Company Tax Reform with a Water's Edge*

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Abstract: Applying a three country model with profit shifting and FDI of multinational enterprises (MNEs), this paper analyzes the effects of a transition from a corporate income tax system based on separate accounting (SA) towards a system in which two countries form a formula apportionment (FA) union, while the third country sticks to SA (water's edge). In the short-run, for given national tax rates, the transition reduces overall profit shifting and FDI from the FA union to non-participating tax havens. The basic insight emerging from a long-run tax competition analysis is that, while under SA corporate income tax rates are inefficiently low in all countries, FA inter alia causes a water's edge externality which may lead to inefficient overtaxation in the FA countries.

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1 Introduction

At an international level, corporate income taxation is based on separate accounting (SA) principles. Profit of a multinational enterprise (MNE) is assigned to the state where it is earned using standard accounting methods. Taking advantage of this legislation, MNEs are well documented distorting transfer prices and the debt-equity structure to shift income from high-tax to low-tax countries in order to reduce their overall tax burden (e.g. Hines, 1999). Owing to such profit shifting activities of MNEs, corporate income tax policy causes a fiscal externality, as governments have an incentive to reduce their corporate tax rates, thereby attracting profit from abroad and improving the national tax base. The negative effect on the tax bases of other countries is ignored implying that the governments engage in a race-to-the-bottom with inefficiently low tax rates on corporate income (e.g. Mintz, 1999).

On a national level, several countries tax multiregional companies applying a formula apportionment (FA) regime instead of SA. Under FA, the corporate income of a multiregional company is consolidated and allocated to the tax regions according to a certain formula, for example, a combination of the capital, payroll and sales shares of the company in the regions. Prominent examples of FA systems are the corporate income taxation on state and province level in the US and Canada, respectively, and the German local business tax ("Gewerbesteuer"). Moreover, the European Commission (2001) proposed to replace the SA principles by a FA regime within EU-borders. Due to the consolidation of tax bases, the central advantage of FA over SA is usually seen in the abolishment of profit shifting incentives of MNEs and, in consequence, the erasement of the fiscal externality mentioned above (McLure, 1980, Mintz, 1999).

This argument implicitly supposes that the headquarters and affiliates of MNEs are located in countries joining the FA union. In reality, however, many MNEs headquartered in a FA union run subsidiaries in countries outside the union. Given the growing importance of international (intra-firm) trade and FDI, this connection between a FA union and the outside world is not a minor issue. FDI of US multinational companies, for example, amounted to 2,063 billion US dollar in 2003 (OECD, 2004), FDI of Canadian and German MNEs to 312 and 718 billion US dollar, respectively. Similarly, if the EU introduced FA, the outside connection to non-EU countries would be substantial as a large part of the member countries' FDI is located outside Europe.

The borders of a FA union are called "water's edge", a concept shaped in the US 20 years ago when world wide corporate income consolidation was abandoned on political pressure of non-US states. Subsequently, corporate income has been consolidated within US borders only and affiliates overseas have been linked to their US parents by SA. The water's edge regulation is also part of the European Commission's FA proposal. If the EU decided to form a FA union, European MNEs would stay linked to non-European affiliates by means of SA. The water's edge regulation implies that profit shifting channels to countries outside the FA union remain open. Politicians and economists thus expressed reservations that income shifting to affiliates located in countries outside a FA union (including tax havens) undermines the aim of FA regarding the reduction of profit shifting. For example, McLure and Weiner (2000) state that " . . . world-wide unitary combination might need to be considered as an option for . . ." solving the limitations of the water's edge.

The aim of this paper is to investigate the taxation of MNEs under FA in the presence of a water's edge. We develop a model with three countries. Each country hosts a MNE which runs a headquarter in the home country and subsidiaries in the other two countries. A MNE decides on investment in each of its entities and may shift profit by transfer pricing methods. The parent company delivers service goods to its subsidiaries abroad. The transfer price of these goods is not observable to tax authorities and, therefore, the MNE may under- or overstate the price in order to shift profit between the headquarter and subsidiaries. Profit shifting is assumed to entail convex concealment cost. Within this framework, we analyze the effects of a transition from a pure SA system to a system in which two countries form a FA union and the third country sticks to SA. In the FA union, tax bases are consolidated and apportioned to member countries according to the MNEs' relative investment shares. The analysis is carried out under different assumptions regarding the time horizon. In the short-run, corporate tax rates are taken as given, while in the long-run the governments may react to the introduction of FA by adjusting their tax policy.

The basic insight emerging from the short-run analysis is that the MNEs' overall volume of profit shifted to and FDI in non-participating tax havens *diminishes* with the formation of a FA union. This result may seem counterintuitive since MNEs might be expected to substitute eliminated profit shifting opportunities to low-tax FA members by a more intense shifting to low-tax countries outside the union. But MNEs do not shift fixed volumes of profit and rather tie their shifting decision to the tax rate differential between home and host countries. Since all corporate income earned within a FA union is taxed at the average of the national tax rates weighted by the relative investment shares, introducing FA increases (decreases) the tax rate differential between the lower-tax (higher-tax) country within the FA union and a non-participating tax haven. Profit shifting and FDI from the lower-tax FA country to the tax haven thus increases, indeed, but shifting and FDI from the higher-tax FA country to the tax haven is reduced. The latter effect dominates as investment in the lower-tax FA country is more attractive than investment in the higher-tax FA country and the weighted average tax rate within the union is biased towards the lower national tax rate.

While this insight of the short-run analysis suggests that a FA system with a water's edge regulation alleviates the profit shifting problems observed under SA, the picture drawn from the long-run analysis is less optimistic. We consider a tax competition game where each country maximizes its tax revenue with respect to the corporate income tax rate. Under SA we obtain the usual race-to-the bottom caused by a positive profit shifting externality. The transition from SA to FA removes this fiscal externality, but at the same time introduces two other distortions. First, a rise in the tax rate of one FA country provides the MNEs the incentive to invest less in that country and more in the other FA country since, by the apportionment formula, this lowers the weighted average tax rate the MNEs face in the FA union. As a consequence, the tax base in the other FA country rises and thereby establishes a positive fiscal externality which may be called formula externality and which points into the same direction as the profit shifting externality under SA. Second, if a FA country increases its national tax rate, for given investment levels, the MNEs' weighted average tax rate in the FA union increases, too. Hence, the tax rate differential to low-tax (high-tax) non-FA countries rises (falls) so that profit shifting to (from) the non-FA country is intensified (lowered). This diminishes the taxable resources of all FA countries. Hence, in the long-run, the water's edge causes a negative fiscal externality which may render corporate income tax rates in the FA union inefficiently high.

The economic literature provides several studies investigating the effects of FA under a short-run perspective, for example, McLure (1980), Weiner (1994), Mintz (1999), Mintz and Smart (2004) and Nielson et al. (2003). But all these articles assume either a pure SA and/or a pure FA system and do not capture interactions between FA union and non-union countries. Hence, in contrast to our analysis, they do not address the question whether in the presence of a water's edge the transition from SA to FA increases or decreases profit shifting to tax havens outside the FA union. Moreover, there are several articles which consider (long-run) tax competition under FA, for instance, Gordon and Wilson (1986), Pethig and Wagener (2003), Eggert and Schjelderup (2003) and Kind et al. (2005). Our paper is related most closely to Nielsen et al. (2004) and Sørensen (2003, 2004). Similar to our results under FA, the authors derive a positive formula externality and a negative fiscal externality which may lead to inefficient overtaxation. However, the mechanism underlying their negative fiscal externality is different to the one in our model. While in Nielsen et al. (2004) and Sørensen (2003, 2004) an increase in the tax rate of one FA country reduces the MNE's global capital stock and therefore the tax base in other FA countries, our negative fiscal externality is caused by the presence of the water's edge.

The paper is organized as follows. In Section 2, we present the basic model and characterize the MNEs' profit maximization under SA and FA. Section 3 analyzes the short-run effects of introducing a FA system, while Section 4 considers the long-run tax competition game. Section 5 summarizes and presents some policy conclusions.

2 Model

We consider a model with three small countries labeled by a, b and c. For notational convenience, let $N = \{a, b, c\}$ be the set of all countries and $N^i = N/\{i\}$ be the set of all countries except for country i with $i \in N$. Each country hosts a MNE which owns two subsidiaries located in the other countries. The MNEs are identical in structure. They have access to a market of internationally mobile capital and produce an output using capital as input in each country. Let subscripts denote the country where a MNE has its headquarter and superscripts the country where the economic activity takes place. Accordingly, k_i^j is the investment of MNE i in country j. The capital stock in all countries depreciates at the same rate δ so that the user cost of a unit of capital is $r = \tilde{r} + \delta$ where $\tilde{r}$ denotes the given world interest rate. The output of MNE

i in country j is given by the production functions $F(k_i^j)$ with the standard properties $F'(k_i^j) > 0$ and $F''(k_i^j) < 0$. We suppose the derivatives of the production functions are monotone. It then follows that $F'''(k_i^j) > 0$ (Manegatti, 2001).

The MNEs may shift profit between their headquarters and entities by transfer pricing methods. Previous articles basically uses two approaches to model transfer pricing. The first assumes that the headquarter of MNE i delivers one unit of an input or overhead good to the entity in country $j \in N^i$. The true transfer price of the good is normalized to unity and cannot directly be observed by the tax authorities. Hence, MNE i may overstate or understate the transfer price and declare unit cost equal to p_i^j in order to reduce total tax payments of the corporation. If MNE i overstates (understates) the transfer price, it shifts profit $p_i^j - 1$ from the entity in j to the headquarter (from the headquarter to the entity in j). This one-good approach is used, for example, by Haufler and Schjelderup (2000). The second possibility to model transfer pricing supposes profit shifting opportunities to depend on capital investment in the affiliates. Formally, the volume of profit shifted by MNE i from or to the entity in country j equals $(p_i^j - 1)k_i^j$. A possible interpretation is that MNEs trade one unit of the service good per unit of capital between the headquarter and the affiliate. This modeling can be found, for example, in Sørensen (2003, 2004). To capture both approaches to transfer pricing, we assume that MNE i's profit shifting with respect to the affiliate in country j equals

$$s_i^j = (p_i^j - 1)(k_i^j)^\alpha \quad \text{with} \quad \alpha \in \{0, 1\}. \tag{1}$$

For $\alpha = 0$ ($\alpha = 1$) we obtain the first (second) approach to profit shifting described above. Note that $\alpha(k_i^j)^{\alpha-1} = \alpha$ as $\alpha \in \{0, 1\}$.

Transfer pricing involves a concealment cost. This cost may reflect the corporation's risk of being detected and the associated expected penalty payment (e.g. Kant, 1988) or the effort cost of effectively hiding the true transfer price from tax authorities (e.g. Huber, 1997, Haufler and Schjelderup, 2000). The concealment cost of MNE i for shifting corporate income between the headquarter and the entity in country $j \in N^i$ is given by $Q(p_i^j)(k_i^j)^\alpha$ with $\alpha \in \{0, 1\}$. For $\alpha = 0$, the concealment cost reduces to $Q(p_i^j)$ since profit shifting does not depend on investment in country j. We assume that the cost function Q satisfies

$$Q(1) = 0, \quad \text{sign}\{Q'(p_i^j)\} = \text{sign}\{p_i^j - 1\}, \quad Q''(p_i^j) > 0, \tag{2}$$

$$Q(1 - \varepsilon) = Q(1 + \varepsilon) \quad \text{for all} \quad \varepsilon > 0. \tag{3}$$

(2) states that the concealment cost is convex with a minimum at the point $p_i^j = 1$ where the firm honestly reports the true transfer price. According to (3), the concealment cost function is symmetric, i.e. the cost of profit shifting are independent of the shifting direction. For $\alpha = 1$, the concealment cost additionally depends on FDI in country j as profit shifting is influenced by this investment, too.

In each country, the MNEs have to pay a corporate income tax. The tax rates and the precise rules of taxation will be explained below. For the time being, only the tax bases of the MNEs have to be specified. We assume that the concealment cost cannot be deducted from the tax base, while the user cost of capital is fully tax deductible. The tax base of MNE $i \in N$ in the home country can then be written as

$$\pi_i^{it} = F(k_i^i) - rk_i^i + \sum_{j \in N^i} s_i^j, \tag{4}$$

while the tax base of MNE $i \in N$ in the host country of its entity $j \in N^i$ amounts to

$$\pi_i^{jt} = F(k_i^j) - rk_i^j - s_i^j. \tag{5}$$

According to (4) and (5), the MNE's tax base equals pre-tax profit corrected by profit shifting. The full deductibility of capital cost implies that, in the absence of transfer pricing and FA, the corporate tax is a non-distortionary profit tax. This assumption enables us to focus solely on the distortions caused by profit shifting and FA which are the main interest of our paper.[1] The non-deductibility of concealment cost is mostly consistent with the interpretation of these cost representing detection risk and penalty payment. Nevertheless, our results would qualitatively remain unchanged, if we made the concealment cost tax deductible.[2]

[1]The distortions resulting from a non or partial deductibility of capital user cost are already well known from previous articles referred to in the Introduction.

[2]In previous articles, there is no uniform modeling with regard to the tax deductibility of concealment cost. While Haufler and Schjelderup (2000) assume concealment cost not to be tax deductible, Sørensen (2004) subtracts them from the tax base.

Having introduced the basic assumptions of the model, the following paragraphs characterize the MNEs' profit maximizing behavior under different tax regimes. As benchmark, we start with a SA system and turn to FA afterwards.

Separate Accounting

Under SA, profit is taxed in the country where it accrues. Denoting the tax rate in country i by $\tau^i \in]0,1[$, after-tax (pre-concealment cost) profit of MNE $i \in N$ in country $j \in N$ amounts to

$$\pi_i^j = (1-\tau^j)\pi_i^{jt}. \tag{6}$$

Summing up the profit of the headquarter and the affiliates and subtracting the concealment cost yields total profit of MNE $i \in N$, i.e.

$$\pi_i = \sum_{j\in N} \pi_i^j - \sum_{j \in N^i} Q(p_i^j)(k_i^j)^\alpha. \tag{7}$$

MNE $i \in N$ chooses k_i^j for $j \in N$ and p_i^j for $j \in N^i$ to maximize the overall company profit. Differentiating (7) and taking into account (1) and (4) – (6), we obtain the first-order conditions

$$Q'(\tilde{p}_i^j) = \tau^j - \tau^i, \qquad j \in N^i, \tag{8}$$

$$F'(\tilde{k}_i^i) = r, \tag{9}$$

$$F'(\tilde{k}_i^j) = r + \frac{\alpha\big[Q(\tilde{p}_i^j) - (\tilde{p}_i^j - 1)Q'(\tilde{p}_i^j)\big]}{1-\tau^j}, \qquad j \in N^i, \tag{10}$$

for all $i \in N$. The tilde indicates profit maximizing values under SA. (8) states that MNE i sets the transfer price for the service goods delivered to the entity j such that the marginal concealment cost equals the marginal gain from profit shifting, i.e. the tax rate differential between host country j and home country i. Hence, if the tax rate in j exceeds the tax rate in i, the marginal concealment cost will be positive. The MNE i overstates the transfer price and shifts profit from the entity in j to the headquarter. If the tax rate in j falls short of the tax rate in i, MNE i will have an incentive to understate the transfer price and shift profit from the headquarter to the affiliate in j.

Equations (9) and (10) characterize MNE i's optimal investment decisions. According to (9), capital investment in the home country is undistorted. The marginal return to investment equals the user cost of capital, as the corporate income tax is modeled as a pure profit tax. The same is true for MNE i's host country investment, provided that the volume of profit shifted does not depend on capital investment at an affiliate's location, i.e. $\alpha = 0$. Formally, the last term in (10) becomes zero and MNE i's optimal investment equates the marginal return to investment and the user cost of capital. However, for $\alpha = 1$ the profit tax distorts MNE i's FDI in country j. In this case, the MNE has an incentive to increase investment in foreign affiliates in order to improve shifting opportunities from or to this affiliate. Formally, the last term in (10) is negative due to $\alpha = 1$ and $Q''(\cdot) > 0$ and, thus, tends to raise $\tilde{k}_i^j$ ceteris paribus.

Formula Apportionment with a Water's Edge

Suppose countries a and b form a FA union, while country c sticks to SA. Let $U = \{a, b\}$ be the set of FA countries. Corporate taxation regulates countries a and b to consolidate their corporate tax base and apportion it according to the relative capital investment shares. The MNEs' tax burdens are calculated by multiplying the respective tax bases with the national corporate tax rate. The tax base in country c is calculated on the grounds of SA and then multiplied by the national tax rate in country c. Thus, the after-tax (pre-concealment cost) profit of MNE $i \in N$ in the FA country $j \in U$ reads

$$\pi_i^j = \pi_i^{jt} - \tau^j \frac{k_i^j}{k_i^a + k_i^b}(\pi_i^{at} + \pi_i^{bt}). \tag{11}$$

The after-tax (pre-concealment cost) profit of MNE $i \in N$ in country c amounts to

$$\pi_i^c = (1 - \tau^c)\pi_i^{ct}. \tag{12}$$

From (11) and (12) and the concealment cost, total profit of the MNE $i \in N$ becomes

$$\pi_i = (1 - \tau_i)(\pi_i^{at} + \pi_i^{bt}) + (1 - \tau^c)\pi_i^{ct} - \sum_{j \in N^i} Q(p_i^j)(k_i^j)^\alpha, \tag{13}$$

where

$$\tau_i = \frac{\tau^a k_i^a + \tau^b k_i^b}{k_i^a + k_i^b} \tag{14}$$

is the weighted average tax rate MNE i faces in the FA countries. The weights equal the investment shares of MNE i in countries a and b, respectively.

The profit maximization problems of MNEs a and b, on the one hand, and of MNE c, on the other hand, are structurally different. According to (13), MNE c's profit earned in its home country is taxed at rate τ^c, while profit earned in the host countries of its subsidiaries is taxed at the average tax rate τ_c. In contrast, for the MNEs a and b profit earned in the home country is taxed at the average tax rate τ_a and τ_b, respectively, while income earned in the host country c is taxed at rate τ^c. Therefore, in characterizing the MNEs' profit maxima, we have to distinguish between MNEs headquartered in the FA union and the MNE headquartered in country c. The analysis starts with profit maximization of MNEs a and b. Differentiating (13) and taking into account (1), (4), (5), (11), (12) and (14), we obtain for every $i \in U$ the first-order conditions

$$Q'(\hat{p}_i^j) = 0, \qquad j \in U,\ j \neq i, \tag{15}$$

$$Q'(\hat{p}_i^c) = \tau^c - \tau_i, \tag{16}$$

$$F'(\hat{k}_i^i) = r + \frac{\tau^i - \tau^j}{1-\tau_i} \frac{\hat{k}_i^j}{(\hat{k}_i^a + \hat{k}_i^b)^2} (\pi_i^{at} + \pi_i^{bt}), \tag{17}$$

$$F'(\hat{k}_i^j) = r + \frac{\tau^j - \tau^i}{1-\tau_i} \frac{\hat{k}_i^i}{(\hat{k}_i^a + \hat{k}_i^b)^2} (\pi_i^{at} + \pi_i^{bt}), \qquad j \in U,\ j \neq i, \tag{18}$$

$$F'(\hat{k}_i^c) = r + \frac{\alpha\big[Q(\hat{p}_i^c) - (\hat{p}_i^c - 1)Q'(\hat{p}_i^c)\big]}{1-\tau^c}, \tag{19}$$

where the hat indicates the solution under FA. (15) shows the conventional wisdom that there is no profit shifting within a FA union, i.e. $\hat{p}_i^j = 1$ for $i, j \in U$ and $j \neq i$. FA eliminates the incentive for misreporting the true transfer price since the tax base is consolidated. Nevertheless, due to the water's edge regulation, profit shifting will still take place between the headquarters located in FA countries and affiliates located in countries that stick to SA, as can be seen from (16). In contrast to the pure SA system, the transfer price now depends on the difference between the tax rate in country c and the average tax rate of MNE i. The reason is that all corporate income generated within the FA union is taxed at the average, not the national tax rate.

The optimal investment decisions of MNEs headquartered within the FA union are described by (17) – (19). Compared to a pure SA system, the first-order condition with respect to investment in country c remains qualitatively unchanged because as country c sticks to SA. This can be seen by comparing (19) – (10) for $j = c$. In contrast, the optimality conditions for investment in the FA countries change in two respects. First, since the profit shifting incentive is eliminated within the FA union, a MNE's additional investment in other FA countries to improve profit shifting opportunities becomes obsolete. Formally, the second term in (10) drops out in (18). Second, tax base allocation by FA creates an investment distortion which is reflected by the second term in (17) and (18). Companies can reduce their tax liabilities by increasing (reducing) their investment in the FA country with the lower (higher) corporate tax rate as this positively influences their average tax rate within the FA union.

For further use, it is helpful to highlight some important properties of the profit maximizing solutions of MNE a and MNE b. It is straightforward to show that the solution to (15) – (19) for $i = a$ is also a solution of (15) – (19) for $i = b$, i.e.

$$\hat{k}_a^a = \hat{k}_b^a =: \hat{k}^a, \quad \hat{k}_a^b = \hat{k}_b^b =: \hat{k}^b, \quad \hat{k}_a^c = \hat{k}_b^c =: \hat{k}^c, \quad \hat{p}_a^c = \hat{p}_b^c =: \hat{p}^c, \quad \hat{p}_a^b = \hat{p}_b^a = 1, \tag{20}$$

$$\pi_a^{at} + \pi_a^{bt} = \pi_b^{at} + \pi_b^{bt} = \sum_{j \in U} \left[F(\hat{k}^j) - r\hat{k}^j \right] + (\hat{p}^c - 1)(\hat{k}^c)^\alpha =: \hat{\pi}, \tag{21}$$

$$\tau_a = \tau_b = \frac{\tau^a \hat{k}^a + \tau^b \hat{k}^b}{\hat{k}^a + \hat{k}^b} =: \hat{\tau}. \tag{22}$$

According to (20), MNE a chooses the same investment levels in countries a, b, and c and the same transfer prices as MNE b does. As a consequence, both MNEs have the same consolidated tax base in the FA union, $\hat{\pi}$ defined in (21), and face the same average tax rate in the FA union, $\hat{\tau}$ defined in (22). $\hat{\tau}$ can further be specified. Suppose $\tau^a > \tau^b$. (17) and (18) then imply $\hat{k}^a < \hat{k}^b$ and $\hat{\tau}$ lies in the interval $]\tau^b, (\tau^a + \tau^b)/2[$. For $\tau^a < \tau^b$, we obtain $\hat{k}^a > \hat{k}^b$ and $\hat{\tau} \in]\tau^a, (\tau^a + \tau^b)/2[$. In sum,

$$\hat{\tau} \in] \min\{\tau^a, \tau^b\}, (\tau^a + \tau^b)/2[. \tag{23}$$

The common average tax rate $\hat{\tau}$ of MNE a and MNE b is biased towards the lower national tax rate within the FA union. The rationale is that as MNEs invest more capital in the low-tax FA country, the lower tax rate is weighted overproportionally in the calculation of the MNEs' common average tax rate.

Let us now turn to the profit maximization problem of the MNE headquartered in the non-FA country c. Differentiating (13) for $i = c$ yields the first-order conditions

$$Q'(\hat{p}_c^a) \;\; = \;\; \tau_c - \tau^c, \tag{24}$$

$$Q'(\hat{p}_c^b) = \tau_c - \tau^c, \tag{25}$$

$$F'(\hat{k}_c^a) = r + \frac{\tau^a - \tau^b}{1-\tau_c}\frac{\hat{k}_c^b}{(\hat{k}_c^a + \hat{k}_c^b)^2}(\pi_c^{at} + \pi_c^{bt}) + \frac{\alpha\big[Q(\hat{p}_c^a) - (\hat{p}_c^a - 1)Q'(\hat{p}_c^a)\big]}{1-\tau_c}, \tag{26}$$

$$F'(\hat{k}_c^b) = r + \frac{\tau^b - \tau^a}{1-\tau_c}\frac{\hat{k}_c^a}{(\hat{k}_c^a + \hat{k}_c^b)^2}(\pi_c^{at} + \pi_c^{bt}) + \frac{\alpha\big[Q(\hat{p}_c^b) - (\hat{p}_c^b - 1)Q'(\hat{p}_c^a)\big]}{1-\tau_c}, \tag{27}$$

$$F'(\hat{k}_c^c) = r. \tag{28}$$

As indicated by (24) and (25), the water's edge regulation implies that MNE c still has an incentive to shift profit between its headquarter and the subsidiaries in the FA countries a and b. In contrast to the pure SA system, however, the extent of the resulting profit shifting depends on the difference between the tax rate in c and the average tax rate MNE c faces in the FA union. Since MNE c still shifts income from or to its affiliates in countries a and b, it has an incentive to increase FDI in these countries (if $\alpha = 1$). This incentive is reflected by the last term on the RHS of (26) and (27). In addition, MNE c faces the same formula manipulation incentive as the MNEs headquartered in the FA union. It can manipulate the formula by increasing (decreasing) FDI in the low-tax (high-tax) FA country. This incentive is represented by the second term on the RHS of (26) and (27).

(24) and (25) immediately imply that MNE c charges the same transfer price to its entities in a and b (as both subsidiaries are taxed with the average tax rate τ_c), i.e.

$$\hat{p}_c^a = \hat{p}_c^b =: \hat{p}_c. \tag{29}$$

Furthermore, similar to the results for MNE a and MNE b we obtain

$$\tau_c \in]\min\{\tau^a, \tau^b\}, (\tau^a + \tau^b)/2[. \tag{30}$$

Hence, MNE c's average tax rate in the union is closer to the tax rate of the low-tax FA country than to the tax rate of the high-tax FA country.

3 Short-Run Analysis: Given National Tax Rates

By comparing the results under SA and FA derived in the previous section, it can be analysed what effect the transition from SA to FA has on the profit shifting activities of the MNEs. In this section, we will first run a short-term analysis, assuming that national tax rates remain unaffected by the transition from SA to FA. Even if governments may adjust national tax rates, the legislative process usually will take a considerable time period during which the statutory tax rates remain unaltered.

Without loss of generality, the national tax rate in the FA country a is assumed to exceed the national tax rate in the FA country b. Furthermore, we almost exclusively focus on the most interesting case that the non-participating country c is a tax haven, i.e. the national tax rate in country c falls short of those in the FA union. Under SA, $\tau^a > \tau^b > \tau^c$ and (8) imply that both MNE a and MNE b shift profit from their headquarters to the subsidiaries in country c. Shifting is higher for MNE a than for MNE b since the tax rate differential between the countries a and c is larger than the differential between countries b and c. Appendix A proves

Proposition 1. *Suppose $\tau^a > \tau^b > \tau^c$. Then the transition from SA to FA increases profit shifting of MNE b to country c, but reduces profit shifting of MNE a to country c. It leaves unaltered investment of MNE a and MNE b in country c, if $\alpha = 0$. In case of $\alpha = 1$, the transition from SA to FA increases investment of MNE b in country c, but reduces investment of MNE a in country c.*

Proposition 1 shows that the introduction of FA does not necessarily induce a MNE headquartered in FA countries to increase profit shifting to non-FA tax havens. While MNE b shifts more income to country c, profit shifting of MNE a to country c declines. The latter effect seems counterintuitive since the introduction of FA eliminates any shifting opportunity between FA countries and one might expect that the MNEs fall back on transfer pricing channels to countries outside the union. But MNEs do not shift a fixed volume of income no matter to which affiliate. Instead, the extent of profit shifting is determined by the tax rate differentials, and FA itself changes these differentials. While under SA, MNE b's home country profit is taxed by the national tax rate τ^b, this profit is taxed by the average tax rate $\hat{\tau} > \tau^b$ under FA. The introduction of FA thus increases the difference to the tax rate in country c and, consequently, MNE b extends income shifting to the tax havens in country c. This argument is reversed for MNE a. Under SA it faces the national tax rate τ^a in its home country, while under FA its home country profit is taxed at the average tax rate $\hat{\tau} < \tau^a$. Hence, the tax rate difference to country c declines and MNE a shifts less profit out of the FA union.

Proposition 1 also proves that the introduction of FA leaves unchanged investment of MNE a and MNE b in country c, if the transfer pricing decision is independent of the investment decision ($\alpha = 0$). However, provided the transfer pricing opportunities are increasing in investment at the affiliate's location ($\alpha = 1$), investment in country c is positively correlated with the volume of profit shifted to country c. MNE b thus increases its FDI in country c to enable a higher volume of income shifting to country c, while MNE a restricts its FDI in country c due to a reduced shifting incentive. The transition from SA to FA therefore does not necessarily induce a MNE headquartered in the FA union to raise its FDI in non-FA countries.

The opposite effects on the behavior of MNE a and MNE b immediately raise the question how the sum of profit shifting and the sum of investment of MNE a and MNE b in country c are affected by the introduction of FA. In Appendix B, we show

Proposition 2. *Suppose $\tau^a > \tau^b > \tau^c$ and $Q''' \geq 0$. Then the transition from SA to FA reduces total profit shifting of MNE a and MNE b to country c. If $\alpha = 0$ ($\alpha = 1$), total investment of MNE a and MNE b in country c remains constant (falls).*

Proposition 2 states that the introduction of FA reduces total profit shifting of MNEs headquartered in the FA union to non-FA tax havens. The rationale of this result can best be explained, if we first focus on the special case $\alpha = 0$ and $Q''' = 0$. For $\alpha = 0$ profit shifting is solely determined by the transfer price. By the assumption $Q''' = 0$ we ignore second-order effects since the marginal concealment cost is linear in the transfer price. According to (8) and (16), a change in the tax rate differential between the FA countries and country c then leads to a proportional change in transfer prices and the associated profit shifting. Moreover, we know from (23) and $\tau^a > \tau^b > \tau^c$ that the introduction of FA decreases the tax rate differential of MNE a by more than it increases the tax rate differential of MNE b. The reduction in profit shifting of MNE a therefore more than outweighs the increase in profit shifting of MNE b and total profit shifting of both MNEs to country c declines. This line of reasoning also holds for $Q''' > 0$ despite the presence of second-order effects. The marginal concealment cost is now convex in the transfer price ensuring that the decline in profit shifting of MNE a remains absolutely higher than the rise in profit shifting of MNE b. We can generalize the result even to the case of $\alpha = 1$ where profit shifting depends on investment. Due to (10), (19) and $F''' > 0$, a change in the transfer price induces an overproportional change in FDI in country c since the marginal return to investment is convex. Employing the same argument as above, total investment of MNE a and MNE b in country c goes down and the result with respect to profit shifting prevails.

Proposition 2 cannot be generalized to the case $Q''' < 0$. As the marginal concealment cost is now concave in the transfer price, it cannot be excluded that the increase in profit shifting of MNE b dominates the reduction in profit shifting of MNE a. Nevertheless, by simple graphical illustrations it can be shown that total shifting and investment to country c increase only if the weighted average tax rate $\hat{\tau}$ is close to the unweighted average tax rate $(\tau^a + \tau^b)/2$. The difference in the national tax rates of countries a and b is then quite small.[3] But under this condition, the governments of the union countries would have less incentives to introduce FA, as profit shifting activities within the union are limited. In fact, FA is discussed as an option for taxing MNEs in Europe mainly because national tax rates differ widely and all harmonization efforts had little success (Sørensen, 2004). Hence, even in case $Q''' < 0$, total profit shifting of MNE a and MNE b to non-FA tax havens is expected to decline.

So far we focused on the effects of FA on the behavior of MNEs headquartered in the FA union. Tax havens usually do not host MNEs so that ignoring MNE c is a suitable procedure. Nevertheless, the FA regimes in the US, Canada and Germany as well as the planned FA system in the EU face low-tax non-participating countries which are not typical tax havens and which host MNEs. This raises the question whether including the effects of FA on the behavior of MNE c changes our conclusions obtained from Proposition 1 and 2. In contrast to MNE a and MNE b, a general analysis is difficult as the investment decisions of MNE c in the host countries of its entities is not only distorted by profit shifting, but according to (26) and (27) also by the apportionment formula. However, for a special case Appendix C proves

Proposition 3. *Suppose $\tau^a > \tau^b > \tau^c$, $Q''' \leq 0$ and $\alpha = 0$. Then the transition from SA to FA reduces total profit shifting of MNE c from the FA union to country c.*

[3] To see this, we have to plot s_i^c as a function of x_i. This function is falling due to $H(x_i) < 0$. The curvature is $H'(x_i)$ determined by (B.2). For $Q''' < 0$ the sign of $H'(x_i)$ is ambiguous. If $H'(x_i) < 0$, then s_i^c is concave in x_i and we obtain the same result as in Proposition 2. If $Q''' < 0$ induces $H'(x_i) > 0$, s_i^c is convex in x_i. Then, $ds_a^c + ds_b^c < 0$ only if $\hat{\tau} \approx (\tau^a + \tau^b)/2$ or, equivalently, $\tau^a \approx \tau^b$.

Proposition 3 shows that the insight of Proposition 2 is qualitatively also true for the MNE headquartered in the non-FA country. If country c is the low-tax country, MNE c transfers income from the subsidiaries in the union countries to the headquarter. Introducing a FA regime in countries a and b reduces this profit shifting. The intuition is basically the same as in Proposition 2. The only difference is that second-order effects are now negligible for $Q''' < 0$ because the tax rate differentials enter the shifting decision of MNE c with the opposite sign compared to the decisions of MNEs a and b. However, for $Q''' > 0$ we can again show that the result of Proposition 3 is reversed only if the tax rates in country a and b are almost equal. As argued above, in this case it is questionable that countries a and b introduce a FA regime at all.

We obtain similar results, if the national tax rate in the non-participating country c exceeds those in the union countries a and b ($\tau^c > \tau^a > \tau^b$). The MNEs then shift income into the union and FA tends to intensify this shifting.[4] Hence, the basic insight of our short-run analysis is that the transition from a pure SA tax system to a FA regime with a water's edge regulation changes the profit shifting behavior of MNEs *in favor* of the countries joining the FA union.

4 Long-Run Analysis: Tax Competition

Constant national tax rates are sustainable only in the short-run. In the long-run, governments adjust their corporate income tax rates in reaction to the introduction of a FA system. In this section, we consider a (Nash) tax competition game in which every government sets its tax rate in order to maximize a certain objective function. Due to the complexity of our model, we restrict attention to the case where governments maximize their tax revenue. In doing so, the governments take into account the impact of their tax policy on capital investment and profit shifting of the MNEs.

Separate Accounting

As benchmark let us again start with the case of a pure SA tax system. A country's revenue from corporate income taxation equals the tax rate times the taxable income earned by the three MNEs in that country. The tax revenue of country $i \in N$ can

[4] A formal proof of this assertion can be obtained from the authors upon request.

therefore be written as

$$R^i(\tau^a,\tau^b,\tau^c) \;=\; \tau^i \sum_{j\in N} \pi_j^{it} \;=\; \tau^i \Big[F(\tilde{k}_i^i) - r\tilde{k}_i^i + \sum_{j\in N^i} (\tilde{p}_i^j - 1)(\tilde{k}_i^j)^\alpha\Big]$$

$$+\; \tau^i \sum_{j\in N^i} \Big[F(\tilde{k}_j^i) - r\tilde{k}_j^i - (\tilde{p}_j^i - 1)(\tilde{k}_j^i)^\alpha\Big], \qquad (31)$$

where $\tilde{k}_i^i$, $\tilde{k}_i^j$, $\tilde{k}_j^i$, $\tilde{p}_i^i$, $\tilde{p}_i^j$ and $\tilde{p}_j^i$ depend on the tax rates τ^a, τ^b and τ^c according to (8) – (10). Country i maximizes this revenue with respect to the own tax rate τ^i, taking as given the tax rates τ^j, $j \in N^i$, chosen by the other countries. The first-order condition of revenue maximization by country $i \in N$ reads

$$\frac{\partial R^i(\tau^a,\tau^b,\tau^c)}{\partial \tau^i} = 0. \qquad (32)$$

Each country choose the tax rate that maximizes the Laffer curve. We assume that the tax revenue is concave in the tax rate so that (32) determines country i's best response on the tax rates chosen by the other countries.

Under SA, all MNEs are structurally identical. It follows that the countries are identical, too. It is then reasonable to focus on the symmetric Nash equilibrium of the tax competition game. Let $\tilde{\tau} = \tau^a = \tau^b = \tau^c$ be the equilibrium tax rate. Equilibrium tax revenue of country $i \in N$ can be written as

$$R^i(\tilde{\tau},\tilde{\tau},\tilde{\tau}) =: R(\tilde{\tau}). \qquad (33)$$

To find out whether the countries choose inefficiently high or low tax rates in equilibrium, we have to determine the impact of a coordinated increase in the common tax rate $\tilde{\tau}$ on the tax revenue of the countries. Differentiating (33) yields

$$\frac{dR(\tilde{\tau})}{d\tilde{\tau}} = \sum_{\ell\in N^i} \frac{\partial R^i(\tau^a,\tau^b,\tau^c)}{\partial \tau^\ell}\Big|_{\tau^a=\tau^b=\tau^c=\tilde{\tau}} \qquad (34)$$

where we used $\partial R^i(\cdot)/\partial\tau^i = 0$ according to (32). The cross effects $\partial R^i(\cdot)/\partial\tau^\ell$ reflect the fiscal externalities under SA. They show how the tax revenue of country i is influenced by the tax policy of the other countries $\ell \in N^i$.

To determine the sign of these fiscal externalities, we have to differentiate (31) with respect to τ^ℓ, $\ell \in N^i$. Using (8) – (10) it is straightforward to show that

$$\frac{\partial \tilde{k}_i^i}{\partial \tau^\ell} = 0, \qquad i \in N, \qquad (35)$$

$$\frac{\partial \tilde{k}_i^j}{\partial \tau^\ell} = \frac{\partial \tilde{p}_i^j}{\partial \tau^\ell} = 0, \qquad i,j \in N^\ell, \quad i \neq j. \qquad (36)$$

(35) holds since the corporate income tax is a pure profit tax and, thus, leaves undistorted investment of the MNEs in their home countries. According to (36), variations in the tax rate of one country do not change the investment flows and profit shifting between the other two countries. Taking this information into account, (31) yields

$$\begin{aligned}\frac{\partial R^i(\tau^a,\tau^b,\tau^c)}{\partial \tau^\ell} &= \tau^i\Bigg\{(\tilde{k}_i^\ell)^\alpha\frac{\partial \tilde{p}_i^\ell}{\partial \tau^\ell}+\alpha(\tilde{p}_i^\ell-1)\frac{\partial \tilde{k}_i^\ell}{\partial \tau^\ell}-(\tilde{k}_\ell^i)^\alpha\frac{\partial \tilde{p}_\ell^i}{\partial \tau^\ell} \\ &\qquad +\Big[F'(\tilde{k}_\ell^i)-r-\alpha(\tilde{p}_\ell^i-1)\Big]\frac{\partial \tilde{k}_\ell^i}{\partial \tau^\ell}\Bigg\}, \end{aligned} \tag{37}$$

for $i,\ell\in N$ and $i\neq\ell$. We have to evaluate (37) at the symmetric equilibrium. For identical tax rates $\tau^a=\tau^b=\tau^c=\tilde{\tau}$, there is no profit shifting since all transfer prices are equal to one, i.e. $\tilde{p}_i^j=1$ for $i,j\in N$ and $i\neq j$. Equations (9) and (10) then yield $F'(\tilde{k}_i^j)=r$ and $\tilde{k}_i^j=\tilde{k}$ for $i,j\in N$. Inserting in (37) gives

$$\frac{\partial R^i(\tau^a,\tau^b,\tau^c)}{\partial \tau^\ell}\Big|_{\tau^a=\tau^b=\tau^c=\tilde{\tau}} = \tilde{\tau}\tilde{k}^\alpha\left[\frac{\partial \tilde{p}_i^\ell}{\partial \tau^\ell}-\frac{\partial \tilde{p}_\ell^i}{\partial \tau^\ell}\right]=\frac{2\tilde{\tau}\tilde{k}^\alpha}{Q''(1)}>0, \tag{38}$$

for $i,\ell\in N$ and $i\neq\ell$. Note that we computed the impact of τ^ℓ on the transfer prices p_i^ℓ and p_ℓ^i by first differentiating (8) – (10) and then applying the symmetry assumption. Equation (38) states that in the symmetric equilibrium an increase in the tax rate of one country raises the tax revenue in the other countries. Using this in (34) implies that, starting from a symmetric Nash equilibrium of the tax competition game, all countries are better off by increasing the common tax rate. The equilibrium is thus characterized by inefficient undertaxation. We summarize this result in

Proposition 4. *Suppose the tax competition game under SA attains a symmetric Nash equilibrium $\tau^a=\tau^b=\tau^c=\tilde{\tau}$. Then the equilibrium tax rate $\tilde{\tau}$ is inefficiently small.*

Hence, under SA we obtain the standard race-to-the-bottom result. The reason is the profit shifting externality already mentioned in the introduction. A marginal increase in the corporate income tax rate of one country induces the MNEs to shift more income to the other countries. The country whose tax rate is increased ignores this cross effect and takes into account only the negative effect on its own tax base. As a consequence, corporate income tax rates in the Nash equilibrium of the tax competition game are inefficiently low. Formally, this profit shifting externality is represented by the terms $\partial\tilde{p}_i^\ell/\partial\tau^\ell$ and $\partial\tilde{p}_\ell^i/\partial\tau^\ell$ in (38). Since we start from the symmetric equilibrium, the externality works through the transfer price channel only. A marginal increase in the equilibrium tax rate does not exert a first-order effect on FDI at the margin, even if the profit shifting opportunities depend on investment in the host countries. Note that the inefficiency result of Proposition 4 holds with respect to the whole set of countries as well as with respect to any subset of countries.

Formula Apportionment with a Water's Edge

Let us finally turn to the tax competition game under FA. Assume again that countries a and b form a FA union, while country c sticks to SA. The revenue from the corporate income tax in the FA country $i \in U$ can now be written as

$$\begin{aligned} R^i(\tau^a, \tau^b, \tau^c) &= \tau^i \left[2 \frac{\hat{k}^i}{\hat{k}^a + \hat{k}^b} \hat{\pi} + \frac{\hat{k}_c^i}{\hat{k}_c^a + \hat{k}_c^b} (\pi_c^a + \pi_c^b) \right] \\ &= 2\tau^i \frac{\hat{k}^i}{\hat{k}^a + \hat{k}^b} \left[\sum_{j \in U} \left[F(\hat{k}^j) - r\hat{k}^j \right] + (\hat{p}^c - 1)(\hat{k}^c)^\alpha \right] \\ &\quad + \tau^i \frac{\hat{k}_c^i}{\hat{k}_c^a + \hat{k}_c^b} \sum_{j \in U} \left[F(\hat{k}_c^j) - r\hat{k}_c^j - (\hat{p}_c - 1)(\hat{k}_c^j)^\alpha \right]. \end{aligned} \tag{39}$$

The first term in (39) represents that part of the tax base of MNE a and MNE b which is apportioned to country i. The second term equals the respective part of MNE c's tax base. Tax revenue of the non-FA country c is computed as under SA, i.e.

$$\begin{aligned} R^c(\tau^a, \tau^b, \tau^c) &= \tau^c \sum_{j \in N} \pi_j^c = 2\tau^c \left[F(\hat{k}^c) - r\hat{k}^c - (\hat{p}^c - 1)(\hat{k}^c)^\alpha \right] \\ &\quad + \tau^c \left[F(\hat{k}_c^c) - r\hat{k}_c^c + \sum_{j \in U} (\hat{p}_c - 1)(\hat{k}_c^j)^\alpha \right]. \end{aligned} \tag{40}$$

The first-order conditions of the countries' revenue maximization problems are analogous to equation (32) under SA.

Under FA, it is not suitable to suppose a symmetric Nash equilibrium of the tax competition game. The countries differ as only a subset of countries join the FA union. Hence, we suppose that the FA countries choose the same tax rate $\tau^a = \tau^b = \tau^*$, while the non-FA country sets $\tau^c = \tau^o$. Tax revenue in this equilibrium are

$$R^a(\tau^*, \tau^*, \tau^o) = R^b(\tau^*, \tau^*, \tau^o) =: R^u(\tau^*, \tau^o), \qquad R^c(\tau^*, \tau^*, \tau^o) =: R^n(\tau^*, \tau^o). \tag{41}$$

Analogously to SA, we investigate whether the equilibrium tax rates are inefficiently low or high. Starting with the tax rate of the non-FA country c, the marginal effect on revenue of country c is zero, while the effect on revenue of the FA members reads

$$\frac{\partial R^u(\tau^*, \tau^o)}{\partial \tau^o} = \frac{\partial R^i(\tau^a, \tau^b, \tau^c)}{\partial \tau^c}\bigg|_{\tau^c=\tau^o}^{\tau^a=\tau^b=\tau^*} \tag{42}$$

for $i \in U$. The cross effect in (42) represents the fiscal externalities caused by the tax policy of the non-FA country. It shows how a marginal increase in the equilibrium tax rate of the non-FA country affects the tax revenue of the FA member countries.

To obtain the sign of this fiscal externality, note first that differentiating (15) – (19) and (24) – (28) and evaluating the results at $\tau^a = \tau^b = \tau^*$ and $\tau^c = \tau^o$ yields

$$\frac{\partial \hat{k}^i}{\partial \tau^c} = 0, \qquad i \in U, \tag{43}$$

$$\frac{\partial \hat{k}_c^a}{\partial \tau^c} = \frac{\partial \hat{k}_c^b}{\partial \tau^c}. \tag{44}$$

Similar to (36) under SA, (43) states that the tax rate of country c does not influence the investment flows between the other two countries. According to (44), the impact of τ^c on MNE c's FDI is identical for countries a and b, as in equilibrium the FA countries are identical. Moreover, $\tau^a = \tau^b = \tau^*$, (17) and (18) imply $\hat{k}^a = \hat{k}^b =: \hat{k}$. Similarly, (26), (27) and (29) yield $\hat{k}_c^a = \hat{k}_c^b =: \hat{k}_c$. Taking into account this information and differentiating (39), we obtain for $i \in U$

$$\begin{aligned}\frac{\partial R^i(\tau^a, \tau^b, \tau^c)}{\partial \tau^c}\bigg|_{\tau^c=\tau^o}^{\tau^a=\tau^b=\tau^*} &= \tau^* \bigg\{ (\hat{k}^c)^\alpha \frac{\partial \hat{p}^c}{\partial \tau^c} - (\hat{k}_c)^\alpha \frac{\partial \hat{p}_c}{\partial \tau^c} + \alpha(\hat{p}^c - 1)\frac{\partial \hat{k}^c}{\partial \tau^c} \\ &\quad + \Big[F'(\hat{k}_c) - r - \alpha(\hat{p}_c - 1)\Big] \frac{\partial \hat{k}_c^i}{\partial \tau^c} \bigg\}. \end{aligned} \tag{45}$$

In Appendix D, we show this expression to be positive and, thus, prove

Proposition 5. *Suppose the tax competition game under FA attains a Nash equilibrium with $\tau^a = \tau^b = \tau^*$ and $\tau^c = \tau^o$. Then τ^o is inefficiently small.*

Proposition 5 shows that under the FA system with a water's edge, we obtain the same undertaxation result for the non-FA country as in case of SA. In equilibrium, country c may increase revenue of the FA countries by marginally increasing its corporate income tax rate. The reason is again the profit shifting externality already explained in the SA analysis. However, a closer inspection of (38) and (45) indicates that the profit shifting externality is sharper under the FA system than under SA. Under SA, the externality works only through the transfer price channel. In the fully symmetric equilibrium, there is no profit shifting and, thus, the marginal increase in the common tax rate has no first-order effect on FDI. Formally, (38) does not contain derivatives of investment levels with respect to tax rates. In contrast, in the equilibrium under FA we still have profit shifting between FA countries and non-FA countries. Hence, if the profit shifting opportunities depend on investment ($\alpha = 1$), a marginal increase in tax rates exerts a first-order effect on the investment flows between the FA union members and the non-FA country. This can be seen at equation (45) which also reflects the impact of the tax rate τ^c on investment.

To evaluate the efficiency of the equilibrium corporate income tax rates of the FA countries, we have to determine the effects of a marginal increase in τ^* on the tax revenue of FA and non-FA countries. Formally, this impact is given by

$$\frac{\partial R^n(\tau^*, \tau^o)}{\partial \tau^*} = \sum_{j \in U} \frac{\partial R^c(\tau^a, \tau^b, \tau^c)}{\partial \tau^j}\Big|_{\tau^c=\tau^o}^{\tau^a=\tau^b=\tau^*}, \tag{46}$$

$$\frac{\partial R^u(\tau^*, \tau^o)}{\partial \tau^*} = \frac{\partial R^i(\tau^a, \tau^b, \tau^c)}{\partial \tau^j}\Big|_{\tau^c=\tau^o}^{\tau^a=\tau^b=\tau^*}, \qquad i, j \in U, \quad i \neq j, \tag{47}$$

where in (47) we used $\partial R^i(\cdot)/\partial \tau^i = 0$ for $i \in U$. The cross effects $\partial R^c(\cdot)/\partial \tau^j$, $j \in U$, can be shown to be identical to the cross effects $\partial R^i(\cdot)/\partial \tau^c$, $i \in U$, determined by (45). The reason is the water's edge stating that FA countries are connected to non-FA countries by means of SA. Hence, we again obtain a profit shifting externality which points into the same direction as under SA. The FA union members do not take into account that a tax rate increase improves the tax base in the non-FA country via profit shifting. However, to conclude that the tax rates of the FA countries are inefficiently low may be forejudged since the tax policy of one FA union member may also impose fiscal externalities on the other member. These externalities are captured by (47).

To determine the sign of (47) note first that (15) – (19) yields $\partial \hat{k}^i/\partial \tau^j = -\partial \hat{k}^j/\partial \tau^j$ for $i, j \in U$ and $i \neq j$. Remember $\hat{k}^a = \hat{k}^b =: \hat{k}$ and $\hat{k}^a_c = \hat{k}^b_c =: \hat{k}_c$ and let $\hat{\pi}_c := \pi^{at}_c + \pi^{bt}_c$. From (39), we obtain for $i, j \in U$ with $i \neq j$

$$\frac{\partial R^i(\tau^a, \tau^b, \tau^c)}{\partial \tau^j}\Big|_{\tau^c=\tau^o}^{\tau^a=\tau^b=\tau^*} = \tau^* \Bigg\{ \frac{\hat{\pi}}{2\hat{k}} \left[\frac{\partial \hat{k}^i}{\partial \tau^j} - \frac{\partial \hat{k}^j}{\partial \tau^j} \right] + \frac{\hat{\pi}_c}{4\hat{k}_c} \left[\frac{\partial \hat{k}^i_c}{\partial \tau^j} - \frac{\partial \hat{k}^j_c}{\partial \tau^j} \right]$$

$$+ (\hat{k}^c)^\alpha \frac{\partial \hat{p}^c}{\partial \tau^j} + \alpha(\hat{p}^c - 1)\frac{\partial \hat{k}^c}{\partial \tau^j} - (\hat{k}_c)^\alpha \frac{\partial \hat{p}_c}{\partial \tau^j} + \frac{F'(\hat{k}_c) - r - \alpha(\hat{p}_c - 1)}{2}\left[\frac{\partial \hat{k}_c^i}{\partial \tau^j} - \frac{\partial \hat{k}_c^j}{\partial \tau^j}\right]. \quad (48)$$

In Appendix E, we show that the sign of (48) is ambiguous and thereby prove

Proposition 6. *Suppose the tax competition game under FA attains a Nash equilibrium with $\tau^a = \tau^b = \tau^*$ and $\tau^c = \tau^o$. Then τ^* may be inefficiently small or large.*

In contrast to the case of SA, under a FA regime with a water's edge the corporate income tax rates in the FA union may be inefficiently high. The reason is that FA removes the profit shifting externality within the union, indeed, but at the same time introduces two other fiscal externalities. First, if one FA country, say country a, increases its corporate income tax, then the MNEs will increase their investment levels in the other FA country b in order to manipulate the formula and reduce their tax bill. This effect is not taken into account by country a and represents the formula externality. It distorts the tax rate downwards, like the profit shifting externality under SA. Formally, the formula externality is represented by the first line on the RHS of (48). Second, FA causes a water's edge externality. For given investment levels, an increase in the tax rate of the FA country a increases the average tax rate of the MNEs in the FA union. This induces the MNEs to shift more income from both FA countries to country c, if the average tax rate in the union is higher than the one in the non-FA country, or to shift less income from c to the FA union countries, if the average tax rate is smaller than the tax rate in country c. Through this channel the increase in country a's tax rate reduces the tax base of both FA countries. The water's edge externality therefore points to inefficiently high tax rates within the union. Formally, it is represented by the second line of the RHS of (48).

5 Conclusion

This paper analyses the effects of introducing a FA regime in the presence of a water's edge, i.e. non-participating countries that stick to corporate income taxation based on SA principles. The analysis is split into a short-run part, assuming fixed national tax rates, and a long-run analysis, investigating a tax competition game. The basic insight emerging from the short-run analysis is that MNEs' overall volume of profit shifted to and FDI in non-participating low-tax countries (including tax havens) *diminishes* with the formation of a FA union. The long-run analysis shows that FA removes the profit shifting externality which the corporate income tax policy of a FA country exerts on other FA countries. However, FA also creates its own fiscal externalities, namely a formula and a water's edge externality. The latter points into the direction of too high tax rates so that the equilibrium of the tax competition game may be characterized by inefficient overtaxation.

Hence, while the short-run analysis draws a positive picture about the introduction of FA, the long-run analysis shows that a FA taxation system entails new problems and its potential to solve the deficiencies of SA is limited. As policy conclusion for the EU, it follows that, at least in the long-run, tax harmonization may be necessary to remove the present distortions caused by international tax policy. Our conclusions are therefore in line with Sørensen (2004), who as well advocates for further tax rate harmonization. Nevertheless, our short-run analysis suggests that FA may serve as an interim solution. The European tax harmonization process has turned out to be a difficult and long lasting procedure. Until an agreement among the EU member countries will be reached, the implementation of a FA regime would eliminate profit shifting activities within the union and, in addition, would have the positive side effect that profit shifting to tax havens is reduced. Of course, these merits must be balanced against the possible handicap of high transaction and transition cost.

Appendix A: Proof of Proposition 1

According to (8), (10), (16) and (19), the transfer price and investment of MNE $i \in U$ in country c are determined by

$$F'(k_i^c) - r - \frac{\alpha\big[Q(p_i^c) - (p_i^c - 1)Q'(p_i^c)\big]}{1 - \tau^c} = 0, \tag{A.1}$$

$$Q'(p_i^c) - \tau^c + x_i = 0. \tag{A.2}$$

Setting $x_i = \tau^i$ yields the solution under SA, i.e. $k_i^c = \tilde{k}_i^c$ and $p_i^c = \tilde{p}_i^c$, while for $x_i = \tau_i = \hat{\tau}$ we obtain the FA solution $k_i^c = \hat{k}^c$ and $p_i^c = \hat{p}^c$. Hence, the impact of the transition from SA to FA on profit shifting to and investment in country c can be characterized by totally differentiating (A.1) and (A.2) with respect to x_i. This yields

$$\frac{dp_i^c}{dx_i} = -\frac{1}{Q''(p_i^c)}, \qquad \frac{dk_i^c}{dx_i} = \frac{\alpha(p_i^c - 1)}{(1-\tau^c)F''(k_i^c)} =: G(x_i), \tag{A.3}$$

$$\frac{ds_i^c}{dx_i} = -\frac{(k_i^c)^\alpha}{Q''(p_i^c)} + \frac{\alpha^2(p_i^c - 1)^2}{(1-\tau^c)F''(k_i^c)} =: H(x_i). \tag{A.4}$$

$\tau^a > \tau^b > \tau^c$ implies $p_i^c - 1 < 0$ and $s_i^c < 0$ for $i \in U$. According to (A.4), we have $ds_i^c/dx_i < 0$. For MNE b the variable x_b increases from τ^b to $\hat{\tau}$. Hence, replacing SA by FA increases MNE b's profit shifting $-s_b^c$ to country c. In contrast, for MNE a the variable x_a is reduced from τ^a to $\hat{\tau}$ so that its profit shifting $-s_a^c$ to country c falls. For $\alpha = 0$, (A.3) states that $dk_i^c/dx_i = 0$, i.e. FA does not change k_a^c and k_b^c. $\alpha = 1$ implies $dk_i^c/dx_i > 0$. Hence, the introduction of FA increases k_b^c, but reduces k_a^c.

Appendix B: Proof of Proposition 2

The change in total profit shifting of MNE a and MNE b can be written as

$$ds_a^c + ds_b^c = H(\tau^a)dx_a + H(\tau^b)dx_b. \tag{B.1}$$

Differentiating H from (A.4) yields

$$H'(x_i) = \frac{d^2 s_i^c}{dx_i^2} = -\frac{3\alpha^2(p_i^c - 1)}{(1-\tau^c)Q''(p_i^c)F''(k_i^c)} - \frac{(k_i^c)^\alpha Q'''(p_i^c)}{[Q''(p_i^c)]^3} - \frac{\alpha^3(p_i^c-1)^3 F'''(k_i^c)}{(1-\tau^c)^2[F''(k_i^c)]^3}. \tag{B.2}$$

The assumption $Q''' \geq 0$ together with $p_i^c - 1 < 0$ for $i \in U$, $Q'' > 0$, $F'' < 0$, $F''' > 0$ and $\alpha \in \{0, 1\}$ implies $H'(x_i) \leq 0$. It follows $H(\tau^a) \leq H(\tau^b) < 0$. Since $\hat{\tau} \in]\tau^b, (\tau^a + \tau^b)/2[$, we have $dx_b = \hat{\tau} - \tau^b < -(\hat{\tau} - \tau^a) = -dx_a$. Using these relations in (B.1) yields $ds_a^c + ds_b^c > 0$, i.e. total shifting $-s_a^c - s_b^c$ to country c falls.

The change in total investment of MNE a and MNE b in country c reads

$$dk_a^c + dk_b^c = G(\tau^a)dx_a + G(\tau^b)dx_b. \tag{B.3}$$

Differentiating G from (A.3) gives

$$G'(x_i) = \frac{d^2 k_i^c}{dx_i^2} = -\frac{\alpha(1-\tau^c)[F''(k_i^c)]^2 + \alpha^2(p_i^c - 1)^2 Q''(p_i^c)F'''(k_i^c)}{(1-\tau^c)^2 Q''(p_i^c)[F''(k_i^c)]^3}. \tag{B.4}$$

If $\alpha = 0$, then $G(x_i) = G'(x_i) = 0$ and $dk_a^c + dk_b^c = 0$, i.e. total investment of MNE a and MNE b in c remains constant. In case of $\alpha = 1$, we obtain $G(x_i) > 0$, $G'(x_i) > 0$ and, thus, $G(\tau^a) > G(\tau^b)$. Inserting this together with $dx_b < -dx_a$ in (B.3) implies $dk_a^c + dk_b^c < 0$, i.e. total investment of MNE a and MNE b in c declines. ■

Appendix C: Proof of Proposition 3

For $\alpha = 0$, profit shifting of MNE c solely depends on the transfer price since (1) implies $s_c^i = p_c^i - 1$ for $i \in U$. According to (8), (24) and (25), p_c^i is determined by

$$Q'(p_c^i) - x^i + \tau^c = 0. \tag{C.1}$$

The solution under SA is obtained for $x^i = \tau^i$, whereas $x^i = \tau_c$ gives the solution under FA. Implicitly differentiating (C.1) yields

$$J(x^i) := \frac{ds_c^i}{dx^i} = \frac{dp_c^i}{dx^i} = \frac{1}{Q''(p_c^i)} > 0, \quad J'(x^i) := \frac{d^2 s_c^i}{dx^{i2}} = \frac{d^2 p_c^i}{dx^{i2}} = -\frac{Q'''(p_c^i)}{[Q''(p_c^i)]^3} \geq 0. \tag{C.2}$$

The change in total profit shifting of MNE c can then be written as

$$ds_c^a + ds_c^b = J(\tau^a)dx^a + J(\tau^b)dx^b. \tag{C.3}$$

(C.2) and $\tau^a > \tau^b$ yield $J(\tau^b) \geq J(\tau^a) > 0$. (30) implies $dx^b = \tau_c - \tau^b < -(\tau_c - \tau^a) = -dx^a$. Inserting these relations in (C.3), we obtain $ds_c^a + ds_c^b < 0$, i.e. FA reduces MNE c's total shifting $s_c^a + s_c^b$ from the FA union to country c.

Appendix D: Proof of Proposition 5

Differentiating (15) – (19) and (24) – (25) and evaluating the results at $\tau^a = \tau^b = \tau^*$ and $\tau^c = \tau^o$ yields

$$\frac{\partial \hat{p}^c}{\partial \tau^c} = \frac{1}{Q''(\hat{p}^c)}, \quad \frac{\partial \hat{p}_c}{\partial \tau^c} = -\frac{1}{Q''(\hat{p}_c)}, \quad \frac{\partial \hat{k}_c^i}{\partial \tau^c} = \frac{\alpha(\hat{p}_c - 1)}{(1-\tau^*)F''(\hat{k}_c)}, \quad i \in U, \tag{D.1}$$

$$\frac{\partial \hat{k}^c}{\partial \tau^c} = \frac{\alpha[Q(\hat{p}^c) - (\hat{p}^c - 1)Q'(\hat{p}^c)]}{(1-\tau^o)^2 F''(\hat{k}^c)} - \frac{\alpha(\hat{p}^c - 1)}{(1-\tau^o)F''(\hat{k}^c)}. \tag{D.2}$$

Moreover, in the equilibrium (16) and (24) become $Q'(\hat{p}_c - 1) = \tau^* - \tau^o = -Q'(\hat{p}^c - 1)$. By the symmetry assumption (3) we obtain $\hat{p}_c - 1 = -(\hat{p}^c - 1)$, $Q(\hat{p}_c) = Q(\hat{p}^c)$ and $\omega := Q(\hat{p}_c) - (\hat{p}_c - 1)Q'(\hat{p}_c) = Q(\hat{p}^c) - (\hat{p}^c - 1)Q'(\hat{p}^c) < 0$. Inserting this expression, (D.1) and (D.2) into (45) and replacing $F'(\hat{k}_c) - r - \alpha(\hat{p}_c - 1)$ by (26) gives

$$\begin{aligned} \left.\frac{\partial R^i(\tau^a,\tau^b,\tau^c)}{\partial \tau^c}\right|_{\tau^c=\tau^o}^{\tau^a=\tau^b=\tau^*} &= \tau^* \left\{ \frac{(\hat{k}^c)^\alpha}{Q''(\hat{p}^c)} + \frac{(\hat{k}_c)^\alpha}{Q''(\hat{p}_c)} - \frac{\alpha^2(\hat{p}^c-1)^2}{(1-\tau^o)F''(\hat{k}^c)} - \frac{\alpha^2(\hat{p}_c-1)^2}{(1-\tau^*)F''(\hat{k}_c)} \right. \\ &\quad \left. + \alpha\omega(\hat{p}^c - 1)\frac{(1-\tau^*)^2 F''(\hat{k}_c) - (1-\tau^o)^2 F''(\hat{k}^c)}{(1-\tau^*)^2(1-\tau^o)^2 F''(\hat{k}_c)F''(\hat{k}^c)} \right\}. \end{aligned} \tag{D.3}$$

The first line on the RHS of (D.3) is positive according to $Q'' > 0$ and $F'' < 0$. The second line is non-negative as can be proven as follows. If $\alpha = 0$, the second line is zero. For $\alpha = 1$, consider first the case of $\tau^* > \tau^o$. It then follows $\hat{p}^c - 1 < 0$. Moreover, (17) and (26) imply $\hat{k}_c > \hat{k}^c$ and, by $F''' > 0$, $F''(\hat{k}_c) > F''(\hat{k}^c)$. The numerator in the second line of (D.3) and, thus, the whole expression is then positive. An analogous argument applies for the case of $\tau^* < \tau^o$. In sum, (D.3) is positive. In connection with (42), this implies that a marginal increase of the tax rate of the non-FA country, starting from the equilibrium tax rates, increases revenue of the FA countries and leaves unchanged revenue of the non-FA country. Hence, τ^o is inefficiently low.

Appendix E: Proof of Proposition 6

The derivatives in (48) can be calculated by conducting a comparative static analysis of (15) – (19) and (24) – (28) and evaluating the results at the equilibrium tax rates. After some tedious calculations we obtain for the first line in (48)

$$\frac{\hat{\pi}}{2\hat{k}}\left[\frac{\partial \hat{k}^i}{\partial \tau^j} - \frac{\partial \hat{k}^j}{\partial \tau^j}\right] + \frac{\hat{\pi}_c}{4\hat{k}_c}\left[\frac{\partial \hat{k}_c^i}{\partial \tau^j} - \frac{\partial \hat{k}_c^j}{\partial \tau^j}\right] = -\frac{1}{1-\tau^*}\left[\frac{\hat{\pi}^2}{2\hat{k}^2 F''(\hat{k})} + \frac{\hat{\pi}_c^2}{8\hat{k}_c^2 F''(\hat{k}_c)}\right] > 0. \tag{E.1}$$

The remaining terms can be written as

$$(\hat{k}^c)^\alpha \frac{\partial \hat{p}^c}{\partial \tau^j} + \alpha(\hat{p}^c - 1)\frac{\partial \hat{k}^c}{\partial \tau^j} = \frac{\alpha^2(\hat{p}^c - 1)^2}{2(1-\tau^o)F''(\hat{k}^c)} - \frac{(\hat{k}^c)^\alpha}{2Q''(\hat{p}^c)} < 0 \tag{E.2}$$

and

$$\frac{F'(\hat{k}_c) - r - \alpha(\hat{p}_c - 1)}{2}\left[\frac{\partial \hat{k}_c^i}{\partial \tau^j} - \frac{\partial \hat{k}_c^j}{\partial \tau^j}\right] - (\hat{k}_c)^\alpha \frac{\partial \hat{p}_c}{\partial \tau^j} = -\frac{(\hat{k}_c)^\alpha}{2Q''(\hat{p}_c)}$$
$$+ \frac{1}{2(1-\tau^*)F''(\hat{k}_c)}\left[\frac{\alpha[Q(\hat{p}_c) - (\hat{p}_c - 1)Q'(\hat{p}_c)]}{1-\tau^*} - \alpha(\hat{p}_c - 1)\right]^2 < 0. \tag{E.3}$$

Hence, the sign of the cross effect in (48) is ambiguous, in general. An increase in the tax rate of one FA country may increase or decrease the tax revenue of the other FA country. This proves the proposition.

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