Why the European Union Should Adopt Formula Apportionment with a Sales Factor*

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Abstract: Using a two country tax competition model with a multinational enterprise (MNE), this paper addresses the question whether the European Union should replace separate accounting (SA) in corporate income taxation by formula apportionment (FA) and, if so, which apportionment factors should be used. Our main result is that FA with a sales factor may mitigate or even eliminate fiscal externalities caused by the countries' tax policy. Hence, our analysis provides a microfoundation of the sales apportionment factor. In an empirical calibration to the EU-15 we show that the transition from SA to FA with a sales only formula raises average tax rates by 2% and average tax revenues by 1 billion euro or 0.1% of GDP. These effects result in an increase of welfare.

JEL classification: H7, H73

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1 Introduction

Corporate income taxation of multinational enterprises (MNEs) can follow two basic principles. Under separate accounting (SA), profit of a MNE's entity is taxed according to the tax code of the country where the entity is located. Under formula apportionment (FA), in contrast, profit is first consolidated across all entities and then assigned to the countries according to a formula that potentially uses the MNE's property, payroll and sales shares. The prevailing tax principle at the international level is SA. But several countries like Canada, Germany and the US use FA at the national level. Remarkably, there is a large variation in the formula under FA. While the German system uses a payroll factor only, the formula in Canada contains payroll and sales with equal weights. The sales factor has become increasingly important also in the US, where the formula may differ across states. Only 13 states still use the traditional Massachusetts formula (with equal weight on property, payroll and sales) while 20 states have turned to the double weighted sales formula and 12 states even have implemented a sales only formula.[1]

It is well known that under SA firms shift corporate income from high-tax to low-tax countries in order to reduce the overall tax burden (e.g. Hines, 1999, Clausing, 2003). Governments therefore engage in inefficient tax competition lowering corporate tax rates in order to improve their tax bases. The great advantage of FA is usually seen in the abolishment of this inefficiency as the consolidation of tax bases removes the MNE's incentive for profit shifting. This is one of the main reasons why the European Commission (2001) proposed to replace SA by FA within the boarders of the European Union.[2] By distorting investment decisions of MNEs, however, FA may create its own inefficiencies in international tax policy, and the extent of the distortions depends on the formula used. This raises the question whether it is beneficial for the European Union to replace SA by FA and, if so, which type of formula should be used to apportion corporate income.

The present paper addresses such questions in a two country tax competition model with a representative MNE producing a good in both countries with mobile capital and immobile labor. Our main result gives a microfoundation of the sales apportionment factor under FA. This is an important result as corporate income taxation is usually seen as a tax on the returns to capital and it is therefore often argued that FA should only use a property factor (e.g. Musgrave, 1984). In our framework, in contrast, the formula can

[1]See Weiner (2005) and http://www.taxadmin.org/fta/rate/corp_app.html.

[2]For the proposal's details see Devereux (2004), Hellerstein and McLure (2004) and Sørensen (2004).

be used to internalize fiscal externalities that cause inefficiencies in the tax policy of the two countries. Under FA, consolidation and apportionment create a tax base externality and a formula externality. The former reflects the fact that a country does not take into account the effect of its tax rate on the MNE's effective tax burden and the MNE's reaction of changing the consolidated tax base which affects both countries. The formula externality emerges as the tax setting country ignores the MNE's formula manipulation incentive, that is the MNE's incentive to move a part of its activities away from a tax increasing country in order to increase the share of profit taxed in the other country.

With the help of these two externalities the rationale for including the sales factor into the apportionment formula under FA can be developed along the following line of reasoning. We identify cases in which the tax base externality is negative, whereas the formula externality is positive. Moreover, under a pure property or payroll formula the sum of both externalities turns out to positive rendering tax rates inefficiently low, while under a pure sales formula we obtain inefficient overtaxation since the sum of externalities is negative. This insight suggests that including sales into the formula may be beneficial. It mixes up the positive sign of the externalities under the property and payroll formula with the negative sign of the externalities under the sales formula. As a consequence, the tax policy of the two countries is shifted towards the efficient policy characterized by a zero sum of externalities. The policy implication is that when replacing SA by FA the European Union should use a formula that contains the sales factor.

We first derive this result for a benchmark case with Cobb-Douglas production technologies exhibiting decreasing returns to scale. The latter assumption implicitly assumes a fixed third production factor (like entrepreneurial service or knowledge) that causes the corporate income taxed by the governments and that explains the intuition of the above result: With a capital or payroll formula, apportionment is targeted *directly* at the production inputs. The MNE's formula manipulation incentive is then quite strong so that the accompanied formula externality outweighs the tax base externality. With a pure sales formula, in contrast, apportionment is directed at the inputs only *indirectly*, i.e. the fixed factor hampers the MNE's ability to manipulate the formula. The formula externality is then relatively weak and overcompensated by the tax base externality. We show that this rationale remains true for a more general CES technology, provided the elasticity of substitution between capital and labor is neither too high nor too low.

Our microfoundation of the sales factor nevertheless rests on some other assumptions which might be seen restrictive, in particular the assumptions that governments maximize tax revenue and capital cost is not deductible. Unfortunately, with welfare maximization and partial deductibility clear-cut analytical results cannot be obtained. We therefore empirically calibrate the more general version of the model to the EU-15. Remarkably, this exercise strengthens the argument in favor of the sales factor: Because of additional private income externalities none of the formulas is able to implement the efficient tax policy. However, the sum of externalities turns out to be the lowest if the formula contains solely a sales factor. In addition, FA with a sales only formula dominates SA in terms of welfare. A transition from SA to FA sales raises the average tax rate in the EU by at least 2% and the average tax revenue by at least 1 billion euro or 0.1% of GDP. This result suggests that the European Union should adopt FA with a sales only formula.

There is an increasing number of articles on SA versus FA, for example, Gordon and Wilson (1986), Eggert and Schjelderup (2003), Nielsen et al. (2003), Wellisch (2004), Kind et al. (2005), Gérard (2005), Riedel and Runkel (2007). Our analysis is closest to Nielsen et al. (2004), Sørensen (2004) and Pethig and Wagener (2007). But none of these authors make the point for the sales factor. Anand and Sansing (2000) show that importing states tend to choose a high formula weight on sales. But their argument is completely different from ours. They consider a decentralized setting where states themselves choose the formula. This assumption is realistic for the US, but the European Commission (2001) does not discuss the option that the formula design is the task of the member states. Since our focus is on the European Union, we assume a centralized choice. Moreover, in Anand and Sansing (2000) the states' choice of the sales factor leads to an inefficient tax policy, while our argument in favor of the sales factor is based on the idea that this factor can be used to remove or mitigate distortions in corporate income taxation.

The paper is organized as follows. In Section 2, we introduce the basic assumptions of our model. Sections 3 and 4 characterize the efficiency properties of corporate tax rates under SA and FA. Section 5 contains the calibration and Section 6 concludes.

2 Basic Assumptions

We consider a model with two small countries labeled by a and b. There is a large number of identical MNEs from which we consider the representative one. The MNE owns an entity in each country. In country $i \in \{a, b\}$ the MNE produces a good according to the production function $F(k_i, \ell_i)$ with k_i capital and ℓ_i labor demand. The production functions are identical in both countries. They have positive and decreasing returns to both inputs, i.e. $F_k, F_\ell > 0$ and $F_{kk}, F_{\ell\ell} < 0$. Moreover, they exhibit decreasing returns to scale so that we can use the Euler Theorem $\mu F = k_i F_k + \ell_i F_\ell$ with $\mu \in]0,1[$. This implicitly assumes a fixed third factor like entrepreneurial service or knowledge which gives rise to a positive pure profit.[3] This assumption is made by almost all above-mentioned studies on SA versus FA. It seems plausible in the context of corporate income taxation, since decreasing returns to scale generate the income that the governments try to tax.

In country i the MNE pays a wage rate $w_i > 0$ per unit of labor. Labor is perfectly immobile and the labor supply $\bar{\ell} > 0$ is the same in both countries. The wage rate is determined by the labor market equilibrium condition $\ell_i = \bar{\ell}$, where labor demand ℓ_i is a function of the wage rate according to the MNE's profit maximization conditions derived below. Capital is perfectly mobile and, as both countries are small, the user cost per unit of capital, $r > 0$, is exogenously given. The MNE may shift profit from one subsidiary to the other, for example, by manipulating the debt-equity structure of the subsidiaries or the transfer prices of goods and services traded between the subsidiaries. The specific channel of shifting is immaterial for our purpose. We therefore simply measure shifting by the variable s, where $s > 0$ ($s < 0$) means that the MNE shifts income from a to b (b to a). Profit shifting entails a concealment cost which reflects, for example, the expense for tax consultants and lawyers or the MNE's risk of being detected by the tax authority illegally shifting income. The concealment cost is represented by the U-shaped function $C(s)$ with $C(0) = 0$, $\text{sign}\{C'(s)\} = \text{sign}\{s\}$ and $C''(s) > 0$.

In order to determine the MNE's tax bases, it remains to specify the deductibility of labor and capital cost. We follow the standard assumption and suppose that labor cost is fully deductible, whereas the user cost of capital may be deductible at rate $\rho \in [0,1[$. For $\rho \in]0,1[$, the latter assumption reflects the fact that most corporate tax systems grant depreciation allowances and allow deduction of debt financing cost. Formally, the tax base of the MNE in country a and country b can be written as, respectively,

$$\pi_{at} = F(k_a, \ell_a) - w_a \ell_a - \rho r k_a - s, \qquad \pi_{bt} = F(k_b, \ell_b) - w_b \ell_b - \rho r k_b + s. \tag{1}$$

Tax bases equal sales adjusted by labor cost, deductible capital cost and profit shifting.

[3] Entrepreneurial service and knowledge possess public good properties and, thus, they may also explain why the two entities are not separate companies but belong to the same MNE.

3 Separate Accounting

Profit Maximization. Under SA, profit is taxed in the country in which the MNE it declares. The government in country i imposes a corporate income tax at rate τ_i on the MNE's tax base in country i. Total after-tax profit of the MNE reads[4]

$$\pi = (1-\tau_a)\pi_{at} + (1-\tau_b)\pi_{bt} - (1-\rho)r(k_a+k_b) - C(s). \tag{2}$$

The MNE maximizes (2) with respect to capital and labor, k_i and ℓ_i for $i \in \{a,b\}$, and shifting, s. Indicating profit-maximizing values by a tilde, the first-order conditions read

$$(1-\tau_i)\left[F_k(\tilde{k}_i,\tilde{\ell}_i) - \rho r\right] - (1-\rho)r = 0, \quad F_\ell(\tilde{k}_i,\tilde{\ell}_i) - w_i = 0, \quad i \in \{a,b\}, \tag{3}$$

$$C'(\tilde{s}) = \tau_a - \tau_b. \tag{4}$$

Equation (3) equates the after-tax (before-tax) marginal return to capital (labor) to the net-of-tax user cost of capital (wage rate). Equation (4) determines optimal profit shifting. If country a is the high-tax country, then $\tilde{s} > 0$ and the MNE will shift income from a to b. Shifting will be the other way round, if country a is the low-tax country.

Equations (3) and (4) together with $\tilde{\ell}_i = \bar{\ell}$ determine capital and labor demand and the equilibrium wage rates as functions of the national tax rates. We follow previous studies and focus on a symmetric situation in which both countries have the same tax rate $\tau_a = \tau_b =: \tau$. It follows $\tilde{k}_a = \tilde{k}_b =: \tilde{k}$, $\tilde{\ell}_a = \tilde{\ell}_b = \bar{\ell}$, $\tilde{w}_a = \tilde{w}_b =: \tilde{w}$, $\tilde{s} = 0$, $\pi_{at} = \pi_{bt} = F - \bar{\ell}F_\ell - \rho r\tilde{k} =: \tilde{\pi}_t$, $\pi = 2(1-\tau)(F - \bar{\ell}F_\ell - \tilde{k}F_k) =: \tilde{\pi}$. In order to figure out the impact of the tax rates on the equilibrium outcome, we first totally differentiate (3) and (4) with $\tilde{\ell}_i = \bar{\ell}$ and then apply the symmetry properties to obtain

$$\frac{\partial \tilde{k}_i}{\partial \tau_i} = \frac{F_k - \rho r}{(1-\tau)F_{kk}}, \qquad \frac{\partial \tilde{w}_i}{\partial \tau_i} = \frac{(F_k - \rho r)F_{k\ell}}{(1-\tau)F_{kk}}, \qquad i \in \{a,b\}, \tag{5}$$

$$\frac{\partial \tilde{k}_j}{\partial \tau_i} = \frac{\partial \tilde{w}_j}{\partial \tau_i} = 0, \qquad i,j \in \{a,b\}, \quad i \neq j, \tag{6}$$

$$\frac{\partial \tilde{s}}{\partial \tau_a} = -\frac{\partial \tilde{s}}{\partial \tau_b} = \frac{1}{C''}, \tag{7}$$

where $F_k - \rho r > 0$ due to (3). Equation (5) shows that an increase in country i's tax rate reduces investment in this country. For a positive (negative) cross derivative of the

[4]We assume the concealment cost not to be tax deductible. This is in line with our interpretation of C as reflecting the detection risk of the MNE. The basic insights of our analysis would remain true, however, if the concealment cost was made deductible from the tax base.

production function this leads to a decrease (increase) in labor demand and in the wage rate in country i. Due to separate taxation, capital and the wage rate in country j are unaffected as shown by (6). The tax base in country j is nevertheless influenced by a tax rate increase in country i since according to (7) the MNE expands shifting to country j.

Tax Competition. Having characterized the behavior of the MNE, we now specify and investigate the tax competition game between the two countries. Each country is inhabited by a representative household. The household in country i derives utility from private consumption and a local public good denoted by c_i and g_i, respectively. Utility is given by the quasi-linear function $U(c_i, g_i) = \lambda c_i + V(g_i)$ with $V' > 0$ and $V'' \leq 0$. The parameter $\lambda \in \{0, 1\}$ allows to separate tax revenue maximization ($\lambda = 0$) from welfare maximization ($\lambda = 1$). The household in country i earns interest income $r\bar{k}$ from the supply of its given capital endowment $\bar{k}$ and labor income $w_i\bar{\ell}$ from the supply of its given labor endowment $\bar{\ell}$. Moreover, we assume that the household owns a share $\theta_i \in [0, 0.5]$ of the MNE and, thus, receives profit income $\theta_i\pi$. In order to warrant a symmetric situation, we focus on the case with equal ownership shares $\theta_a = \theta_b =: \theta$. The household in country i spends all income on private consumption so that its budget constraint reads $c_i = r\bar{k} + w_i\bar{\ell} + \theta\pi$. The fiscal budget constraint equates the expenditure on the public good and the tax revenue from the corporate tax. Under SA we get $g_i = \tau_i\pi_{it}$.

Inserting the private and fiscal budget constraints into the utility function yields country i's welfare function $W^i(\tau_i, \tau_j) = \lambda(r\bar{k} + \tilde{w}_i\bar{\ell} + \theta\pi) + V(\tau_i\pi_{it})$ for $i \in \{a, b\}$, and $i \neq j$. The government of country i maximizes $W^i(\tau_i, \tau_j)$ with respect to τ_i. In doing so, it takes into account that the equilibrium variables depend on the tax rates according to (5) – (7). Moreover, country i takes as given the tax rate chosen by country j. Hence, we consider a Nash tax competition game between the two countries. The equilibrium $(\tilde{\tau}_a, \tilde{\tau}_b)$ is determined by the first-order conditions $\partial W^i(\cdot)/\partial\tau_i = 0$ for $i \in \{a, b\}$. As already mentioned above, we follow the previous literature and focus on a symmetric equilibrium with both countries having the same tax rate $\tilde{\tau}_a = \tilde{\tau}_b =: \tilde{\tau}$.

As we are interested only in the efficiency properties of the equilibrium tax rates, we need not fully analyze the tax competition game. It suffices to consider the fiscal externalities, that means the effect of country i's tax rate τ_i on country j's welfare $W^j(\cdot)$. These externalities reflect the deviation of the equilibrium tax policy from the cooperative (pareto-efficient) tax policy that maximizes joint welfare $W^a(\cdot) + W^b(\cdot)$. For a positive (negative) externality, the equilibrium tax rates are inefficiently low (high). Due to symmetry we can focus on the externality caused by country b's tax rate. Differentiating $W^a(\cdot)$ with respect to τ_b yields $\partial W^a/\partial\tau_b = \text{IE} + \text{PE}$ with

$$\text{IE} = \lambda\theta\frac{\partial\pi}{\partial\tau_b} = \lambda\theta(1-\mu)\left[\frac{(F_k-\rho r)F_k}{F_{kk}} - F\right] \leq 0, \quad \text{PE} = -\tilde{\tau}V'\frac{\partial\tilde{s}}{\partial\tau_b} = \frac{\tilde{\tau}V'}{C''} > 0, \tag{8}$$

where in the first part of (8) we used $\partial\pi/\partial\tau_b = -\tilde{\pi}_t - (1-\tilde{\tau})\bar{\ell}(\partial\tilde{w}_b/\partial\tau_b)$ and $(\mu-1)F_k = \tilde{k}F_{kk} + \bar{\ell}F_{k\ell}$ according to the Euler Theorem and $\ell_i = \bar{\ell}$.

The total cross country effect of τ_b can be decomposed in two sub-externalities. First, if country b sets its tax rate, it ignores the negative impact on the MNE's after-tax profit and, thus, on profit income of country a's residents. This effect is reflected by the profit income externality IE in (8). Second, if τ_b increases, the MNE shifts more income to country a so that the tax base and tax revenue in country a are enhanced. This constitutes the profit shifting externality PE in (8). If governments maximize tax revenue ($\lambda = 0$) or if the MNE is fully owned by a third country ($\theta = 0$), the income externality vanishes. We then obtain inefficient undertaxation due to PE > 0. However, under welfare maximization ($\lambda = 1$) and positive ownership shares ($\theta > 0$), IE is strictly negative so that tax rates may become inefficiently high. Similar results are derived by Nielsen et al. (2004) and Riedel and Runkel (2007) in models without labor.

4 Formula Apportionment

Profit Maximization. Under FA, the MNE's tax bases are consolidated and apportioned according to a certain formula. The consolidated tax base reads

$$\pi_{at} + \pi_{bt} = F(k_a, \ell_a) + F(k_b, \ell_b) - w_a\ell_a - w_b\ell_b - \rho r(k_a + k_b). \tag{9}$$

The share of this tax base assigned to country a is determined by the formula

$$A(k_a, k_b, \ell_a, \ell_b, w_a, w_b) = \gamma\frac{k_a}{k_a + k_b} + \sigma\frac{F(k_a, \ell_a)}{F(k_a, \ell_a) + F(k_b, \ell_b)} + \varphi\frac{w_a\ell_a}{w_a\ell_a + w_b\ell_b}, \tag{10}$$

with $\gamma, \sigma, \varphi \in [0, 1]$ and $\gamma + \sigma + \varphi = 1$. The share of the consolidated tax base assigned to country b equals $1 - A(\cdot)$. The apportionment formula in (10) contains the MNE's property, payroll and sales shares in country a. Hence, we allow for the general case in which FA allocates the MNE's consolidated tax base according to all three factors mainly used in practice. The parameters γ, σ and φ are the formula weights of the three factors.

The tax burden of the MNE in country a and b reads $\tau_a A(\cdot)(\pi_{at} + \pi_{bt})$ and $\tau_b[1 - A(\cdot)](\pi_{at} + \pi_{bt})$, respectively. The MNE's after-tax profit can then be written as

$$\pi = (1 - \bar{\tau})(\pi_{at} + \pi_{bt}) - r(1 - \rho)(k_a + k_b) - C(s), \tag{11}$$

where $\bar{\tau} = \tau_b + (\tau_a - \tau_b)A(k_a, k_b, \ell_a, \ell_b, w_a, w_b)$ is the effective tax rate the MNE faces under FA. The MNE maximizes (11) with respect to investment, labor demand and profit shifting taking into account (9), (10) and the definition of $\bar{\tau}$. As tax bases are consolidated, the MNE cannot reduce its tax liability by profit shifting. Independent of the tax rates, it therefore chooses zero shifting in order to minimize the concealment cost, i.e. $\hat{s} = 0$ where the hat indicates the solution under FA. Profit-maximizing investment and labor demand are determined by the first-order conditions

$$(1 - \bar{\tau})[F_k(\hat{k}_i, \hat{\ell}_i) - \rho r] - r(1 - \rho) - (\tau_a - \tau_b)A_{k_i}(\cdot)(\pi_{at} + \pi_{bt}) = 0, \tag{12}$$

$$(1 - \bar{\tau})[F_\ell(\hat{k}_i, \hat{\ell}_i) - w_i] - (\tau_a - \tau_b)A_{\ell_i}(\cdot)(\pi_{at} + \pi_{bt}) = 0, \tag{13}$$

for $i \in \{a, b\}$. There are two differences between (12) and (13), on the one hand, and the corresponding conditions under SA in (3), on the other hand. First, the after-tax marginal return to investment is not computed with the national tax rate τ_i but with the effective tax rate $\bar{\tau}$ since under FA the latter applies to all profit earned. Second, the terms in (12) and (13) containing derivatives of the apportionment formula do not emerge under SA. These terms reflect the MNE's formula manipulation incentive, i.e. the incentive to invest more and demand more labor in the low-tax country than in the high-tax country in order to increase the share of the consolidated profit assigned to the low-tax country. In doing so, the MNE reduces the effective tax rate and the overall tax burden.

Analogous to SA, the labor market clears so that $\hat{\ell}_i$ in (12) and (13) can be replaced by $\bar{\ell}$ and w_i can be treated as endogenous. Our focus is again on a symmetric situation with both countries imposing the same tax rate $\tau_a = \tau_b =: \tau$. We obtain the same symmetry properties as under SA except for replacing the tildes by hats. In addition, symmetry implies $A(\cdot) = 1 - A(\cdot) = 1/2$, $\bar{\tau} = \tau$ and

$$A_{k_a} = -A_{k_b} = \frac{\gamma}{4\hat{k}} + \frac{\sigma F_k}{4F}, \quad A_{\ell_a} = -A_{\ell_b} = \frac{\varphi}{4\bar{\ell}} + \frac{\sigma F_\ell}{4F}, \quad A_{w_a} = -A_{w_b} = \frac{\varphi}{4\hat{w}}. \tag{14}$$

A comparative static analysis of (12) and (13) yields

$$\frac{\partial \hat{k}_i}{\partial \tau_i} = \frac{1}{2(1 - \tau)F_{kk}} \left[F_k - \rho r + \hat{\pi}_t \left(\frac{\gamma}{\hat{k}} + \frac{\sigma F_k}{F} \right) \right], \quad i \in \{a, b\}, \tag{15}$$

$$\frac{\partial \hat{k}_j}{\partial \tau_i} = \frac{1}{2(1-\tau)F_{kk}}\left[F_k - \rho r - \hat{\pi}_t\left(\frac{\gamma}{\hat{k}} + \frac{\sigma F_k}{F}\right)\right], \quad i,j \in \{a,b\},\ i \neq j, \tag{16}$$

$$\frac{\partial \hat{w}_i}{\partial \tau_i} = -\frac{\hat{\pi}_t}{2(1-\tau)}\left(\frac{\varphi}{\bar{\ell}} + \frac{\sigma F_\ell}{F}\right) + F_{k\ell}\frac{\partial \hat{k}_i}{\partial \tau_i}, \quad i \in \{a,b\}, \tag{17}$$

$$\frac{\partial \hat{w}_j}{\partial \tau_i} = \frac{\hat{\pi}_t}{2(1-\tau)}\left(\frac{\varphi}{\bar{\ell}} + \frac{\sigma F_\ell}{F}\right) + F_{k\ell}\frac{\partial \hat{k}_j}{\partial \tau_i}, \quad i,j \in \{a,b\},\ i \neq j, \tag{18}$$

$$\frac{\partial(\hat{k}_a + \hat{k}_b)}{\partial \tau_i} = \frac{F_k - \rho r}{(1-\tau)F_{kk}}, \quad \frac{\partial(\hat{w}_a + \hat{w}_b)}{\partial \tau_i} = \frac{(F_k - \rho r)F_{k\ell}}{(1-\tau)F_{kk}}, \quad i \in \{a,b\}. \tag{19}$$

Similar to SA, (15) implies that a tax rate increase in country i has a negative impact on investment in country i. As explained above, however, under FA the MNE faces the effective instead of the national tax rate and has an incentive to manipulate the formula. This is the reason why the effect on country i's wage rate in (17) not only depends on the cross derivative of the production function, but also on the formula weights. Moreover, the increase in τ_i now affects investment and the wage rate in country $j \neq i$, as shown by (16) and (18). The signs of these effects depend on the formula weights and the properties of the production function. Finally, (19) states that the effect on total investment is negative whereas the effect on total payroll is negative (positive) if $F_{k\ell}$ is positive (negative). Both effects do not depend on the formula weights and, thus, are the same as under SA.

Tax Competition. We are now in the position to analyze the tax competition game under FA. Welfare in country a can be written as $W^a(\tau_a, \tau_b) = \lambda(r\bar{k} + \hat{w}_a\bar{\ell} + \theta\pi) + V[\tau_a A(\cdot)(\pi_{at} + \pi_{bt})]$. The term for country b's welfare is analogous. The tax rates in the Nash equilibrium of the tax competition game are determined by $\partial W^i(\cdot)/\partial \tau_i = 0$ for $i \in \{a,b\}$. We again restrict attention to a symmetric equilibrium with $\tau_a = \tau_b = \bar{\tau} =: \hat{\tau}$ and figure out the efficiency properties of the tax rates by investigating the fiscal externalities. Differentiating $W^a(\cdot)$ with respect to τ_b and using symmetry yields $\partial W^a/\partial \tau_b = \text{IE} + \text{WE} + \text{TE} + \text{FE}$ where IE is the same as in (8), $\text{WE} = \lambda\bar{\ell}\,(\partial \hat{w}_a/\partial \tau_b)$ and

$$\begin{aligned}\text{TE} &= \frac{\hat{\tau}V'(\cdot)}{2}\,\frac{\partial(\pi_{at} + \pi_{bt})}{\partial \tau_b} = \frac{\hat{\tau}V'(\cdot)}{2}\left[(F_k - \rho r)\frac{\partial(\hat{k}_a + \hat{k}_b)}{\partial \tau_b} - \bar{\ell}\,\frac{\partial(\hat{w}_a + \hat{w}_b)}{\partial \tau_b}\right] \\ &= \frac{\hat{\tau}V'(\cdot)(F_k - \rho r)(F_k - \rho r - \bar{\ell}F_{k\ell})}{2(1-\hat{\tau})F_{kk}},\end{aligned} \tag{20}$$

$$\text{FE} = 2\hat{\tau}\hat{\pi}_t V'(\cdot)\,\frac{\partial A(\cdot)}{\partial \tau_b} = 2\hat{\tau}\hat{\pi}_t V'(\cdot)\left[A_{k_a}\frac{\partial(\hat{k}_a - \hat{k}_b)}{\partial \tau_b} + A_{w_a}\frac{\partial(\hat{w}_a - \hat{w}_b)}{\partial \tau_b}\right]$$

$$= \frac{\hat{\tau}\hat{\pi}_t^2 V'(\cdot)}{2(1-\hat{\tau})F_{kk}} \left\{ \frac{\varphi}{F_\ell} \left[F_{kk} \left(\frac{\varphi}{\bar{\bar{\ell}}} + \frac{\sigma F_\ell}{F} \right) - F_{k\ell} \left(\frac{\gamma}{\hat{k}} + \frac{\sigma F_k}{F} \right) \right] - \left(\frac{\gamma}{\hat{k}} + \frac{\sigma F_k}{F} \right)^2 \right\}. \quad (21)$$

FA eliminates profit shifting and the corresponding externality PE. But the profit income externality IE is maintained and three new externalities emerge. First, if country b changes its tax rate, the MNE's labor demand and wage rate in country a are altered. This effect causes the wage income externality WE. The sign of WE can be shown to depend on the formula weights and the properties of the production function. Second, an increase in country b's tax rate raises the MNE's effective tax rate and thereby gives the MNE the incentive to reduce aggregate investment and to change total payroll (confer (19)). Both effects change the consolidated tax base and, thus, tax revenue and welfare in country a. We obtain the tax base externality TE defined in (20). In general, the sign of TE is ambiguous because the reduction in total investment lowers the consolidated tax base, whereas the effect on payroll may go into the opposite direction. We will see below that the properties of the production function are decisive for the relative magnitude of the two effects. Finally, the formula externality FE in (21) is based on the MNE's formula manipulation incentive. If country b increases its tax rate, the MNE will raise investment in a relatively to investment in b since this gives the increased tax rate of country b a lower weight in the effective tax rate. Depending on $F_{k\ell}$, a similar effect holds with respect to labor demand and the wage rates. As consequence, the share of the MNE's consolidated profit assigned to country a and, thus, tax revenue and welfare in country a change.

IE is non positive due to (8). FE will turn out to be always positive. Unfortunately, the signs of the other externalities and of the sum of all externalities are ambiguous. But in the following we investigate certain specifications of our model in order to gain some basic insights into the efficiency properties of the equilibrium tax rates under FA.

A Benchmark Case. We start by assuming that governments maximize tax revenue instead of welfare ($\lambda = 0$). There are several good reasons to consider this special case. The assumption of revenue maximization has frequently been used by previous studies on tax competition since it approximates the behavior of a Leviathan government which is often seen to be more realistic than welfare maximization (see e.g. the survey of Wilson, 1999). Haufler (2007) supports this line of reasoning in the context of corporate income taxation. He argues that the revenue from corporate taxes more and more falls short of the revenue from other taxes, and that the general public regards this development as unfair so that politicians mainly aim at stabilizing or maximizing the revenue from corporate taxes. Moreover, restricting attention to revenue maximization helps focusing on the externalities that are directly caused by the tax rules of SA and FA, namely the profit shifting, tax base and formula externalities. Finally, it may be argued that income externalities are better addressed by other policy instruments than corporate taxation.

The benchmark case proceeds on two further assumptions. We follow most previous studies referred to in the Introduction and suppose the user cost of capital is not deductible at all ($\rho = 0$). Moreover, the production function is Cobb-Douglas so that $F(k_i, \ell_i) = k_i^\alpha \ell_i^\beta$ with $\alpha, \beta \in]0,1[$ and $\alpha + \beta < 1$. Using all these assumptions yields IE = WE = 0. Summing (20) and (21) and, for notational convenience, defining $\vartheta := \hat{\tau}(1-\beta)FV'/[2(1-\alpha)(1-\hat{\tau})]$, we can write the total externality under FA as

$$\left.\frac{\partial W^a}{\partial \tau_b}\right|_{(1,0,0)} = \vartheta \, \frac{1-\alpha^2-\beta}{\alpha}, \quad \left.\frac{\partial W^a}{\partial \tau_b}\right|_{(0,0,1)} = \vartheta \, \frac{1-\alpha-\beta}{\beta}, \quad \left.\frac{\partial W^a}{\partial \tau_b}\right|_{(0,1,0)} = -\vartheta\alpha\beta, \quad (22)$$

where $(\partial W^a/\partial \tau_b)|_{(\gamma,\sigma,\varphi)}$ denotes the fiscal externality when the formula uses the weights $(\gamma, \sigma, \varphi)$. Equation (22), $\alpha, \beta \in]0,1[$ and $\alpha + \beta < 1$ immediately imply

Proposition 1. *Suppose governments maximize tax revenue* ($\lambda = 0$) *and capital cost is not deductible* ($\rho = 0$). *Furthermore, suppose* $F(k_i, \ell_i) = k_i^\alpha \ell_i^\beta$ *with* $\alpha, \beta \in]0,1[$ *and* $\alpha + \beta < 1$. *Then the equilibrium tax rate* $\hat{\tau}$ *under FA is inefficiently low for* $(\gamma, \sigma, \varphi) = (1,0,0)$ *and* $(\gamma, \sigma, \varphi) = (0,0,1)$. *It is inefficiently high if* $(\gamma, \sigma, \varphi) = (0,1,0)$.

The intuition of Proposition 1 is as follows. Under tax revenue maximization, the profit income externality IE and the wage income externality WE disappear and only the tax base externality TE and the formula externality FE remain. Under the conditions of Proposition 1, it is straightforward to show that TE is negative while FE is positive. If now the consolidated profit of the MNE is apportioned according to property or payroll shares, the MNE's incentive to manipulate the formula is quite strong since apportionment is targeted *directly* at the production factors. As a consequence, FE outweighs TE and the tax rate is inefficiently low. In contrast, if apportionment uses the sales share, it will be directed at the production factors only *indirectly*, namely via the production function. The fixed production factor now makes the difference to the property and payroll formulas. The larger the fixed factor's production share, the lower is the sum $\alpha + \beta$ of the variable factors' production shares and the less sensitive reacts sales to changes in these variable inputs. Under the sales formula, manipulating the formula is therefore more difficult than under the other formulas. FE is then relatively weak and overcompensated by TE leading to inefficiently high tax rates.

This line of reasoning provides a possible microfoundation of the sales factor in the apportionment formula. As already stated in the Introduction, corporate income taxation is often understood as a tax on the return to capital implying that FA should employ the property share only. However, the results in Proposition 1 suggest that combining the property/payroll factor with the sales factor mixes up the positive externality under the property/payroll formula with the negative externality under the sales formula. We then come closer to the efficient tax policy characterized by a zero fiscal externality. Hence, even though FA creates its own distortions, it is superior to SA since the central authority (e.g. the European Commission) can use the formula in order to internalize the fiscal externalities. Such an instrument is not available under SA. The policy implication is that the European Union should adopt FA with a sales apportionment factor. Moreover, this argument may be viewed as an economic justification of the widespread use of the sales factor in many real-world FA tax systems.

To further illustrate this point, consider the following example. For illustrative purpose suppose $\gamma = 0$ so that $\varphi = 1 - \sigma$. Inserting this together with the assumptions made in Proposition 1 into (20) and (21) and fixing the production share of labor at the empirically relevant value of $\beta = 2/3$ (e.g. Ortigueira and Santos, 1997, Steger, 2005), we can solve for the optimal σ that solves $\partial W^a / \partial \tau_b = \mathrm{FE} + \mathrm{TE} = 0$. Plotting this against the production share of the fixed factor, $\varepsilon := 1 - \mu = 1 - \alpha - \beta \in]0, 1/3[$, yields the following figure.

Figure 1 here

Figure 1 confirms our above intuition and highlights the important role the fixed production factor plays for the validity of our argument. As long as the production share of the fixed production factor is positive ($\varepsilon > 0$), the optimal formula weight on sales is positive, too ($\sigma > 0$). If the fixed factor becomes negligible ($\varepsilon \to 0$), in contrast, the optimal formula does not contain a sales factor ($\sigma \to 0$). Hence, we need the fixed production factor and, thus, positive pure profit for our argument in favor of the sales apportionment factor. As argued above, however, there are good reasons to suppose a fixed production factor in the context of corporate income taxation as this factor causes economic rents that the governments try to absorb with their tax policy.

A More General Production Function. Some authors argue that the Cobb-Douglas production function fits empirical data poorly (e.g. Duffy and Papageorgio, 2000). For that reason we now analyze how the above insights change if we turn to the more general CES function $F(k_i, \ell_i) = [\delta k_i^\nu + (1-\delta)\ell_i^\nu]^{\frac{\mu}{\nu}}$ with $\delta \in]0,1[$, $\mu \in]0,1[$ and $\nu \leq 1$. The parameter ν is positively correlated with the elasticity of substitution between capital and labor by the formula $\eta := 1/(1-\nu)$. Hence, the higher ν the higher is the substitution elasticity. For $\nu = 1$ ($\nu \to -\infty$) capital and labor are perfect substitutes (complements).

For notational convenience define $K := \delta \hat{k}^\nu$, $L = (1-\delta)\bar{\ell}^\nu$ and $Z := K + L$. The CES function and its derivatives can then be written as $F = Z^{\frac{\mu}{\nu}}$, $F_k = \mu K Z^{\frac{\mu}{\nu}-1}/\hat{k}$, $F_\ell = \mu L Z^{\frac{\mu}{\nu}-1}/\bar{\ell}$, $F_{kk} = -\mu[(1-\mu)K + (1-\nu)L]KZ^{\frac{\mu}{\nu}-2}/\hat{k}^2$ and $F_{k\ell} = \mu(\mu-\nu)KLZ^{\frac{\mu}{\nu}-2}/\hat{k}\bar{\ell}$. An increase in the substitution elasticity (an increase in ν) therefore reduces $F_{k\ell}$ from a positive value (for $\nu < \mu$) to a negative value (for $\nu = 1$) since the higher degree of substitution makes it more likely that an increase in labor reduces the marginal return to capital. A higher substitution elasticity also weakens the impact of capital on its own marginal return so that an increase in ν reduces the absolute value of F_{kk}. These relations are important to understand the intuition of the results derived below.

We stick to the case with no deductibility of capital cost ($\rho = 0$) and tax revenue maximization ($\lambda = 0$) so that the profit and labor income externalities (IE and WE) are still absent. Inserting these assumptions together with the CES specification into (20) and, for notational convenience, defining $\Psi := \hat{\tau}\mu K V' Z^{\frac{\mu}{\nu}-1}/[2(1-\hat{\tau})] > 0$ yields

$$\mathrm{TE} = -\Psi \, \frac{K + (1-\mu+\nu)L}{(1-\mu)K + (1-\nu)L}. \tag{23}$$

Equation (23) shows that a reduction in the substitution elasticity (ν declines) increases the tax base externality from an initially negative value (for $\nu = 1$) to a positive value (for $\nu \to -\infty$). To understand the intuition of this result, consider the effects of an increase in country b's tax rate. Remember from (19) that for all ν the MNE reduces its total investment, that is $\partial(k_a + k_b)/\partial\tau_b < 0$. Moreover, if capital and labor are strong substitutes in the sense that $\nu > \mu$, then $F_{k\ell}$ is negative and the reduction in investment induces the MNE to demand more labor which drives up payroll, i.e. $\partial(w_a + w_b)/\partial\tau_b > 0$ according to (19). In this case, the reduction of total investment and the increase in payroll reduce the MNE's consolidated tax base and TE is unambiguously negative. But this argument may be reversed if capital and labor are complements so that $\nu < \mu$. We then obtain $F_{k\ell} > 0$ and total payroll falls upon an increase of τ_b. This effect counteracts the decline in total investment and TE becomes positive for sufficiently low ν.[5]

Consider next the formula externality FE. Inserting $\rho = 0$ and the CES specification into (21) and defining $\Psi_\gamma := \hat{\tau}V'Z^{\frac{\mu}{\nu}}/[2\mu(1-\hat{\tau})K] > 0$, $\Psi_\sigma := \hat{\tau}\mu K V' Z^{\frac{\mu}{\nu}-2}/[2(1-\hat{\tau})] > 0$ and $\Psi_\varphi := \hat{\tau}V'Z^{\frac{\mu}{\nu}-1}/[2\mu(1-\hat{\tau})L] > 0$, we obtain

$$\mathrm{FE}|_{(1,0,0)} = \Psi_\gamma \frac{[K+(1-\mu)L]^2}{(1-\mu)K+(1-\nu)L}, \quad \mathrm{FE}|_{(0,1,0)} = \Psi_\sigma \frac{[K+(1-\mu)L]^2}{(1-\mu)K+(1-\nu)L}, \tag{24}$$

$$\mathrm{FE}|_{(0,0,1)} = \Psi_\varphi \,[K+(1-\mu)L]^2. \tag{25}$$

According to (24) and (25), the formula externality FE is always positive. Moreover, while FE is increasing in the substitution elasticity under the property and the sales formula, ν does not directly influence FE when apportionment is done purely by payroll. The intuition for this result is as follows. Under the property or payroll formula ($\gamma = 1$ or $\sigma = 1$), we have $A_{k_a} > 0$ and $A_{w_a} = 0$ due to (14). Hence, the impact of country b's tax rate on the investment levels enters FE directly by the term $\partial(\hat{k}_a - \hat{k}_b)/\partial\tau_b$ (confer (21)). If now the substitution elasticity increases (ν increases), we know from above that the absolute value of F_{kk} declines. Due to (15) and (16), this raises the sensibility of the MNE's investment with respect to tax rates. Put differently, it becomes easier for the MNE to manipulate the formula and the formula externality FE goes up. In contrast, under the payroll formula we have $\gamma = \sigma = 0$, $A_{k_a} = 0$ and $A_{w_a} > 0$, so neither $\partial(\hat{k}_a - \hat{k}_b)/\partial\tau_b$ nor F_{kk} enters FE. This means that the increase in ν and the corresponding decline in $|F_{kk}|$ do not affect the MNE's ability to manipulate the formula and the magnitude of FE.

With this information, we can prove (see Appendix)

Proposition 2. *Suppose governments maximize tax revenue* ($\lambda = 0$) *and capital cost is not deductible* ($\rho = 0$). *Furthermore, suppose* $F(k_i, \ell_i) = [\delta k_i^\nu + (1-\delta)\ell_i^\nu]^{\frac{\mu}{\nu}}$ *with* $\delta \in]0,1[$, $\mu \in]0,1[$ *and* $\nu \leq 1$. *Then the equilibrium tax rate* $\hat{\tau}$ *under FA is inefficiently low for* $(\gamma,\sigma,\varphi) = (1,0,0)$. *It is inefficiently low for* $(\gamma,\sigma,\varphi) = (0,0,1)$ *if* $\nu \leq (2\mu^2 - 5\mu + 3)/(\mu^2 - 2\mu + 2)$. *It is inefficiently high for* $(\gamma,\sigma,\varphi) = (0,1,0)$ *if* $\nu \geq \mu(\mu - 1)$.

Proposition 2 derives sufficient conditions for the insights derived in Proposition 1 to be true also under the more general CES production technology. The relevant parameter constellations are illustrated in Figure 2.

Figure 2 here

[5] As F_{kk} affects both total investment and payroll, the effect of ν on F_{kk} is immaterial for this intuition.

All (μ, ν) within the area enclosed by the ν-axis, the two plotted curves and the dashed curve at $\nu = 1$ satisfy the conditions of Proposition 2. For these parameter constellations the sum of the tax base and formula externalities is positive under the property or payroll formula, but negative under the sales formula. As consequence, the argument in favor of the sales formula that we derived in the previous paragraph still holds.

We may therefore conclude that the rationale for the sales factor can be generalized to a wide range of parameter values under the more general CES function. However, Proposition 2 also reveals that the elasticity of substitution between capital and labor plays an important role for the validity of the result. For intermediate values of ν the result holds. But if the substitution elasticity is (a) relatively low ($\nu < \mu(\mu-1)$) or (b) relatively high combined with an unimportant fixed factor ($\nu > (2\mu^2 - 5\mu + 3)/(\mu^2 - 2\mu + 2)$), we cannot necessarily preserve the argument in favor of the sales factor. Intuitively, the problem in case (a) is that the sum of the tax base and formula externalities, $\mathrm{FE} + \mathrm{TE}$, may be positive under the sales formula. The reason is that TE is decreasing in ν as known from the discussion of (23). Hence, when capital and labor become more and more complements (ν falls), TE increases above zero and the sum of FE and TE becomes positive even under the sales formula. The problem in case (b) is that $\mathrm{FE} + \mathrm{TE}$ may be negative under the payroll formula. The intuition follows from our discussion of (23) – (25). An increase in the substitution elasticity makes the tax base externality TE more negative. For the capital and sales formulas this effect is compensated by the increase in the formula externality FE. But for the payroll formula, FE is virtually independent of ν so that the sum $\mathrm{FE} + \mathrm{TE}$ declines and may even fall below zero.

Proposition 2 and Figure 2 also confirm the important role of the fixed factor which we already identified in the previous paragraph. The locus $\mu = 1$ does not lie in the set of all (μ, ν) that ensure a positive externality under the property and payroll formula and a negative externality under the sales formula. Hence, without the fixed factor ($\mu \to 1$) the argument in favor of the sales formula may not be true.

5 An Empirical Calibration to EU-15

The main contribution of the previous section was to present a microfoundation of the sales factor. Strictly speaking, however, it also turned out that the validity of this foundation in the end is an empirical question since it depends on the fixed production factor and the substitution elasticity between capital and labor. Moreover, even though we thoroughly motivated the case of tax revenue maximization, one might want to know whether the results change when governments maximize welfare. In this case, the profit and wage income externalities are present and may destroy our above conclusion. In addition, the assumption of no deductibility of capital cost was made for tractability reasons, but it is only a rough approximation for the properties of real-world tax systems. Allowing deductibility may affect the magnitude of the externalities derived and may therefore affect the results. Finally, when we generalize the model it is no longer clear whether the formula can be used to *fully* internalize the fiscal externalities. It then arises the question whether FA is still superior to SA. In order to answer all these questions we now empirically calibrate the model to the EU-15.

We retain the assumption of CES production technologies. A complete empirical estimation of this functional specification is given by Duffy and Papageorgiou (2000). They find $\mu \approx 0.97$, $\nu \approx 0.45$ and $\delta \approx 0.23$. Note that by setting μ close to unity we choose quite unfavorable conditions for our theoretical results to remain true. The deductibility parameter ρ and the user cost r are determined by the same method as in Riedel and Runkel (2007). We distinguish between the deductibility of debt financing cost and depreciation allowances. The MNE finances a share ρ_ι of its activities by debt and the interest rate is ι. In the long-run, depreciation is 100% while we assume a share of ρ_ξ to be tax deductible. Our model reflects both reasons of deductibility if we set $\rho r = \rho_\iota \iota + \rho_\xi$ and $(1-\rho)r = (1-\rho_\iota)\iota + 1 - \rho_\xi$. Desai et al. (2004) show $\rho_\iota \approx 0.4$ and Devereux et al. (2002) estimate $\rho_\xi \approx 0.7$. Setting $\iota = 0.05$ then implies $\rho \approx 0.68$ and $r \approx 1.05$.

With respect to the welfare function we follow Nielsen et al. (2004) and choose a linear specification $U(c_i, g_i) = c_i + \psi g_i$ with $\psi > 1$. The parameter ψ can be interpreted as the marginal cost of public funds. It is empirically estimated by Kleven and Kreiner (2007). We use the lower bound of the range identified by the authors and set $\psi = 1.3$. The MNE is assumed to be fully owned by the residents of the two countries, thereby implying $\theta = 0.5$. The concealment cost function is $C(s) = qs^2/2$ with $q > 0$. The parameter q together with the fixed labor supply $\bar{\ell}$ is used to calibrate the model to EU-15 data in 2004. The prevailing tax system in Europe is SA. Hence, $\bar{\ell}$ and q are chosen such that in our model the tax rate under SA just equals the EU-15 average tax rate of 31.4% and the tax revenue under SA just equals the EU-15 average tax revenue of 15.55 billion euros.[6]

[6] These data have been taken from the Eurostat website under http://epp.eurostat.cec.eu.int.

More specifically, we insert $\tilde{\tau} = 0.314$ into $\partial W^i/\partial \tau_i = 0$, set $0.314 \cdot \tilde{\pi}_t = 15.55$ and then solve the two equations with respect to $\bar{\ell}$ and q. The result is $\bar{\ell} \approx 1988.4$ and $q \approx 0.017$.[7]

With this calibration it is possible to compute the efficient tax policy and to simulate the effects of a tax reform that replaces SA by FA. The efficient tax rate is the solution to $\partial(W^a + W^b)/\partial \tau_i = 0$. The equilibrium tax rate under FA follows from $\partial W^i/\partial \tau^i = 0$. The results are displayed in Table 1 and 2.[8]

Table 1 and 2 here

The efficient tax rate is about 46%. The tax rates under all FA regimes are inefficiently low. The main reason is that the sum of income externalities is positive and relatively large. However, we can also see that the pure sales formula performs best. The reason lies again in the very low formula externality which almost vanishes under the pure sales formula. This confirms our reasoning in the theoretical model above.[9] Moreover, FA with pure sales is the only FA regime that dominates the current tax system of SA. A shift from SA to pure sales FA mitigates the inefficient race to the bottom in tax competition and increases welfare. It raises the tax rate by 2% and enhances tax revenue by roughly one billion euro or 0.1% of GDP. All these results strengthen the argument in favor of the sales factor. Sales should not only be included in the formula, but it should even be the only apportionment factor in order to maximize the welfare gains from the tax reform.

We run a comprehensive sensitivity analysis. Though there are changes in details of the results, the main conclusion that FA with a pure sales formula performs best remains true. It even turned out that in Table 1 and 2 we choose the most unfavorable conditions for this result. With $\psi = 1.3$ we selected a very low value for the marginal cost of public funds since Kleven and Kreiner (2007) estimate $\psi \in]1.3, 2.0[$. The returns to scale parameter μ was set close to unity despite the fact that some studies find considerably lower values, for example, $\mu \approx 0.6$ as in Chirinko et al. (2004). Finally, the ownership share θ was set at its upper bound of 0.5, even though a considerably part of European MNEs is owned by non Europeans. It can be shown that an increase in ψ, a reduction in μ and/or a reduction in θ strengthen the argument in favor of the sales formula since the

[7] Details on the computations and on the simulations presented below can be obtained upon request.

[8] At first glance, the displayed figures for tax revenue as percentage of GDP seem to be quite small. However, they are in accordance with empirical values that lie around 2% (e.g. Haufler, 2007).

[9] We can also show that every non sales formula causes a less efficient tax rate than the pure sales formula. This insight is in line with our arguments in the theoretical part, too.

efficiency gains which can be realized with this formula compared to the current system of SA become larger.

6 Summary and Discussion

This paper provides a microfoundation of including a sales factor into the apportionment formula under the tax principle of FA. The basic argument in favor of the sales factor is that it may mitigate or even eliminate the distortions in the international taxation of MNEs under FA. More specifically, corporate income taxation of MNEs under FA causes tax base and formula externalities. In certain cases, the sum of these two fiscal externalities is positive when property or payroll is used as apportionment factor, but negative for a pure sales formula. This insight suggests that including a sales factor weakens the sum of fiscal externalities and improves efficiency of corporate tax rates. Even though this result depends on the degree of returns to scale and on the elasticity of substitution between capital and labor, it turned out to be valid for a wide range of model specifications. Moreover, an empirical calibration of a rather general version of our model to the EU-15 strengthens the rationale for the sales factor as the pure sales formula performs best among all formulas and even dominates the current system of SA.

Though we apply our results mainly to corporate income taxation in the European Union, the analysis has important implications for existing FA tax systems as well. As already stated in the Introduction, for example, local business taxation in Germany follows the FA principle with a pure payroll formula. Our results suggest that there exist apportionment formulas containing the sales factor which would improve the efficiency of the German tax system. Moreover, the Canadian FA system already uses a sales factor with a formula weight of 50%. Our analysis can be viewed as a normative justification of this policy, even though it is an open question whether the formula weight has the right value. A similar argument applies to the US where each state uses a sales apportionment factor. Furthermore, as reported in the Introduction the US system is characterized by a tendency to increase the formula weight placed on sales. A large number of states already turned to a pure sales formula. If the conditions in the US are not too different from the conditions in the EU-15, this observation is in line with the results of our empirical calibration where pure sales performs best.

Nevertheless, this last point brings us to an important limitation of our analysis. In our framework, the sales apportionment factor is computed on the basis of the origin principle, whereas in the US some states calculate the sales share according to the destination principle (e.g. Mazerov, 2001). The use of the origin principle in our framework can be motivated by the currently debated question whether the European Union should adopt FA with a value-added at origin factor in the apportionment formula. For a comprehensive discussion of this point see Hellerstein and McLure (2004). However, with the destination principle it is no longer clear whether the argument in favor of the sales factor still holds. One might argue that also a destination-based sales factor is difficult to manipulate since its determination is out of the firm's control. The basic rationale of our results then would go through. But we think that such arguments need a thorough analysis and that our framework is not suitable to investigate the destination principle. What is required is a rather different model with a more sophisticated trade structure. This is beyond the scope of the present paper and left for future research.

Appendix: Proof of Proposition 2

Consider first the case $(\gamma, \sigma, \rho) = (1, 0, 0)$. Using $F_{kk} = -\mu K Z^{\frac{\mu}{\nu}-2}[(1-\mu)K+(1-\nu)L]/\hat{k}^2$, adding up TE and FE$|_{(1,0,0)}$ from (23) and (24) and rearranging terms yields

$$\left.\frac{\partial W^a}{\partial \tau_b}\right|_{(1,0,0)} = -\frac{\hat{\tau} V' Z^{2\frac{\mu}{\nu}-3}}{2(1-\hat{\tau})\hat{k}^2 F_{kk}}\Bigg[(1-\mu^2)K^3 + \mu^2\Bigg(\underbrace{\frac{\mu^3-\mu^2-2\mu+3}{\mu^2}}_{=:G^1(\mu)}-\nu\Bigg)K^2L + (1-\mu)(3-\mu)KL^2 + (1-\mu)^2L^3\Bigg]. \quad (26)$$

Since $\mu \in]0,1[$, $\nu \leq 1$ and $G^1(\mu) > 1$, the externality in (26) is positive as stated in the proposition. For $(\gamma, \sigma, \varphi) = (0, 0, 1)$ we obtain

$$\left.\frac{\partial W^a}{\partial \tau_b}\right|_{(0,0,1)} = -\frac{\hat{\tau} V' K Z^{2\frac{\mu}{\nu}-3}}{2(1-\hat{\tau})\hat{k}^2 F_{kk} L}\Bigg[(1-\mu)K^3 + (\underbrace{\mu^2-4\mu+3}_{=:G^2(\mu)}-\nu)K^2L + \underbrace{(\mu^2-2\mu+2)}_{=:G^3(\mu)}\Bigg(\underbrace{\frac{2\mu^2-5\mu+3}{\mu^2-2\mu+2}}_{=:G^4(\mu)}-\nu\Bigg)KL^2 + (1-\mu)^2(1-\nu)L^3\Bigg] \quad (27)$$

From $\mu \in]0,1[$ it follows $G^3(\mu) > 0$. Moreover, it is straightforward to show that $G^4(\mu) < G^2(\mu)$ for $\mu \in]0,1[$. Hence, if $\nu \leq G^4(\mu)$, then $\nu < G^2(\mu)$ and (27) becomes positive. This proves the second part of the proposition. Finally, setting $(\gamma, \sigma, \varphi) = (0, 1, 0)$ yields

$$\left.\frac{\partial W^a}{\partial \tau_b}\right|_{(0,1,0)} = \frac{\hat{\tau}\mu^2 K^2 L V' Z^{2\frac{\mu}{\nu}-4}}{2(1-\hat{\tau})\hat{k}^2 F_{kk}} \Big[(\mu+\nu)K + (\mu - \mu^2 + \nu)L\Big]. \tag{28}$$

If $\nu \geq \mu^2 - \mu = \mu(\mu - 1)$, then $\nu > -\mu$ and (28) becomes negative as stated.

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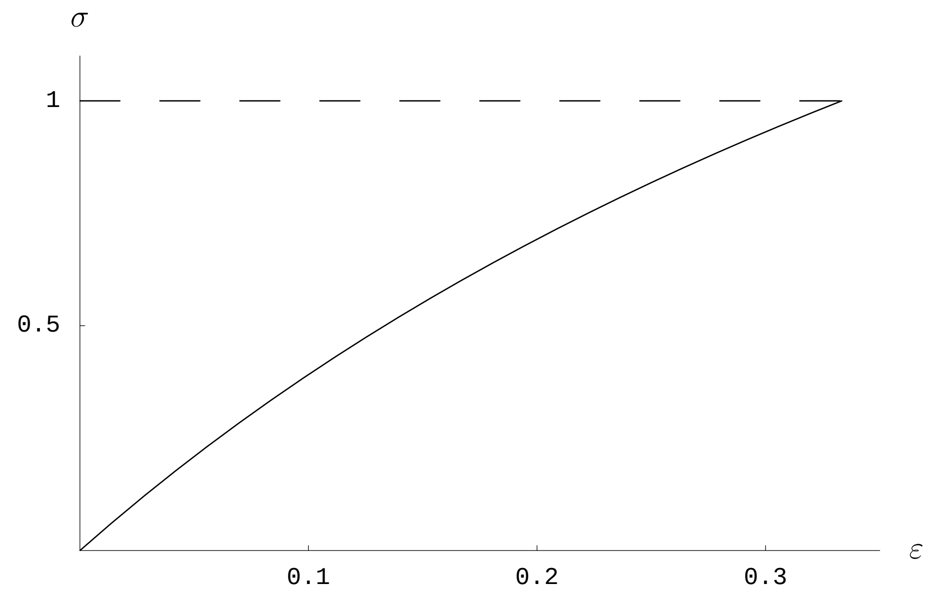

Figure 1: Optimal Formula Weight σ

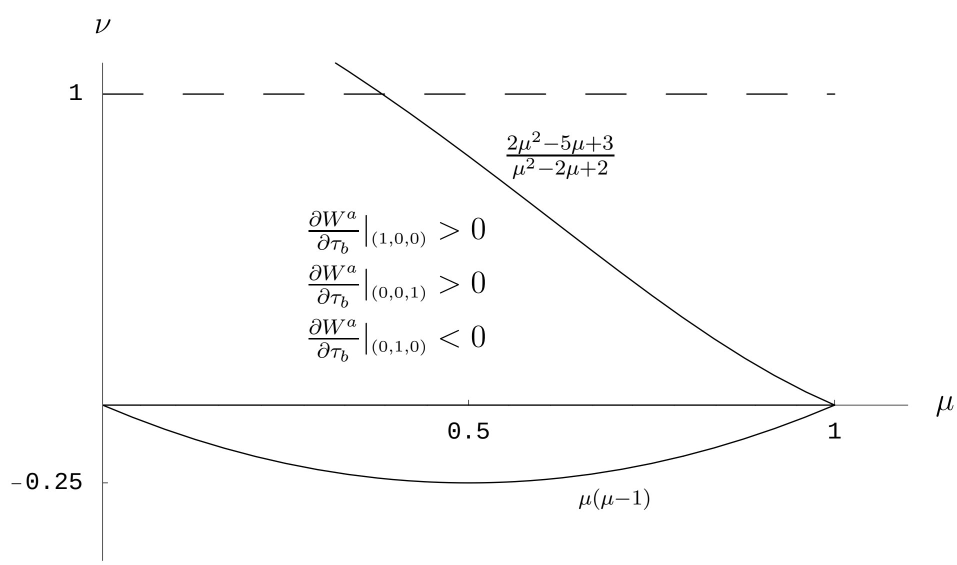

Figure 2: Fiscal Externalities under a CES Production Function

Table 1: Simulation Results

regime		tax rate (in percent)	tax revenue (in billion euro)	tax revenue (in percent of GDP)	welfare
separate accounting		31.40	15.55	1.54	970.06
efficient solution		46.21	23.13	2.32	970.76
formula apportionment by ...					
... property:	$(\gamma, \sigma, \varphi) = (1, 0, 0)$	15.65	7.62	0.75	968.36
... payroll:	$(\gamma, \sigma, \varphi) = (0, 0, 1)$	30.77	15.23	1.51	970.00
... sales:	$(\gamma, \sigma, \varphi) = (0, 1, 0)$	33.36	16.55	1.65	970.21
... Massachusetts:	$(\gamma, \sigma, \varphi) = (1/3, 1/3, 1/3)$	28.58	14.12	1.40	969.80
... double sales:	$(\gamma, \sigma, \varphi) = (1/4, 1/2, 1/4)$	30.22	14.95	1.48	969.95

(*parameter values*: $\mu = 0.97$, $\nu = 0.45$, $\delta = 0.23$, $\rho = 0.68$, $r = 1.05$, $\psi = 1.3$, $\theta = 0.5$, $\bar{\ell} = 1988.4$, $q = 0.017$)

Table 2: Externalities

regime		IE	PE	WE	TE	FE	Σ
separate accounting		-15.65	24.10	–	–	–	8.44
formula apportionment by ...							
... property:	$(\gamma, \sigma, \varphi) = (1, 0, 0)$	-15.74	–	17.00	0.57	10.72	12.55
... payroll:	$(\gamma, \sigma, \varphi) = (0, 0, 1)$	-15.66	–	22.62	0.96	0.76	8.68
... sales:	$(\gamma, \sigma, \varphi) = (0, 1, 0)$	-15.64	–	22.26	0.98	0.07	7.66
... Massachusetts:	$(\gamma, \sigma, \varphi) = (1/3, 1/3, 1/3)$	-15.67	–	20.91	0.92	3.28	9.44
... double sales:	$(\gamma, \sigma, \varphi) = (1/4, 1/2, 1/4)$	-15.66	–	21.36	0.95	2.24	8.88