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Local Taxation of Global Corporation: A Simple Solution

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The globalization of world markets has prompted firms' search for benefits of international tax differentials. In this paper we consider a simple world with two countries and two multinationals with a division in each country. Both countries, that differ in market size, use a source-based profit tax on multinationals, who compete *à la* Cournot in local markets and use profit shifting based on the tax differential. We assess policies aimed to mitigate inefficient tax choices and show that tax harmonization cannot benefit the small country. We then propose a simple revenue sharing mechanism in which countries share equal proportion of their own revenue with each other, and show that revenue sharing increases equilibrium tax rates in each country, reduces the tax differential, and benefits both countries. Lastly we show that contrary to revenue sharing, the tax base equalization formula raises a fundamental equity issue.*

I. Introduction

While globalization has removed barriers on corporations' mobility across jurisdictions, it has also prompted the emergence of multinational firms with divisions in different countries. The latter posed challenges for tax authorities everywhere. Since the *residence-based taxation*, under which income from capital is taxed in the country of residence of the capital owner, is difficult to implement, many countries utilized *source-based taxation* when the income from capital is taxed in the country where the income is earned. The source-based taxation however creates an incentive for a multinational firm to choose the location of profit creation in a low-tax jurisdiction. While it can be achieved by changing the physical location of the firm, a much easier route is to direct financial flows between divisions to make it appear that profit is earned in a low-tax location. DEVEREUX and GRIFFITH [2003] and AUERBACH, DEVEREUX, and SIMPSON [2010] indeed show that this strategy is used increasingly often by multinational firms.

It is well-known that multinational firms carry out growing proportions of international economic activity (according to the OECD, around 60% of international trade involves transactions between two related parts of multinationals). But even the fast growth of international

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Tax Competition, Revenue Sharing.

trade among industrialized countries has been far outpaced by the rapid raise of foreign direct investment by multinationals. Foreign-owned multinationals employ 20% and 14% of workers in European and US manufacturing, respectively. The shares of multinationals in producing the total value of manufactured goods are even higher: 25% in Europe and 20% in the US (OECD, 2001). Multinationals utilize their affiliates for profit shifting across countries by using transfer prices, dividend and royalty payments, and other devices.¹ The result is costly for both firms and tax authorities due to business uncertainty and because governments' coordination failures lead to an inefficiently low taxation. In the same time a country with higher corporate taxes will quickly discover other countries reaping the benefits of tax differentials. Throughout this paper we consider that profit shifting is detrimental. It is however fair to say that there exist some arguments claiming that profit shifting can also have positive effects in a broader framework where some countries (tax havens) compete for profits and other countries compete for firms (see HONG and SMART [2010], JOHANNESSEN [2010], and the recent survey in KEEN and KONRAD [2012]).

The first response to profit shifting was to impose limits on *transfer pricing* (see SAMUELSON [1982]), when, naturally, a higher transfer price will raise the profit of the division producing the good, whereas a lower transfer price will raise the profit of the user. To prevent firms from using transfer pricing, many governments have adopted rules, the key feature of which is the principle of an arm's-length price to put lower and upper bounds on transfer prices. Those limits, however, must be chosen independently by different governments and early contributions have identified a tendency for race to the top on transfer pricing limits (MANSORI and WEICHENRIEDER [2001], and RAIMONDOS-MØLLER and SCHARF [2002]). The race to the top result was later challenged by KIND, SCHJELDERUP, and ULLTVEIT-MOE [2004], PERALTA, WAUTHY, and YPERSELE [2006], BUCOVETSKY and HAUFLE [2008], who model competing governments together with firms who optimize their tax bills in response to profit tax rates.²

A second response to profit shifting is the *formula apportionment* to allocate the consolidated profit of the multinational firm across different tax jurisdictions according to a pre-determined formula and regardless of the location of origin. The European Commission has proposed to use this mechanism by basing the apportionment on the proportions of total sales that take place in each country. There are few problems with this approach. First, different profit margins across countries skew the overall profit picture. Secondly, it offers wrong incentives for misreporting or shifting sales across divisions to reduce the tax liability. Thirdly, low-tax jurisdictions are likely to reject this formula which removes the option of shifting profits from high-tax jurisdictions. It is especially true for small countries that are often low-tax jurisdictions and generate a smaller proportion of total sales.

1. See HINES [1999] for a survey of the empirical literature, CLAUSING [2003], HUIZINGA and LAEVEN [2008], and WEICHENRIEDER [2009], as examples of more recent contributions using firm-level data, COLLINS and SHACKELFORD [1997] for non-transfer pricing channels of profit shifting. See also HINDRIKS and MYLES [2013], Chapter 21 for a general overview of the international capital taxation issues.

2. Other references modeling competing governments include ELITZUR and MINTZ [1996], who recognized the use of transfer pricing as a means to give the appropriate incentives to subsidiaries. HAUFLE and SCHJELDERUP [2000], NIELSEN, RAIMONDOS-MØLLER, and SCHJELDERUP [2003] and SCHJELDERUP and WEICHENRIEDER [1999] focus on the use of transfer prices as a profit shifting and/or incentive device in different product market and tax system contexts, and multinational organizational forms, without explicitly modeling competing governments.

In this paper we will examine the implications of alternative solutions, including revenue sharing, that could be accepted by all tax jurisdictions with different taxes and market sizes. When different governments share a mobile tax base, one country's tax rate changes the tax base of the other, thus creating a fiscal externality which leads to sub-optimal outcomes. The tax competition literature has identified this fiscal externality and, more importantly, proposed several policies to curb its negative effects. Full tax harmonization, tax floors, tax ranges (OHSAWA [2003], PERALTA, WAUTHY, and YPERSELE [2006]), matching grants (DEPATER and MYERS [1994], WILDASIN [1991]), and tax equalization or revenue sharing and matching grants agreements (BOADWAY and FLATTERS [1982], KOETHENBUERGER [2002], HINDRIKS and MYLES [2003], FIGUIÈRES, HINDRIKS, and MYLES [2004], BUCOVETSKY and SMART [2006], HINDRIKS, PERALTA, and WEBER [2008], DRÈZE, FIGUIÈRES, and HINDRIKS [2007]) are among the policies that have been put forward by the literature.³ Most of this literature considers the issue of countries competing for firms (but not for profits). However, despite the persuasive evidence of increasing importance of multinational firms in the globalized economy and their capacity to restructure financial flows across divisions to reduce tax liability, a study of corrective devices for countries competing for the profits of multinationals has yet to be completed. As we will see tax competition for profits leads to some clear cut results due to the separation between production and taxation. On the contrary, competition for firms implies necessarily that local production levels are related to local tax choices, via the amount of capital used locally.

Many federal countries, such as Canada, Australia, Denmark and Switzerland, as well as some developing countries (SMART [1998], AHMAD and THOMAS [1996], SHAH [2004]) run equalization schemes whereby a central government transfers resources between jurisdictions. The European Union's Cohesion Fund and Structural Funds, this latter including the European Regional Development Fund and the European Social Fund, offer an example of revenue sharing among sovereign states.⁴ Another example is Germany, where in addition to transfers from the Federal to State governments, there is a transfer scheme across states, where states whose revenue per capita is above national average make payments to poorer states (SPAHN and FÖTTINGER [1997]). In the US, the state tax sharing is one of important forms of state intergovernmental aid to local governments. Data shows that state intergovernmental aid to local governments (combined city and county) is almost as large as that on education and public welfare. In 2011 the share of intergovernmental expenditures, that include grant-in-aid, shared taxes and reimbursement for the cost of certain programs carried out by localities, accounted for 29.8% state expenditures in the US. From 1985 to 2000, payments to local governments have varied within a very narrow range (32% to 33 %) of total general expenditures. The states also benefit from Federal grants, which accounted for 34.7 percent of all state government general

3. When this paper was completed, we learned about the recent work by HAUFLE and LÜFESMANN [2013] in which they propose a dual structure of capital taxation to reduce competition for mobile capital in an union of asymmetric countries. The union chooses first cooperatively a common minimum federal tax rate, and then the members set non-cooperatively local taxes. They demonstrate that this two-tier scheme can achieve Pareto improvement over the fully decentralized tax choices. Their model is different from ours, and it would be interesting to investigate how this scheme would perform in our model of profit shifting.

4. The EU Regional Policy amounts to 35% of the EU budget between 2007 and 2013 and is the second largest budget item. Source: http://europa.eu/legislation_summaries/glossary/structural_cohesion_fund_en.htm.

revenue in 2011, compared to 35.5 percent of state government general revenues in 2010, and 30.4 percent in 2009.⁵

Although the alleged purpose of those transfer schemes is *equalization* of citizens' access to public services across jurisdictions, or correction of fiscal imbalances, the literature has identified the potential efficiency gains from their implementation. The seminal contribution by BOADWAY and FLATTERS [1982],⁶ shows that fiscal equalization schemes can generate *efficiency gains* by internalizing the fiscal externality (through federal transfers equal to the difference between a jurisdiction's actual source-based revenue and the average level in the federation). While BOADWAY and FLATTERS [1982] assumed the lack of jurisdictions' incentives to alter tax rates in response to equalization policies, it has been later shown that the efficiency gains carry over in the case of fiscal response to equalization policies.⁷ Then the federal planner may design intergovernmental transfers to implement the efficient tax rates at the local level.⁸ However, unless there are lump sum transfers at the federal level, there is no guarantee that all jurisdictions would benefit from such transfers and implement it on a voluntary basis. To address the issue of voluntary participation, HINDRIKS and MYLES [2003] have shown that symmetric jurisdictions, while competing for a mobile tax base, can voluntarily agree to share revenue as a *strategic device* to limit harmful tax competition. When countries are heterogenous, notably in terms of fiscal revenue, it is no longer clear that they could all benefit from revenue sharing arrangements. Those with low fiscal revenue would benefit while those with high fiscal revenue could bear disproportionate shares of the fiscal burden (HINDRIKS, PERALTA, and WEBER [2008]).

To make the argument as clear as possible, we develop a simple model that contains a world of two countries with different market sizes and two multinational firms that own divisions in each country, while competing locally in each market à la Cournot. Countries set source-based taxes on the profit that multinational firms choose to report in each division. Countries compete in tax rates anticipating the resulting production decision and the profit reported by all divisions. In the presence of tax differentials, multinational firms shift profits from the high to the low tax country, and, following KIND, SCHJELDERUP, and ULLTVEIT-MOE [2004], we assume a convex concealment cost.⁹ We show that both countries will undertax in equilibrium, with the smaller country imposing a lower tax, thus shifting some of the profit from the large country. We also demonstrate that this tax-cutting strategy will reduce the fiscal gap between the two countries and that tax harmonization may hurt the small country. We then turn to the analysis of a revenue sharing scheme and show that it will raise equilibrium taxes and reduce the tax differential. More surprisingly we show that both countries would benefit from sharing an equal proportion of their own fiscal revenue regardless of the extent of the gap in their market sizes. Under revenue sharing, the large country transfers more fiscal resources to the small country

5. The fiscal data is from the US Bureau of the Census, <http://www2.census.gov/govs/state/11statesummaryreport.pdf>.

6. See also STIGLITZ [1983] and DAHLBY and L. WILSON [1994].

7. See, e.g., BIRD and SLACK [1990], WILDASIN [1991], SMART [1998], KOETHENBUERGER [2002], BUCOVETSKY and SMART [2006], FIGUIÈRES, HINDRIKS, and MYLES [2004].

8. There is also some empirical literature on the relationship between intergovernmental transfers and local tax effort: BUETTNER [2006], DAHLBY and WARREN [2003], BARETTI, HUBER, and LICHTBLAU [2002], HEPP and HAGEN [2001], among others. A more theoretical paper is BORDIGNON, MANASSE, and TABELLINI [2001] who show how intergovernmental transfers affect tax enforcement.

9. See also NIELSEN, RAIMONDOS-MOLLER, and SCHJELDERUP [2005], PERALTA, WAUTHY, and YPERSELE [2006], AMERIGHI and PERALTA [2010] and SWENSON [2001].

than it receives, but in exchange it benefits from the reduction in the tax differential and the harmful profit shifting. Interestingly, GAIGNÉ and RIOU [2007] obtain similar effects of revenue sharing in a different economic geography model where governments compete for firms in the presence of agglomeration rents. This suggests our results are rather robust and could equally apply to a model of competition for firms and a model of competition for profit.

The paper is organized as follows. In SECTION II we present the model. In SECTION III we characterize the tax equilibrium outcome and discuss implications of tax harmonization. SECTION IV contains the analysis of impact of revenue sharing on equilibrium taxes and the fiscal revenues of each country. SECTION V demonstrates that tax base equalization formula can also reduce competition and enhance revenue but creates a more unequal distribution of revenues.

II. The Model

There are two countries, 1 and 2, with linear (inverse) demands for a homogeneous good, given by

$$p_1 = \gamma_1 - \beta q_1 \quad \text{and} \quad p_2 = \gamma_2 - \beta q_2. \quad (1)$$

We assume that $\gamma_1 \geq \gamma_2$, that is, country 1 is the *large* country with a higher demand for the good. This is equivalent to say that countries differ in population size.

There are two multinational firms, owning one branch in each country, which compete *à la* Cournot in the corresponding markets. The unit production cost is normalized to zero; so is the cost of shipping goods across countries.¹⁰ In addition, firms may, at a cost, shift profits across locations, in order to minimize their tax liability. More precisely, let π_i^j be the profit effectively generated by firm $j = a, b$ in country $i = 1, 2$. The firm must decide how much profit to declare in country i , $\tilde{\pi}_i^j$, given the constraint $\tilde{\pi}_1^j + \tilde{\pi}_2^j = \pi_1^j + \pi_2^j$. We follow KIND, SCHJELDERUP, and ULLTVEIT-MOE [2004] and introduce a convex non-fiscally deductible concealment cost, given by for $i = 1, 2$ and $j = a, b$

$$C(\pi_i^j, \tilde{\pi}_i^j) = 2\delta (\pi_i^j - \tilde{\pi}_i^j)^2.$$

Hence, the parameter δ is a scaling factor of the cost of restructuring financial flows across divisions to shift profits to the low-tax jurisdiction.¹¹ This may either reflect the cost of hiring accounting experts in charge of producing the necessary documents supporting declared profits, or an expected fine to be paid to the government.¹² The parameter δ may reflect the degree of enforcement of the transfer pricing rules: weaker enforcement implies smaller δ . It is worth

10. One can think of each firm having its headquarters in one of the countries, although the distinction between headquarters and affiliate is immaterial as we are not modeling transportation costs, that could be easily incorporated here without altering the main results.

11. See also NIELSEN, RAIMONDOS-MOLLER, and SCHJELDERUP [2005], PERALTA, WAUTHY, and YPERSELE [2006], AMERIGHI and PERALTA [2010], and SWENSON [2001]. See also HUIZINGA and LAEVEN [2008] for a specification of the concealment cost as a function of the reported to true profit ratio. We do not expect our results to be influenced by this alternative specification.

12. In some circumstances, the consumers may wish to sanction a multinational caught cheating on their tax liabilities as it was recently the case in the UK with Starbucks coffee. The concealment cost could then be interpreted as the expected market sanction for cheating.

noting that the cost of profit shifting does not distinguish between inward and outward profit shifting since it is the same multinational that bears the full concealment cost no matter the direction of its financial flows.

Government i sets a source-based tax rate t_i on profit reported within its tax-jurisdiction by multinational firms. The government fiscal revenue is given by

$$R_i = t_i \left(\tilde{\pi}_i^a + \tilde{\pi}_i^b \right) = t_i \tilde{\pi}_i.$$

To simplify the matters and to focus on local taxation of global corporation, we assume that governments seek to maximize their fiscal revenue.¹³ Adding the consumer surplus in the governmental objective function will not affect the analysis, because as will become clear shortly the production decisions, and thus the consumer surplus, are independent of the tax choices.¹⁴ We assume that $t_i \leq 1$, for $i = 1, 2$. This is the equivalent of a free disposal assumption in our setting.

The sequence of events is as follows. First, both countries choose simultaneously and independently their tax rates so as to maximize their tax revenue. Second, given tax choices, multinational firms compete à la Cournot on each local market and choose a level of production in each country and the fraction of profit to be shifted to low-tax jurisdiction.

II.1. *Firms' Decisions*

Proceeding backwards, we analyze production decisions in each country given the tax choices made at the previous stage. Firms determine the quantities to produce in each market and the amount of profit shifting. Given the non-deductibility of profit-shifting cost, the firms' production decisions are independent of tax rates (maximizing before and after taxes profits is equivalent). Therefore adding consumer surplus in the objective function will not affect the governmental choices of taxes. The problem of firm a is to maximize

$$(1 - t_1)\tilde{\pi}_1^a + (1 - t_2)\tilde{\pi}_2^a - 2\delta(\pi_1^a - \tilde{\pi}_1^a)^2,$$

subject to

$$\tilde{\pi}_1^a + \tilde{\pi}_2^a = p_1(q_1^a + q_1^b)q_1^a + p_2(q_2^a + q_2^b)q_2^a,$$

with the inverse demand function given by (1). Thus the concealment cost depends only on the deviation between the true profit and the reported profit $\pi_1^a - \tilde{\pi}_1^a$. Due to its quadratic form, this cost is the same regardless of the direction of profit shifting (that is for the large country

13. The assumption of revenue maximizing government is a shortcut for describing a situation where residents care about taxing global corporations alike to contribute to the provision of public goods (see also KANBUR and KEEN [1993]). Obviously there is no explicit redistributive motive in our model. However, it can be argued that if the government maximizes a social welfare function with a redistributive objective in mind, then, under revenue constraints, the optimal policy could be net revenue maximizing. This is true if the welfare gains from higher net revenue are sufficient to offset the losses in welfare due to a net revenue maximizing policy (see CHANDER and WILDE [1998]).

14. As pointed out by an anonymous referee, the profit tax may harm the MNE owners and this may matter for the governments if at least part of the MNE is owned by residents. The focus on revenue maximization is without loss of generality if (i) the MNE is foreign owned or (ii) if it is owned by residents and tax revenue is rebated to the consumers as a lump-sum transfer, since it is a pure redistribution from capital owners to consumers without any implied distortion.

1, either outward profit shifting $\pi_1^a > \tilde{\pi}_1^a$ or inward profit shifting $\pi_1^a < \tilde{\pi}_1^a$). The optimization problem of firm a is then equivalent to

$$\max_{q_1^a, q_2^a, \tilde{\pi}_1^a} (1-t_1)\tilde{\pi}_1^a + (1-t_2) \left[(\gamma_1 - \beta(q_1^a + q_1^b))q_1^a + (\gamma_2 - \beta(q_2^a + q_2^b))q_2^a - \tilde{\pi}_1^a \right] - 2\delta \left[(\gamma_1 - \beta(q_1^a + q_1^b))q_1^a - \tilde{\pi}_1^a \right]^2.$$

We show in Appendix A below that the reaction functions and reported profits of firm $j \in \{a, b\}$, $j \neq k$ are given by

$$q_1^j = \frac{\gamma_1 - \beta q_1^k}{2\beta}$$

$$q_2^j = \frac{\gamma_2 - \beta q_2^k}{2\beta}$$

$$\tilde{\pi}_1^j = (\gamma_1 - \beta(q_1^j + q_1^k))q_1^j - \frac{t_1 - t_2}{4\delta}$$

$$\tilde{\pi}_2^j = (\gamma_2 - \beta(q_2^j + q_2^k))q_2^j + \frac{t_1 - t_2}{4\delta},$$

respectively. The reported profit in each country is the true profit (first term) adjusted for the tax differential weighted by the cost of profit shifting (second term). The equilibrium production choices are $q_1^a = q_1^b = \gamma_1/3\beta$, and $q_2^a = q_2^b = \gamma_2/3\beta$, yielding equilibrium prices $p_1 = \gamma_1/3$ and $p_2 = \gamma_2/3$. The total profit reported in country i , $\tilde{\pi}_i^b + \tilde{\pi}_i^a$, is

$$\tilde{\pi}_i = \frac{2}{\gamma_i^2} 9\beta - \frac{t_i - t_j}{2\delta}, \quad i = 1, 2, j \neq i.$$

We can normalize production assuming $\gamma_1 = \frac{3}{2}\sqrt{\beta(1+\varepsilon)}$, $\gamma_2 = \frac{3}{2}\sqrt{\beta(1-\varepsilon)}$, so that

$$\tilde{\pi}_1 = \frac{1+\varepsilon}{2} - \frac{t_1 - t_2}{2\delta}$$

$$\tilde{\pi}_2 = \frac{1-\varepsilon}{2} + \frac{t_1 - t_2}{2\delta}$$

for countries 1 and 2. The aggregate profit is therefore equal to 1 regardless of the tax choices, making the tax game a zero-sum game. Note that for identical taxes $t_1 = t_2$ the distribution of aggregate profits between two countries is solely determined by the market size parameter, i.e., $\tilde{\pi}_1(t, t) = (1+\varepsilon)/2$. Note also that given the normalization of the production, the market size parameter must satisfy $0 \leq \varepsilon \leq 1$, the assumption that will be imposed through the rest of the paper.¹⁵

15. One anonymous referee suggested that if the normalization of demand functions lead to elegant and clear cut results, it could also limit their scope by limiting implicitly the degree of heterogeneity between countries. The issue is that revenue sharing may no longer be beneficial to both countries for a larger degree of heterogeneity. We do not share this view, because the upper limit on heterogeneity in our model involves $\varepsilon = 1$ which implies that with equal taxes the entire profit share will be located in the large country.

Notice that if countries cooperate in their choice of tax rates, they would maximize the joint fiscal revenue

$$t_1 \left(\frac{1 + \varepsilon}{2} - \frac{t_1 - t_2}{2\delta} \right) + t_2 \left(\frac{1 - \varepsilon}{2} + \frac{t_1 - t_2}{2\delta} \right)$$

which leads to the optimal tax harmonization $t_1^o = t_2^o = 1$, and maximal joint fiscal revenue equal to 1.

III. Tax Competition

We now move to the tax game. The government of country 1 chooses t_1 to maximize

$$R_1 = t_1 \left(\frac{1 + \varepsilon}{2} - \frac{t_1 - t_2}{2\delta} \right).$$

The first-order condition is

$$\frac{dR_1}{dt_1} = \frac{1 + \varepsilon}{2} - \frac{t_1 - t_2}{2\delta} - \frac{t_1}{2\delta} = 0. \tag{2}$$

Analogously, the first-order condition for country 2 is

$$\frac{dR_2}{dt_2} = \frac{1 - \varepsilon}{2} + \frac{t_1 - t_2}{2\delta} - \frac{t_2}{2\delta} = 0. \tag{3}$$

It is interesting to note that (2) and (3) differ in fact only in the first term, which is larger for the country 1. This implies that for equal tax rates the large country has a stronger incentive to tax than the small one.¹⁶

Solving the first-order conditions, one obtains the best replies¹⁷

$$\hat{t}_1(t_2) = \delta \frac{1 + \varepsilon}{2} + \frac{t_2}{2}, \quad \text{and} \quad \hat{t}_2(t_1) = \delta \frac{1 - \varepsilon}{2} + \frac{t_1}{2}.$$

On its best-response function, each country reaches the top of its Laffer curve conditional on the tax choice of the other country. Taxes are strategic complements: if, say, country 2 raises its tax rate, the tax base of country 1 expands, thus, strengthening country 1's incentive to tax. The intersection of the two best replies gives the Nash equilibrium taxes,

$$t_1^* = \delta \left(1 + \frac{\varepsilon}{3} \right) \quad \text{and} \quad t_2^* = \delta \left(1 - \frac{\varepsilon}{3} \right).$$

In equilibrium, both countries are on the top of their respective Laffer curves. To insure an interior solution to the tax game, we assume throughout the rest of the paper that

$$\delta \leq \bar{\delta} = \frac{3}{3 + \varepsilon} \leq 1.$$

16. It is worth pointing out that the heterogeneity between countries makes the firms more inclined to declare profits in one of the countries but does not affect the perceived elasticity of the tax base in the different countries. In standard tax competition models it is the asymmetry in the perceived elasticity of the tax base which generates the asymmetric choice of taxes (see HAUFLER [2001]).

17. Notice that the revenue function is concave in the tax rate, $d^2R_1/dt_1^2 = -1/\delta < 0$ so the existence of equilibrium is ensured.

and, hence, the profit shifting is effectively binding and limits governments' tax choices.

It is worth noting that tax competition induces a net loss of tax base (relative to tax harmonization) for the large country which taxes more in equilibrium.¹⁸ The tax rate difference $t_1^* - t_2^* = 2\delta\varepsilon/3$ implies that both firms shift profits from the large to the small country. However, this profit shifting is not enough to cancel out the market size effect, and the large country ends up with a larger tax base in equilibrium,

$$\tilde{\pi}_1^* = \frac{1}{2} + \frac{\varepsilon}{6}, \quad \tilde{\pi}_2^* = \frac{1}{2} - \frac{\varepsilon}{6}.$$

With a larger tax base and a higher tax rate, the large country also ends up with a higher fiscal revenue in equilibrium,

$$R_1^* = \frac{\delta}{18}(3 + \varepsilon)^2, \quad R_2^* = \frac{\delta}{18}(3 - \varepsilon)^2$$

Naturally, the cost of shifting profit measured by δ , affects tax levels in equilibrium: lower δ exacerbates the tax competition between countries and reduces the equilibrium taxes and joint tax revenue. It is straightforward to conclude that if $\delta < \bar{\delta}$ the joint tax revenue generated by the competitive outcome is smaller than under the cooperative outcome. This allows us to state our first proposition.

Proposition 1. In the Nash equilibrium, there is under-taxation and joint tax revenue is sub-optimal. If the profit shifting becomes more easier (i.e., if δ decreases) Nash equilibrium taxes decrease, and so does joint tax revenue.

Another question is whether countries would benefit from cooperation, when they both set the cooperative tax rates $t_1^o = t_2^o = 1$ and get the respective tax revenue, $R_1^o = (1 + \varepsilon)/2$, $R_2^o = (1 - \varepsilon)/2$.¹⁹ Comparing this cooperative outcome with the Nash equilibrium outcome, we obtain the following result.

Proposition 2. While the tax revenue of the large country is higher under optimal (harmonized) taxes than in the Nash equilibrium, the effect is ambiguous for the small country. However there exists δ^* , such that the tax revenue of the small countries decreases with (optimal) harmonization whenever $\delta > \delta^*$ and increases otherwise.

The potential advantage of the small country is its lower tax rate, which allows it to attract a fraction $\varepsilon/3$ of the large country tax base. With tax harmonization, this is no longer possible. Thus, unless the fiscal competition is too intense and leads to very low tax rates in both countries, the small country prefers the competition outcome to the tax harmonization outcome. The intensity of tax competition is inversely proportional to the profit shifting parameter δ so that for sufficiently high $\delta > \delta^*$ the small country prefers competition to cooperation. The fact that small countries tax less, and may end up benefiting from tax competition, has already

18. See EXBRAYAT and GEYS [2013] for empirical analysis of the link between market size and the difference in the profit tax rates across countries.

19. It is straightforward that there is a cooperative tax revenue split that benefits both countries. We concentrate here on the no transfer benchmark.

been established in capital tax competition literature (BUCOVETSKY [1991], J. D. WILSON [1991]), where low tax rates in small countries are driven by their limited market power in the international capital markets.²⁰

Given that harmonization on the fully cooperative outcome is not necessarily beneficial to the small country, we now wish to verify whether a milder form of tax harmonization could provide benefits for both countries. Consider the tax level given by the following formula:

$$\bar{t}(\lambda) = \lambda t_1^* + (1 - \lambda)t_2^*$$

with $0 \leq \lambda \leq 1$. So the uniform tax rate represents a convex combination of the equilibrium tax rates, where for large λ there is harmonization toward high tax rate and with low λ there is harmonization close to the low tax rate. We have the following result:

Proposition 3. Consider a tax harmonization in the form of convex combination between the high and low equilibrium taxes. Then there exists no harmonized tax rate that could benefit the small country.

The reason is that the small country loses its tax base as a result of tax harmonization. With harmonization to the bottom, $\lambda \rightarrow 0$, the small country gets smaller tax base but taxes the same in equilibrium, which lowers its tax revenue. Contrarily, with harmonization to the top $\lambda \rightarrow 1$, the large country is better off because it will get an expanded tax base, while taxing the same in equilibrium, but the small country is worse off because it deviates from its best response to the large country's choice of high tax.

In summary, tax competition leads to inefficiently low taxes, with the large country getting higher tax revenue than the small country. Cooperation via tax harmonization could be harmful for the small country that could end up losing as compared with tax competition. So the small country has no incentive to cooperate. The next section analyzes the impact of alternative arrangements, namely, revenue sharing schemes, on the equilibrium outcome to verify whether both countries could benefit from such an arrangement. Obviously if tax harmonization is beneficial to the small country, then there is no need for a revenue sharing scheme. But if it is not the case, we propose a solution to the tax competition problem that can usefully complement the tax harmonization scheme.

IV. Introducing Revenue Sharing

We now consider a *revenue sharing* scheme (which is a form of revenue equalization) where both countries share a proportion α of their tax revenue with the other. Usually, the introduction of revenue sharing serves the purpose of ameliorating the fiscal disparities that would otherwise exist across regions and countries. The revenue sharing arrangements can also help to reduce the intensity of tax competition across and avoid the race towards inefficiently low tax rates.

20. According to the *small country advantage* obtained by these authors, the small country has a higher payoff than the large country in the tax competition equilibrium, but the payoffs are equal in the cooperative outcome. In our setup, the large country has a higher fiscal revenue than the small one both in the competitive equilibrium and the cooperative outcome *but* the small country gains when moving from cooperation to competition.

Formally, we now allow the countries to introduce the possibility of sharing a uniform proportion $0 \leq \alpha$ of their own fiscal revenue with each other.²¹ For simplicity we assume that $\alpha < 1/2$. This assumption is reasonable since for $\alpha > 1/2$ each country would care more about the fiscal revenue in the other country than its own, which would make the tax choices in the competition game a bit weird. With revenue sharing, country $i = 1, 2$'s fiscal revenue becomes

$$R_i(\alpha) = (1 - \alpha)t_i \tilde{\pi}_i + \alpha t_j \tilde{\pi}_j, \quad j \neq i \tag{4}$$

IV.1. *Equilibrium Taxes with Revenue Sharing*

Computing the first-order conditions for the two countries and solving yields the following best-reply functions:

$$\hat{t}_1(t_2; \alpha) = \delta \frac{1 + \varepsilon}{2} + \frac{t_2}{2(1 - \alpha)}, \quad \text{and} \quad \hat{t}_2(t_1; \alpha) = \delta \frac{1 - \varepsilon}{2} + \frac{t_1}{2(1 - \alpha)}.$$

Note that taxes are strategic complements, and the effect of revenue sharing is to reinforce this strategic complementarity.²² For $\alpha < 1/2$ the slopes of the tax responses are less than one. Strategic complementarity is reinforced because revenue sharing smoothes out the impact of each country's tax rate change on its own tax revenue.²³

FIGURE 1 illustrates the tax response functions.

Solving for the Nash equilibrium tax rates yields

$$t_1^*(\alpha) = \delta(1 - \alpha) \left(\frac{1}{1 - 2\alpha} + \frac{\varepsilon}{3 - 2\alpha} \right)$$

and

$$t_2^*(\alpha) = \delta(1 - \alpha) \left(\frac{1}{1 - 2\alpha} - \frac{\varepsilon}{3 - 2\alpha} \right).$$

It is easy to see that equilibrium taxes are positive for $\alpha < 1/2$ and that tax rates are less than one if given $0 \leq \varepsilon \leq 1, 0 \leq \alpha < 1/2$,

$$\delta < \bar{\delta}(\alpha) = \frac{(3 - 2\alpha)(1 - 2\alpha)}{((3 - 2\alpha) + \varepsilon(1 - 2\alpha))(1 - \alpha)} \leq 1, \tag{5}$$

so that the cost of profit shifting must be sufficiently low to (effectively) limit the tax choices of governments. We now restrict our attention to the values of $\delta < \bar{\delta}(\alpha)$ for all $\alpha < 1/2$.

Note that the large country's tax rate is higher than that of the small one as with no revenue sharing.

21. We did not investigate the case of different revenue shares, because as will be clear later, uniform sharing is already beneficial to both countries, given our normalization of the model. Obviously, asymmetric revenue shares provide more flexibility that cannot harm any country.

22. It is straightforward to obtain that $d^2R_i/dt_i^2 = -(1 - \alpha)/\delta$, hence the existence of equilibrium is ensured for $\alpha < 1/2$.

23. Indeed, the following value is between 0 and 1:

$$\frac{d\hat{t}_1(t_2; \alpha)}{dt_2} = -\frac{\frac{d^2R_1(\alpha)}{dt_1 dt_2}}{\frac{d^2R_1(\alpha)}{dt_1^2}} = \frac{1/(2\delta)}{(1 - \alpha)/\delta} = \frac{1}{2(1 - \alpha)}$$

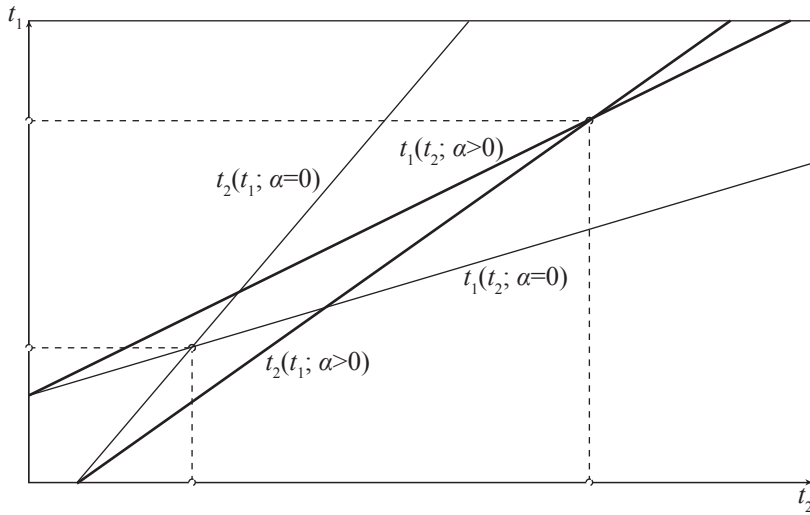


FIGURE 1. – Tax Choice

IV.2. *Efficiency and Equalizing Effects of Revenue Sharing*

The interesting question is the extent to which revenue sharing may improve upon the tax competition outcome. More specifically, we analyze the impact of increasing revenue sharing on joint tax revenue and on the tax revenue in each country. We also examine its potential equalizing effect by reducing the fiscal imbalances.

It is straightforward to show that both taxes increase in the degree of revenue sharing,

$$\frac{dt_1^*(\alpha)}{d\alpha} = \delta \left(\frac{1}{(1-2\alpha)^2} - \frac{\epsilon}{(3-2\alpha)^2} \right) > 0, \text{ for } \epsilon \leq 1 \tag{6}$$

$$\frac{dt_2^*(\alpha)}{d\alpha} = \delta \left(\frac{1}{(1-2\alpha)^2} + \frac{\epsilon}{(3-2\alpha)^2} \right) > 0. \tag{7}$$

This positive impact on equilibrium tax rates is the result of the reinforced strategic complementarity. By reducing (in absolute value) the own tax effect on marginal revenue, revenue sharing induces countries to set higher taxes. This effect is reminiscent of country’s market power in capital tax competition models, where the international capital price absorbs part of a given country’s tax increase, provided that countries are large enough to have market effect on the price of capital. Hence, for sufficiently large countries, the tax base becomes less elastic with respect to its own tax rate, thereby increasing Nash equilibrium tax rates.

It is also immediate from (6) and (7) that the impact of revenue sharing is greater for the small than for the large country, so that the tax gap actually shrinks and tax choices converge with the degree of revenue sharing. This implies that revenue sharing reallocates tax base (profit) from the (low-tax) small to the (high-tax) large country.

We summarize these findings in the next proposition.

Proposition 4. A higher degree of revenue sharing raises the tax rates of both countries. In addition, the tax gap shrinks and causes a shift of a part of the tax base from the (low tax) small to the (high tax) large country.

Interestingly, since the value of profits shifted from the low to the high tax country is proportional to the tax difference, the lower tax gap induces the firms to reduce profit shifting. Given that profit shifting is costly, revenue sharing has the advantage of reducing the incentive for firms to waste resources on profit shifting. Under revenue sharing, the declared profits in each country are respectively given by

$$\begin{aligned}\tilde{\pi}_1 &= \frac{1}{2} \left(1 + \frac{\varepsilon}{3-2\alpha} \right) \geq 0 \\ \tilde{\pi}_2 &= \frac{1}{2} \left(1 - \frac{\varepsilon}{3-2\alpha} \right) \geq 0.\end{aligned}$$

Thus, an increased revenue sharing transfers resources from the low-tax jurisdiction (country 2) to the high-tax jurisdiction (country 1).

The fact that both tax rates increase with the degree of revenue sharing, and that the overall tax base is fixed, implies that revenue sharing increases the joint tax revenue. Indeed, straightforward algebra shows that

$$\begin{aligned}R_1^*(\alpha) &= \delta \frac{1-\alpha}{2} \left(\frac{1}{1-2\alpha} + \frac{2(1-\alpha)}{3-2\alpha} \varepsilon + \frac{1}{(3-2\alpha)^2} \varepsilon^2 \right), \\ R_2^*(\alpha) &= \delta \frac{1-\alpha}{2} \left(\frac{1}{1-2\alpha} - \frac{2(1-\alpha)}{3-2\alpha} \varepsilon + \frac{1}{(3-2\alpha)^2} \varepsilon^2 \right)\end{aligned}$$

so that total fiscal revenue is

$$R_1^*(\alpha) + R_2^*(\alpha) = \delta(1-\alpha) \left(\frac{1}{1-2\alpha} + \frac{1}{(3-2\alpha)^2} \varepsilon^2 \right)$$

and the impact of revenue sharing is then

$$\frac{d(R_1^*(\alpha) + R_2^*(\alpha))}{d\alpha} = \delta \left(\frac{1}{(1-2\alpha)^2} + \frac{(1-2\alpha)}{(3-2\alpha)^3} \varepsilon^2 \right) > 0.$$

What about the impact of revenue sharing for each country separately? Notice that one may rewrite tax revenue of country $i = 1, 2$ as

$$R_i(\alpha) = t_i \tilde{\pi}_i + \alpha(t_j \tilde{\pi}_j - t_i \tilde{\pi}_i), \quad i = 1, 2, \quad j \neq i. \tag{8}$$

The first term is the pre-sharing tax revenue. This term is increasing for the large country, given that both its tax rate and its tax base are increasing with revenue sharing. As regards the small country, even though its tax rate is increasing in α , its tax base is reduced (due to the smaller tax gap), hence the impact is, a priori, ambiguous. Note, however, that the final division of the tax base depends entirely on the tax differential, which is less sensitive to revenue sharing than own tax rate change. It is therefore not surprising that the tax rate increase dominates the tax base loss, and

$$\frac{d(t_2^*(\alpha)\tilde{\pi}_2^*(\alpha))}{d\alpha} = \delta \left(\frac{1}{2(1-2\alpha)^2} - \frac{4(1-\alpha)\varepsilon}{2(1-2\alpha)^2(3-2\alpha)^2} + \frac{(1-2\alpha)\varepsilon^2}{2(3-2\alpha)^3} \right) > \delta \left(\frac{1}{2(1-2\alpha)^2} - \frac{4(1-\alpha)}{2(1-2\alpha)^2(3-2\alpha)^2} \right) = \delta \left(\frac{3-4\alpha(2-\alpha)}{2(1-2\alpha)^2(3-2\alpha)^2} \right) > 0$$

Hence, pre-sharing tax revenues increase with revenue sharing in both countries.

The second term in (8) is the net transfer between countries involved by the revenue sharing. The small country has smaller revenue and so is a net beneficiary of the revenue sharing, whereas the large country is a net contributor to the scheme. Formally, the fiscal revenue differential is given by

$$t_1^*(\alpha)\tilde{\pi}_1^*(\alpha) - t_2^*(\alpha)\tilde{\pi}_2^*(\alpha) = \delta\varepsilon \frac{2(1-\alpha)^2}{3-4\alpha(2-\alpha)} > 0$$

and the net transfer $\alpha [t_1^*(\alpha)\tilde{\pi}_1^*(\alpha) - t_2^*(\alpha)\tilde{\pi}_2^*(\alpha)]$ is increasing in the degree of revenue sharing, since

$$\frac{d[(t_1^*(\alpha)\tilde{\pi}_1^*(\alpha) - t_2^*(\alpha)\tilde{\pi}_2^*(\alpha))]}{d\alpha} = \delta\varepsilon \frac{4(1-\alpha)}{(3-4\alpha(2-\alpha))^2} > 0.$$

That is, the own-tax revenue differential is increasing with revenue sharing (in spite of the convergence in tax rates). It is then evident that the small country always benefits from increasing revenue sharing: both its pre-sharing tax revenue and the net transfers from the large country raise with revenue sharing.

Another question pertains to the equalizing effect of revenue sharing. Notice that $\Delta(\alpha) = R_1^*(\alpha) - R_2^*(\alpha) = (1-2\alpha)(t_1^*(\alpha)\tilde{\pi}_1^*(\alpha) - t_2^*(\alpha)\tilde{\pi}_2^*(\alpha))$. On the one hand, increasing revenue sharing implies that countries retain a decreasing part of their own tax revenue; on the other hand, the own-tax revenue differential is increasing in the degree of revenue sharing. It turns out that the first effect always dominates the second, so that revenue sharing has an overall fiscal equalization effect. Indeed, after straightforward simplification,

$$\frac{d\Delta(\alpha)}{d\alpha} = -4\delta\varepsilon \frac{(2-\alpha)(1-\alpha)}{(3-2\alpha)^2} < 0.$$

The discussion above allows us to establish the following result.

Proposition 5. The joint tax revenue increases with revenue sharing whereas the fiscal imbalances shrinks. Moreover, the tax revenue of the small country increases with revenue sharing.

Thus, the small country gains from revenue sharing because the shrinkage of its tax base is more than offset by the increase of its tax rate and the net transfer received from the large country. Obviously, the fact that total fiscal revenue increases with revenue sharing is a necessary but not a sufficient condition for the large country to gain from revenue sharing. Fiscal revenue in the large country is the sum of its pre-sharing revenue and the net transfer. The first term is increasing with revenue sharing because both the tax rate and tax base increase. It is possible to show that this benefit always dominates the cost of the net transfer to the small country, so that the large country also benefits from revenue sharing.

Proposition 6. The tax revenue of the large country increases with revenue sharing. The benefit from revenue sharing to the large country is smaller the greater the degree of heterogeneity between the countries.

When countries' size heterogeneity is small, the net transfer is also small and the benefit of revenue sharing is to limit the harmful tax competition. When the countries are very heterogeneous, the result stems from the tax gap, which is proportional to ε . Reducing this gap causes an inflow of tax base (profit) to the large country. To fix ideas, consider that the heterogeneity is at its maximum value $\varepsilon = 1$ and consider the no-revenue sharing outcome. We know from SECTION III that $t_1^* = 4\delta/3$ and $t_2^* = 2\delta/3$, leading to a distribution of tax base of $2/3$ for the large and $1/3$ for the small country, respectively (compared to a zero tax base in the small country with equal taxes). Actually, the aggressiveness of the small country in the tax competition game is proportional to the extent of heterogeneity, which leads to a greater loss of tax base for the large country when heterogeneity is high. Introducing a small amount of revenue sharing in this setting increases t_1^* by $8\delta/9$ and t_2^* by $10\delta/9$, thus leading to a transfer of tax revenue from the small to the large country of $1/9$, at a negligible cost of a net transfer close to 0.

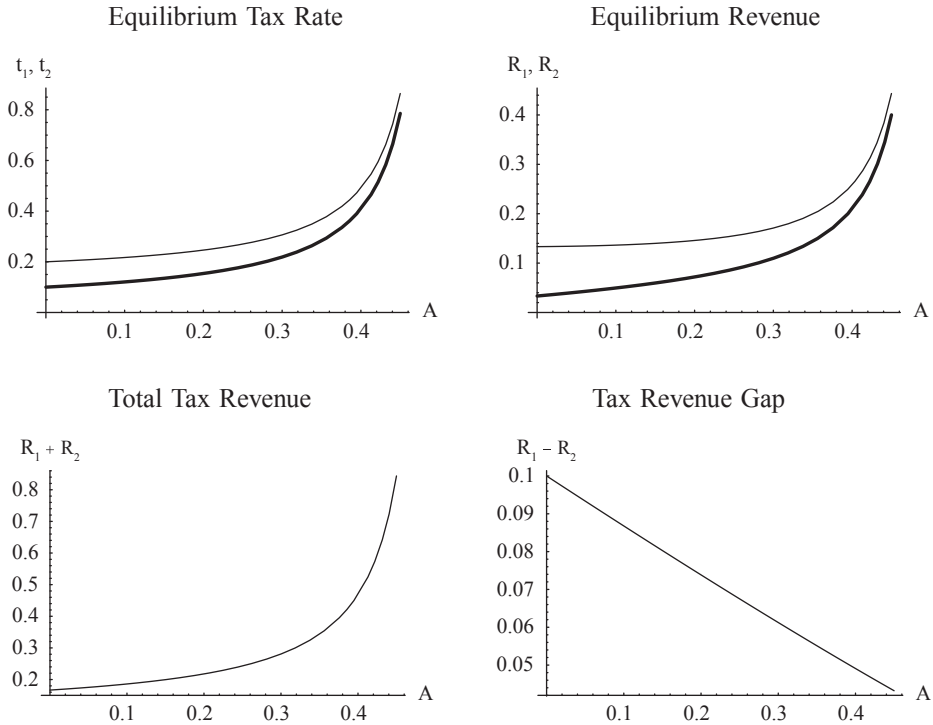
FIGURE 2 shows how the tax revenue of both countries increase, and tax rates increase and converge, with α , in the specific case of $\varepsilon = 1$.²⁴

To summarize, revenue sharing raises the joint tax revenue and reduces the fiscal imbalances between countries, implying that the small country benefits from revenue sharing. This is not so surprising. Perhaps more surprising is the result that the large country also benefits from revenue sharing, even if its fiscal capacity is much larger. In this case, the efficiency gain (i.e., reducing tax competition) from revenue sharing outweighs the cost of transferring resources to the small country. The natural question is whether the benefit of revenue sharing is not due to some artifact of the specific model used. This is notably the case for the large country that is supposed to share more revenue than what it gets from the other country. To get some sense of the generality of our result, we can use the envelope argument. Starting from the equilibrium taxes, the large country is choosing a tax rate that maximizes its payoff conditional on the degree of revenue sharing. A change in revenue sharing at the margin will induce both countries to increase their tax rates. The induced increase in the large country tax rate has only a second order effect on its payoff (by an envelope argument), however due to the positive externality, the induced increase in the small country tax rate has a first order positive effect for the large country. Thus revenue sharing is beneficial to the large country in a rather general context.

V. Tax Base Equalization

The revenue sharing scheme discussed so far is one of *tax revenue equalization*. One alternative, used in Canada, is *tax base equalization*, entailing a transfer across jurisdictions proportional to the tax base differential, weighted by a reference (average) tax rate. Both BUCOVETSKY and

24. The mobility cost of the tax base is set to $\delta = 0.15$. Since this value is just a multiplicative factor in equilibrium tax rates and fiscal revenues, it does not impact our results. The value used does ensure that the boundary condition (5) is satisfied.



The simulations use the following parameter values: $\varepsilon = 1$, $\delta = 0.15$.

FIGURE 2. – The Impact of Tax Revenue Equalization

SMART [2006] and KOETHENBUERGER [2002] have shown that such a scheme reduces the inter-governmental competition for firms, and leads to higher equilibrium capital taxation. In their model, tax choices influence production activities due to the mobility of firms. However they demonstrated that higher equilibrium taxes still raise social welfare, even if the consumer surplus is taken into account (although it is unclear whether this result always holds for asymmetric jurisdictions). In our model of competition for profits, we have already mentioned that production is independent of tax choices, and so we do not need to take into account the consumer surplus in the analysis. Following tax base equalization, in our model, country i receives a transfer which is equal to

$$T_i = \alpha \bar{t} (\bar{\pi}_j - \tilde{\pi}_i)$$

with $\alpha \in [0, 1/2)$, measuring the degree of fiscal equalization, and the average tax rate is given by

$$\bar{t} = \frac{t_1 \tilde{\pi}_1 + t_2 \tilde{\pi}_2}{\tilde{\pi}_1 + \tilde{\pi}_2} = t_1 \tilde{\pi}_1 + t_2 \tilde{\pi}_2$$

Notice that, by construction, $T_1 = -T_2$. The country payoff therefore becomes

$$\rho_i(\alpha) = t_i \tilde{\pi}_i + \alpha T_i,$$

that can be rewritten as

$$\rho_i(\alpha) = t_i \tilde{\pi}_i + \alpha (\tilde{\pi}_j - \tilde{\pi}_i) (t_1 \tilde{\pi}_1 + t_2 \tilde{\pi}_2). \quad (9)$$

We compute in the Appendix the Nash equilibrium tax rates and the equilibrium payoff functions. It is also shown that the tax gap is in equilibrium

$$t_1^* - t_2^* = 2\delta\varepsilon \frac{1-\alpha}{3-2\alpha} > 0$$

which is decreasing in α . For further reference, notice that with full equalization $\alpha \rightarrow 1/2$, the tax rate differential is still positive.

We may thus establish our next result (see Appendix for the proof).

Proposition 7. Under tax base equalization, a higher degree of equalization raises the tax rates of both countries. In addition, the tax gap shrinks, causing a shift of tax base from the (low tax) small to the (high tax) large country.

The system of tax base equalization imposes a penalty on the country which is trying to expand its tax base by reducing its own profit tax rate, since it raises its contribution to the equalization system accordingly. Therefore, increased equalization reduces the incentive for wasteful tax competition.

We now turn to the analysis of the impact of equalization on tax revenue. As with tax revenue equalization, the fact that both tax rates increase with the degree of fiscal equalization, and that the total tax base is fixed ensure that the total revenue is increasing with α .

Let us examine the tax revenue of each country separately and begin by analyzing the transfer from the large to the small country, which is equal to

$$\alpha (\tilde{\pi}_1 - \tilde{\pi}_2) (t_1^* \tilde{\pi}_1 + t_2^* \tilde{\pi}_2)$$

We already know that the average tax rate $\bar{t} = t_1^* \tilde{\pi}_1 + t_2^* \tilde{\pi}_2$ increases in α . We also have that tax rate convergence shifts tax base from the (low-tax) small to the (high-tax) large country, i.e., as established in the Appendix

$$\tilde{\pi}_1^* - \tilde{\pi}_2^* = \frac{\varepsilon}{3-2\alpha}$$

which is increasing in α . Therefore, the net transfer increases in α . We summarize these effects as follows. For the large country, the pre-sharing tax revenue increases with equalization, but the transfer to the small country is also increasing. For the small country, the transfer it gets from the large country is increasing, but the effect on pre-sharing tax revenue is ambiguous, because the tax rate increases but the base shrinks. However, we show in the appendix that the pre-sharing fiscal revenue of the small country increases with equalization, and the overall effect is thus positive.

As regards the large country, it is also demonstrated in the appendix that its payoff is increasing with equalization. We establish our next result (see Appendix for the proof).

Proposition 8. With a system of tax base equalization, the joint tax revenue increases with the degree of equalization, and so do the separate tax revenues of the two countries.

The system of tax base equalization therefore has similar effects to the one based on tax revenue equalization when it comes to tax rate levels and convergence, tax base transfer from the small to the large country, and to its Pareto improving nature. However contrarily to revenue sharing, we now highlight a striking effect of tax base equalization: the fact that it actually contributes to increasing revenue inequality between the two countries. So contrary to the conventional wisdom, tax base equalization improves tax efficiency at the equity cost of a more unequal distribution of revenue, and not the other way around.

Proposition 9. With a system of tax base equalization, the tax revenue gap increases.

Notice that the positive tax revenue gap is given by (see appendix)

$$\rho_1^*(\alpha) - \rho_2^*(\alpha) = \delta \frac{\varepsilon}{3 - 2\alpha} \left(2 - \alpha + \frac{(1 - 2\alpha)\alpha}{(3 - 2\alpha)^2} \varepsilon^2 \right) > 0.$$

Interestingly, it remains positive, even with the system of transfers fully implemented when $\alpha \rightarrow 1/2$. This is because the system of tax base equalization is *not* designed to equalize tax revenue, but rather to give the countries a comparable tax base.

If we now let the degree of fiscal equalization vary, it is straightforward that

$$\frac{d(\rho_1^*(\alpha) - \rho_2^*(\alpha))}{d\alpha} = \frac{\delta \varepsilon}{(3 - 2\alpha)^4} \left((3 - 2\alpha)^2 + (3 - 2\alpha(4 + 2\alpha))\varepsilon^2 \right)$$

which is positive, since $(3 - 2\alpha(4 + 2\alpha))\varepsilon^2 \geq -2$ and $(3 - 2\alpha)^2 \geq 4$.

In order to explain this result, let us present the tax revenue gap as follows

$$\rho_1^*(\alpha) - \rho_2^*(\alpha) = t_1^* \tilde{\pi}_1^* - t_2^* \tilde{\pi}_2^* - 2\alpha (\tilde{\pi}_1^* - \tilde{\pi}_2^*) (t_1^* \tilde{\pi}_1^* + t_2^* \tilde{\pi}_2^*),$$

where the first term is the pre-equalization revenue gap, and the second term is (twice) the transfer from the large to the small country. As noted above, the transfer is increasing in α , given the redistribution of the tax base from the small to the large region and the increased total tax revenue. Hence, as expected, the direct impact of fiscal equalization indeed decreases country inequality. However, the pre-equalization gap is increasing in α . Indeed,

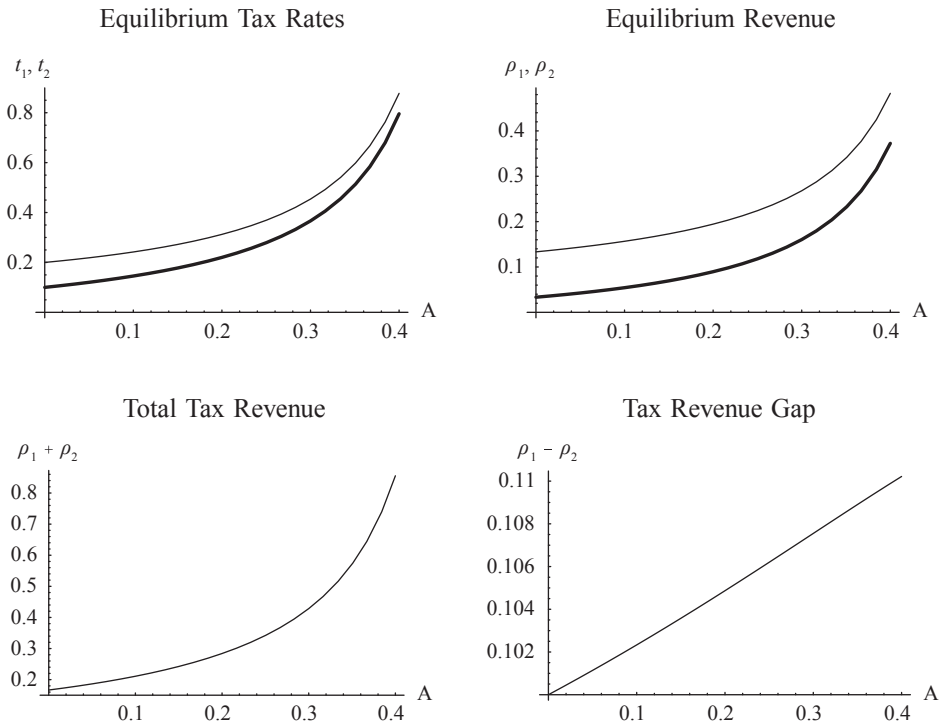
$$t_1^* \tilde{\pi}_1^* - t_2^* \tilde{\pi}_2^* = \delta \varepsilon \left(\frac{2 - \alpha(3 - 2\alpha)}{3 - 4\alpha(2 - \alpha)} + \frac{\alpha(3 - 4\alpha)}{(3 - 2\alpha)^3(1 - 2\alpha)} \varepsilon^2 \right)$$

Simple computations show that both terms are increasing in α , and so the pre-equalization fiscal revenue gap increases with the degree of equalization.²⁵ The reason is that the revenue of the large country increases both due to the increased tax rate and tax base, whereas that of the small country increases because of the increased tax rate, despite the smaller tax base. Therefore, in terms of the pre-equalization revenue, the large country gains more than the small one from fiscal equalization, and this effect actually dominates that of equalization.

Notice that when full equalization $\alpha \rightarrow 1/2$ is implemented, the tax revenue gap is equal to

$$\rho_1^* - \rho_2^* = 2\tilde{\pi}_1^* \tilde{\pi}_2^* (t_1^* - t_2^*) > 0$$

25. Please refer to the Appendix for detailed computations.



The simulations use the following parameter values: $\varepsilon = 1$, $\delta = 0.15$.

FIGURE 3. – The Impact of Tax Base Equalization

This is not surprising. Contrary to the system of tax revenue equalization, whose objective is to equalize tax revenue, this system of tax base equalization has a different aim. Indeed, with full equalization, the tax revenue of the two countries is proportional to the tax rate difference.

FIGURE 3 plots the equilibrium tax rates and the total revenue for a case of extreme country inequality, i.e., $\varepsilon = 1$. The bottom panel illustrates the result that total tax revenue increases at the expense of country inequality.

The two equalization systems considered differ in their impact on the tax revenue gap between the two countries. While tax revenue equalization indeed decreases the fiscal gap, tax base equalization increases it. In this sense, tax revenue equalization may be preferred if the social preferences display some concern for equity.

VI. Conclusion

Globalization with the expansion of the reach of global corporation undermines the capacity of local governments to tax corporate income. With divisions in so many different countries, those corporations do not need to physically change location to get a more favorable tax treatment. They can restructure their financial flows across divisions to exploit the tax loopholes in the

different locations. Global corporations can use transfer pricing to obtain favorable tax treatment of profit. With no limitation on transfer pricing the firms will set extreme value to shift as much profit as possible to the low-tax jurisdiction. This process undermines the capacity to tax corporate income and encourages tax competition to reap the corporate income from other jurisdictions. One solution is to set limits on transfer pricing but those limits are hard to fix and difficult to enforce. The second solution, recommended by the European Commission, is the formula apportionment rules that aggregate corporate income regardless of location and distribute the tax base across jurisdiction according to some fixed rules. The apportionment rule proposed by the European Commission is based on the proportion of total sales generated in each jurisdiction. The implementation of this rule may not be acceptable by all jurisdictions, notably the small jurisdiction with low corporate taxes and small proportion of total sales. This paper offers an alternative solution which is the revenue sharing scheme. We analyze the impact of revenue sharing on corporate tax competition between heterogeneous countries and show that revenue sharing is desirable in a variety of settings, both for the federation as a whole as well as for each country separately, even for the country which is a net contributor in the proposed scheme. We also show that revenue sharing is preferred by the small countries to the tax harmonization, and that revenue sharing reduces the fiscal imbalances across countries.

Our results suggest a complement to the policy instruments used to mitigate the harmful consequences of profit shifting and corporate tax competition. Given the classical divide between large high-tax jurisdictions and small low-tax jurisdictions, revenue sharing can offer a way out. The large jurisdiction benefits from revenue sharing because it limits the harmful tax competition from the small jurisdiction. The small jurisdiction benefits from revenue sharing because it gets more revenue from the big jurisdiction than they pay to it. There is another way out recently suggested by HAUFLER and LÜFESMANN [2013] that consists of a two-tier capital taxation structure. The countries first set cooperatively a minimum federal tax rate, and then each country set its local taxes non cooperatively. It is intermediate solution between full harmonization and full decentralization. It would be interesting to investigate in future work the effect of this two-tier scheme in our profit shifting model. Another interesting extension of our analysis would be to study the Stakelberg equilibrium and to compare the effect of revenue sharing with the Nash equilibrium outcome. (see WANG [1999]).

Appendix

A. The Cournot with Profit Shifting Equilibrium

The first order condition for $\tilde{\pi}_1^a$ is

$$-t_1 + t_2 + 4\delta \left[(\gamma_1 - \beta(q_1^a + q_1^b))q_1^a - \tilde{\pi}_1^a \right] = 0 \quad (\text{A.1})$$

from which one obtains

$$\tilde{\pi}_1^a = (\gamma_1 - \beta(q_1^a + q_1^b))q_1^a - \frac{t_1 - t_2}{4\delta}$$

i.e., the firm declares the profit actually realized minus a term which depends negatively on the tax disadvantage of country 1; this last term is decreasing with the cost to shift profits, δ .

As regards the choice of q_1^a , we have

$$(1 - t_2) [\gamma_1 - 2\beta q_1^a - \beta q_1^b] - 4\delta [(\gamma_1 - \beta(q_1^a + q_1^b))q_1^a - \tilde{\pi}_1^a] [\gamma_1 - 2\beta q_1^a - \beta q_1^b] = 0$$

which, using (A.1), may be written as

$$(1 - t_2 - t_2 + t_1) [\gamma_1 - 2\beta q_1^a - \beta q_1^b] = 0,$$

yielding the reaction function

$$q_1^a = \frac{\gamma_1 - \beta q_1^b}{2\beta} \tag{A.2}$$

Finally, the quantity sold in market 2 solves

$$(1 - t_2)[\gamma_2 - 2\beta q_2^a - \beta q_2^b] = 0$$

yielding the reaction function

$$q_2^a = \frac{\gamma_2 - \beta q_2^b}{2\beta} \tag{A.3}$$

Solving the analogous program for firm b , we get the declared profit

$$\tilde{\pi}_1^b = (\gamma_1 - \beta(q_1^a + q_1^b))q_1^b - \frac{t_1 - t_2}{4\delta}$$

and the quantity reaction functions

$$q_1^b = \frac{\gamma_1 - \beta q_1^a}{2\beta} \quad \text{and} \quad q_2^b = \frac{\gamma_2 - \beta q_2^a}{2\beta}. \tag{A.4}$$

Hence, the equilibrium quantities are $q_2^a = q_2^b = \gamma_2/(3\beta)$, and $q_1^a = q_1^b = \gamma_1/(3\beta)$, yielding equilibrium prices $p_1 = \gamma_1/3$ and $p_2 = \gamma_2/3$. The profit declared in country 1 is then

$$\tilde{\pi}_1^a = \frac{\gamma_1^2}{9\beta} - \frac{t_1 - t_2}{4\delta}$$

and we may use $\tilde{\pi}_1^a + \tilde{\pi}_2^a = (\gamma_1 - \beta(q_1^a + q_1^b))q_1^a + (\gamma_2 - \beta(q_2^a + q_2^b))q_2^a$ to obtain

$$\tilde{\pi}_2^a = \frac{\gamma_2^2}{9\beta} - \frac{t_2 - t_1}{4\delta}.$$

Similarly, for firm b we have

$$\tilde{\pi}_1^b = \frac{\gamma_1^2}{9\beta} - \frac{t_1 - t_2}{4\delta}, \quad \text{and} \quad \tilde{\pi}_2^b = \frac{\gamma_2^2}{9\beta} - \frac{t_2 - t_1}{4\delta}$$

B.

Proof of Proposition 3.2. It is straightforward to obtain

$$R_1^* - \frac{1+\varepsilon}{2} = \frac{1}{18} (\delta(3+\varepsilon)^2 - 9(1+\varepsilon)) \leq -6\varepsilon \leq 0, \text{ for } \delta \leq \bar{\delta}$$

$$R_2^* - \frac{1-\varepsilon}{2} = \frac{1}{18} (\delta(3-\varepsilon)^2 - 9(1-\varepsilon)) \leq 0, \text{ for } \delta \leq \frac{9(1-\varepsilon)}{(3-\varepsilon)^2} \leq \bar{\delta}.$$

□

Proof of Proposition 4.3. Straightforward algebra allows us to obtain

$$\phi(\varepsilon, \alpha) = \frac{\partial R_1^*(\alpha)}{\partial \alpha} = \frac{\delta}{2} \left(\frac{1}{(1-2\alpha)^2} + \frac{1-2\alpha}{(3-2\alpha)^3} \varepsilon^2 - \frac{4(2-\alpha)(1-\alpha)}{(3-2\alpha)^2} \varepsilon \right)$$

Also,

$$\frac{\partial \phi}{\partial \varepsilon} = \frac{\delta}{2} \left(2\varepsilon \frac{1-2\alpha}{(3-2\alpha)^3} - \frac{4(2-\alpha)(1-\alpha)}{(3-2\alpha)^2} \right) < 0, \text{ for } 0 \leq \varepsilon \leq 1.$$

This proves the second part of the proposition.

We now compute $\phi(1, \alpha)$. Some algebra allows us to write

$$\phi(1, \alpha) = \frac{\delta}{2} \left(-1 + \frac{1}{(1-2\alpha)^2} - \frac{2}{(3-2\alpha)^3} + \frac{2}{(3-2\alpha)^2} \right) > 0,$$

where the inequality is obtained using the fact that $0 < 1 - 2\alpha \leq 1$ and that $2 < 3 - 2\alpha \leq 3$. We have thus established that $\phi(\varepsilon, \alpha) > 0$, for $0 \leq \varepsilon \leq 1$, which is the first part of the proposition. □

Proof of Proposition 4.4.

$$\bar{r}(\lambda) = \delta \left[1 + \frac{\varepsilon}{3} (2\lambda - 1) \right]$$

This gives the revenue under harmonization in the small country 2

$$\bar{R}_2(\lambda) = \delta \bar{r}(\lambda) \frac{1-\varepsilon}{2}$$

The revenue in the small country attains a maximum at $\lambda = 1$. So

$$\bar{R}_2(1) = \delta \left(1 + \frac{\varepsilon}{3} \right) \left(\frac{1-\varepsilon}{2} \right)$$

Compared to the equilibrium revenue without harmonization

$$R_2^* = \delta \left(1 - \frac{\varepsilon}{3} \right) \left(\frac{1-\varepsilon}{2} \right)$$

It follows that

$$R_2^* > \bar{R}_2(\lambda) \text{ for all } \lambda$$

which completes the proof. □

C.

Proof of Proposition 5.1. The first order condition for the choice of t_i reads

$$\frac{d\rho_1}{dt_1} = -\frac{1}{2\delta} \frac{\partial \rho}{\partial \pi_1} + \frac{1}{2\delta} \frac{\partial \rho}{\partial \pi_2} + \frac{\partial \rho}{\partial t_1} = 0$$

some trivial algebra allows us to write

$$\frac{d\rho_1}{dt_1} = -\frac{t_1}{2\delta} + \frac{1+\varepsilon}{2}(1-\alpha\varepsilon) - \frac{t_1-t_2}{2\delta}(1-\alpha(1+4\varepsilon)) - 6\alpha\left(\frac{t_1-t_2}{2\delta}\right)^2 + \alpha\frac{t_1+t_2}{2\delta} \quad (C.1)$$

analogously,

$$\frac{d\rho_2}{dt_2} = -\frac{t_2}{2\delta} + \frac{1-\varepsilon}{2}(1+\alpha\varepsilon) + \frac{t_1-t_2}{2\delta}(1-\alpha(1-4\varepsilon)) - 6\alpha\left(\frac{t_1-t_2}{2\delta}\right)^2 + \alpha\frac{t_1+t_2}{2\delta} \quad (C.2)$$

The two conditions $d\rho_1/dt_1 = d\rho_2/dt_2 = 0$ imply that

$$\begin{aligned} &-\frac{t_1}{2\delta} + \frac{1+\varepsilon}{2}(1-\alpha\varepsilon) - \frac{t_1-t_2}{2\delta}(1-\alpha(1+4\varepsilon)) = \\ &-\frac{t_2}{2\delta} + \frac{1-\varepsilon}{2}(1+\alpha\varepsilon) + \frac{t_1-t_2}{2\delta}(1-\alpha(1-4\varepsilon)) \end{aligned}$$

which boils down to

$$t_1 - t_2 = \frac{2(1-\alpha)}{3-2\alpha} \delta\varepsilon. \quad (C.3)$$

We now use this fact to substitute $t_1 - t_2$ in (C.1) and (C.2), and solve the resulting system of linear equations for the Nash equilibrium tax rates,

$$\begin{aligned} t_1^* &= \delta \left(\frac{1}{1-2\alpha} + \frac{1-\alpha}{3-2\alpha} \varepsilon + \frac{\alpha(3-4\alpha)}{(3-2\alpha)^2(1-2\alpha)} \varepsilon^2 \right) \\ t_2^* &= \delta \left(\frac{1}{1-2\alpha} - \frac{1-\alpha}{3-2\alpha} \varepsilon + \frac{\alpha(3-4\alpha)}{(3-2\alpha)^2(1-2\alpha)} \varepsilon^2 \right) \end{aligned}$$

With these equilibrium tax rates, we obtain

$$\begin{aligned} \rho_1^*(\alpha) &= \delta \left(\frac{1}{2(1-2\alpha)} + \frac{2-\alpha}{2(3-2\alpha)} \varepsilon + \frac{(1-2\alpha^2)}{2(3-2\alpha)^2(1-2\alpha)} \varepsilon^2 + \frac{(1-2\alpha)\alpha}{2(3-2\alpha)^3} \varepsilon^3 \right) \\ \rho_2^*(\alpha) &= \delta \left(\frac{1}{2(1-2\alpha)} - \frac{2-\alpha}{2(3-2\alpha)} \varepsilon + \frac{(1-2\alpha^2)}{2(3-2\alpha)^2(1-2\alpha)} \varepsilon^2 - \frac{(1-2\alpha)\alpha}{2(3-2\alpha)^3} \varepsilon^3 \right) \end{aligned}$$

Note also that the sign of the following expression, in general, cannot be determined:

$$\frac{d^2\rho_1}{dt_1^2} = \frac{-6\alpha(t_1-t_2) - \delta(2(1-2\alpha\varepsilon) - 2\alpha)}{2\delta^2}.$$

However, at the Nash equilibrium tax rates, we use (C.3) to obtain

$$\left. \frac{d^2\rho_1}{dt_1^2} \right|_{t_1=t_1^*, t_2=t_2^*} = \frac{5\alpha - 2\alpha^2(1-\varepsilon) - 3}{\delta(3-2\alpha)},$$

which is negative, since $5\alpha - 2\alpha^2(1 - \varepsilon) \leq 5/2$. Similarly, we have

$$\left. \frac{d^2 \rho_2}{dt_2^2} \right|_{t_1=t_1^*, t_2=t_2^*} = \frac{5\alpha - 2\alpha^2(1 + \varepsilon) - 3}{\delta(3 - 2\alpha)} < 0.$$

The concavity of the payoff functions is thus locally respected.

We now show that the tax rates increase and the tax rate difference declines in α . The straightforward algebra allows us to obtain

$$\begin{aligned} \frac{dt_1}{d\alpha} &= \delta \left(\frac{2}{(1 - 2\alpha)^2} + \frac{\varepsilon}{(3 - 2\alpha)^2} \left(-1 + \frac{9 - 18\alpha + 16\alpha^3}{(3 - 2\alpha)(1 - 2\alpha)^2} \varepsilon \right) \right) \\ \frac{dt_2}{d\alpha} &= \delta \left(\frac{2}{(1 - 2\alpha)^2} + \frac{\varepsilon}{(3 - 2\alpha)^2} \left(1 + \frac{9 - 18\alpha + 16\alpha^3}{(3 - 2\alpha)(1 - 2\alpha)^2} \varepsilon \right) \right). \end{aligned}$$

Note that $9 - 18\alpha + 16\alpha^3 \geq 16\alpha^3 \geq 0$ for $\alpha \in [0, 1/2]$, hence it is immediate that t_2^* is increasing in α . With respect to t_1^* , notice that it is straightforward that

$$\left(-1 + \frac{9 - 18\alpha + 16\alpha^3}{(3 - 2\alpha)(1 - 2\alpha)^2} \varepsilon \right) \geq -1,$$

hence

$$\frac{\varepsilon}{(3 - 2\alpha)^2} \left(-1 + \frac{9 - 18\alpha + 16\alpha^3}{(3 - 2\alpha)(1 - 2\alpha)^2} \varepsilon \right) \geq \frac{-1}{(3 - 2\alpha)^2}$$

for $\varepsilon \in [0, 1]$, and since $17 - 20\alpha > 7$ for all $\alpha \in [0, 1/2]$. We have

$$\frac{dt_1}{d\alpha} \geq \delta \left(\frac{2}{(1 - 2\alpha)^2} - \frac{1}{(3 - 2\alpha)^2} \right) = \delta \frac{17 - 20\alpha + 4\alpha^2}{(3 - 2\alpha)^2(1 - 2\alpha)^2} > 0.$$

Moreover,

$$t_1^* - t_2^* = \delta \varepsilon \frac{2(1 - \alpha)}{3 - 2\alpha} > 0,$$

which is decreasing in α . □

Proof of Proposition 5.2.

The pre-equalization tax revenue of the small country is given by

$$t_2^* \tilde{\pi}_2^* = \delta(3 - 2\alpha - \varepsilon) \left(\frac{1}{2(3 - 2\alpha)(1 - 2\alpha)} - \varepsilon \frac{1 - \alpha}{2(3 - 2\alpha)^2} + \varepsilon^2 \alpha \frac{3 - 4\alpha}{2(3 - 2\alpha)^3(1 - 2\alpha)} \right),$$

from which we have

$$\begin{aligned} \frac{dt_2^* \tilde{\pi}_2^*}{d\alpha} &= \frac{\delta}{(1 - 2\alpha)^2} \left(1 - \left(\frac{1}{2} - \frac{(1 - 2\alpha)^2}{(3 - 2\alpha)^2} \right) \varepsilon + \frac{6(1 - \alpha)^2 - 1 + 4\alpha^3}{(3 - 2\alpha)^3} \varepsilon^2 \right. \\ &\quad \left. - \frac{3(3 + 2\alpha(1 - \alpha)^2 - \alpha^2(17 - 26\alpha))}{2(3 - 2\alpha)^4} \varepsilon^3 \right). \end{aligned}$$

It easy to establish that within our range of parameters we have:

$$\frac{1}{2} - \frac{(1 - 2\alpha)^2}{(3 - 2\alpha)^2} > 0,$$

$6(1 - \alpha)^2 - 1 + 4\alpha^3 > 6/4 - 1 > 0$, $3(3 + 2\alpha(1 - \alpha)^2 - \alpha^2(17 - 26\alpha)) > 0$, $3(3 + 2\alpha(1 - \alpha)^2) \geq 9$ and $\alpha^2(17 - 26\alpha) < 1$. Since $0 \leq \varepsilon < 1$, we obtain

$$\begin{aligned} \frac{dt_2^* \tilde{\pi}_2^*}{d\alpha} &\geq \frac{\delta}{(1 - 2\alpha)^2} \left(1 - \left(\frac{1}{2} - \frac{(1 - 2\alpha)^2}{(3 - 2\alpha)^2} \right) - \frac{3(3 + 2\alpha(1 - \alpha)^2 - \alpha^2(17 - 26\alpha))}{2(3 - 2\alpha)^4} \right) \\ &= \frac{(45 - 60\alpha + 41\alpha^2)(1 - \alpha)^2 + \alpha^3(14 - 17\alpha)}{(3 - 2\alpha)^4(1 - 2\alpha)^2} > 0. \end{aligned}$$

With respect to the tax revenue of the large country we obtain

$$\begin{aligned} \frac{d\rho_1^*(\alpha)}{d\alpha} &= \delta \left(\frac{1}{(1 - 2\alpha)^2} + \varepsilon \frac{1}{2(3 - 2\alpha)^2} + \varepsilon^2(1 - \varepsilon) \frac{6(1 - \alpha)^2 - 1 + 4\alpha^3}{(3 - 2\alpha)^3(1 - 2\alpha)^2} \right. \\ &\quad \left. + \varepsilon^3 \frac{(33 - 46\alpha)(1 - \alpha)^2 - \alpha^2(1 - 30\alpha + 32\alpha^2)}{2(3 - 2\alpha)^4(1 - 2\alpha)^2} \right). \end{aligned}$$

Since $(33 - 46\alpha)(1 - \alpha)^2 > 10/4$, and $\alpha^2(1 - 30\alpha + 32\alpha^2) < 9/4$ we conclude that for $\alpha < 1/2$, the last expression is greater than zero. \square

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