In this scenario, the trade unions will claim sufficiently higher wages in response to the reduced working time such that any employment effect is fully washed away. The explanation runs as follows. For $\alpha = 0$, we know from equations (5.5) and (5.9) that $\varepsilon_{l,w} = \varepsilon_{l,h}$ and $(\partial \varepsilon_{l,w}/\partial w) \cdot w = (\partial \varepsilon_{l,h}/\partial h) \cdot h$ so that the wage rate amounts to a perfect mimicry of the working hours in restoring the initial Nash equilibrium. Otherwise, i.e. for $\alpha > 0$, a favorable total employment effect remains since the wage rate is not fully used to go back to the initial employment level. In fact, the second-order condition of the unions' decision problem with respect to the wage rate is sufficient to ensure that the adjustment of the wage rate is small enough not to compensate the effect of the working time reduction.

Welfare effect

For the repercussion of each union's welfare, we might expect a similar pattern as in the preceding subsection in the sense that the sign of the employment effect also determines the direction of the welfare effect. This can be confirmed by inspecting

$$\begin{aligned}\frac{dV}{dh} &= \frac{\partial V}{\partial h}+\frac{dw}{dh}\frac{\partial V}{\partial w} \\ &= \left(\frac{\partial NB(w)}{\partial w}\right)^{-1}\cdot\left(\frac{\partial \varepsilon_{l,w}}{\partial w}w\frac{\varepsilon_{l,h}}{\varepsilon_{l,w}}-\frac{\partial \varepsilon_{l,w}}{\partial h}h+\varepsilon_{l,w}-\varepsilon_{l,h}\right)\frac{whl}{\varepsilon_{l,w}}\frac{l}{m}.\end{aligned}$$

Repercussion on profit income

Finally, we can again analyze whether profit income is increased or not following a collective reduction in working time with wage autonomy left to each single trade union. We arrive at:

$$\frac{d[X-whl]}{dh}=-wl\left[(1-\alpha)+\frac{dw}{dh}\frac{h}{w}\right].$$

Recalling the reference case of full coordination [see equation (5.19)], profits remain unchanged when the wage rate is not adjusted and employment and working time are perfect substitutes ($\alpha = 1$). However, if the wage rate remains at discretion of unions, the special case of perfect substitutes implies that recipients of profit income are worse-off if unions agree to jointly reduce working time. To see this, note that equation (5.8) implies that $\varepsilon_{l,w}$ remains constant for $\alpha = 1$ and Appendix 5 shows that this is sufficient to infer that $dw/dh < 0$.

5.4 Concluding remarks

When individual decision-making imposes external effects on others, the resulting equilibrium will be inefficient. It is well known that cooperating on the externality generating activity can make all participants better off. In our framework, we apply this idea to decentralized trade union behavior, where the externality runs through each small union's contribution to the overall (un)employment rate. However, each union has two possibilities to impose the external effect - by choosing its wage rate and the hours of work, respectively. An internalization agreement should therefore cover both of them. If only a partial agreement on one instrument is possible, the outcome of such coordination is less clear-cut. In general, we can conclude that they are less effective. For very special cases, they have no impact at all or are even counterproductive. A constant marginal disutility of labor can contribute to such extreme cases. Together with employment and working time being perfect substitutes, partial wage cooperation is unable to affect employment and welfare. Given that employment and the hours of work are less than perfectly substitutable, joint (partial) wage moderation even lowers employment if the labor demand becomes less elastic with respect to the working hours.

It is important to note that the only coordination agreement considered in this contribution is among individual trade unions. On the one hand, this approach might be a suitable starting point as it puts a lower bound what can be expected from coordination given that it is not possible to attract other participants in negotiations (government, firms). Thus, in our setting, the best outcome can only entail eliminating externalities between trade unions. On the other hand, of course, even stronger effects on employment and welfare are possible if other parties effectively joint the agreement. In the spirit of McDonald and Solow (1981), both parties can commit to policies that deviate from their individual optimum but make both parties together better off.

What is the policy relevance of this contribution? Basically, our analysis has only shown that institutional arrangement matter for the effectiveness of agreements among private agents. If trade unions can influence the employment level in their respective sector by using more than one instrument and the employment level imposes external effects on members of other unions, then any cooperation must include all these instruments that affect employment. If this is not possible, coordination is most likely to be less effective or may even be doomed to fail. This is what policy makers should be interested in. In the light of the (potential) inability of private institutions to correct for an external effect, assigning this internalization to the government will, in principle, perform better. The results therefore support government interventions which make unions be aware of the full costs of their behavior.

Appendix

1. Fully centralized wage setting

A countrywide monopoly trade union would maximize

$$\max_{w,h} V = l(w,h)\,[wh - e(h)] + [m - l(w,h)]\,\frac{l(w,h)}{m}\,[wh - e(h)]\,.$$

The first-order conditions are

$$\left(2 - \frac{l}{m}\right) lh + 2\frac{\partial l}{\partial w}\,[wh - e(h)]\left(1 - \frac{l}{m}\right) = 0$$

and

$$l\,[w - e'(h)]\left(2 - \frac{l}{m}\right) + 2\frac{\partial l}{\partial h}\,[wh - e(h)]\left(1 - \frac{l}{m}\right) = 0,$$

which, again, imply $l < m$ and $w > e'(h)$. However, rewriting both conditions shows that the wage rate and the hours of work are now chosen to attain a higher employment level as is the case with decentralized trade unions. To see this, we express both conditions as

$$-\frac{l}{m}lh + 2\left\{lh + \frac{\partial l}{\partial w}\,[wh - e(h)]\left(1 - \frac{l}{m}\right)\right\} = 0$$

and

$$-\frac{l}{m}l\,[w - e'(h)] + 2\left\{l\,[w - e'(h)] + \frac{\partial l}{\partial h}\,[wh - e(h)]\left(1 - \frac{l}{m}\right)\right\} = 0.$$

The terms in curly brackets are equivalent to the first-order conditions in the case of decentralized decision problem. Since in both equations an additional negative term enters, a central union perceives the marginal net benefit from increasing w and h, respectively, to be lower and will therefore choose lower levels of both the wage rate and the hours of work. In turn, this implies a higher employment level in the country.

2. The sign of dh/dw

Recalling equation (5.22) in the text, i.e.

$$\frac{dh}{dw} = -\frac{\partial NB(h)}{\partial w}\cdot\left(\frac{\partial NB(h)}{\partial h}\right)^{-1},$$

we know that stability of the Nash equilibrium requires $\partial NB(h)/\partial h < 0$. Hence,

$$sign\left\{\frac{dh}{dw}\right\} = sign\left\{\frac{\partial NB(h)}{\partial w}\right\}.$$

We have

$$\frac{\partial NB(h)}{\partial w} = h + \varepsilon_{l,h}h\left(1 - \frac{l}{m}\right) - \varepsilon_{l,w}\varepsilon_{l,h}\frac{l}{m}\frac{wh - e(h)}{w} + \frac{\partial \varepsilon_{l,h}}{\partial w}\,[wh - e(h)]\left(1 - \frac{l}{m}\right),$$

which is rewritten as

$$\frac{\partial NB(h)}{\partial w} = h\left(1+\varepsilon_{l,h}\right) - \frac{l}{m}\varepsilon_{l,h}h\left[1+\varepsilon_{l,w}\frac{wh-e(h)}{wh}\right] + \frac{\partial \varepsilon_{l,h}}{\partial w}\left[wh-e(h)\right]\left(1-\frac{l}{m}\right).$$

As stated in the text, $\varepsilon_{l,h} \leq -1$. From equation (5.13), we know that

$$\varepsilon_{l,w}\frac{wh-e(h)}{wh} = -\left(1-\frac{l}{m}\right)^{-1},$$

i.e. since $0 < (1-l/m) < 1$, we have $\varepsilon_{l,w}\left[wh-e(h)\right]/wh < -1$. Hence, for $\partial\varepsilon_{l,h}/\partial w \leq 0$ we can unambiguously sign

$$\frac{\partial NB(h)}{\partial w} < 0,$$

so that a joint wage cut increases the hours of work.

3. Derivation of equation (5.26): The employment effect of a partial agreement with respect to the wage rate

The overall employment effect is given by

$$\frac{dl}{dw} = \frac{\partial l}{\partial w} + \frac{dh}{dw}\frac{\partial l}{\partial h}.$$

Inserting in the corresponding expression for dh/dw, this becomes

$$\frac{dl}{dw} = \frac{1}{\partial NB(h)/\partial h}\left[\frac{\partial NB(h)}{\partial h}\frac{\partial l}{\partial w} - \frac{\partial NB(h)}{\partial w}\frac{\partial l}{\partial h}\right].$$

Plugging in (5.23) and (5.24) and using (5.15) as given in the text, the expression in brackets is written as follows

$$\left[\left(\frac{\partial \varepsilon_{l,h}}{\partial h}\frac{\varepsilon_{l,w}}{w} - \frac{\partial \varepsilon_{l,h}}{\partial w}\frac{\varepsilon_{l,h}}{h}\right)\left(wh-e(h)\right)\left(1-\frac{l}{m}\right) - \varepsilon_{l,w}\frac{h}{w}e''\right]l.$$

Using equation (5.13), i.e.

$$\left[wh-e(h)\right]\left(1-\frac{l}{m}\right) = -\frac{wh}{\varepsilon_{l,w}}, \tag{5.33}$$

this can be rewritten as

$$\left(\frac{\partial \varepsilon_{l,h}}{\partial w}w\frac{\varepsilon_{l,h}}{\varepsilon_{l,w}} - \frac{\partial \varepsilon_{l,h}}{\partial h}h - \frac{h}{w}\varepsilon_{l,w}e''\right)l.$$

4. The welfare effect of a partial agreement with respect to the wage rate

We have

$$\begin{aligned} \frac{dV}{dw} &= \frac{\partial V}{\partial w} + \frac{dh}{dw}\frac{\partial V}{\partial h} \\ &= \left(\frac{\partial NB(h)}{\partial h}\right)^{-1} \frac{l}{m}\left\{-h \cdot \frac{\partial NB(h)}{\partial h} + [w - e'(h)] \cdot \frac{\partial NB(h)}{\partial w}\right\} l, \end{aligned}$$

where, after using (5.23), (5.24) and (5.15), the terms in curly brackets can be written as

$$\left(\frac{\varepsilon_{l,h}}{\varepsilon_{l,w}}\frac{\partial \varepsilon_{l,h}}{\partial w}w - \frac{\partial \varepsilon_{l,h}}{\partial h}h\right)[wh - e(h)]\left(1 - \frac{l}{m}\right) + hhe''.$$

Recalling equation (5.33), this expression reads

$$\left(\frac{\partial \varepsilon_{l,h}}{\partial h}h - \frac{\varepsilon_{l,h}}{\varepsilon_{l,w}}\frac{\partial \varepsilon_{l,h}}{\partial w}w + \frac{h}{w}\varepsilon_{l,w}e''\right)\frac{wh}{\varepsilon_{l,w}}.$$

5. The sign of dw/dh

As has been set out in the text, the sign of $\partial NB(w)/\partial h$ also determines the direction of the adjustment of the wage rate following a joint reduction in the hours of work. Rewriting this expression yields

$$\begin{aligned} \frac{\partial NB(w)}{\partial h} &= w + \varepsilon_{l,w}(w - e')\left(1 - \frac{l}{m}\right) - \frac{wh - e(h)}{h}\left(1 - \frac{l}{m}\right)\varepsilon_{l,h}\varepsilon_{l,w} \\ &\quad - \frac{wh - e(h)}{h}\varepsilon_{l,h}\varepsilon_{l,w} + \frac{\partial \varepsilon_{l,w}}{\partial h}[wh - e(h)]\left(1 - \frac{l}{m}\right). \end{aligned}$$

Using equation (5.13), the third term in the upper line is equivalent to

$$-\frac{wh - e(h)}{h}\left(1 - \frac{l}{m}\right)\varepsilon_{l,h}\varepsilon_{l,w} = \varepsilon_{l,h}w,$$

so that we are able to write

$$\begin{aligned} \frac{\partial NB(w)}{\partial h} &= w(1 + \varepsilon_{l,h}) + \varepsilon_{l,w}(w - e')\left(1 - \frac{l}{m}\right) - \frac{wh - e(h)}{h}\varepsilon_{l,h}\varepsilon_{l,w} \\ &\quad + \frac{\partial \varepsilon_{l,w}}{\partial h}[wh - e(h)]\left(1 - \frac{l}{m}\right), \end{aligned}$$

where all terms in the upper line are negative in sign. Thus, if $\partial \varepsilon_{l,w}/\partial h \leq 0$, a joint reduction in h will induce trade unions to unambiguously raise the wage as a response.

6. Derivation of equation (5.32): The employment effect of a partial agreement with respect to the working hours

We have,

$$\begin{aligned}\frac{dl}{dh} &= \frac{\partial l}{\partial h} + \frac{dw}{dh}\frac{\partial l}{\partial w}, \\ &= \frac{1}{\partial NB(w)/\partial w}\left[\frac{\partial l}{\partial h}\frac{\partial NB(w)}{\partial w} - \frac{\partial l}{\partial w}\frac{\partial NB(w)}{\partial h}\right] \end{aligned} \tag{5.34}$$

where the term in brackets can be written as

$$l\left[\varepsilon_{l,h} - \varepsilon_{l,w} + \left(\varepsilon_{l,h}\frac{\partial \varepsilon_{l,w}}{\partial w} - \varepsilon_{l,w}\frac{\partial \varepsilon_{l,w}}{\partial h}\right)\frac{wh - e(h)}{w}\left(1 - \frac{l}{m}\right)\right].$$

Again, making use of equation (5.33), this can be simplified to

$$l\left[\varepsilon_{l,h} - \varepsilon_{l,w} + \left(\varepsilon_{l,w}\frac{\partial \varepsilon_{l,w}}{\partial h} - \varepsilon_{l,h}\frac{\partial \varepsilon_{l,w}}{\partial w}\right)\frac{h}{\varepsilon_{l,w}}\right].$$

Summary

As externalities give rise to allocations that are not Pareto-efficient, coordination seems to be promising remedy. In the present thesis, we argue that the welfare gains of cooperation might be limited if such coordination is incomplete. Provided that joint agreements on externality generating activities do not cover all activities that are able to impose an external effect on others, there is still room for the harmful behavior to continue.

The present thesis analyzed this issue in several settings. Chapter 2 laid out the basic model of partial tax coordination with taxes on mobile capital and immobile labor in the presence of a fully competitive labor market. It was shown that capital tax coordination is less effective if countries are allowed to choose their wage tax freely afterwards. The extent to which countries are able to wash away the welfare gain of capital tax coordination depends on how costly the tax adjustment is in terms of the worldwide distortion this adjustment creates. For a worldwide adjustment in the wage tax, the substitutability between the factors capital and labor is important since it determines the change in labor employment given that each country still employs its capital employment. For the extreme case of perfect complements, there is no overall welfare effect from partial capital tax coordination. On the other hand, if partial wage tax coordination is carried out, the subsequent capital tax adjustment is, in principle, able to fully destroy the welfare gain of coordination again. Nevertheless, welfare effects arise if the initial wage tax coordination augments or alleviates the pre-existing distortion on the labor market by changing the labor supply elasticity.

Since the incompleteness of cooperation agreements can be interpreted as an important institutional detail, it is interesting to study its interactions with other institutions. Chapter 3 introduced two important institutional details to be found in many countries. Firstly, we took into account that public expenditures can either be used as public consumption goods or employed in the production process as public inputs. Secondly, we incorporated wage negotiations between unions and firms giving rise to involuntary unemployment. The distinction between public

consumption goods and public inputs allowed us to interpret partial tax coordination as an agreement that leaves door open for competition in the type of the public good. Since countries are free to spend their additional tax revenue from coordination on the alternative that better attracts capital, the external effects on others are far from being eliminated.

The case of partial tax coordination in the presence of unemployment was studied in detail in chapter 4. It was demonstrated that imperfections on the labor market do not lead to different welfare consequences as long as full coordination is considered. However, introducing unemployment due to wage bargaining alters the welfare effects of partial tax coordination. Even though countries also try to compete back to the initial Nash equilibrium, additional welfare effects enter since the Nash equilibrium is characterized by additional distortions which have to be taken into account by the tax rates.

Chapter 5 applied the idea of partial cooperation to the case of decentralized trade unions which decide upon the wage rate and the hours of work on the firm level. Both union instruments are able to impose an external effect on other trade union members since they negatively affect the outside opportunities of all other unions. When partial coordination is carried out with respect to the wage rate or the hours of work, similar mechanisms are at work as is the case with the analysis of partial tax coordination. Trade unions use the instrument that is free to be adjusted to go back to the initial Nash equilibrium. In addition, the unions' decision problem might be altered at the margin which can either augment or alleviate the pre-existing distortion.

The implications that can be derived from this thesis are mixed and depend on the framework chosen. In the context of international tax competition, we draw a rather pessimistic picture of the feasibility of effective tax coordination. By adjusting the tax on a complementary factor, tax coordination loses much of its welfare impact. With a richer set of policy instruments (e.g., depreciation allowances, sales taxes) to be found in reality, effective coordination becomes even more difficult to implement. The rather pessimistic assessment then stems from the fact that there is no supranational institution which is able to enforce a policy to internalize the externalities better than (incomplete) joint coordination agreements among countries. This is different in our second framework of decentralized trade union behavior. In this case, the government can step in and use public policy to internalize the external effects given that unions are unable to effectively coordinate their externality generating activity.

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