The cost of tax competition. Insights from a dynamic two-country model

Eva Luthi

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Abstract

Tax competition is a real concern among governments and policy makers. We infer the cost of capital tax competition by means of a dynamic two-country model where countries are considered being large. To solve for the optimal taxation policy we apply the Ramsey framework. We find that tax competition bears considerable costs compared to the first-best case of a fiscal union. In the long run capital tax rates converge to zero both in the fiscal union and with tax competition. Therefore the costs of capital tax competition have the origin not in the long run, but arise during transition. With tax competition we find that during transition capital tax rates are inefficiently low and even negative, with long-run effects on the economy. To finance these capital tax subsidies, labour tax rates and government debt are higher under tax competition both during transition and in steady state. Indeed we find that long run debt levels are not only higher than in a fiscal union, but even positive. This is in contrast with the standard prediction from the optimal taxation literature that government debt is negative in the long run. In steady state consumption, labour, production and the capital stock are lower in an economy with tax competition than in a fiscal union.

1 Introduction

In a world of ever increasing financial market integration and capital mobility, it becomes more and more difficult for countries to conduct an independent fiscal policy. The increased interdependence in fiscal policy results in an increasing importance of the discussion of tax competition. Being aware of this, the OECD as well as the European Commission intensely discuss taxation policies, harmful tax practices and cooperation among governments to exchange information (see Ruding Report (1992), European Comission (2001, 2003), OECD (1998, 2007)).

There exists ample empirical evidence of the importance of tax competition. Griffith and Klemm (2004) for instance have a close look at the evolution of corporate tax rates over the last two decades and show that the corporate tax rates in the OECD decreased steadily over this time period. Decreasing statutory tax rates are not per se an evidence of tax competition. A look at the empirical literature[1] confirms the intuition of interdependent taxation policies behind the fact of decreasing statutory tax rates. But competition for mobile resources is not just an issue at the OECD or EU level but also within many countries, as regions try to attract labour and capital by setting taxes strategically.[2]

Tax competition is a real concern among governments and policy makers. In this paper we analyze the cost of capital tax competition. The model we employ is a two-country version of the standard dynamic optimal taxation model. To solve for the optimal taxation policy we use the Ramsey framework. To asses the costs of capital tax competition, we compare an economy with tax competition to the first-best case of a fiscal union. In the fiscal union a central fiscal authority decides on the tax rates in the two countries, whereas with tax competition governments care only about the welfare of their own citizens. Strategic issues arise in the model with tax competition, where we assume that both economies are large.

How harmful is capital tax competition really? We find that capital tax rates converge to zero in the long run, both in a fiscal union and with tax competition. This is a standard result in the optimal taxation literature, first established by Chamley (1986) and Judd (1985). Therefore the costs of capital tax competition can not have the origin in the long run, but must arise during transition. We find that during transition capital tax rates are inefficiently low and even negative under tax competition, with long-run effects on the economy. To finance the capital tax subsidies, labour tax rates and government debt are higher under tax competition both during transition and in steady state. Indeed, we find that with tax competition long-run

[1] See Griffith and Klemm (2004) for a discussion of the empirical literature on tax competition.

[2] See Solé-Ollé (2003), Buettner (2001), and Brueckner and Saavedra (2001) among others.

debt levels are not only higher than in a fiscal union, but even positive. This contrasts with the standard prediction from the optimal taxation literature that government debt is negative in the long run. The drastic difference in capital taxation during transition is very costly and leads to lower consumption, lower capital stock and lower labour participation in the steady state with tax competition.

As a robustness check we consider a model where governments face balanced budgets, and therefore can not get indebted. This assumption deviates from the more common assumption in the literature where governments can issue debt.[3] We find as well with balanced budget the Chamley/Judd result of zero taxation in the long run. With balanced budgets not only capital tax rates, but all variables are the the same in steady state with tax competition and the fiscal union. But this does not imply that tax competition is not costly. In fact, the costs to tax competition arise during transition, and have no long-run effect on the economy. During transition capital tax rates are much lower with tax competition than in a fiscal union, just as in the model with government debt.

There are two streams of literature related to this paper. From the extensive literature on optimal taxation only a few papers consider tax competition. Klein et al. (2005) employ a model of optimal time-consistent taxation with international mobility of capital. They do a positive analysis to explain the heavy reliance on capital taxation of the US compared to Europe. In contrast to their paper we do an optimal taxation analysis, where the governments can commit to their fiscal policies. Mendoza and Tesar (2005) analyze the question of why tax competition has not triggered a race to the bottom in capital tax rates in the EU. They assume that the governments of the two countries meet once to decide on invariant capital tax rates forever. We in contrast examine a Ramsey plan of optimal taxation, where tax rates are allowed to change over time.

The standard literature on tax competition has its roots back to Tiebout (1956) and Oates (1972). Oates (1972) already describes the problem of governments decreasing tax rates to attract investment, as well as possible effects thereof on public spending. The first formal models following this idea were developed by Zodrow and Mieszkowski (1986) and Wilson (1986). Surveys on the tax competition literature can be found by Wilson (1999) and more recently by Wilson and Wildasin (2004). Traditionally tax competition is studied in static models. Two exceptions are the dynamic studies by Razin and Sadka (1995) and Wildasin (2003), where optimal taxation in a small open economy is discussed. This approach contrasts with the Nash equilibria discussed in Klein et al. (2005), Mendoza and Tesar (2005) and our model. As far as we know this is the first paper to consider optimal taxation with commitment in a two-country model where countries

[3] An exception to this is Stockman (2001) who discusses balanced-budget rules.

are considered being large. Using a dynamic taxation model allows us to discern optimal steady-state taxation policies from optimal policies during transition, which are remarkably different. For example we observe during transition the prediction of the standard tax competition literature that due to tax competition capital tax rates are inefficiently low. But we do not find this result in the long run, where capital tax rates are optimally equal to zero both in a fiscal union and with tax competition.

The remainder of the paper is structured as follows. In section 2 we explain the features of the model and define the equilibrium. In section 3 we discuss the setup of the fiscal union and the model with tax competition. The steady state, calibration and numerical solutions to the model with government debt are discussed in section 4. We go over to the problem where governments face balanced budget in section 5. In the final section we conclude.

2 Model

Our model is a two-country version of a standard dynamic optimal taxation model. We consider two symmetric countries. In each country there are households and a production firm. Households decide on consumption, labour supply, capital accumulation and the amount of government debt they want to hold. Households can only hold debt of their own government. Each household can decide every period in which country to invest the current capital. Labour is assumed immobile, whereas capital is perfectly mobile between the two countries. The decision on investment depends on capital returns and capital taxation in both countries. Firms rent capital and labour from the households. Governments have to finance exogenously given expenditures by labour and capital taxation and can get indebted. In section 5 we look at the special case where government debt is set equal to zero for all periods, and hence governments face balanced budgets.

We assume capital taxation to be source based. Razin and Sadka (1995) found that residence based capital taxation is more efficient than source based taxation. In reality residence based taxation of a mobile factor is very difficult to implement, as this way of taxation includes taxing all the capital abroad earned by residents. Therefore most countries employ source based tax schemes or a mixture of the two. Even countries applying residence based taxation usually tax income only on repatriation, which then is much like the source based principle.

In our model the world is governed by the following aggregate resource constraint:

$$\sum_{i=1,2} (g_{i,t} + c_{i,t} + k_{i,t} - (1-\delta)k_{i,t-1}) = \sum_{i=1,2} F(k_{i,t-1}, (1-\ell_{i,t})) \qquad (1)$$

which assures that the amounts consumed by governments ($g_{i,t}$) and households ($c_{i,t}$) plus investment are not higher than overall production. $k_{i,t}$ denotes the total capital invested in country i, δ is the depreciation rate of capital and $F(k_{i,t-1}, (1-\ell_{i,t}))$ the production technology of the final good.

2.1 Governments

The governments finance a stream of exogenously given, invariant government expenditures by taxing labour and capital income of households, and decide on the amount of government debt to issue each period.

$$g_{i,t} + b_{i,t-1} = \tau^k_{i,t}(r_{i,t} - \delta)k_{i,t-1} + \tau^l_{i,t} w_{i,t}(1 - \ell_{i,t}) + p_{i,t} b_{i,t} \tag{2}$$

$b_{i,t}$ is government debt issued at time t and can be bigger or smaller than zero. $p_{i,t}$ is the rate of return to debt. $\tau^k_{i,t}$ is the tax rate on household capital income net of depreciation and $r_{i,t}$ the rental rate of capital paid by the firms located in country i. $\tau^l_{i,t}$ denotes the tax rate on labour income charged by the government, and $w_{i,t}$ is the wage rate paid by the firms in i to the households. Total time available to households is normalized to 1 so the time they spend working is equal to $(1 - \ell_{i,t})$, where $\ell_{i,t}$ denotes leisure time.

2.2 Households

Households maximize discounted lifetime utility deciding on consumption, labour supply, capital accumulation and the amount of government debt they want to hold. We can write the households' problem as

$$\max_{c_{i,t}, \ell_{i,t}, a^n_{i,t}, b_{i,t}} \sum_{t=0}^{\infty} \beta^t u(c_{i,t}, \ell_{i,t}) \tag{3}$$

s.t.

$$c_{i,t} + \sum_{n=1,2} a^n_{i,t} + b_{i,t} p_{i,t} = \sum_{n=1,2} \left[1 + (r_{n,t} - \delta)(1 - \tau^k_{n,t})\right] a^n_{i,t-1} + (1-\tau^l_{i,t}) w_{i,t} (1-\ell_{i,t}) + b_{i,t-1} \tag{4}$$

where β is the rate at which households discount the future and $a^n_{i,t}$ the capital households of country i invest in country n, $i = 1, 2$ and $n = 1, 2$.

Households' capital relates in the following way to the aggregate capital $k_{i,t}$ in equation (1) and further down, in equation (12):

$$k_{i,t} = \sum_{n=1,2} a^i_{n,t} \tag{5}$$

and hence $k_{i,t}$ is the total capital invested in country i by the households of the two countries. From the first-order conditions of the households' problem with respect to capital and consumption we find the Euler equations,

which describe the way in which current consumption relates to future consumption. Because households can decide on investing capital at home ($a^i_{i,t}$) or abroad ($a^j_{i,t}$, $i \neq j$), there exist as well two Euler equations for country i,

$$u_{c_{i,t}} = \beta u_{c_{i,t+1}} \left[1 + (r_{i,t+1} - \delta)(1 - \tau^k_{i,t+1})\right] \tag{6}$$

$$u_{c_{i,t}} = \beta u_{c_{i,t+1}} \left[1 + (r_{j,t+1} - \delta)(1 - \tau^k_{j,t+1})\right]. \tag{7}$$

Equations (6) and (7) imply that the after-tax return on capital in the two countries has to be equal at equilibrium,

$$(r_{i,t+1} - \delta)(1 - \tau^k_{i,t+1}) = (r_{j,t+1} - \delta)(1 - \tau^k_{j,t+1}). \tag{8}$$

From the first-order conditions with respect to consumption and leisure we find that

$$\frac{u_{\ell_{i,t}}}{u_{c_{i,t}}} = (1 - \tau^l_{i,t}) w_{i,t}. \tag{9}$$

Hence labour taxes introduce a wedge between the marginal rate of substitution between leisure and consumption and the wage rate.

From the first-order conditions with respect to government debt and consumption we find that

$$u_{c_{i,t}} p_{i,t} = \beta u_{c_{i,t+1}}. \tag{10}$$

Equation (10) combined with the Euler equation (6) implies that the return on government debt has to be related to the after-tax return on capital in the following way:

$$\frac{1}{p_{i,t}} = \left[1 + (r_{i,t+1} - \delta)(1 - \tau^k_{i,t+1})\right]. \tag{11}$$

2.3 Firms

Firms maximize profits. Because of perfect competition equilibrium profits are zero after paying wages and the rental price of capital.

$$\max_{k_{i,t-1},(1-\ell_{i,t})} F(k_{i,t-1}, (1 - \ell_{i,t})) - r_{i,t} k_{i,t-1} - w_{i,t}(1 - \ell_{i,t}) \tag{12}$$

The good produced by firms is the same in the two countries, so there will be no trade in goods with the aim of increasing the variety of goods at disposal of consumers.

First-order conditions from the firms' problem imply that the capital and the wage rental rate equal marginal productivities of capital and labour respectively.

$$r_{i,t} = F_{k_{i,t-1}}(k_{i,t-1}, (1 - \ell_{i,t})) \tag{13}$$

$$w_{i,t} = F_{(1-\ell_{i,t})}(k_{i,t-1}, (1 - \ell_{i,t})) \tag{14}$$

2.4 Equilibrium

A competitive equilibrium with taxes in this two-country model is a sequence of allocations $\{c_{i,t}, \ell_{i,t}, a^n_{i,t}, k_{i,t}\}_{i=1,2,\ n=1,2}$, prices $\{p_{i,t}, w_{i,t}, r_{i,t}\}_{i=1,2}$, and government policies $\{b_{i,t}, \tau^l_{i,t}, \tau^k_{i,t}, g_{i,t}\}_{i=1,2}$ for $t = 0, \ldots, \infty$ such that given prices and government policies, households maximize utility (3) under the budget constraint (4), production firms maximize profits (12), the government budget constraints (2) hold and markets clear: $k_{i,t} = \sum_{n=1,2} a^i_{n,t}$, for $i = 1, 2$.

Because at equilibrium equation (8) holds, the households are indifferent about where to invest their capital. For this reason only the total amount of capital invested ($k_{i,t}$) in each country is defined at equilibrium, but not the proportion $a^n_{i,t}$ of capital the households in country i invest in country n. We impose here a normalization and assume that $a^i_{i,t} = a^i_{j,t}$ at equilibrium, for $i, j = 1, 2$ and $i \neq j$.

There exist many different competitive equilibria, depending on the government policy. The Ramsey problems we discuss in the following section help to choose one of them.

3 Optimal fiscal policy

In this part of the paper we study the policy objective of the governments and the interaction of the countries with tax competition. To assess the cost of tax competition we compare an economy with tax competition with the first-best case of a fiscal union. In the fiscal union, a central fiscal authority sets tax rates for two countries, maximizing the overall welfare of the two countries. With tax competition governments care only about the welfare of their own households, and take foreign tax rates as given. We assume the two countries are large, and therefore take into account the effect of their taxation policy on the foreign economy.[4]

Governments can commit to their future policies at the beginning of time. Solving a Ramsey plan, the governments solve for a stream of tax rates in order to maximize the objective function, taking into account how the private sectors in the two countries respond to these tax rates.

3.1 Fiscal union

We assume that a central fiscal authority decides on fiscal policy maximizing the weighted sum of the utility of consumers in the two countries, and taking into account all the equilibrium conditions of the two countries. The fiscal authority has at disposal the full array of tax instruments $\{\tau^l_{i,t}, \tau^k_{i,t}\}_{i=1,2}$ for

[4]The interaction between the two countries are treated similar to Benigno and Benigno (2006), who study international monetary policy.

each country, and for periods $t = 0, \ldots, \infty$. The Ramsey plan for the fiscal union is to maximize

$$\sum_{t=0}^{\infty} \beta^t \sum_{i=1,2} \varphi_i u(c_{i,t}, \ell_{i,t})$$

subject to equations (2), (4), (6), (9), (10), (13), (14) for each country, and equation (8). The aggregate resource constraint (1) can be found by adding up the household and government budget constraints of the two countries. Hence, we can use as well the aggregate resource constraint instead of one of the government budget constraints (2). φ_i is the weight the government attaches to the utility of households in i. We analyze the symmetric case and assume that $\varphi_i = 0.5$, for $i = 1, 2$.

For the first period capital is given, and hence inelastically supplied. Taxing initial capital is therefore very interesting for governments, as it is non-distortionnary. To avoid unrealistically high capital tax rates we set an upper bound on capital tax rates for all periods: $\tau^k_{i,t} \leq \bar{\tau}^k$, $t = 0, \ldots, \infty$.

3.2 Tax competition

With tax competition the governments care only about the welfare of their own households, in contrast with the fiscal union discussed above. We assume that both economies are large, from where strategic issues arise. The government of country i sets a sequence of tax rates $\{\tau^l_{i,t}, \tau^k_{i,t}\}_{t=0}^{\infty}$ taking the foreign tax rates $\{\tau^l_{j,t}, \tau^k_{j,t}\}_{t=0}^{\infty}$ as given, $i \neq j$.

Concerning the Ramsey plan, this means that each government maximizes the utility of its own households, taking into account all first-order conditions and budget constraints of both countries. To know the effect of taxation policies, the governments take first-order conditions with respect to all the variables, except the foreign tax rates, which are taken as given. The solution to the constraints and first-order conditions of the Ramsey plan then represents the reaction function of the respective government. A tax competition solution consists in a Nash equilibrium, which is the point where the reaction functions of the two governments meet. We can write the tax competition problem for the government of country i as maximizing

$$\sum_{t=0}^{\infty} \beta^t u(c_{i,t}, \ell_{i,t}) \tag{15}$$

subject to equations (2), (4), (6), (9), (10), (13), (14) for each country, and equation (8). We can also replace one of the government budget constraints by the resource constraint (1).

As in the fiscal union, we apply an upper bound on capital tax rates in all periods: $\tau^k_{i,t} \leq \bar{\tau}^k$, $t = 0, \ldots, \infty$.

4 Results with government debt

In this section we discuss the numerical results of the optimal taxation policy in the fiscal union and for tax competition.

4.1 Steady-state results

Chamley (1986) and Judd (1985) first found what we call the Chamley/Judd result, that in the long run optimal capital tax rates are equal to zero. The intuition is that to finance government spending, a government would optimally use non-distortionary lump-sum taxes. Having only access to distortionary taxation, i.e., capital and labour taxation, the government chooses the combination of the two which is best for the economy. It turns out that capital taxation distorts the economy more than labour taxation by biasing future investment. Therefore it is optimal to set the capital tax rate to zero in the long run and rely only on labour taxation to finance government spending.

We find the Chamley/Judd result as well in our two-country model. Zero capital tax rates in the long run are optimal both with tax competition and in the fiscal union. Therefore this result is not due to capital tax competition. Tax competition is nevertheless costly. We find that in steady state consumption, labour, production and the capital stock are lower and labour taxation higher in an economy with tax competition than in a fiscal union. A standard prediction from the optimal taxation literature is that government debt is negative in the long run. We find that with tax competition long-run debt levels are not only higher than in a fiscal union, but even positive.

The static models of the standard tax competition literature predict that capital tax rates are inefficiently low with tax competition, a very different result from what we find at steady state. But as we will see in the following section, our results are much closer to this in the short run.

4.2 Numerical results

An overview of the parameters used for calibration is provided in table 1. The period length is one year. The discount rate of households β and the depreciation of capital δ are set accordingly. Households have a log utility function of the form $u(c_{i,t}, \ell_{i,t}) = \log(c_{i,t}) + \varepsilon \log(\ell_{i,t})$, where $\ell_{i,t}$ is leisure. ε is chosen such that labour in steady state is equal to about 1/3, which corresponds to a working day of 8 hours. The production function is Cobb-Douglas with a capital income share of $\alpha = 0.3$. Government spending does not vary over time and is assumed to be around 30% of GDP in steady state. To avoid unreasonably high capital tax rates we set an upper bound on capital tax rates of 57%. This is the average marginal tax rates calculated

by McGrattan et al. (1997) for the period 1947-87.

Parameter	Value	Interpretation
α	0.3	Share of capital in production
β	0.96	Discount rate of households
δ	0.1	Depreciation rate of capital
ε	1.5	Utility parameter
g_i	0.15	Government spending
$a^n_{i,-1}$	0.3	Initial capital stock
$b_{i,0}$	0	Initial government debt
$\tau^k_{i,0}$	0.57	Upper bound on capital tax rate

Table 1: Parameter values

We start with discussing the results for capital and labour tax rates, as all the other results follow from here. As we can see in figure 1 the evolution of capital tax rates is very different in a fiscal union than with tax competition. In the fiscal union capital tax rates stay at the upper bound for several periods, and then decrease to the steady-state level of zero over just two periods. This pattern has been found in the literature before, see Greulich and Marcet (2008) for example. The evolution with tax competition is completely different. Even with tax competition governments would love to tax initial capital very high because it is inelastically supplied. But after the first period capital tax rates drop from the upper bound over 72 percentage points to a negative level. After this capital is subsidized for a long time (around 60 periods) before converging to the steady-state level of zero. This result is a direct effect of tax competition: governments want to attract the mobile resource, capital, from the foreign country and therefore set capital tax rates much lower than they would in a fiscal union. This matches the result from the static tax competition models, that tax rates are inefficiently low under tax competition.[5] But the capital tax rates we find are not only inefficiently low, but even negative during transition. As we can see from figure 1 we find a dramatic difference in tax rates from period 2 to 8. This gap in tax rates drives the differences in the evolution of the other variables, resulting in the steady-state differences discussed in section 4.1.

Labour tax rates in the fiscal union increase from 25% in the first period to 43% in period 8, where they practically reach the steady-state level. This coincides with the time span in which the capital tax rates are at the upper bound. When capital tax rates decrease to zero, the government has to rely more on the income from labour taxation to finance government expenditures, and therefore labour tax rates increase. With tax competition we observe a jump in labour tax rates from period 1 to period 2 of over 34

[5]See Zodrow and Mieszkowski (1986) and Wilson (1986) for example.

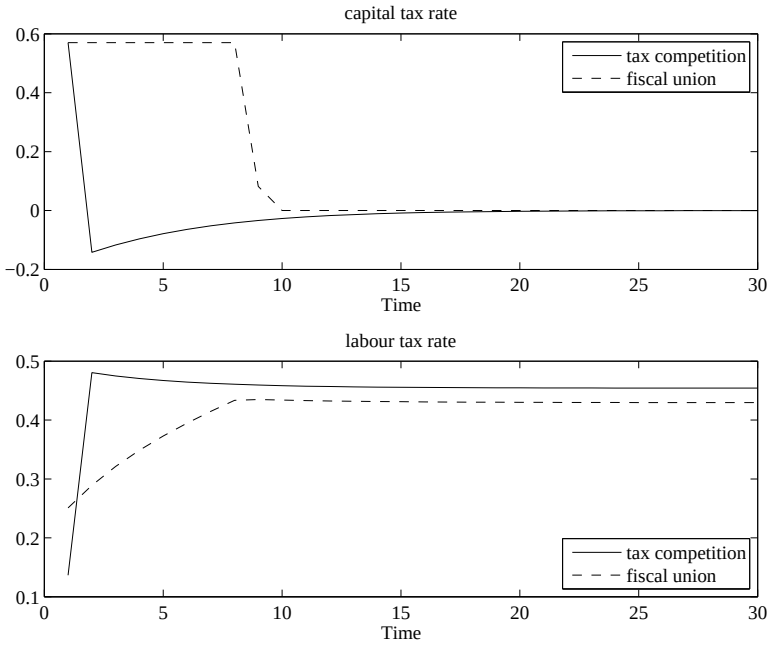

Figure 1: Capital and labour tax rates

percentage points. This reflects the drop in capital tax rates during the same period. Because the government decides to subsidize capital from period 2 onwards, it has to finance government expenditure plus the subsidies to capital by labour taxation. Therefore labour taxation is higher with tax competition in all periods apart from the first one, as well in steady state. The shift from capital taxation to labour taxation is one manifestation of capital tax competition. Because labour is in contrast to capital not mobile, a bigger part of the tax burden is shifted to labour. This matches empirical findings. Despite a wide consensus among policy makers on the desirability of lower labour taxation, they face difficulties in achieving this aim.[6]

Governments can not only raise income through taxation, but have as well the possibility of issuing debt, depicted in figure 2. In the fiscal union governments take advantage of this by getting indebted for the first five periods. Because of the the upper limit on capital tax rates, governments can not raise as much income from capital taxation as they would like to. The alternatives to capital taxation for financing government expenditure are labour taxation or getting indebted. It appears to be more desirable to get indebted than increasing labour taxation even more. Government debt is at its height in period 3, after which debt decreases to the steady-state level. The kink in the evolution of debt in period 8 can be attributed to the moment when the upper limit on capital tax rates stops being binding. The

[6]Compare European Comission (2007).

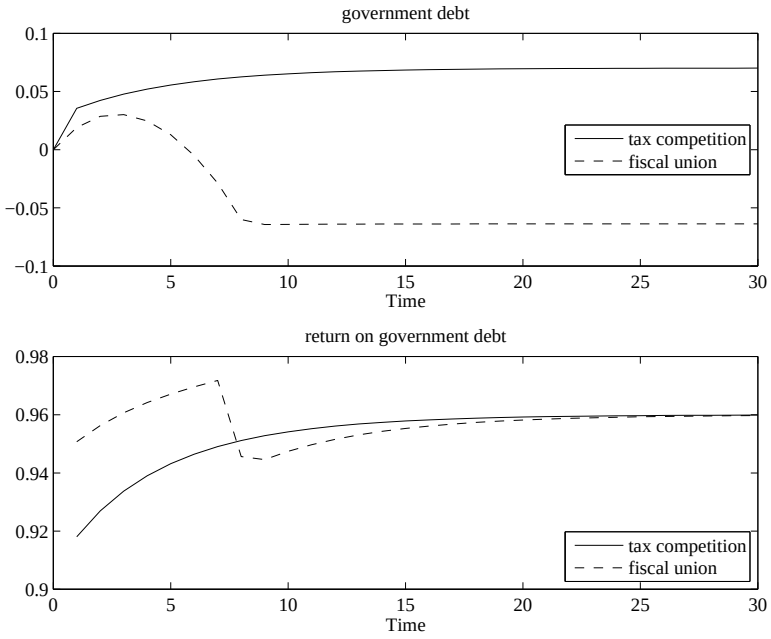

Figure 2: Government debt and return to debt

case for tax competition is different. Because of the capital tax subsidies governments have to finance government expenditure as well as subsidies through labour tax income and government debt. Therefore government debt increases rapidly during the first periods, where subsidies to capital are the highest. Because capital tax rates are increasing very slowly to zero, government can not afford to decrease debt, as in the fiscal union, and as a consequence government debt stays at a positive level even in the long run.

The return to government debt ($p_{i,t}$ in the government budget constraint (2)) is shown in figure 2. We know from equation (11), that the return to debt in period t is inversely related to the evolution of capital tax rates and the capital rental rate in period $t+1$. The drop of the return to debt in the fiscal union in period 8 can be explained by the drop in capital tax rates one period later. The increase in the return to debt before and after this moment can be explained by the decline of the capital rental rate.[7] With tax competition the return to debt increases steadily over time, to finally reach the same steady-state value as in the fiscal union. From equation (11) it follows that in steady state the return to debt is equal to β, the discount rate of households, which is the same in both models.

Going over to figure 3 we can see that the subsidies to capital in the model with tax competition have the expected effect of an over-accumulation of capital. According with the initial drop in capital tax rates capital stock

[7]For capital rental rates and wage rates see figure 8 in the appendix section A.

jumps upwards in period 1. But after this capital accumulation slows down despite the subsidies, converging to a lower steady-state level than in the fiscal union. In the fiscal union the capital stock increases smoothly from the exogenously given initial level to the steady state. Interesting to observe is that apart from the first period capital accumulation is faster in the fiscal union than with tax competition.

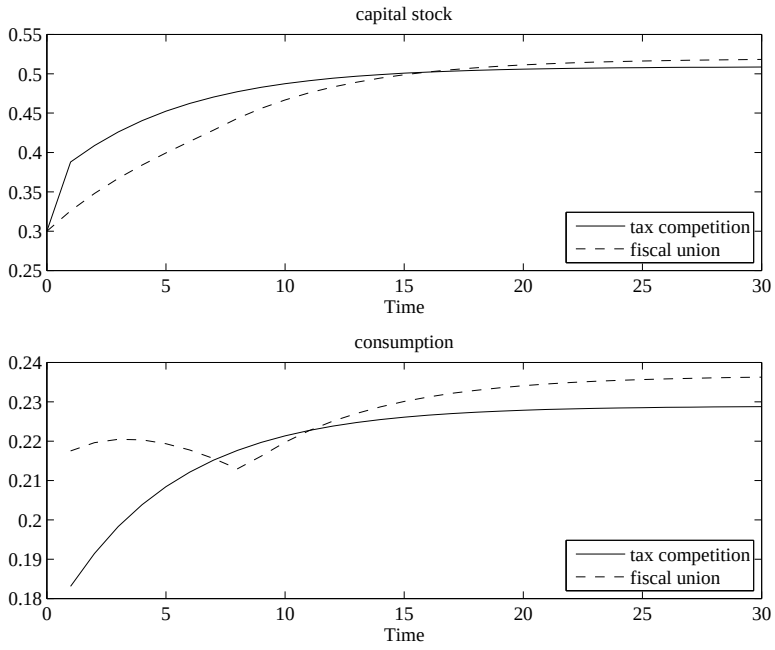

Figure 3: Capital stock and consumption

In the fiscal union consumption (see figure 3) increases as long as the net return to the government debt holdings is positive ($p_{i,t} * b_{i,t} - b_{i,t-1} > 0$), which is from period 1 to 3. When these net returns turn negative consumption starts decreasing, reaching a low the same period capital tax rates drop from the upper bound. The drop in capital tax rates has as an immediate effect an increase in after-tax returns to capital, with which consumption starts growing again, and then continues growing until it reaches the steady state.

Consumption in the fiscal union is much higher than with tax competition during the first few periods. This is closely related with the evolution of capital tax rates. It might seem paradoxical that households can afford to spend more on consumption because capital tax rates are higher, which represent a reduction of the households' income. What happens with tax competition is that because capital is subsidized, households divert consumption and decide on saving more of their income instead of consuming it. But as subsidies to capital decrease over time, consumption increases and

eventually reaches a steady-state level somewhat lower than in the fiscal union.

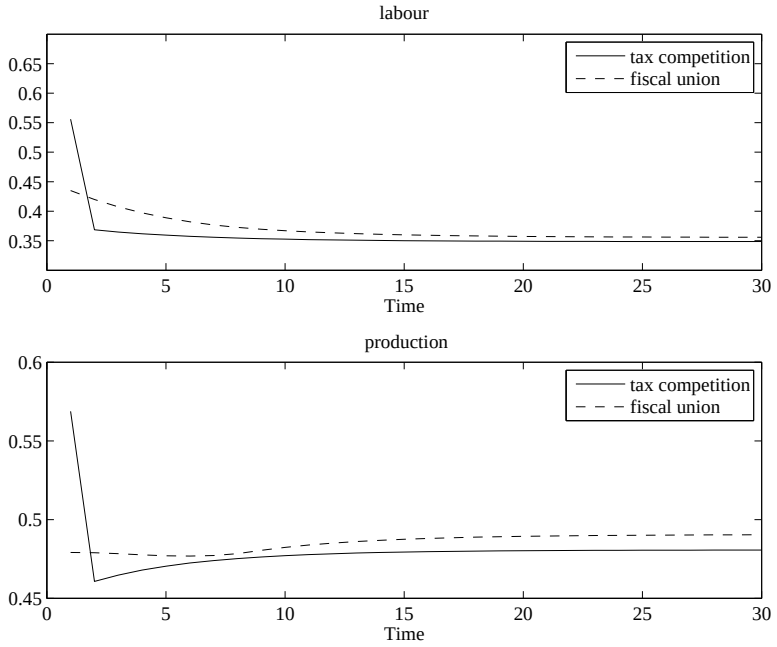

Figure 4: Labour and production

The evolution of labour, as depicted in figure 4 can be explained by labour tax rates. In the fiscal union labour tax rates start out being rather low, and increase over time. Therefore households work more in the fiscal union during the first periods, because their salary is taxed less. As labour tax rates increase, households prefer to take more time off instead of working, and therefore labour participation decreases. With tax competition the mechanism is very similar. Because labour tax rates are extremely low in the first period, working is very rewarding, and labour participation very high. With the jump in labour tax rates in period 2 working becomes much less interesting and labour drops almost to the steady-state level.

In the fiscal union labour is decreasing over several periods, and this shows in the evolution of production in figure 4. Because of the high capital tax rates capital accumulation is dampened and does not offset the decrease in labour participation. After this production increases steadily to the steady-state level. The effect is that production decreases slightly until the capital stock has grown enough to offset the decrease in labour. With tax competition production is very high in the first period, reflecting the very high labour participation in that period. Just as in the fiscal union, production decreases jointly with labour participation in the second period. After this production immediately starts growing again; the high capital

stock due to capital subsidies offsetting low labour participation.

5 Results with balanced budget

In this section we discuss a special case of the model discussed so far, where government debt is set to zero for all periods. Setting $b_{it} = 0$ for all t, all the equations from section 2 and section 3 are still true. We can neglect equations (10) and (11), the conditions concerning government debt and the return to debt. A common assumption in the optimal taxation literature is that governments can get indebted. But we think balanced budget is an important case to consider, as in reality many governments face some kind of budget constraint. The European Union for instance established in the Maastricht Treaty that the ratio of government deficit to GDP should not exceed 3%. The balanced budget case makes as well a good robustness test to the results obtained in section 4.

With balanced budgets we do not observe any differences in the long-run results for the fiscal union and tax competition. Hence all the costs of tax competition arise during transition. The parameter values we use for the balanced budget case are the same as for the model with debt, apart from government debt, which we set to zero for all periods: $b_{it} = 0$ for all t.

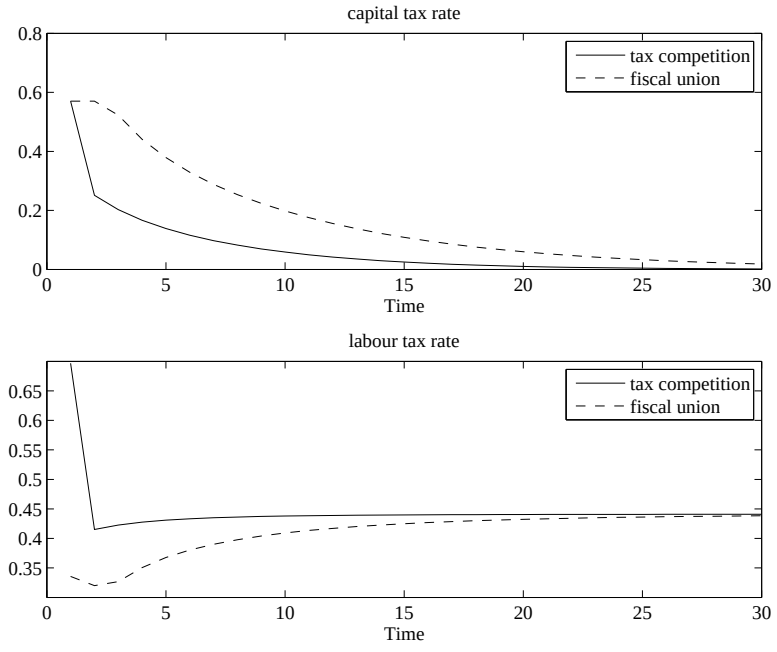

Figure 5: Capital and labour tax rates

We start again with discussing the evolution of tax rates (figure 5), as all the other results follow from here. Because we put an upper bound

on capital tax rates of 0.57 in all periods, the government is disabled from taxing inelastically supplied initial capital as high as it wishes to. Previously the government could get indebted, and therefore it was optimal in the fiscal union to have capital tax rates at the upper bound for several periods, and save some of the tax income so after this it could decrease capital tax rates rapidly to the steady state level of zero. In the long run capital tax rates are optimally equal to zero as well with balanced budgets. But now capital tax rates stay at the upper bound only for two periods and then decrease slowly to zero over time, because the government can not save the income from earlier periods. With tax competition there is a huge drop in capital taxation after the first period, just as in the case where the governments can get indebted. But this time the capital tax rate stays positive, slowly decreasing to zero over time.

In the fiscal union labour tax rates decrease from the first to the second period, the time where capital taxes are at the upper bound. After this they increase smoothly over time, compensating for the gradual decrease in capital tax rates and the implied loss in tax revenues. With tax competition labour tax rates are very high in the first period and then drop slightly below the steady state level in the second period. To explain this effect we have a look at figure 6. Because labour taxation is very high in the first period, households prefer leisure to working, and therefore labour participation is very low in the first period. With the drop in labour taxation thereafter households increase their working hours. When governments can get indebted labour tax rates are lower in the first period, because the government can raise some income by getting indebted. With tax competition, labour tax rates are higher than in a fiscal union for the entire time of transition. This result matches what we found with government debt, where labour tax rates are higher with tax competition both during transition and in the long run.

The decrease in labour tax rates in figure 5 is reflected by the increase in labour participation in the same period. Because labour tax rates are higher under tax competition, labour participation is lower. In the model with government debt we found that labour participation decreased steadily in the fiscal union and dropped heavily in period 2 with tax competition, reflecting the movements of labour tax rates. But in either case labour tax rates were higher with tax competition for almost all periods.

In figure 6 we observe a sharp increase in production with tax competition from the first to the second period. This is due to the initially very low level of labour participation, and therefore of production, and the sharp increase in employment the period after. Because of the continuing lower labour participation under tax competition, production converges to the level in the fiscal union only in the long run. The evolution in the first periods contrasts again with the case where governments can get indebted. With debt we observed that production in the fiscal union initially decreased,

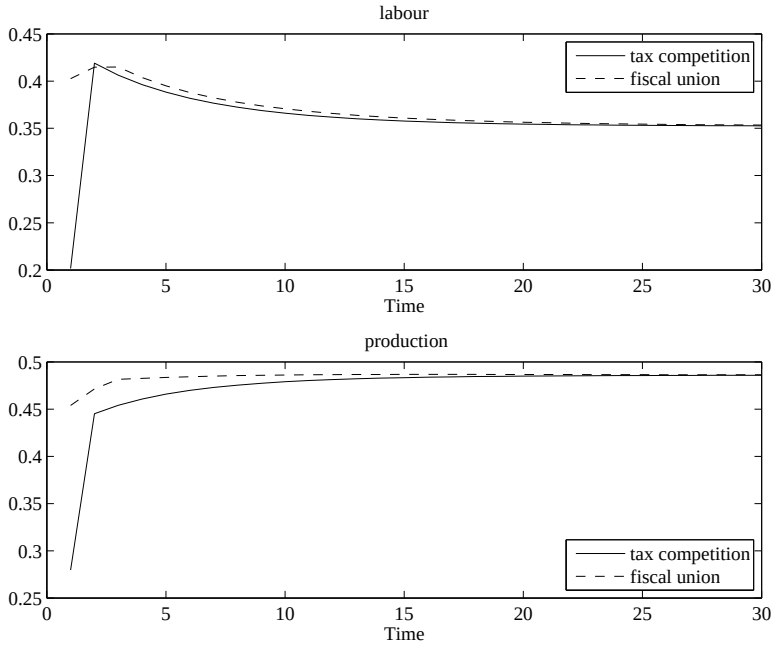

Figure 6: Labour and production

because of the decrease in labour participation and low capital stock, due to high capital taxation. With tax competition production dropped with labour in the second period, but then immediately started increasing again, because of the high capital stock, due to capital subsidies.

Households want to have the lowest possible capital stock when capital tax rates are the highest, to minimize the tax burden. Therefore capital accumulation in the first period in figure 7 is very low, and with tax competition even negative. After period one capital accumulation is always positive, and because of the lower capital tax rates faster with tax competition. Nevertheless is the capital stock with tax competition lower during transition, because of the initial desinvestment. This is an interesting difference with the model with government debt, where capital stock with tax competition is higher than in the fiscal union for several periods. But capital accumulation is slower despite the subventions to capital.

The evolution of consumption over time (see figure 7) can be explained by the high labour tax rates under tax competition. This induces households to work less, and they therefore find their labour income reduced. Because of the low capital tax rates they have an incentive to invest more capital instead of spending it on consumption. The effect is lower consumption during transition to the steady state. With government debt we found a particular behavior of consumption in the fiscal union, which was mainly due to the evolution of government debt, and the fact that capital tax rates

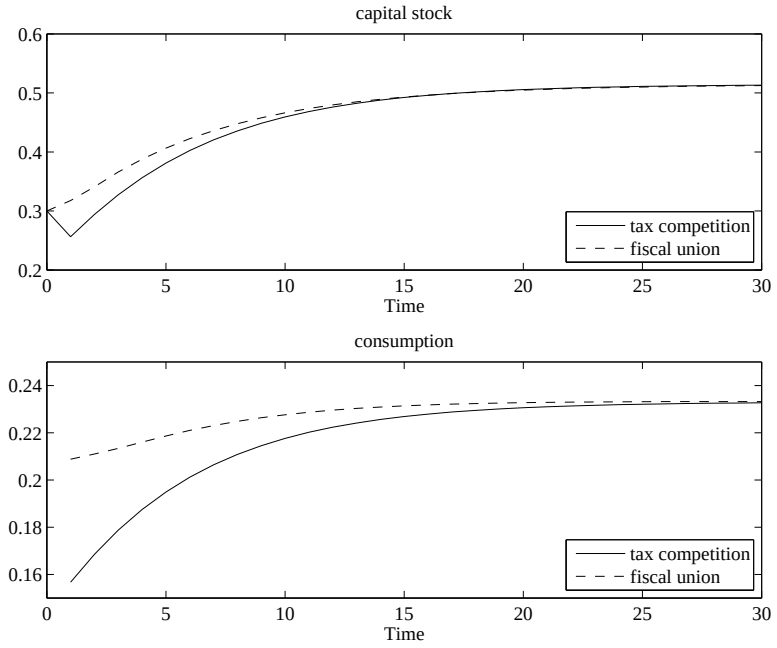

Figure 7: Consumption and capital stock

were at the upper bound for such a long period. But as well in the model with government debt consumption is higher in a fiscal union for almost all the periods. A graph with the evolution of capital rental rates and wage rates can be found in figure 9 in appendix B.

6 Conclusion

Tax competition is a real concern among governments and policy makers. But how costly is capital tax competition really? In this paper we employed a two-country version of the standard optimal taxation model to identify the costs of tax competition. As far as we know this is the first paper to consider optimal taxation with commitment in a two-country model where countries are considered being large. We find that capital tax rates converge to zero in the long run both in a fiscal union and with tax competition. Therefore the costs of tax competition have the origin not in the long run, but arise during transition. We find in the model with tax competition that during transition capital tax rates are inefficiently low and even negative, with long-run effects on the economy. The difference in tax rates during the first few periods is of over 60 percentage points. This gap in tax rates drives the differences in the evolution of other variables, resulting even in different steady-state values. To finance the capital tax subsidies, labour tax rates and government debt are higher with tax competition both during transition and in steady state.

Indeed, we find that long-run debt levels are not only higher than in a fiscal union, but even positive. This is in contrast with the standard prediction from the optimal taxation literature that government debt is negative in the long run. We find that in steady state consumption, labour, production and the capital stock are lower in an economy with tax competition than in a fiscal union.

Using a dynamic taxation model allows us to discern optimal steady-state taxation policies from optimal policies during transition, which are remarkably different. For example we observe during transition the prediction of the standard tax competition literature that due to tax competition capital tax rates are inefficiently low. But we do not find this result in the long run, where capital tax rates are optimally equal to zero both in a fiscal union and with tax competition.

To check for the sensitivity of the results we look at what happens if the government faces balanced budgets. We find that capital tax rates are always inefficiently low under tax competition. Because of capital mobility, the governments want to attract foreign capital, and therefore set inefficiently low capital tax rates. As a result a bigger share of taxation is shifted to labour.

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A Appendix section 4

Capital rental rate and wage rate for the the model discussed in section 4.

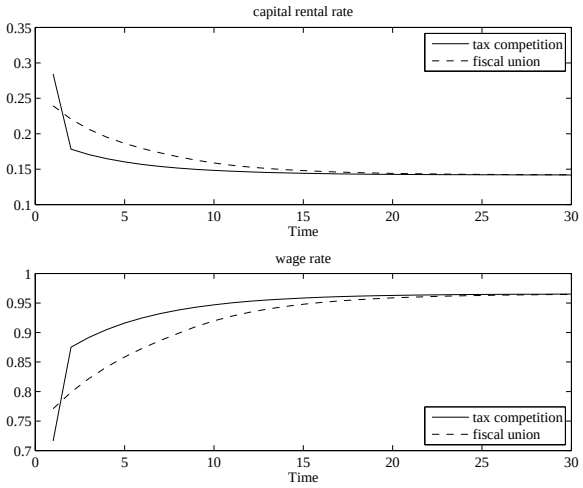

Figure 8: Capital rental rate and wage rate with government debt

B Appendix section 5

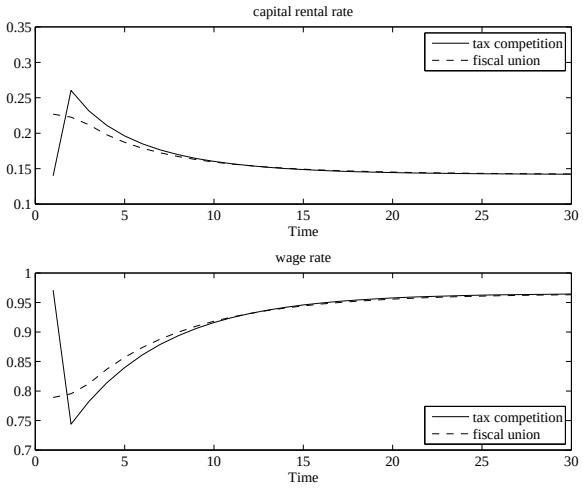

Figure 9: Capital rental rate and wage rate with balanced budget

Capital rental rate and wage rate for the the model with balanced budget, discussed in section 5.