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**Symmetric Tax Competition under Formula  
Apportionment**

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# Symmetric Tax Competition under Formula Apportionment\*

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## Abstract

This paper compares property taxation to a corporate income tax based on formula apportionment in a model where identical countries compete to attract capital. We find that if countries can pair a residence-based capital tax with a property tax (source tax on capital) the tax equilibrium is efficient. In contrast, the use of a 2-factor FA scheme based on sales and capital combined with a residence-based capital tax leads to an inefficient outcome.

*Keywords:* Tax competition over capital, formula apportionment

*JEL classification:* H7; H73

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# 1 Introduction

In the US each state that levies a corporate income tax uses an apportionment formula (FA) to determine taxable corporate income within its state. Typically states employ a three-factor formula consisting of payroll, property and sales (gross receipts).<sup>1</sup> In reality jurisdictions can employ multiple tax instruments on capital. An alternative or supplement to apportion corporate income is the use of a property tax and/or a residence-based capital tax.

One important result in the literature on formula apportionment taxation is obtained by Gordon and Wilson (1986) who compare FA to property taxation in a setting with identical countries. They show that tax competition is harmful under both types of taxes, but that welfare is lowest when the FA tax applies. In this paper we allow a residence-based capital tax to be combined with either a property tax or a corporate FA tax. Different from Gordon and Wilson, we use a two period model where the supply of capital is endogenously determined. We find that when a property tax is paired with a residence-based tax on capital the tax equilibrium is efficient, in the sense that an effort by all countries to change tax rates does not increase utility. We confirm the finding of Gordon and Wilson (1986) that government use of FA taxation is inefficient, and we show that this case extends to a situation where a residence-based tax on capital is available.

Our results should be contrasted with some recent literature. Goolsbee and Maydew (2000) investigate the impact of FA using panel data from 1978-1994. They find that the FA system imposes important negative externalities on other states supporting the result that welfare is adversely affected under FA. Anand and Sansing (2000) show that while the harmonized apportionment rule will prevail as the cooperative solution of a game between two states, states have unilateral incentives to deviate from such a coordinated solution leading to a typical Prisoner's Dilemma situation.

The paper is structured as follows. Section 2 in this paper outlines the model, while the comparison of taxes are executed in section 3. Section 4 offers some concluding remarks.

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<sup>1</sup>Most states use a simple average, but some states double weight sales or use some other variation.

## 2 The model

The model we use has two periods and entails a symmetric tax competition game between a large number of  $n$  identical countries, which are linked through an international market for capital. Capital market clearing requires that there exists a world return to capital such that capital supply meets capital demand. In what follows we assume that this world return to capital is unaffected by the policy choices undertaken by a single country. The time structure of the model is as follows. In the first period, governments determine their tax policy and residents make their savings decision, while in the second period production takes place, taxes are collected and the proceeds are used to cover the costs of public good provision. The representative consumer in country  $i$  maximizes a utility function  $u(c_i^1, c_i^2) + \tilde{v}(g_i)$ , where  $c_i^1$  and  $c_i^2$  denote the consumption levels in each period and  $g_i$  is the public good. The utility function is assumed to be twice continuously differentiable and strictly quasi-concave, with  $g_i$  being essential in the sense that  $\lim_{g_i \rightarrow 0} \partial \tilde{v} / \partial g_i = \infty$ . The consumer receives an endowment  $e$  in the first period, which can either be consumed or saved at home or abroad. Assuming that each resident has an equal ownership-stake in the corporate sector, the intertemporal budget constraint for the representative household is

$$[1 + \theta_i] [e - c_i^1] + p_i = c_i^2, \quad (1)$$

where  $\theta_i$  is the after-tax interest rate, and  $p_i$  denotes net profits in each country. Utility maximization subject to (1) yields the consumption functions  $c_i^1(\theta_i, p_i)$ ,  $c_i^2(\theta_i, p_i)$ , and the indirect utility function  $v(\theta_i, p_i) + \tilde{v}(g_i)$ .

We focus on a globalized economy in the sense that the representative firm is a multinational firm. Since there are  $n$  identical countries, the multinational firm has  $n$  subsidiaries, that is, one in each country. Output is produced in period 2 with a constant-returns-to-scale production function using capital and a fixed factor, the latter giving rise to pure profits. The production technology fulfills the usual Inada conditions. Output per unit of the fixed factor is  $f(k_i)$ , where  $k_i$  denotes capital investment in country  $i$ . Corporate profits before tax in each country are

$$\pi_i = f(k_i) - [1 + r_i] k_i, \quad (2)$$

where  $r_i$  denotes the domestic user costs of capital.<sup>2</sup>

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<sup>2</sup>In order to concentrate on the effects of the FA tax, we assume that all capital in the economy

Each country may levy proportional, ad valorem taxes on property ( $t_i^s$ ) and residence-based capital taxes ( $t_i^r$ ), and these two taxes create the following tax wedges

$$\begin{aligned} r_i &= (1 + t_i^s) R && \text{property tax,} \\ \theta_i &= (1 - t_i^r) R && \text{residence-based tax on capital income,} \end{aligned} \quad (3)$$

where  $R$  is the world return to capital. In addition, each country uses a corporate income tax  $t_i$  to apportion income based on capital invested and the relative volume of sales. The tax liability of the multinational in a country is given by:<sup>3</sup>

$$\tilde{t}_i = t_i \left[ \alpha \frac{k_i}{k_i + \sum_{j \neq i}^n k_j} + (1 - \alpha) \frac{f(k_i)}{f(k_i) + \sum_{j \neq i}^n f(k_j)} \right] \Pi \quad \alpha \in [0, 1], \quad (4)$$

where  $\alpha$  is the weight given to capital in the apportionment formula, and  $\Pi = \sum_{i=1}^n \pi_i$  denotes global profits before tax. In the formula above we have assumed that true profits are equal to taxable profits, and that countries use the same apportionment weights. In making these assumptions we have eliminated the most common distortions that arise under formula apportionment. Global after-tax profits are

$$P = \Pi - \sum_{i=1}^n \tilde{t}_i, \quad (5)$$

and net profits in each country are  $p_i = \pi_i - \tilde{t}_i$ . We define  $T \equiv (\Pi - P) / \Pi$  as the average FA tax. Using the envelope theorem on (5) we obtain some useful properties

$$\frac{\partial P}{\partial r_i} = -(1 - T) k_i < 0, \quad \frac{\partial^2 P}{\partial r_i^2} > 0, \quad \frac{\partial P}{\partial t_i} = -\frac{\tilde{t}_i}{t_i} < 0, \quad \frac{\partial^2 P}{\partial r_i \partial t_i} > 0. \quad (6)$$

At the beginning of the first period the government maximizes the indirect utility function  $v(\theta_i, p_i) + \tilde{v}(g_i)$  subject to the budget constraint

$$g_i = t_i^r R [e - c_i^1] + t_i^s R k_i + \tilde{t}_i, \quad (7)$$

is corporate. Although this assumption distracts from reality it serves to concentrate on the effects of the FA tax in tax competition, but comes at the cost of neglecting capital allocation between sectors within a country.

<sup>3</sup>We assume that global profits are observable by the tax authorities in each country.

taking  $t_i, t_i^r, t_i^s$  (or subsets) as the control variables. Using (6) to substitute out for  $k_i$  in (7) the Lagrangian of the government's problem reads

$$\mathcal{L}_i = v(\theta_i, p_i) + \tilde{v}(g_i) + \lambda_i \left[ t_i^r R [e - c_i^1(\theta_i, p_i)] - t_i^s \frac{\partial P(r_i, t_i)}{\partial r_i} \frac{R}{1 - T(r_i, t_i)} + \tilde{t}_i(r_i, t_i) - g_i \right]. \quad (8)$$

To derive the first-order conditions of the problem for the tax parameters we normalize the utility of income to unity; use  $\partial v / \partial \theta_i = e - c_i^1$  and  $\partial v / \partial p_i = 1$  from Roy's identity as well as the tax definitions (3) to get:

$$\frac{\partial \mathcal{L}_i}{\partial t_i^r} = -R[e - c_i^1] + \lambda_i R \left[ [e - c_i^1] + t_i^r R \frac{\partial c_i^1}{\partial \theta_i} \right] = 0, \quad (9a)$$

$$\begin{aligned} \frac{\partial \mathcal{L}_i}{\partial t_i^s} = R \frac{\partial p_i}{\partial r_i} + \lambda_i R \left[ \frac{\partial P / \partial r_i}{T - 1} - t_i^r R \frac{\partial c_i^1}{\partial p_i} \frac{\partial p_i}{\partial r_i} \right. \\ \left. + \frac{t_i^s R}{T - 1} \left[ \frac{\partial^2 P}{\partial r_i^2} - \frac{\partial P}{\partial r_i} \frac{\partial T / \partial r_i}{T - 1} \right] + \frac{\partial \tilde{t}_i}{\partial r_i} \right] = 0, \end{aligned} \quad (9b)$$

$$\frac{\partial \mathcal{L}_i}{\partial t_i} = \frac{\partial p_i}{\partial t_i} + \lambda_i \left[ \frac{\partial \tilde{t}_i}{\partial t_i} - t_i^r R \frac{\partial c_i^1}{\partial p_i} \frac{\partial p_i}{\partial t_i} + \frac{t_i^s R}{T - 1} \left[ \frac{\partial^2 P}{\partial r_i \partial t_i} - \frac{\partial P}{\partial r_i} \frac{\partial T / \partial t_i}{T - 1} \right] \right] = 0. \quad (9c)$$

After differentiation we substitute out  $e - c_i^1$  for  $k_i$  and use the property that in the symmetric equilibrium  $\frac{\partial f(k_i)}{\partial k_i} = \frac{\partial f(k_j)}{\partial k_j}$ . Furthermore, we make use of the assumption that each resident has an equal ownership-stake in the corporate sector, and that  $\partial P / \partial r_i = \partial P / \partial r_j = -(1 - T)k_i$  from (6). This allows us to show that  $\frac{\partial P}{\partial r_i} = \frac{\partial p_i}{\partial r_i}$  and  $\frac{\partial P}{\partial t_i} = \frac{\partial p_i}{\partial t_i}$  and we use these properties in (10) and characterize the first-order conditions in the symmetric tax equilibrium as:

$$\frac{\partial \mathcal{L}_i}{\partial t_i^r} = R \frac{\partial P / \partial r_i}{1 - T} + \lambda_i R \left[ \frac{\partial P / \partial r_i}{T - 1} + t_i^r R \frac{\partial c_i^1}{\partial \theta_i} \right] = 0, \quad (10a)$$

$$\begin{aligned} \frac{\partial \mathcal{L}_i}{\partial t_i^s} = R \frac{\partial P}{\partial r_i} + \lambda_i R \left[ \frac{\partial P / \partial r_i}{T - 1} - t_i^r R \frac{\partial c_i^1}{\partial p_i} \frac{\partial P}{\partial r_i} + \frac{t_i^s R}{T - 1} \left[ \frac{\partial^2 P}{\partial r_i^2} - \frac{\partial P}{\partial r_i} \frac{\partial T / \partial r_i}{T - 1} \right] \right. \\ \left. + \frac{t_i}{n^2} \frac{R}{\partial P / \partial r_i} \left[ n \frac{\partial \Pi}{\partial r_i} \frac{\partial P}{\partial r_i} + (n - 1) \Pi \frac{\partial^2 P}{\partial r_i^2} \right] \right] = 0, \end{aligned} \quad (10b)$$

$$\begin{aligned} \frac{\partial \mathcal{L}_i}{\partial t_i} = \frac{\partial P}{\partial t_i} + \lambda_i \left[ \frac{\Pi}{n} - t_i^r R \frac{\partial c_i^1}{\partial p_i} \frac{\partial P}{\partial t_i} + \frac{t_i^s R}{T - 1} \left[ \frac{\partial^2 P}{\partial r_i \partial t_i} - \frac{\partial P}{\partial r_i} \frac{\partial T / \partial t_i}{T - 1} \right] \right. \\ \left. + \frac{t_i}{n^2} \frac{1}{\partial P / \partial r_i} \left[ n \frac{\partial \Pi}{\partial t_i} \frac{\partial P}{\partial r_i} + (n - 1) \Pi \frac{\partial^2 P}{\partial r_i \partial t_i} \right] \right] = 0. \end{aligned} \quad (10c)$$

In the next section we will use these first-order conditions to characterize nationally optimal tax structures assuming that they are necessary and sufficient for a maximum.<sup>4</sup> The purpose is to compare the effects of decentralized decision-making by countries under two different assumptions concerning the policy tools available. In the first scenario we characterize a Nash equilibrium under the assumption that all countries have at their disposal a residence tax on capital income and a property tax. In the second scenario countries can use a residence tax on capital income paired with a formula apportionment tax.<sup>5</sup>

### 3 Tax competition

In our first policy scenario the capital taxes  $t^s$  and  $t^r$  are the only fiscal instruments available to the policy-makers. Then:

**Proposition 1** *If all countries have at their disposal a residence-based tax on capital ( $t_i^r$ ) and a property tax ( $t_i^s$ ) there is no welfare loss from tax competition.*

**Proof.** To derive the optimal tax structure in the Nash equilibrium we form  $\frac{\partial \mathcal{L}_i}{\partial t_i^s} - \frac{\partial \mathcal{L}_i}{\partial t_i^r} = 0$  at  $t_i = 0$ . Using the Slutsky equation to decompose the first-period consumption function  $c_i^1$  allows to solve for the optimal tax structure,

$$t_i^s \frac{\partial^2 P}{\partial r_i^2} = -t_i^r \frac{\partial c_i^1}{\partial \theta_i} \Big|_{\bar{u}}. \quad (10k)$$

Equation (10k) shows that the government chooses to use both taxes in equilibrium to cover the costs of public good provision. To complete the proof notice that  $\partial P / \partial r_i |_{\tilde{t}_i=0} = -k_i$  is independent of  $n$ . It follows that  $\partial^2 P / \partial r_i^2 > 0$  is not a function of  $n$ . Hence, the nationally optimal tax policy in (10k) is Pareto efficient, given the available tax instruments. ■

Proposition 1 shows that residence and property taxes are efficient in the Nash equilibrium in the sense that a coordinated effort by all countries to change the

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<sup>4</sup>We will employ compensated rather than Marshallian functions in the following analysis. The use of (6) and  $e - c_i^1 = k_i$  in the Slutsky equation for  $c_i^1$  shows that  $\left( \frac{\partial c_i^1}{\partial \theta_i} + \frac{\partial P / \partial r_i}{1-T} \frac{\partial c_i^1}{\partial p_i} \right) < 0$ , since the derivative of the Hicksian consumption function is negative,  $\frac{\partial c_i^1}{\partial \theta_i} \Big|_{\bar{u}} < 0$ .

<sup>5</sup>Hence, we do not discuss the transitional effects of a switch from one tax structure to the other.



tax structure does not improve welfare. The intuition is straightforward. From (5) it is seen that  $t_i^s$  is an indirect tax on gross profits. Since  $t_i^r$  directly affects the consumer's intertemporal consumption decision there are two independent tax instruments available for the two prices in the consumer's budget constraint. This means that each government can control the capital income of its citizens and, as a consequence, no fiscal externality arises from tax competition.<sup>6</sup>

We now compare our result in Proposition 1 to a different economic environment where the residence tax on capital ( $t_i^r$ ) is available together with the FA tax ( $t_i$ ). In the Nash equilibrium we have:

**Proposition 2** *If all countries have at their disposal a residence-based tax on capital ( $t_i^r$ ) and a formula apportionment tax ( $t_i$ ), tax competition leads to a loss in welfare.*

**Proof.** The structure is similar to the proof under Proposition 1. We form  $\frac{\partial P}{\partial t_i} \frac{\partial \mathcal{L}_i}{\partial t_i^r} + \frac{\partial P}{\partial r_i} \frac{R}{1-T} \frac{\partial \mathcal{L}_i}{\partial t_i} = 0$  at  $t_i^s = 0$ . Then use the Slutsky equation on  $c_i^1$  to derive the tax structure in the Nash equilibrium:

$$t_i^r n R (1-T) \frac{\partial P}{\partial t_i} \frac{\partial c_i^1}{\partial \theta_i} \Big|_{\bar{u}} = t_i \left( \frac{\partial \Pi}{\partial t_i} \frac{\partial P}{\partial r_i} + \Pi \frac{n-1}{n} \frac{\partial^2 P}{\partial r_i \partial t_i} \right). \quad (12)$$

First notice that  $\partial \Pi / \partial t_i|_{n=1} = 0$  and  $\partial P / \partial t_i|_{n=1} = -\Pi$  from (5). The terms in brackets on the r.h.s. of (12) vanish at  $n = 1$ , implying that first-order conditions (10a) and (10c) require  $t_i^r = 0$ . Second, capital mobility implies that the marginal productivities of capital employed in production, gross-of-tax, are equated across countries in any symmetric tax equilibrium. Hence, a unilateral tax increase cannot increase output and global gross profits. Using (6) in (12) then shows that  $t_i^r = 0$ , at  $n > 1$ , cannot simultaneously fulfill the first-order conditions (10a), (10c) and the requirement that  $g_i > 0$ . Since the tax structure given by (12) is a function of  $n$  the nationally optimal tax policy is not Pareto efficient, given the available tax instruments. ■

The reason for the inefficient outcome described in Proposition 2 is the inability of the FA tax to fully tax gross profit. The distortion caused by apportionment (through the activity weight) enables the firm to relocate activities to low tax countries thereby reducing the average effective tax. As shown in the proof, a coordinated

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<sup>6</sup>A similar type of argument is present in Bucovetsky and Wilson (1991, Sec. 4). Related, Koskela and Schöb (2002) argue that governments in countries characterized by unemployment may choose to use a source-based capital tax in the absence of a direct tax on profits.

effort by all countries will remedy the externality from the apportionment rule and improve welfare. In comparing Proposition 1 and 2 the crucial element in the analysis is that the property tax in combination with the residence-based tax do not allow capital income to escape residence while taxation can be evaded under the FA tax. The reason is that the multinational firm can affect its tax burden by manipulating sales and capital investments thereby reducing the average tax rate.

An alternative comparison would be to allow for transfer pricing and compare the FA scheme to a system of separate accounting (SA). Under SA, each subsidiary of a multistate enterprise is treated as an independent company, and the aim of the tax code is to identify the precise receipts and expenditures attributable to the corporation's activities in each jurisdiction. Under the FA system allowing profit shifting would not affect the tax base if the tax base is uniform across countries. The SA system is vulnerable to transfer pricing, and the comparison of these two systems would then depend on the externality caused by the activity formula under FA and the cost of transfer pricing under SA. Nielsen, Raimondos-Møller and Schjelderup (2001) have analyzed this question. They find that starting from a non-cooperative equilibrium under SA, sufficient conditions for a move to the FA system to lower tax revenue and welfare are low rents from the fixed factor and intermediate costs of transfer pricing (presuming there are concealment costs).

In comparing the property tax and the FA tax we have assumed that capital is perfectly mobile. Under other assumptions where capital was less than perfectly mobile one would not think that our conclusions would be altered. The reason is that as long as there is some capital mobility, the firm could reduce the average tax by manipulating sales and capital investments. Hence, our results should not change, but the externality under the FA system would be less severe the less mobile is capital.

## 4 Concluding remarks

The purpose of this paper has been to compare the outcome of tax competition if different tax instruments on capital are paired. We have shown that an efficient allocation can be decentralized when a property tax and a residence-based tax on savings co-exist. In contrast, welfare is adversely affected due to tax competition when a corporate tax based on formula apportionment is used, even in the presence

of a residence-based tax on savings income.

Our analysis has been carried out by assuming symmetric countries. With differences in country size our results are likely to change. In asymmetric tax equilibria governments may choose to use terms-of-trade effects to change the international distribution of income to their advantage. When the tax structure chosen by the government depends on the net imports of goods and capital there might therefore exist Pareto improving tax reforms that require a reduction of tax rates in at least one trading partner (as opposed to our findings where the equilibrium is efficient in one case). The reason is that the perceived marginal social cost of public funds could be underestimated in one country when terms-of-trade effects are exploited via strategic use of the tax system.<sup>7</sup> However, asymmetries do not change the type of fiscal externality present in our analysis so a reasonable conjecture is that the distortion present under FA is likely to remain even under differences in country size.

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<sup>7</sup>In a recent paper Keen and Wildasin (2000) identify cases where governments may choose to use production taxes in order to obtain a Pareto improvement that is sustainable in a world with asymmetric countries.

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