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CAPITAL INCOME TAX COORDINATION AND THE INCOME TAX MIX

Harry Huizinga   Søren Bo Nielsen

Department of Economics - Solbjerg Plads 3, C5 - DK-2000 Frederiksberg

Capital Income Tax Coordination and the Income Tax Mix

Harry Huizinga*
Tilburg University and CEPR

Søren Bo Nielsen
Copenhagen Business School, EPRU and CEPR

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Abstract: Europe has seen several proposals for tax coordination only in the area of capital income taxation, leaving countries free to adjust their labor taxes. The expectation is that higher capital income tax revenues would cause countries to reduce their labor taxes. This paper shows that such changes in the mix of capital and labor taxes brought on by capital income tax coordination can potentially be welfare reducing. This reflects that in a non-cooperative equilibrium capital income taxes may be more distorting from an international perspective than are labor income taxes. Simulations with a simple model calibrated to EU public finance data suggest that countries indeed lower their labor taxes in response to higher coordinated capital income taxes. The overall welfare effects of capital income tax coordination, however, are estimated to remain positive.

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* Huizinga (corresponding author): Department of Economics, Tilburg University, P.O. Box 90153, 5000 LE Tilburg, Netherlands. Tel: +31-13-466-2623; fax: 31-13-466-3042; email: huizinga@uvt.nl. Nielsen: Department of Economics, Copenhagen Business School, Solbjerg Plads 3, 2000 Frederiksberg, Denmark. Tel: +45-38152596; fax: +45-38152576; e-mail: sbn.eco@cbs.dk.
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1. *Introduction*

Observing movements to lower capital taxes and higher labor taxes in the EU, the European Commission stated that EU tax policies should aim to reverse these trends (European Commission, 1996). In 1997, the European Union launched the so-called ‘tax package’ of initiatives in the area of capital income taxation to bring about higher capital income taxation in the EU. As part of this package, the EU was to identify and roll back so-called harmful tax practices in the area of corporate income taxation.[1] There similarly was a call for cooperation in the area of savings taxation, which led to an agreement on the exchange of information on international interest flows in 2003. The ‘tax package’ is the latest in a series of attempts to coordinate either corporate income taxes or the taxation of savings in the EU. To wit, the European Commission proposed a minimum withholding tax on interest of 15 percent in 1989, to be superceded by a proposal where countries could choose between a minimum withholding tax of 20 percent on international interest payments and exchanging information regarding these payments (European Commission, 1998). In 1975, there was a proposal to contain corporate tax rates within the 45-55 percent bracket. The Ruding committee (European Commission, 1992) instead recommended a band of 30 to 40 percent for corporate tax rates.

Like the ‘tax package’, these previous attempts always were partial in that they only pertained to capital income taxes. Labor taxes, specifically, have never been included in tax coordination proposals (beyond cooperation related to frontier workers). The expectation and indeed the intention, however, is that higher coordinated capital income taxes in the EU lead to lower taxes on labor.

Table 1 summarizes recent trends in capital and labor income taxation in the EU15 since 1995.[2] As seen in Panel A, capital income taxes have risen from 7.7 percent of GDP in 1995 to 9.2 percent in 2000, to fall back to 8.3 percent of GDP in 2002. Labor income taxes instead have declined from 21.5 percent of GDP in 1995 to 20.7 percent of GDP in 2001, while consumption taxes have varied little from the level of 11.5 percent in 1995. Correspondingly, Panel B of the figure shows that capital income taxes have risen from 19.0 percent of total taxes in 1995 to 22.0 percent in 2000 to decline slightly to 20.6 percent in 2002. The share of labor taxes instead has declined over this period from 52.7 percent in 1995 to 50.9 percent in 2002, against a fairly stable share of consumption taxes in the overall tax mix. An increased share of capital income taxes in total taxes may to some extent reflect actual or anticipated tax policy coordination at EU level, in addition to the business cycle (an expanding EU economy till 2000) or perhaps increasing foreign ownership (which could lead countries to try to export their capital income taxes; see Huizinga and Nielsen (1997)).

Regardless of recent trends, EU capital income tax policy coordination potentially can shift the overall tax mix towards higher capital income taxes and lower labor income taxes. Following the contributions by Zodrow and Mieszkowski (1986)) and Wilson (1986) to the tax competition literature, higher capital income taxes – beyond their uncoordinated levels – should yield higher welfare. This reflects that higher capital income taxes create positive externalities abroad – in the form of higher capital employment – that countries ignore, if they set capital income taxes in an uncoordinated fashion. The resulting higher tax revenues increase the supply of public goods, and hence they reduce the need to raise revenues by way of labor income taxes. Policy coordination towards higher capital income taxes thus is expected to bring about lower labor income taxes.

Lower labor taxes induced by higher capital taxes, however, are welfare reducing per se, as labor taxes in the uncoordinated tax competition equilibrium are equally set too low. This suggests that the overall welfare implications of partial capital income tax coordination – bringing about higher capital income taxes and lower labor income taxes - are ambiguous. The net welfare effect of capital tax coordination, in fact, can be expected to reflect i) the relative merit of capital and labor income taxation at the margin from an *international* or system perspective and on ii) the downward responsiveness of labor taxes following the coordinated increase in capital taxes. If a reduction in labor income taxes is especially undesirable from an international perspective (relative to a capital income tax decrease), and if the downward response in labor taxes following a coordinated increase in capital income taxes is strong, then a deterioration of welfare cannot be ruled out. The possibility of welfare reducing partial capital tax coordination arises from the fact that both no and partial tax coordination are second best outcomes. A priori it is not clear which of these suboptimal outcomes produces higher welfare.

The purpose of this paper is twofold. First, it presents a simple two-country model with mobile labor and capital that enables us to analyze the welfare consequences of capital income tax coordination theoretically. For special cases of this model, we can explicitly derive how the welfare consequences of partial capital tax coordination depend on underlying factor demand and supply elasticities and on the strength of the demand for public goods. Secondly, the paper presents the results of simulations with a slightly more complicated two-period, two-country model - calibrated to EU public finance figures - to arrive at an informed estimate of the welfare consequences of partial tax coordination in practice.

In a tax competition game, countries maximize their national welfares by equating the excess burdens from a *national* perspective of raising additional revenue through either capital or labor taxes. A basic insight is that this does not imply that the excess burdens created by the two factor taxes are equalized from an *international* perspective. Moreover, the fact that capital income taxes are relatively low does not imply that a tax mix shift towards higher capital taxes – induced by capital tax coordination – is necessarily welfare improving. To see this, we can, for example, assume that the supply of capital through savings is relatively elastic. This gives rise to relatively low taxes on capital in the non-cooperative tax equilibrium. The high sensitivity of savings supply, however, precisely makes the capital income tax a bad tax to increase through coordination. In the worst case scenario for capital tax coordination, labor supply would be completely inelastic at the national level, even if each country's labor employment is sensitive to taxation on account of the international mobility of labor. A shift towards higher capital income taxes and lower labor income taxes – induced by the higher capital income taxes – would then be in the wrong direction. It would be wiser to coordinate towards higher labor taxes instead, even if they initially already are relatively high. The theoretical model serves to demonstrate how the relative merits of coordinated increases of capital and labor taxes generally depend on factor demand and supply elasticities as well as on the flexibility of the demand for public goods to be financed with tax revenues.

With the aid of the simulation model, we examine a joint increase in the capital income tax from the uncoordinated Nash level. For fixed levels of labor income taxes, capital income tax coordination of this kind raises spending on public goods as well as welfare, confirming that capital income taxes in the Nash outcome are too low. Next, we let countries adjust their labor income taxes to the higher levels of capital income taxes and public goods. For our base-line simulation, countries adjust their labor income downward from the Nash level. This secondary adjustment reduces public goods and welfare levels. However, in all our simulations the overall welfare effect of partial capital income tax coordination remains positive. This reflects that the overall impact on tax revenues is positive and, not least, that the revealed excess burdens of capital and labor taxation in the Nash equilibrium are rather similar.

Several authors have considered tax policy coordination in a partial or second-best setting before. Fuest and Huber (1999) examine partial tax coordination in a setting where several tax instruments can be used to affect the effective rate of taxation of capital income – these are the corporate tax rate, depreciation allowances, a withholding tax on interest and an origin-based VAT. In this setting, partial tax coordination related to only one or a few of these instruments has no real effects, if countries continue to have the disposal of other instruments with which they can offset changes in the coordinated instruments. Marchand, Pestieau and Sato (2003) investigate the welfare consequences of partial tax coordination in a model where the only purpose of fiscal policy is income redistribution. Partial tax coordination in the sense of involving only some countries is considered by Konrad and Schjelderup (1998) and also by Sørensen (2000) whose simulation results suggest that the welfare gains of regional capital coordination in the EU are relatively small compared to the gains to be realized by global capital tax coordination.[3] Sørensen (2000) finds that capital income tax coordination raises an egalitarian social welfare function partly because of lower labor income taxes. Mendoza and Tesar (2005) have analyzed international capital tax coordination in a model calibrated to European data for the case where labor taxes are adjusted to maintain revenue neutrality. In their benchmark two-country model, capital tax coordination leads to higher capital taxes and lower labor taxes, with a rather small welfare gain of 0.26 percent in terms of a compensating variation in lifetime consumption.[4]

It should also be mentioned that partial policy coordination in other areas than taxation has been investigated. For instance, Rogoff (1985) and Ploeg (1988) have considered partial macroeconomic policy coordination, while Gatsios and Karp (1992) have analyzed the partial coordination of international trade policies. In all of these settings, policy coordination is potentially welfare reducing.

In the remainder, section 2 presents the theoretical analysis of the welfare consequences of partial tax coordination. Section 3 contains the simulation results, and section 4 concludes.

2. *The model*

This section presents a simple stylized model with a view to analyzing the welfare consequences of capital income tax coordination theoretically. There are a domestic and a foreign country that are fully symmetric, with stars denoting foreign variables. The two variable factors of production are called capital and labor. The supplies of the two factors of production originating from the domestic country are denoted $\overline{K}$ and $\overline{M}$.[5] These two factor supplies generate disutilities $D(\overline{K})$ and $E(\overline{M})$ respectively, with marginal disutilities increasing in factor supplies. The two factors are internationally mobile. This implies that domestic capital and labor employments, denoted K and $M,$ can be different from domestic capital and labor supplies, $\overline{K}$ and $\overline{M}$. Private utility in addition depends on a private consumption good, C, and a public consumption good, $G.$ Welfare of the domestic representative agent, W, is for simplicity taken to be additively separable and linear in private consumption. It is represented as follows

$$W = C + V(G) - D(\overline{K}) - E(\overline{M}) \tag{1}$$

with $V' > 0, V'' \leq 0$.

The private good, C, and the public good, G, are both produced with the same technology embodied in the production function $f(K,M)$. The production function f displays decreasing returns to scale regarding the two variable inputs and decreasing marginal returns, while in addition we assume $f_{km} \geq 0$, $f_{kk}\, f_{mm} - (f_{km})^2 > 0.$ The net-of-tax return to capital and the wage are denoted r and w, respectively. The public good is financed through taxes on the employment of capital and labor.[6] We will use τ_i, $i = k,m,$ to denote the domestic tax on the employment of factor $i.$[7] The budget constraints of the domestic private agent and the domestic government are represented as follows:

$$C = f(K,M) - (r + \tau_k) K - (w + \tau_m) M + r\overline{K} + w\overline{M} \tag{2}$$

$$G = \tau_k K + \tau_m M \tag{3}$$

International factor market clearing requires that the world demand for either factor of production equals the world supply. This gives rise to two clearing conditions for the world capital and labor markets given by $K + K^* = \overline{K} + \overline{K}^*$ and $M + M^* = \overline{M} + \overline{M}^*$, respectively.[8] The capital and labor supplies of the domestic agent are governed by familiar optimality conditions that equate marginal disutilities to net factor rewards given by $D_k = r$ and $E_m = w.$ The government chooses the rates, τ_k and $\tau_m,$ and the volume of public goods, $G,$ to maximize private overall welfare as represented by the following Lagrangean:

$$L = C - D(\overline{K}) - E(\overline{M}) + V(G) + \lambda(\tau_k K + \tau_m M - G) \tag{4}$$

The first order conditions with respect to the policy variables τ_k, τ_m and G are as follows

$$-1+\lambda\left[1-\varepsilon_k^n\tau_k-\hat{\varepsilon}_m^n\frac{M}{K}\tau_m\right]=0 \tag{5}$$

$$-1+\lambda\left[1-\varepsilon_m^n\tau_m-\hat{\varepsilon}_k^n\frac{K}{M}\tau_k\right]=0 \tag{6}$$

$$V'-\lambda=0 \tag{7}$$

where $\varepsilon_k^n=-\frac{1}{K}\frac{dK}{d\tau_k}$, $\varepsilon_m^n=-\frac{1}{M}\frac{dM}{d\tau_m}$ and $\hat{\varepsilon}_k^n=-\frac{1}{K}\frac{dK}{d\tau_m}$, $\hat{\varepsilon}_m^n=-\frac{1}{M}\frac{dM}{d\tau_k}$ are the own and the cross factor employment semi-elasticities evaluated in the two-country non-cooperative equilibrium with factor mobility. These factor elasticities reflect that a change in a tax rate in a country triggers a relocation of the mobile factors of production so as to equate the net factor rewards, w and r, in the two countries. These factor employment elasticities are distinct from the 'regular' own and cross factor demand semi-elasticities given by $\varepsilon_k^d=-\frac{1}{K}\frac{dK}{dr}$, $\varepsilon_m^d=-\frac{1}{M}\frac{dM}{dw}$ $\hat{\varepsilon}_k^d=-\frac{1}{K}\frac{dK}{dw}$ and $\hat{\varepsilon}_m^d=-\frac{1}{M}\frac{dM}{dr}$. For special cases of the model considered below, we will relate the factor employment elasticities (ε_k^n, ε_m^n, $\hat{\varepsilon}_k^n$ and $\hat{\varepsilon}_m^n$) to the factor demand elasticities (ε_k^d, ε_m^d, $\hat{\varepsilon}_k^d$ and $\hat{\varepsilon}_m^d$) and to the factor supply elasticities given by $\varepsilon_k^s=\frac{1}{\overline{K}}\frac{d\overline{K}}{dr}$ and $\varepsilon_m^s=\frac{1}{\overline{M}}\frac{d\overline{M}}{dw}$.[9] Note that the government's first-order conditions (5)-(7) can be solved for the optimal values of the capital and labor tax rates in the symmetric, non-cooperative tax equilibrium to yield $\tau_k=\frac{V'-1}{V'}\frac{1}{\Delta}\left[\varepsilon_m^n-\frac{M}{K}\hat{\varepsilon}_m^n\right]$ and $\tau_m=\frac{V'-1}{V'}\frac{1}{\Delta}\left[\varepsilon_k^n-\frac{K}{M}\hat{\varepsilon}_k^n\right]$ with $\Delta=\varepsilon_k^n\varepsilon_m^n-\hat{\varepsilon}_k^n\hat{\varepsilon}_m^n$.[10]

2.1 *The welfare implications of capital tax coordination*

We consider stylized partial tax coordination in the form of an increase in the capital tax in both countries starting from the non-cooperative overall tax equilibrium. The change in the common capital tax causes both countries to adjust their labor taxes until a new non-cooperative equilibrium in these taxes is reached. In the new equilibrium, there are again fully symmetric labor tax policies in the two countries. The overall welfare implications of the changed tax structure depend on the combined effects of the initial capital tax increase and the induced changes in labor taxes. As seen below, the cooperative increase in capital taxes is expected to lead to a reduction in non-cooperative labor taxes. The welfare implications of the overall change in the tax structure then depend on the relative merits of marginal changes in capital and labor taxes and on the strength of the response of labor taxes to the coordination of capital taxes.

To understand what drives the overall welfare effect, it is useful to consider two simplified versions of the theoretical model in turn. In the first version we shall assume that capital and labor supplies are elastic, but that the two factor demands are independent of each other as $f_{km} = 0$. This allows us to develop some insight into the roles of factor demand and supply elasticities and of the implicit demand for public goods in determining the sign of the overall welfare implications.

In the second version of the model, we shall assume that capital and labor are in fixed supplies, but that factor demands are interdependent as $f_{km} > 0$. This second case serves to bring out how the size of f_{km} can affect the welfare implications. The intuition developed in these two cases should continue to hold in the general theoretical model as well as in the simulation model considered in section 3.

2.2 *The case of variable factor supplies and independent factor demands*

Following higher coordinated capital taxes, the adjustment in non-cooperative labor taxes can conceptually be divided into two parts. First, each country can be thought to adjust its own labor tax in response to the jointly increased capital tax for a given labor tax abroad. This initial adjustment of the labor tax in each country is downward if the demand for public goods is relatively inflexible, or equivalently if γ, defined as $-V'' / (V')^2$, is large enough.[11] Second, the two countries adjust their labor taxes in response to each other's labor taxes until a new non-cooperative labor tax equilibrium is reached. The pertinent reaction curves will be downward sloping, if the demand for public goods is sufficiently inflexible.[12] For a large enough γ, the overall effect of higher capital income taxes on non-cooperative labor income taxes thus will be negative.

To find the overall change in the common labor income tax, we can totally differentiate

(9) with respect to the two factor taxes where $\hat{\varepsilon}_k^n = 0$ with $f_{km} = 0$. Using the 'bar' notation to denote equal tax change in both countries, we find

$$- \varepsilon_m^n \, d\bar{\tau}_m - \tau_m \frac{d\varepsilon_m^n}{d\bar{\tau}_m} d\bar{\tau}_m - \gamma \left[K \, [\, 1 - \varepsilon_k^c \, \tau_k] \, d\bar{\tau}_k + M \, [\, 1 - \varepsilon_m^c \, \tau_m \,] \, d\bar{\tau}_m \right] = 0 \tag{8}$$

where $\varepsilon_k^c = -\dfrac{1}{K}\dfrac{dK}{d\bar{\tau}_k}, \varepsilon_m^c = -\dfrac{1}{M}\dfrac{dM}{d\bar{\tau}_m}$. Here, ε_i^c is the semi-elasticity of the employment of factor i in either country in response to a coordinated, common change in $d\bar{\tau}_i$ in both countries.

It is now useful to relate the factor employment semi-elasticities ε_i^n and ε_i^c to the conventional factor demand and supply semi-elasticities ε_k^d and ε_m^d. To do so, we first note that a change in either tax affects the net factor rewards, *w* and *r*, as follows: $\dfrac{dr}{d\tau_k} = -\dfrac{\varepsilon_k^d}{2\left(\varepsilon_k^d + \varepsilon_k^s\right)} < 0$, $\dfrac{dw}{d\tau_m} = -\dfrac{\varepsilon_m^d}{2\left(\varepsilon_m^d + \varepsilon_m^s\right)} < 0$, $\dfrac{dw}{d\tau_k} = \dfrac{dr}{d\tau_m} = 0$. Now it is straightforward to see that the factor employment elasticities are given by $\varepsilon_i^n = \varepsilon_i^d \left[\dfrac{\varepsilon_i^s + (1/2)\, \varepsilon_i^d}{\varepsilon_i^d + \varepsilon_i^s} \right]$ and $\varepsilon_i^c = \dfrac{\varepsilon_i^d \, \varepsilon_i^s}{\varepsilon_i^d + \varepsilon_i^s}$ for $i = k,m$. Note that $\varepsilon_i^n > \varepsilon_i^c$ if the underlying demand and supply elasticities are positive. This reflects that a factor tax increase in a single country induces a greater reduction in the employment of the affected factor in that country than a joint factor tax increase in both countries.

From (8) we can explicitly solve for the common change in the labor tax resulting from the common capital tax increase as follows

$$\frac{d\bar{\tau}_m}{d\bar{\tau}_k} = -\theta \frac{K}{M} \tag{9}$$

with $\theta = \dfrac{\gamma \, [\, 1 - \varepsilon_k^c \, \tau_k \,] \, M}{\varepsilon_m^n + \tau_m \dfrac{d\varepsilon_m^n}{d\bar{\tau}_m} + \gamma \, [\, 1 - \varepsilon_m^c \, \tau_m] \, M}$. The variable θ is an 'offset coefficient' that indicates to what extent a coordinated increase in capital taxes is followed by a reduction in labor taxes.

Note that the offset coefficient can in principle be of either sign given that $\frac{d\varepsilon_m^n}{d\bar{\tau}_m}$ can be of either sign. However, θ is positive if $\frac{d\varepsilon_m^n}{d\bar{\tau}_m}$ is not too negative, which we take to be the normal case. In this normal case, labor taxes fall in response to a coordinated increase in capital taxes and. At the same time, the offset coefficient θ then increases with the inflexibility of the demand for public goods as measured by γ.

The overall welfare implications of the capital tax coordination, as indicated, reflect the changes in both factor taxes. An increase in the common capital tax by itself affects welfare positively as $\frac{dW}{d\bar{\tau}_k} = \left[\, -1 + V'(1-\varepsilon_k^c \tau_k)\,\right] K > 0$ with $\varepsilon_k^c < \varepsilon_k^n$, given (5). Similarly, an increase in the common labor tax by itself increases welfare as $\frac{dW}{d\bar{\tau}_m} = \left[\, -1 + V'(1-\varepsilon_m^c \tau_m)\,\right] M > 0$ with $\varepsilon_m^c < \varepsilon_m^n$, given (6). The welfare implications of a coordinated capital tax increase are hence in principle ambiguous in the normal case, where labor taxes are reduced. At the same time, welfare is more likely to decrease, the stronger is the negative response of labor taxes to the capital tax increase reflected in the offset coefficient θ. To see this, the overall change in welfare, W, can be expressed as follows:

$$\frac{dW}{d\bar{\tau}_k} = -(1-\theta)K + V'\left[\, 1 - \varepsilon_k^c \tau_k - \theta\,(\, 1 - \varepsilon_m{}^c\, \tau_m \,)\right] K\,. \qquad (10)$$

The first term in (10) represents the impact of overall tax changes on welfare as affected by factor supplies and consumption of the private good. This term is seen to be negative with incomplete offset, or $\theta < 1$. The second term reflects the changed expenditure on public goods, given that $\frac{dG}{d\bar{\tau}_k} = \left[\, 1 - \varepsilon_k^c \tau_k - \theta(\, 1 - \varepsilon_m{}^c\, \tau_m \,)\right] K$ which is positive if $\varepsilon_m^n + \tau_m \frac{d\varepsilon_m^n}{d\bar{\tau}_m}$ is positive (this follows from the expression for θ). Next, we find the following result:

Proposition 1.

Assume that the supplies of capital and labor are flexible, but that the cross employment elasticities of capital and labor are zero. Then the welfare effect in either country of a coordinated increase in the tax on capital, including the induced change in the tax on labor, can be written as

$$\frac{dW}{d\bar{\tau}_k} = K(V' - 1)\left[\frac{\varepsilon_k^n - \varepsilon_k^c}{\varepsilon_k^n} - \theta\,\frac{\varepsilon_m^n - \varepsilon_m^c}{\varepsilon_m^n}\right] \tag{11}$$

which has ambiguous sign.

For a proof, see the Appendix. Expression (11) generally depends on the factor demand and supply elasticities as reflected in ε_k^n and ε_k^c and on the preferences for public goods as reflected in γ (which enters θ). Some of these dependencies are clarified by

Proposition 2

i. If $\gamma = 0$, then $\frac{dW}{d\bar{\tau}_k} > 0$.

ii. If $\gamma = \infty$, then

$$\frac{dW}{d\bar{\bar{\tau}}_k} > 0 \quad \text{if } \frac{\varepsilon_k^s}{\varepsilon_k^d} < \frac{\varepsilon_m^s}{\varepsilon_m^d}$$

iii. If $E_{mmm} = f_{mmm} = 0$, then

a. $\frac{dW}{d\tau_k}$ decreases in θ,

b. $\frac{\varepsilon_k^s}{\varepsilon_k^d} < \frac{\varepsilon_m^s}{\varepsilon_m^d}$ is a sufficient condition for $\frac{dW}{d\bar{\tau}_k} > 0$.

For a proof, see the Appendix. Part i considers the case where *V(G)* is linear in the relevant range so that $\gamma = 0$ and also $\theta = 0$. Then in (11) we see that $dW / d\bar{\tau}_k > 0$, as $\varepsilon_k^n > \varepsilon_k^c$. In this instance, the coordinated increase in τ_k is not followed by a change in τ_m, as τ_k and τ_m are determined independently given that $\lambda = V'$ in (5) and (6). The capital tax increase thus is not offset by a subsequent reduction in the non-coordinated labor income tax. The coordinated increase in τ_k now is welfare enhancing, as the original non-coordinated value of τ_k is too low.

Next, part ii takes the case where the demand for public goods is very inflexible. In the extreme, we can take γ to be infinite so that $\theta = \frac{1 - \varepsilon_k^c\ \tau_k}{1 - \varepsilon_m^c\ \tau_m}$. This is the case where effectively the government has a fixed revenue requirement to finance an inflexible demand for public goods. The increase in τ_k is now followed by a reduction in τ_m so as to leave total tax revenues and the supply of the public good unchanged. This reshuffling of the tax mix enhances welfare, if at the margin the capital tax causes less dead-weight loss than the labor tax as seen from a system or world perspective. Formally, eq. (11) is now seen to imply $\frac{dW}{d\bar{\tau}_k} > 0$, if $\frac{\varepsilon_k^s}{\varepsilon_k^d} < \frac{\varepsilon_m^s}{\varepsilon_m^d}$ and vice versa. Thus, a sufficient condition for the coordinated capital income tax to be welfare enhancing in this case is $\varepsilon_k^s = 0, \varepsilon_m^s > 0, \varepsilon_k^d > 0, \varepsilon_m^d > 0$. If the elasticity of capital (labor) supply is zero (positive), so that the capital (labor) tax is non-distorting (distorting) at the world level, then the reshuffling of the tax mix towards the capital income tax will be welfare improving.

More generally, the coordinated increase in the capital tax is more likely to be welfare increasing, the smaller ε_k^s is relative to ε_m^s. At the same time, the partial coordination initiative is more likely to be welfare enhancing, the larger ε_k^d is relative to ε_m^d, as a high capital demand elasticity leads to a low capital tax in the non-coordinated equilibrium. Increasing the capital income tax from a low level is relatively non-distorting. Note, however, that a relatively low capital tax, i.e. $\tau_k < \tau_m$, is not a sufficient condition for a coordinated capital tax increase to be welfare enhancing.[13]

Finally, part iii makes the additional assumptions that the third derivatives of the production function f w.r.t. M and the disutility function of labor E w.r.t. $\overline{M}$ are locally zero. For these additional assumptions, the employment elasticity ε_m^n is invariant to a common change in labor tax rates. This implies that the offset coefficient θ is positively related to γ. In words, the coordinated capital tax increase causes countries to lower their labor taxes relatively much, if the demand for public goods is relatively inflexible (so that a reduction in public goods raises the marginal utility of these public goods relatively much). This works towards negative welfare implications of a coordinated capital tax increase, as a reduction in labor taxes by itself is welfare reducing.

2.3 *The case of fixed factor supplies and interdependent factor demands*

Next, we take the two factors to be in worldwide fixed supply, i.e. $\varepsilon_k^s = 0$ and $\varepsilon_m^s = 0$, but now assume $f_{km} > 0$ so that factor demands are interdependent. Again the two countries are assumed to collectively raise the capital income tax, τ_k, beyond the non-cooperative level in (6). Higher capital tax revenues continue to cause a reconsideration of labor tax policy. In response to the higher capital taxes, each country specifically wishes to adjust its labor tax downward for γ high enough.[14] At the same time, reaction curves, that indicate how one country adjusts its labor tax in response to the other country's labor tax, are downward sloping for high enough values of γ.[15] Eq. (6) should hold in the new non-cooperative equilibrium in the two labor tax rates as well.

Differentiating (6), we see that the changes in the coordinated capital income tax and the non-coordinated labor income tax are related as follows

$$-\varepsilon_m^n d\bar{\tau}_m - \hat{\varepsilon}_k^n \frac{K}{M} d\bar{\tau}_k - \gamma \left[M d\bar{\tau}_m + K d\bar{\tau}_k \right] = 0 \tag{12}$$

given that the factor employment elasticities ε_m^n and $\hat{\varepsilon}_k^n$ are unaffected by symmetric tax changes for fixed factor supplies. We again wish to relate the factor employment elasticities $\varepsilon_k^n, \varepsilon_m^n, \hat{\varepsilon}_k^n$ and $\hat{\varepsilon}_m^n$ to the underlying factor demand elasticities $\varepsilon_k^d, \varepsilon_m^d, \hat{\varepsilon}_k^d$ and $\hat{\varepsilon}_m^d$. As a first step, we can establish that the net factor rewards, w and r, are related to the two factor taxes as follows: $\frac{dr}{d\tau_k} = \frac{dw}{d\tau_m} = -\frac{1}{2}; \frac{dw}{d\tau_k} = \frac{dr}{d\tau_m} = 0$. It is now straightforward to see that the factor employment elasticities are related to the conventional factor demand elasticities as follows: $\varepsilon_i^n = \frac{1}{2}\varepsilon_i^d, \hat{\varepsilon}_i^n = \frac{1}{2}\hat{\varepsilon}_i^d$, which are all positive with $f_{kk} f_{mm} - (f_{km})^2 > 0$.

From (12) we can solve for the change in the common labor tax following the coordinated increase in the capital tax as follows:

$$\frac{d\bar{\tau}_m}{d\bar{\tau}_k} = -\theta' \frac{K}{M} \tag{13}$$

with $\theta' = \frac{\hat{\varepsilon}_k^n + \gamma M}{\varepsilon_m^n + \gamma M} > 0$.

The offset coefficient θ' in (13) is positive so that higher coordinated capital taxes are now surely followed by lower labor taxes. Once more we infer that the higher capital taxes by themselves imply higher welfare, while the lower labor taxes imply lower welfare. So in principle the welfare implications are again ambiguous. To proceed, we note that the changes in private and public goods following the overall tax changes are given by $dC = -(1-\theta') K d\bar{\tau}_k$, and $dG = (1-\theta')K d\bar{\tau}_k$. The impact on overall welfare, W, can now be stated as follows:

Proposition 3.

Assume that the supplies of capital and labor are fixed in both countries. Then the welfare effect in either country of a coordinated rise in the tax on capital, including the induced change in the tax on labor, is given by

$$\frac{dW}{d\bar{\tau}_k} = (V'-1)(1-\theta')K = (V'-1)\left[\frac{\varepsilon_m^n - \hat{\varepsilon}_k{}^n}{\varepsilon_m^n + \gamma M}\right] K \qquad (14)$$

which has ambiguous sign.

From (14), we in fact see that the coordinated capital tax increase is welfare-improving, if $\varepsilon_m^n > \hat{\varepsilon}_k{}^n$ (or equivalently $\varepsilon_m^d > \hat{\varepsilon}_k{}^d$), and vice versa. In (14), the expression for the welfare change is smaller (in absolute value), the larger is the parameter γ of the inflexibility of the demand for public goods. Specifically, the expression for $dW / d\bar{\tau}_k$ in (14) approaches zero, as γ approaches infinity. This is the case where total tax revenues and the provision of public goods are not affected by the coordinated capital tax increase. The capital tax coordination just causes higher capital tax revenues to substitute exactly for lower labor tax revenues. Such a switch now does not affect welfare, as we take the capital and labor supplies to be inelastic.

To provide further insight, we next provide an example with a specific CES production structure which allows us to evaluate the demand elasticities $\varepsilon_m{}^d$ and $\hat{\varepsilon}_k^d$, and thus also condition (14). In addition to the variable inputs K and M, there is a fixed factor called L. The production technology takes the form of a nested CES structure. Inputs of capital, K, and the fixed factor, L, together produce the intermediate input I, while labor, M, and the intermediate input, I, together produce the final output, F. Formally, the production relationships are given by

$$I = [\beta K^{-\rho_i} + (1-\beta) L^{-\rho_i}]^{-\frac{1}{\rho_i}} \qquad (15)$$

$$F = [\alpha\, I^{-\rho} + (1-\alpha)\, M^{-\rho}\,]^{-\frac{1}{\rho}} \qquad (16)$$

where $\sigma_i = 1/(1+\rho_i)$ and $\sigma = 1/(1+\rho)$ are the constant elasticities of substitution. Further, let b be the share of total output paid in (gross) wages to workers. We can state our result in Proposition 3 as follows for this nested CES production structure in

Proposition 4.

Assume that the production structure in either country is as given by eqns. (15) and (16), and that the supply of capital and labor is fixed. Then we have

i) a coordinated increase in capital income taxes is welfare reducing, if $\sigma < b\sigma_i$, and vice versa,

ii) a coordinated increase in the labor income taxes is always welfare improving.

For a proof, see the Appendix. Thus, a coordinated increase in capital taxes is welfare decreasing for low substitution possibilities between M and I (low σ), high substitution possibilities between L and K (high σ_i), and a high factor share for M (high b). These considerations in part reflect under what circumstances the capital tax increase engenders a lower return to the fixed factor L, thereby increasing the implicit (non-distorting) taxation of the return to this factor. Clearly, unless $\sigma = b\, \sigma_i$, capital tax coordination (either an increase in or a reduction of taxes) is always potentially welfare improving. The proposition also makes clear that the exact specification of the production structure (here nested CES) affects the welfare implications of a coordinated capital income tax increase. To see this, reverse the positions of K and M in the production structure in formulas (15)-(16). In this instance, the results regarding the welfare properties of coordinated capital and labor tax increases in proposition 4 also switch. Specifically, a coordinated increase in capital income taxes is then always welfare improving, while the welfare results of a coordinated increase in labor income taxes are ambiguous.

3. *Simulation results*

This section presents some estimates of the welfare effects of partial capital tax coordination obtained with the aid of a simple two-country simulation model. In several respects, though, the simulation model is somewhat more complicated and realistic than the stylized theoretical model. First, the simulation model has two periods. Second, we make an effort to calibrate the model to EU-15 public finances statistics.

Welfare W in each country depends on consumption levels C_1 and C_2 in the two periods, on second-period leisure $M' - M$ (with M' being a time endowment) and on second-period public goods G (see Table 2 for the selected iso-elastic welfare specification). In the first period, an endowment Y_1 is divided between first-period consumption C_1 and savings in the form of capital K. The production function $f(K, M)$ is taken to be Cobb-Douglas with α_k and α_m, $\alpha_k + \alpha_m < 1$, being the fixed shares of capital and labor income in total output.[16] After second-period production, a share δ of the capital is taken to be depreciated. The scrap value of capital, $(1-\delta)K$, is available for second-period consumption along with the after-tax remuneration of domestic production factors. In the second period, consumers pay a lump sum tax of t. This tax is meant to represent exogenously given consumption taxes. The corresponding tax revenues, t, in addition to factor tax revenues, are available to finance public goods G.

Parameter values and calibration targets are summarized in Table 3. We assume that it takes a relatively long period of around 5 years for (labor) tax policies and public spending policies to reach a new international equilibrium following any capital tax coordination. Thus, we take the discount factor β to be 0.88, corresponding to a discount rate of 0.024 per annum (in this value for the annual discount rate and several other parameter values we follow Klein, Quadrini and Rios-Rull (2005)). Similarly, we set the depreciation rate to 0.38, five times an annual depreciation rate of 0.076. Next, the utility parameters σ, σ_m and σ_g are chosen to be 1.5, 2.0, and 2.0 respectively. Finally, the capital and labor shares in output are put to 0.30 and 0.60, respectively. These values imply decreasing returns to scale in the variable inputs of capital and labor.

Remaining parameters in the model are selected so as to meet several calibration targets (see Panel B of Table 3). First, we target the gross rate of return r received by savers to 1.15, to reflect a net return per annum of about 0.03. Second, the fraction of time spent in work is calibrated to 0.40. Third, the share of public goods in total second-period consumption is set to 0.21 (to mirror that general government final consumption expenditures in the EU15 in 2002 are 21 percent of GDP). Fourth, exogenously given taxes t as a share of total second-period consumption are calibrated to 0.12 (to recognize that consumption taxes in the EU15 in 2002 are

12 percent of GDP).

The simulation model is too complex to yield explicit expressions for the factor employment elasticities ε_k^n, ε_m^n, $\hat{\varepsilon}_k^n$, and $\hat{\varepsilon}_m^n$. Therefore, we use an iterative simulation approach that computes these elasticities jointly with other variables.[17] Table 4 presents the main results. Column 1 first presents the outcome in the Nash equilibrium where the two countries set their capital and labor taxes independently. The ad valorem capital tax rate t_k, shown in the table, is defined as $\tau_k/(\tau_k + r - 1)$, while the ad valorem labor tax rate t_m is constructed as $\tau_m/(\tau_m + w)$. Migrating workers are likely to take into account taxes to be paid as well as employment-related benefits to be received in countries concerned. Therefore, we take all factor taxes to be taxes net of the corresponding benefits stemming from factor employment. Thus labor taxes represent labor taxes net of work-related benefits such as worker disability insurance, unemployment insurance and retirement benefits. This explains that we obtain a relatively low ad valorem labor tax rate of 0.135 in the Nash scenario. The corresponding share of capital income taxes in total factor taxes is calculated to be 0.360. This is somewhat higher than the actual capital share in factor tax revenues of 0.28 for the EU15 in 2002, reflecting that benefits related to factor employment accrue more to workers than to capital owners.

In our capital tax coordination experiment, the capital tax rate τ_k is raised by 0.0096 or 10 percent of the Nash level of 0.096. In columns (2) through (4) of Table 4, we in turn consider that government budget balance is reestablished by only a change in the labor tax τ_m (for fixed *G*), by only a change in *G* (for fixed τ_m), or by changes in both τ_m and *G*. In column (2), the share of capital taxes in total taxes and also the share of public consumption in total consumption are raised. Welfare, however, is unchanged, which reveals that capital and labor taxes have similar excess burdens in the Nash equilibrium – not only from a national perspective but also from an international perspective. In column 3, we further see that welfare is raised relative to the Nash equilibrium. This confirms that capital income taxes are set too low in the Nash equilibrium. Next, in column 4 we see that τ_m and t_m fall relative to column 3. Thus the additional revenues from capital income taxation prompt countries to lower their labor tax rates in the new tax competition game. As a result, welfare in column 4 is lower than in column 3. Welfare in column 4, however, remains higher than in column 1. This shows that with the particular magnitudes and elasticities we employ, the overall welfare effect of partial tax coordination – taking into account the adjustment in labor taxes - is positive.

Finally, in Table 5 we consider whether this main result is robust to changes in several parameter values. Thus we consider changes in σ to either 1.2 or to 1.8, and changes in σ_m or σ_g to either 1.6 or to 2.4. For all of these alternative calibrations, we see qualitatively the same results as before. However, it is interesting to note that the fall-back in welfare from the adjustment in labor taxes - in column (3) relative to column (2) – is larger for $\sigma_g = 2.4$ than for $\sigma_g = 1.6$. This reflects that the downward adjustment is labor taxes is larger if the demand for public goods is relatively inflexible (corresponding to equation (9)).

Next, we set non-factor taxes t to zero to reflect that consumption taxes can be interpreted partly as indirect factor taxes. For this case, we interestingly find that welfare in column 4 exceeds welfare in column 3. The reason is that now capital tax coordination prompts countries to increase rather than reduce labor taxes in their subsequent labor tax competition – taking the relevant Nash equilibrium as a starting point. This possibility corresponds to the case where θ is negative in (9). Finally, Table 5 reports the case where capital tax coordination increases the capital tax τ_k by 0.0048 or 50 percent from the Nash level. The welfare effects in the table are larger but similar to those before. In summary, we conclude that the result that partial tax coordination yields positive welfare effects is robust to a variety of changes in parameters and to the specifics of the capital tax coordination experiment.

4. *Conclusion*

This paper has addressed the welfare implications of partial factor tax coordination in a world where two factors, capital and labor, are internationally mobile. A coordinated increase in, say, the capital tax may or may not be welfare improving, despite the fact that the non-cooperative capital tax is unambiguously below the optimal level. The reason is that countries will generally wish to alter other taxes, which are not subject to tax coordination, in a non-cooperative way, and this tax response may in itself deteriorate welfare. In particular, higher coordinated capital taxes generally lead to lower non-coordinated labor taxes. Such a shift in the tax mix is, however, welfare improving, if the capital tax is relatively less distorting from a system perspective and vice versa.

Indeed, our analysis has revealed that in order to produce a positive welfare result, partial coordination of capital income taxes must avoid the scenario where (i) higher capital taxes barely influence the provision of public goods, instead leading to a significant decrease in labor income taxes *and* (ii) labor taxes are less distortionary from a systems perspective than are capital taxes. At a theoretical level, we found that higher coordinated capital taxes tend to increase welfare, if the capital demand (supply) elasticity is large (small) enough relative to the labor demand (supply) elasticity for the case where the demand for public goods is very inflexible. In addition, we found that a coordinated capital tax increase may be welfare improving, if the elasticity of labor demand with respect to the gross wage exceeds the (cross) elasticity of capital demand with respect to the same gross wage.

To gain further insight into the welfare effects of partial tax coordination, the paper also analyzed a two-country simulation model of capital and labor tax competition with factor mobility. The simulation model confirms that there is likely to be a downward adjustment in labor taxation following a joint increase in capital taxes as a result of international tax coordination. This induced reduction in labor taxation is in itself welfare-reducing. The simulation results, however, suggest that the overall welfare effects of capital tax coordination in the model are positive, when the model is calibrated to typical EU public finance data.

Our results have been derived in models where two factors of production – capital and labor – are internationally mobile. It is natural to enquire in which way the results might change if the degree of labor mobility is less than perfect. We know from the work of Bucovetsky and Wilson (1991),[18] that if countries have access to labor income and (source-based) capital income taxes, and labor (capital) is perfectly immobile (mobile) internationally, then there will be scope for coordinating national capital taxes, and a joint increase in these will be welfare-enhancing. Hence, the paradox of welfare-deteriorating partial capital tax coordination cannot occur without labor mobility. However, we conjecture that if labor is imperfectly mobile, but not perfectly immobile, then the possibility of the paradox re-emerges, presumably in such a way that the more mobile is labor, ceteris paribus, the higher is the chance of welfare-deteriorating partial tax coordination. A full examination of the impact of imperfect labor mobility requires an exact specification of the cause of imperfect mobility and is beyond the scope of the present paper.

Appendix

Proof of proposition 1.

Eq. (10) and $V'-1 = V'\varepsilon_k^n\ \bar{\tau}_m$ give

$$\frac{dW}{d\bar{\tau}_k} = K\,V'\ \left[(1-\theta)\ \varepsilon_m^n\ \bar{\tau}_m - (\ \varepsilon_k^c\ \bar{\tau}_k - \theta\,\varepsilon_m^c\ \bar{\tau}_m\ ) \right].$$

Substituting $\varepsilon_k^n\ \bar{\tau}_k$ for $\varepsilon_m^n\ \bar{\tau}_m$ and rearranging yields

$$\frac{dW}{d\bar{\tau}_k} = K\,V'\ \left[(\ \varepsilon_k^n - \varepsilon_k^c\ )\ \bar{\tau}_k - \theta(\ \varepsilon_m^n - \varepsilon_m^c\ )\ \bar{\tau}_m\ \right].$$

Next, we can substitute $\bar{\tau}_k\ \varepsilon_k^n\ /\ \varepsilon_m^n$ for $\bar{\tau}_m$ from (5)-(6) and realize that $V' - 1 = V'\ \bar{\tau}_k\ \varepsilon_k^n$ to yield (11). Ambiguity of this general expression is proved for the specific case of γ equal to infinity in Proposition 2.ii.

Proof of proposition 2.

i. With $\gamma = 0, \theta = 0$.

Then in (11) $\frac{dW}{d\bar{\tau}_k} > 0$ as $\varepsilon_k{}^n > \varepsilon_k{}^c$.

ii. With γ going to infinity, $\theta = \dfrac{1-\varepsilon_k{}^c\tau_k}{1-\varepsilon_m{}^c\tau_m}$

Using this and $\varepsilon_m{}^n\tau_m = \varepsilon_k{}^n\tau_k$ from (8)-(9), $\frac{dW}{d\bar{\tau}_k} > 0$ in (11) can be seen to be

equivalent to $\dfrac{\varepsilon_k{}^s}{\varepsilon_k{}^d} < \dfrac{\varepsilon_m{}^s}{\varepsilon_m{}^d}$.

iii. First we want to show that $E_{mmm} = f_{mmm} = 0$ implies $\frac{d\varepsilon_m{}^n}{d\bar{\tau}_m} = 0$.

Note that $\varepsilon_m{}^d = -\frac{1}{f_{mm}}\frac{1}{M}$ and $f_{mmm} = 0$ imply $\frac{d\left(\varepsilon_m^d\right)}{\varepsilon_m^d} = -\frac{dM}{M}$.

Also $\varepsilon_m^s = \frac{1}{E_{mm}}\frac{1}{\overline{M}}$ and $E_{mmm} = 0$ imply $\frac{d\left(\varepsilon_m{}^s\right)}{\varepsilon_m{}^s} = -\frac{d\overline{M}}{\overline{M}}$.

A symmetric labor tax change implies that $\frac{dM}{M} = \frac{d\overline{M}}{\overline{M}}$. Hence $\varepsilon_m{}^d$ and $\varepsilon_m{}^s$ undergo the same proportional change following an equal labor tax change. This implies $\frac{d\varepsilon_m{}^n}{d\bar{\tau}_m} = 0$ given that $\varepsilon_m{}^n = \varepsilon_m^d\left(\frac{\varepsilon_m{}^s + \varepsilon_m{}^d/2}{\varepsilon_m{}^d + \varepsilon_m{}^s}\right)$.

Thus we have $\theta = \frac{1-\varepsilon_k{}^c\tau_k}{\left[\varepsilon_m{}^n/(\gamma M)\right]+1-\varepsilon_m{}^c\tau_m}$.

a. This follows from (11) and the fact that θ is positively related to γ.

b. This follows from combining the results under ii. and iii.a.

Proof of proposition 4.

The marginal productivity conditions can be written as

$$(1-\alpha)\left(\frac{F}{M}\right)^{1+\rho} = w + \tau_m$$

$$\alpha\,\beta\left(\frac{F}{I}\right)^{1+\rho}\left(\frac{I}{K}\right)^{1+\rho_i} = r + \tau_k$$

Log differentiation yields

$$\hat{M} = \hat{F} - \sigma\,(w \hat{+} \tau_m)$$

$$\sigma^{-1}\,\hat{F} + (\sigma_i^{-1} - \sigma^{-1})\,\hat{I} - \sigma_i^{-1}\,\hat{K} = (r \hat{+} \tau_k)$$

where the "^" notation stands for relative or percentage changes.

Further, we have

$$\hat{I} = a\,\hat{K}$$

$$\hat{F} = (1 - b)\,\hat{I} + b\,\hat{M}$$

where a is the output elasticity of I w.r.t. K, and b is the output elasticity of F w.r.t. M. These elasticities correspond to factor shares due to constant returns to scale.

We can now solve for $\hat{K}$ and $\hat{M}$ as follows

$$\hat{K} = -\frac{\sigma_i}{1 - a}\left[\frac{b}{1 - b}(w \hat{+} \tau_m) + (r \hat{+} \tau_k)\right]$$

$$\hat{M} = -\left[\frac{\sigma_i\,a\,b + (1 - a)\,\sigma}{(1 - b)\,(1 - a)}(w \hat{+} \tau_m) + \frac{\sigma_i a}{(1 - a)}(r \hat{+} \tau_k)\right]$$

From this, we can see that, for instance, the elasticity of K w.r.t. r, or $-\dfrac{d\,K}{d\,(r + \tau_k)}\dfrac{r + \tau_k}{K}$, is given by $\sigma_i\,/(1\text{-}a)$. The semi-elasticity of K w.r.t. r or $\varepsilon_k^{\,d}$, is then given by $\sigma_i\,/\,[(1\text{-}a)\,(r+\tau_k)]$, while the factor employment elasticity $\varepsilon_k^{\,n}$ is half of this, as $\varepsilon_k^{\,n} = ½\,\varepsilon_k^{\,d}$. In this manner, we can derive the four factor employment elasticities as follows

$$\varepsilon_k^{\,n} = \frac{1}{2}\left[\frac{\sigma_i}{1 - a}\right]\frac{1}{r + \tau_k}$$

$$\hat{\varepsilon}_k^{\,n} = \frac{1}{2}\left[\frac{\sigma_i\,b}{(1 - b\,)\,(1 - a)}\right]\frac{1}{w + \tau_m}$$

$$\varepsilon_m{}^n = \frac{1}{2}\left[\frac{\sigma_i\, a\, b + (1-a)\sigma}{(1-b)(1-a)}\right]\frac{1}{w+\tau_m}$$

$$\hat{\varepsilon}_m{}^n = \frac{1}{2}\left[\frac{\sigma_i\, a}{1-a}\right]\frac{1}{r+\tau_k}$$

We now see that

$$\varepsilon_m{}^n - \hat{\varepsilon}_k{}^n = (\sigma - \sigma_i\, b)\frac{1}{2(1-b)(w+\tau_m)}$$

so $\varepsilon_m{}^n - \hat{\varepsilon}_k{}^n >_< $ as $\sigma >_< \sigma_i\, b$. This together with eq. (14) proves part i of proposition 4.

Further note that

$$\varepsilon_k{}^n - \hat{\varepsilon}_m{}^n = \frac{1}{2}\frac{\sigma_i}{r+\tau_k}$$

This together with an eq. analogous to (14) for a coordinated labor tax increase proves that such a coordinated tax increase always improves welfare, as in part ii of proposition 4.

It can further be seen that

$$\varepsilon_k{}^n - \frac{K}{M}\hat{\varepsilon}_k{}^n = \frac{1}{2}\frac{\sigma_i}{r+\tau_k} > 0$$

while

$$\varepsilon_m{}^n - \frac{M}{K}\hat{\varepsilon}_m{}^n = (\sigma - \sigma_i\, b)\frac{1}{2(1-b)(w+\tau_m)}$$

where $\Delta = \varepsilon_k{}^n \varepsilon_m{}^n - \hat{\varepsilon}_k{}^n \hat{\varepsilon}_m{}^n$ can be checked to be positive.

This shows that $\tau_k > 0$ and $\tau_m >_< 0$. At the same time, the condition for $\tau_m > 0$ is the same condition as the condition for a capital tax increase to be welfare improving in part i of proposition 4. Thus in this instance a coordinated capital tax increase increases welfare in the ordinary case where the labor tax is positive.

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Table 1. Taxes by economic function in the EU, 1995-2002

A. As a percent of GDP

	95	96	97	98	99	00	01	02
Capital	7.7	8.3	8.7	8.7	9.0	9.2	8.8	8.3
Labor	21.5	21.6	21.3	21.2	20.9	20.8	20.7	n.a.
Consumption	11.5	11.5	11.6	11.6	11.9	11.8	11.6	11.6

B. As a percent of total taxation

	95	96	97	98	99	00	01	02
Capital	19.0	20.1	20.9	21.0	21.4	22.0	21.3	20.6
Labor	52.7	52.2	51.3	51.0	50.3	50.0	50.7	50.9
Consumption	28.2	27.8	27.8	28.0	28.3	28.0	28.0	28.6

Source: Eurostat

Table 2. Specification of the simulation model for the domestic economy

Definition of welfare:

$$W = \frac{C_1^{1-\sigma} - 1}{1-\sigma} + \beta \left[\frac{C_2^{1-\sigma} - 1}{1-\sigma}\right] + \mu \left[\frac{(M' - M)^{1-\sigma_m} - 1}{1-\sigma_m}\right] + \pi \left[\frac{G^{1-\sigma_g} - 1}{1-\sigma_g}\right]$$

Production function:

$$f(K, M) = aK^{\alpha_k} M^{\alpha_m}$$

First-period resource constraint:

$$Y_1 = C_1 + K$$

Second-period private budget constraint:

$$C_2 = f(K,M) - (r + \tau_\kappa) K - (w + \tau_m) M + r\overline{K} + w\overline{M} + (1-\delta) K - t$$

Government budget constraint:

$$G = \tau_\kappa K + \tau_m M + t$$

Table 3. Calibration of the model

A. Parameter values

Discount rate	β	0.88
Depreciation rate	δ	0.38
Utility parameter	σ	1.50
Utility parameter	σ_m	2.00
Utility parameter	σ_g	2.00
Capital share	α_k	0.30
Labor share	α_m	0.60

B. Calibration targets

Rate of return	r	1.15
Fraction of time worked	M / M'	0.40
Share of public goods in second period consumption	$G/(C_2 + G)$	0.21
Share of non-factor taxes in second period consumption	$t/(C_2 + G)$	0.12

Note: The parameter values (apart from the labor share) and the calibration target for the fraction of time worked correspond to those in Klein, Quadrini and Rios-Rull (2005, Tables 5 and 6)

Table 4. Simulation results

	Nash	Capital tax coordination		
		G fixed, τ_m variable	G variable, τ_m fixed	G and τ_m both variable
	(1)	(2)	(3)	(4)
Simple factor taxes:				
τ_k	0.096	0.106	0.106	0.106
τ_m	0.441	0.416	0.441	0.439
Ad valorem factor taxes:				
t_k	0.384	0.416	0.420	0.419
t_m	0.135	0.128	0.135	0.135
Share of capital tax in total factor taxes	0.360	0.394	0.382	0.383
Share of public goods in total second-period consumption	0.214	0.214	0.218	0.218
Change in welfare	0	0.000	0.013	0.012

Note. Capital tax coordination refers to a joint increase in the capital tax τ_k of 0.0096 (10 percent of the Nash level). Change in welfare is calculated as the equivalent proportional variation in all arguments in the welfare function relative to the Nash outcome.

Table 5. Sensitivity analysis of welfare effects of capital tax coordination

Change in parameter relative to Table 4	*G* fixed, τ_m variable	*G* variable, τ_m fixed	*G* and τ_m both variable
	(1)	(2)	(3)
σ = 1.2	0.000	0.011	0.010
σ = 1.8	0.000	0.015	0.014
σ_m = 1.6	0.000	0.013	0.012
σ_m = 2.4	0.000	0.013	0.012
σ_g = 1.6	0.000	0.013	0.012
σ_g = 2.4	0.000	0.013	0.011
t = 0	0.000	0.024	0.025
$\Delta\tau_k$ = 0.048	0.000	0.062	0.056

Note. Capital tax coordination refers to a joint increase in the capital tax τ_k of 0.0096 (10 percent of the Nash level in the base case) in all but the last case. The change in welfare is calculated as the equivalent proportional variation in all arguments in the welfare function relative to the relevant Nash outcome.

Endnotes

[1] See, for instance, Devereux, Griffith and Klemm (2002) for a discussion of recent corporate tax reform proposals in the EU.

[2] Comparable data for years before 1995 unfortunately do not exist.

[3] Kehoe (1989) shows that capital tax policy coordination may yield capital taxes that are too high if capital income tax policies suffer from time inconsistency.

[4] The welfare gains of higher capital income taxes under revenue neutrality may in part reflect that in Mendoza and Tesar (2005) higher capital income taxes also apply to previously accumulated capital.

[5] There generally can be a third, immobile and untaxed factor.

[6] There are no taxes on saving on the assumption that these are difficult to enforce in practice. Bucovetsky and Wilson (1991) have shown that there is a scope for international tax policy coordination in a world where the tax instrument set consists of a source-based capital income tax and a labor tax.

[7] In the two-country model, both countries are large enough to affect the net factor returns, w and r. In a different scenario, two small neighboring countries may have significant influences on each other's labor markets, but they may together be too small to affect the worldwide net return to capital. In this instance, clearly labor taxes can be coordinated with unambiguously positive welfare implications for the two countries.

[8] We assume that the wage w is flexible in both countries. Alternatively, we could assume that the wage is rigid leading to unemployment. In this scenario, there may still be a role for a labor tax paid by employers in so far as the incidence of this tax is on profits rather than affecting the marginal employment of capital. In this scenario, there remains a trade-off between labor and capital taxation as affected by partial tax coordination.

[9] We assume that policy makers can commit to capital income taxes so that they take the capital supply response to taxation into account. In the absence of commitment, capital taxes would be determined for a given world capital stock (with policy makers ignoring any capital supply response). Capital taxes chosen in this way could alternatively serve as a starting point to evaluate the welfare effects of partial tax coordination in section 2.1.

[10] In the Appendix, Δ is argued to be positive for the CES production structure in eqns. (15) and (16).

[11] Totally differentiating (6) we see that the partial effect of the common capital tax, $\bar{\tau}_k$, on τ_m is found to be

$$\frac{d\tau_m}{d\bar{\tau}_k} = -\frac{\gamma K(1-\varepsilon_k{}^c)}{\varepsilon_m{}^n + \tau_m \dfrac{d\varepsilon_m{}^n}{d\tau_m} + \gamma M\left(1-\varepsilon_m{}^n\right)} \gtrless 0$$

which with γ going to infinity becomes

$$\frac{d\tau_m}{d\bar{\tau}_k} = \frac{-K\left(1-\varepsilon_k{}^c\right)}{M\left(1-\varepsilon_m{}^n\right)} < 0 .$$

[12] Totally differentiating (6) we see that the partial effect of $\tau_m{}^*$ on τ_m is given by

$$\frac{d\tau_m}{d\tau_m{}^*} = -\frac{\tau_m \dfrac{d\varepsilon_m{}^n}{d\tau_m{}^*} - \gamma M \varepsilon_{m^*}{}^n}{\varepsilon_m{}^n + \tau_m \dfrac{d\varepsilon_m{}^n}{d\tau_m} + \gamma M\left(1-\varepsilon_m{}^n\right)} \underset{<}{>} 0$$

with

$$\varepsilon_{m^*}^n = -\frac{1}{M}\frac{dM}{d\tau_m^*}$$

$$= -\frac{\left(\varepsilon_m{}^d\right)^2}{2\left(\varepsilon_m{}^d + \varepsilon_m{}^s\right)} < 0 .$$

With γ going to infinity, we get

$$\frac{d\tau_m}{d\tau_m^*} = \frac{\varepsilon_{m^*}{}^n}{1-\varepsilon_m{}^n} < 0 .$$

[13] To see this, we can check that $\tau_k < \tau_m$ is equivalent to $\varepsilon_k^n > \varepsilon_m^n$ from (5)-(6). This latter condition is equivalent to $\varepsilon_k^d / 2 > \varepsilon_m^d \left[\dfrac{\varepsilon_m^s + (1/2)\,\varepsilon_m{}^d}{\varepsilon_m^d + \varepsilon_m^s}\right]$ with $\varepsilon_k^s = 0$. For high enough ε_k^d, we thus have $\tau_k < \tau_m$ even with $\varepsilon_k^s = 0, \varepsilon_m^s > 0$ so that higher coordinated capital taxes are welfare reducing with a very inflexible demand for public goods or γ going to infinity.

[14] In fact, after differentiating (6) the partial effect of the common capital tax, $\bar{\tau}_k$, on τ_m is now found to be

$$\frac{d\,\tau_m}{d\,\bar{\tau}_k} = -\frac{\hat{\varepsilon}_k^n \dfrac{K}{M} + \gamma\, K}{\varepsilon_m^n + \tau_m \dfrac{d\,\varepsilon_m^n}{d\,\tau_m} + \tau_k \dfrac{d\left(\hat{\varepsilon}_k^n \dfrac{K}{M}\right)}{d\,\tau_m} + \gamma\left[M(1-\tau_m\,\varepsilon_m^n) - \tau_k\,K\,\hat{\varepsilon}_k^n\right]}$$

which is of ambiguous sign. Note that for γ large enough, $\frac{d\,\tau_m}{d\,\bar{\tau}_k}$ is necessarily negative. In fact $\frac{d\,\tau_m}{d\,\bar{\tau}_k}$ approaches $-\lambda\frac{K}{M}$ as γ approaches infinity.

[15] After differentiating (6), we see that the partial effect of τ_m^* on τ_m is now given by

$$\frac{d\,\tau_m}{d\,\tau_m^*}=\frac{\tau_m\frac{d\,\varepsilon_m^n}{d\,\tau_m}+\tau_k\frac{d\,(\hat{\varepsilon}_k^n\frac{K}{M})}{d\,\tau_m}-\gamma\,[\,\tau_m M\,\varepsilon_m^n+\tau_k K\,\hat{\varepsilon}_k^n]}{\varepsilon_m^n+\tau_m\frac{d\,\varepsilon_m^n}{d\,\tau_m}+\tau_k\frac{d\,(\,\hat{\varepsilon}_k^n\frac{K}{M})}{d\,\tau_m}+\gamma\,[M\,(1-\tau_m\,\varepsilon_m^n)-\tau_k K\,\hat{\varepsilon}_k^n]}$$

which is of ambiguous sign. For γ large enough, $\frac{d\,\tau_m}{d\,\tau_m^*}$ is negative. In fact $\frac{d\,\tau_m}{d\,\tau_m^*}$ approaches $1-\lambda<0$ as γ goes to infinity.

[16] Unfortunately, there is little empirical basis for choosing any other production function at this level of abstraction. We acknowledge that our simulation results partly hinge on the choice of production structure.

[17] We first guess some values for the employment elasticities. Next, we simulate private and public sector activity given these elasticities. Then we calculate the employment elasticities implied by the model just simulated. To do this, we consider a small increase in the capital tax τ_k (by 0.0001) and resimulate private activity including capital and labor employment. The implied changes in factor employment are used to update our values of ε_k^n and $\hat{\varepsilon}_m^n$. Similarly, refitting the model for a slightly higher value of τ_m yields updated values of ε_m^n and $\hat{\varepsilon}_k^n$. These updated values of the factor employment elasticities are subsequently used to recalculate the entire model (including public activity). This procedure continues until the factor employment elasticities have converged. For our base case, we find that the factor employment elasticities are about half the corresponding demand elasticities. Specifically, we find $\varepsilon_k^n = 0.512\,\varepsilon_k^d$, $\varepsilon_m^n = 0.512\,\varepsilon_m^d$, $\hat{\varepsilon}_k^n = 0.458\,\hat{\varepsilon}_k^d$ and $\hat{\varepsilon}_m^n = 0.472\,\hat{\varepsilon}_m^d$.

[18] See their Proposition 2.