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## ECORE DISCUSSION PAPER

2013/41

### **Local Taxation of Global Corporation: A Simple Solution**

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CORE DISCUSSION PAPER  
2013/11

**Local taxation of global corporation:  
a simple solution**

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February 2013

**Abstract**

The explosion of globalization has increased firms incentives to exploit international tax differentials to their benefit. In this paper we consider a simple world with two countries with different market sizes and two multinationals with a division in each country. Both countries use a source-based profit tax on multinationals, who compete a la Cournot in each local market 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 which adopts a lower tax rate to channel a tax revenue from the large country. We propose a simple revenue sharing mechanism in which countries share equal proportion of their own revenue with each other. It is shown that revenue sharing increases equilibrium tax rates in each country, reduces the tax differential, and benefits both countries despite of reallocation of resources from the high tax to the low tax country

**Keywords:** Heterogeneous countries, Profit Shifting, Tax Competition Revenue Sharing.

**JEL Classification:** F23, F68, H25, H70

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# 1 Introduction

Globalization has made corporations increasingly mobile across jurisdictions but it is also characterized by the development of multinational firms with many divisions across different countries. The source-based system of corporate taxation is widely used due to the practical difficulties of implementing the residence-based systems (according to which income from capital is taxed in the country of residence of the owner of capital). Under the source-based taxation, the income from capital is taxed in the country in which the income is generated. If the tax authority seeks to tax the profit where it is generated, then a multinational firm will have an incentive to choose the location of profit in a low-tax jurisdiction. This can be done by changing the physical location of the firm, but it can also be more easily done by restructuring the financial flows between divisions to make it appear that profit is earned in a different location. This option is increasingly used by multinational firms as illustrated in Devereux et al (2003) and Auerbach et al (2010).

Horizontal foreign direct investment has become a major policy issue in the past decades, as 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). The empirical evidence indicates that FDI by multinationals grew rapidly in the last 15 years of the 20th century, far outpacing the growth of international trade among industrialized countries. Foreign-owned multinationals employ 1 worker in every 5 in European manufacturing and 1 in every 7 in US manufacturing; they sell 1 euro in every 4 of manufactured goods in Europe and 1 dollar in every 5 in the US (OECD, 2001). The fact that multinationals use their various affiliates as a means to shift profits across countries is well documented. Examples of the means used for profit shifting are the transfer prices, dividend and royalty payments, among others.<sup>1</sup> This situation is costly for both firms and tax authorities because it creates business uncertainty and because governments' coordination failures lead to inefficiently low taxation. Also a country that chooses higher corporate taxes will quickly discover other countries reaping the benefits.

The first response to profit shifting was to impose limits on *transfer pricing* (see Samuelson (1982)).<sup>2</sup> To prevent firms from using transfer pricing to

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<sup>1</sup>See Hines (1999) for a survey of the empirical literature, Clausing (2003), Huizinga and Laeven (2007), and Weichenrieder (2007), as examples of the more recent contributions using firm-level data, and Collins and Shackelford (1997) for non-transfer pricing channels of profit shifting

<sup>2</sup>The limits on transfer prices have simple implications: A higher transfer price will raise the profit of the division producing the good, whereas a lower transfer price will raise

reduce tax liability many government have adopted rules on transfer pricing. The key feature of these rules is the principle of an arm's-length price putting lower and upper bounds on transfer prices. The problem is that those limits must be acceptable and freely chosen by different governments. In this case, early contributions have identified a tendency for a race to the top on transfer pricing limits that are chosen non cooperatively by governments that can enforce them (Mansori and Weichenrieder, 1999, and Raimondos-Møller and Sharf, 2002). This race to the top result was later challenged by, e.g., Kind et al. (2004), Peralta et al. (2006), Bucovetsky and Haufler (2008), who model competing governments facing firms who optimize their tax bills in response to profit tax rates.<sup>3</sup>

A second response to profit shifting is the *formula apportionment* to allocate the consolidated profit of the multinational firm across different tax jurisdiction, regardless of the location of origin, according to a pre-agreed formula. The European Commission has proposed to use this solution with the apportionment based on the proportion of total sales that take place in each country. The problem is that this solution provides a bad approximation of profit if the profit margin is different and variable across countries. Secondly, it opens up the scope for misreporting or restructuring sales across divisions to reduce the tax liability. Thirdly, the low-tax jurisdiction are likely to disagree with this formula apportionment because it will remove the possibility of reaping profit from high-tax jurisdictions. Given that small countries will get smaller proportion of total sales, and that they are also low-tax jurisdiction, we should expect disagreement from them.

In this contribution, we will analyze the implications of some alternative solutions that could be accepted by all tax jurisdictions with different taxes and market sizes. When several national fiscal authorities 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 fiscal 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 (Oshawa, 2003, Peralta and van Ypersele, 2006), central government's matching grants (De Pater and Myers, 1994, Wildasin,

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the profit of the user.

<sup>3</sup>Other references modeling competing governments include Elitzur and Mintz (1996) and Kind et al. (2004), who recognize the use of transfer pricing as a means to give the appropriate incentives to subsidiaries, and Haufler and Schjelderup (2000). Nielsen et al. (2003, 2005) 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 modeling competing governments.

1989), and tax equalization or revenue sharing and matching grants agreements (Boadway and Flatters, 1982, Hindriks and Myles, 2003, Hindriks, Peralta and Weber, 2008, Drèze, Figuières and Hindriks, 2008) are among the policies that have been put forward by the literature. However, despite the pervasive evidence about the increasing importance of multinational firms in the globalized economy and on their capacity to restructure financial flows across divisions to reduce tax liability, the study of corrective devices in setups in which countries compete for the profits of multinationals has not been studied so far. This paper concentrates on the use of revenue sharing agreements with a comparison with tax harmonization.

Many federal countries, such as Canada, Australia, Denmark and Switzerland, and many developing countries (Smart, 1996, Ahmad and Thomas, 1996, Shah, 2004) run equalization schemes whereby a central government transfers resources between jurisdictions. The European Union's Structural Funds (the Development Fund, the Social Fund, the Financial Instrument for Fisheries Guidance and the European Agricultural Guidance and Guarantees Fund) are an example of revenue sharing among sovereign states.<sup>4</sup> Another example is Germany, where in addition to the transfers from the Federal to State governments, there exists a scheme of transfers across states. Payments out of states with more than average revenue per capita into those with less than average amount to 25 million Euros in 1996 (Spahn and Föttinger, 1997). In the US, the state tax sharing is one of two forms of state intergovernmental aid to local governments. Data show that state intergovernmental aid by each state to its local governments (combined city and county) is the largest element of state expenditures. In 2000 the share of state intergovernmental expenditures in state general revenue was on average 33.2% in the US, and the average for the Southern states was 29.9%. This intergovernmental expenditures includes grant-in-aid, shared taxes and reimbursement for the cost of certain programs carried out by localities. From 1985 to 2000, payments to local governments have remained at an almost constant percentage of total general expenditures (32% to 35 %).<sup>5</sup>

Although these schemes' alleged purpose is to *equalize* the citizens access to public services across jurisdictions, i.e., correct fiscal imbalances, the literature has identified the potential efficiency gains from their implementation. The seminal contribution by Boadway and Flatters (1982),<sup>6</sup> shows

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<sup>4</sup>The EU's structural funds amount to one third of the EU budget between 2000 and 2006 (European Communities, 2004). This figure does not include the Common Agricultural Policy.

<sup>5</sup>Fiscal year 2000 data is from the US Bureau of the Census, <http://www.census.gov/govs/www/estimate>.

<sup>6</sup>See also Stiglitz (1983) and Dahlby and Wilson (1994).

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 of 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.<sup>7</sup> Then the federal planner may design intergovernmental transfers to implement the efficient tax rates at the local level.<sup>8</sup> However, unless there exist lump sum transfers at the federal level, there is no guarantee that all jurisdictions would benefit from such transfers and would 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 will develop a simple model. We consider a world of two countries that differ in market size with two multinational firms that own division in each country, and compete locally on each market à la Cournot. Countries set source-based profit 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 each multinational divisions. In the presence of tax differential, multinational firms shift profits from the high to the low tax country at some cost. We follow Kind et al. (2004, 2005) and impose a convex concealment cost.<sup>9</sup> We show that countries will both undertax in equilibrium, and that the small country (i.e., smaller market size) will tax less in equilibrium reaping some of the profit from the big country. This tax-cutting strategy will reduce the fiscal gap between the two countries. We show that imposing tax harmonization may hurt the small country. We then show that a revenue

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<sup>7</sup>See, e.g., Bird and Slack (1990), Wildasin (1991), Smart (1998), Koethenbueger (2002), Bucovetsky and Smart (2006), Figuières et al. (2004).

<sup>8</sup>There is also some empirical literature on the relationship between intergovernmental transfers and local tax effort: Buettner (2005), Dahlby and Warren (2003), Barette et al. (2003), Hepp and von Hagen (2001), among others. A more theoretical paper is Bordignon et al. (2001) who show how intergovernmental transfers affect tax enforcement.

<sup>9</sup>See also Nielsen et al. (2005), Peralta et al. (2006), Amerighi and Peralta (2008). and Swenson (2001)

sharing scheme will increase 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. This result holds true regardless of the extent of the difference in market sizes. With this revenue sharing, the big country transfers more fiscal resources to the small country than it receives, but in exchange it benefits from the reduction in the tax differential and the harmful profit shifting.

The paper is organized as follows. Section 2 gives a presentation of the model. Section 3 characterizes the tax equilibrium outcome and discusses the implications of tax harmonization. Section 4 analyses the consequences of revenue sharing on equilibrium taxes and the fiscal revenues of each country. Section 5 provides some concluding remarks.

## 2 The model

There are two countries, 1 and 2, where (inverse) demands are linear, and given by

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

Country 1 is therefore the *big* country, with a higher demand for the good.

There are two multinational firms, owning one branch in each country, which compete *à la* Cournot in each market. The unit production cost is normalized to zero; so is the cost to ship goods across countries.<sup>10</sup> In addition, firms may shift profits across locations, in order to minimize their tax liability, at a cost. More precisely, letting  $\pi_i^j$  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 et al. (2004, 2005) 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  $\delta$  is a scaling factor of the cost of restructuring financial flows across divisions to shift profits to the low-tax jurisdiction.<sup>11</sup> This may either reflect the cost of hiring accounting experts in charge of producing

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<sup>10</sup>One can think of each firm having its headquarters in one of the countries, although the distinction between headquarters and affiliate is immaterial here for we are not modeling transportation costs. One could easily add transport costs to the model without changing the main results.

<sup>11</sup>See also Nielsen et al. (2005), Peralta et al. (2006), Amerighi and Peralta (2008), and Swenson (2001).

the necessary documents to sustain the declared profits, or an expected fine to be paid to the government. The parameter  $\delta$  may reflect the degree of enforcement of the transfer pricing rules: weaker enforcement implies smaller  $\delta$ .

Government  $i$  set a source-based tax rate  $t_i$  on profit reported within its tax-jurisdiction by both multinational firms, and its fiscal revenue is given by

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

To concentrate on the key issues which is the problem of local taxation of global corporation, we will consider that governments seek to maximize fiscal revenue.<sup>12</sup> We assume that  $t_i \leq 1$ , for  $i = 1, 2$ . This is the equivalent of a free disposal assumption in our setting, or it may reflect an alternative free trade area where the multinational firms can locate and enjoy zero profits.

The sequence of event is the following. 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 chooses how much to produce in each country and how much profit to shift in the low-tax jurisdiction.

We will later introduce the possibility for countries to share a uniform proportion  $0 \leq \alpha < 1/2$  of their own fiscal revenue with each other. In that case, country  $i = 1, 2$ 's fiscal revenue becomes

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

## 2.1 The firms' decision

Proceeding backwards, we analyze production decisions in each country given the tax choices. The firms decide the quantities to produce in each market and the amount of profit shifting. Given the non-deductibility of cost of profit shifting cost, the firms' production decisions are independent of tax rates (maximizing before and after taxes profits is equivalent). 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

<sup>12</sup>The assumption of revenue maximizing government is a shortcut for describing a situation where residents care sufficiently about the provision of public goods that are financed by tax revenues (see Kanbur and Keen, 1993). What is the appropriate objective function for the principal is ultimately an empirical question. However, it can be argued that if the government maximizes a social welfare function with redistributive objective in mind, then, under revenue constraints, in some cases the optimal policy must 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).



$\tilde{\pi}_1^a + \tilde{\pi}_2^a = p_1(q_1^a + q_1^b)q_1^a + p_2(q_2^a + q_2^b)q_2^a$ , with the inverse demand function given by (1). This is equivalent to

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

We show in Appendix A that the firm's reaction functions are given by

$$q_1^j = \frac{\gamma_1 - \beta q_1^k}{2\beta}, \quad q_2^j = \frac{\gamma_2 - \beta q_2^k}{2\beta}, \quad j \in \{a, b\}, \quad j \neq k$$

And the reported profits are

$$\begin{aligned} \tilde{\pi}_1^j &= (\gamma_1 - \beta(q_1^j + q_1^k))q_1^j - \frac{t_1 - t_2}{4\delta}, \quad j \in \{a, b\}, \quad j \neq k \\ \tilde{\pi}_2^j &= (\gamma_2 - \beta(q_2^j + q_2^k))q_2^j - \frac{t_2 - t_1}{4\delta}, \quad j \in \{a, b\}, \quad j \neq k \end{aligned}$$

Hence equilibrium quantities 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  $p_2 = \gamma_2/3$ , and the total profit reported in country  $i$   $\tilde{\pi}_i^b + \tilde{\pi}_i^a$  is

$$\tilde{\pi}_i = 2\frac{\gamma_i^2}{9\beta} - 2\frac{t_i - t_j}{4\delta}, \quad i = 1, 2, \quad j \neq i$$

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

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

and similarly for country 2,

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

The aggregate profit is therefore equal to 1 regardless of the tax choices, making the tax game a simple zero-sum game. Note that for identical taxes  $t_1 = t_2$  the distribution of aggregate profits between the two countries is entirely determined by the market size parameter, i.e.,  $\tilde{\pi}_1(t, t) = (1 + \epsilon)/2$ . Note also that given the normalization of the production, the market size parameter must satisfy  $\epsilon \in [0, 1]$ .

As a benchmark for the tax competition game, notice that if countries cooperate, they would maximize the joint fiscal revenue

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

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

### 3 Tax competition

We now move to the tax game. We first assume no revenue sharing. The government of country 1 chooses  $t_1$  to maximize

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

The first-order condition is

$$\frac{dR_1}{dt_1} = \frac{1 + \epsilon}{2} - \frac{t_1 - t_2}{2\delta} - \frac{t_1}{2\delta} = 0 \quad (3)$$

Analogously, the first-order condition for country 2 is

$$\frac{dR_2}{dt_2} = \frac{1 - \epsilon}{2} - \frac{t_2 - t_1}{2\delta} - \frac{t_2}{2\delta} = 0 \quad (4)$$

It is interesting to note that (3) and (4) are analogous up to the first constant, which is higher for the country 1 (with larger market), implying that, for equal tax rates, the big country has greater incentive to tax than the small one.<sup>13</sup>

Solving the first-order conditions, one obtains the best replies<sup>14</sup>

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

Taxes are strategic complements: if, say, country 2 increases its tax rate, the tax base of country 1 increases, thus increasing country 1's incentive to tax. The intersection of the two best replies gives the Nash equilibrium taxes,

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

To insure interior solution to the tax game, we assume in the rest of the analysis that

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

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<sup>13</sup>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 is the driving force in generating the asymmetric choice of taxes (see Haufler, 2001).

<sup>14</sup>Notice that the revenue function is concave in the tax rate,  $d^2 R_1 / dt_1^2 = -1/\delta < 0$  so the existence of equilibrium is ensured.

This equivalent to say that the profit shifting issues 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 big country which is taxing more in equilibrium. The tax rate difference is  $t_1^* - t_2^* = 2\delta\epsilon/3$  implying that both firms shift profits from the big to the small country. However, this profit shifting is not enough to cancel out the market size effect, and the big country ends up with larger tax base in equilibrium,

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

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

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

Naturally, the cost of shifting profit measured by  $\delta$ , has an impact on the level of taxes in equilibrium: lower  $\delta$  exacerbates the tax competition between countries and reduces the equilibrium taxes and joint tax revenue. It is straightforward to conclude that joint tax revenue is smaller in the competitive outcome than under the cooperative outcome for  $\delta < \bar{\delta}$ .

This allows us to state our first proposition

**Proposition 3.1** *Suppose  $\epsilon \leq 1$  and  $\delta \leq \bar{\delta}$ . Then, in the Nash equilibrium, there is under-taxation and joint tax revenue is sub-optimal. If the profit shifting becomes more costly (i.e., if  $\delta$  increases) Nash equilibrium taxes increase, and so does joint tax revenue.*

Another question is whether each country would benefit from cooperation in the absence of transfers, that is, if they both set the cooperative tax rates  $t_1^o = t_2^o = 1$  and get the respective tax revenue, i.e.,  $R_1^o = (1 + \epsilon)/2$ ,  $R_2^o = (1 - \epsilon)/2$ .<sup>15</sup> Comparing this cooperative outcome with the Nash equilibrium outcome, we get the following result.

**Proposition 3.2** *Suppose  $\epsilon < 1$  and  $\delta \leq \bar{\delta}$ . Moving towards optimal (harmonized) taxes increases the tax revenue of the big country and has ambiguous effect on the tax revenue of the small country. However there exists  $\delta^* < \bar{\delta}$ , such that the tax revenue of the small country decreases under tax harmonization, when  $\delta > \delta^*$ .*

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<sup>15</sup>It is straightforward that there is a cooperative tax revenue split that benefits both countries. We concentrate here on the no transfer benchmark.

The potential advantage of the small country is its lower tax rate, which allows to reap a fraction  $\epsilon/3$  of the big 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  $\delta$  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 been established in capital tax competition literature (Bucovetsky, 1991, Wilson, 1991). In this literature, the small country taxes less due to its smaller market power in the international capital markets.<sup>16</sup>

Summing up, tax competition leads to inefficiently low taxes, with the big country getting more tax revenue than the small country. Cooperation via tax harmonization is difficult because the small country could end up worse off with tax cooperation than with tax competition. So the small country has no incentive to cooperate. The next section analyse the impact of the revenue sharing arrangement on the equilibrium outcome to see whether both countries could benefit from such arrangement. Obviously if tax harmonization is beneficial to the small country, then the revenue sharing arrangement is no longer needed. So what we propose is a solution to the tax competition problems that can usefully complement the tax harmonization solution.

## 4 Introducing revenue sharing

We now let each country share a proportion  $\alpha$  (with  $0 \leq \alpha < 1/2$ ) of its own tax revenue with the other, according to (2).

### 4.1 Equilibrium taxes with revenue sharing

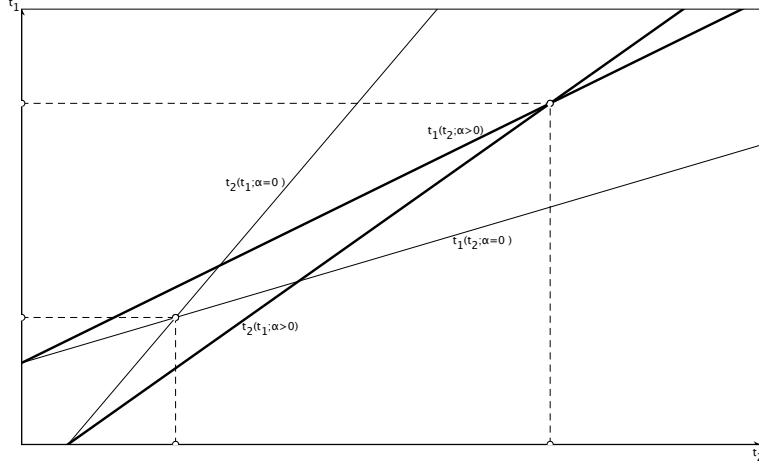
Computing the first-order conditions for the two countries and solving yields the following best-replies

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

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<sup>16</sup>According to the *small country advantage* obtained by these authors, the small country has a higher payoff than the big country in the tax competition equilibrium, and they have equal ones in the cooperative outcome. In the current setup, the big 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.

Figure 1: Tax Choice



Note that taxes are strategic complements, and the effect of revenue sharing is to reinforce this strategic complementarity.<sup>17</sup> 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.<sup>18</sup>

Figure 1 illustrates the tax response functions.

Solving for the Nash equilibrium tax rates, and simplifying, yields

$$t_1^*(\alpha) = \delta(1-\alpha) \left( \frac{1}{1-2\alpha} + \frac{\epsilon}{3-2\alpha} \right), \quad \text{and} \quad t_2^*(\alpha) = \delta(1-\alpha) \left( \frac{1}{1-2\alpha} - \frac{\epsilon}{3-2\alpha} \right)$$

Note that we get interior solution if

$$\delta < \bar{\delta}(\alpha) = \frac{(3-2\alpha)(1-2\alpha)}{((3-2\alpha) + \epsilon(1-2\alpha))(1-\alpha)} \leq 1, \quad \text{for } 0 \leq \epsilon \leq 1, \quad 0 \leq \alpha < 1/2 \quad (5)$$

so that the cost of profit shifting must be sufficiently low to limit the tax choices of governments.

<sup>17</sup>It is straightforward to obtain that  $d^2 R_i / dt_i^2 = -(1-\alpha)/\delta$ , hence the existence of equilibrium is ensured for  $\alpha \leq 1$ .

<sup>18</sup>Algebraically,

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

Note that the big country's tax rate is higher than the small one's (see Baldwin and Krugman, 2004 and Krogstrup, 2003), and, for  $0 \leq \epsilon \leq 1$ , we have

$$\delta \frac{1 - \alpha}{1 - 2\alpha} \leq t_1^*(\alpha) \leq \delta \frac{4(1 - \alpha)^2}{(1 - 2\alpha)(3 - 2\alpha)}$$

$$\delta \frac{2(1 - \alpha)}{(1 - 2\alpha)(3 - 2\alpha)} \leq t_2^*(\alpha) \leq \delta \frac{1 - \alpha}{1 - 2\alpha}$$

hence, both tax rates are positive.

## 4.2 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 analyse the impact of increasing revenue sharing on joint tax revenue and on the tax revenue in each country. We also analyse its potential equalizing effect by reducing the fiscal imbalances.

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

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

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

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. In such settings, the international capital price absorbs part of a given country's tax increase, provided that countries are large enough to have market power on the price of capital. Hence, for sufficiently large countries, the tax base of a given country 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 big country, so that the tax gap actually shrinks and tax choices converge with the degree of revenue sharing. This implies that revenue sharing reallocate tax base (profit) from the (low-tax) small to the (high-tax) big country.

We summarize these findings in the next proposition.

**Proposition 4.1** *Suppose  $\epsilon \leq 1$  and  $\delta \leq \bar{\delta}(\alpha)$ . Increased revenue sharing increases the tax rates of both countries. In addition, the tax gap decreases, causing a redistribution of the tax base from the (low tax) small to the (high tax) big country.*

Interestingly, since the amount 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

$$\begin{aligned}\tilde{\pi}_1 &= \frac{1}{2} \left( 1 + \frac{\epsilon}{3 - 2\alpha} \right) \geq 0 \\ \tilde{\pi}_2 &= \frac{1}{2} \left( 1 - \frac{\epsilon}{3 - 2\alpha} \right) \geq 0, \text{ for } 0 \leq \epsilon \leq 1\end{aligned}$$

from which it is clear that 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

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

so that total fiscal revenue is

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

and the impact of revenue sharing is then

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

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

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

The first term is the pre-sharing tax revenue. This term is increasing for the big country, given that both its tax rate and its tax base are increasing with revenue sharing. As regards the small country, although its tax rate is increasing in  $\alpha$ , 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

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

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 big country is a net contributor to the scheme. Formally, the fiscal revenue differential is given by,

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

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

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

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 high country increase 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,

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

The discussion above allows us to establish the following result.

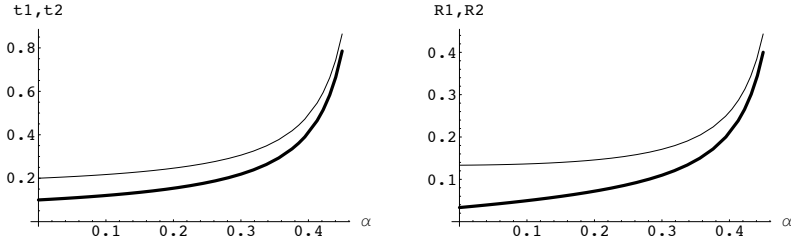
**Proposition 4.2** *Suppose that  $\epsilon \leq 1$  and  $\delta \leq \bar{\delta}(\alpha)$ . The joint tax revenue increases with revenue sharing whereas the fiscal imbalances shrinks. Moreover, the tax revenue of the small country increases with revenue sharing.*

Thus the small country gains from revenue sharing because the reduction of its tax base is more than offset by the increase of its tax rate and the net transfer received from the big country. Obviously, the fact that total fiscal revenue increases with revenue sharing is a necessary but not a sufficient condition for the big country to gain from revenue sharing. Fiscal revenue in the big 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 big country also benefits from revenue sharing.

**Proposition 4.3** *Suppose that  $\epsilon \leq 1$  and  $\delta \leq \bar{\delta}(\alpha)$ . The tax revenue of the big country increases with revenue sharing. The benefit from revenue sharing to the big country is smaller the greater the degree of heterogeneity between the countries.*

When country 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  $\epsilon$ . Reducing this gap causes a big inflow of tax base (profit) to the big country. To fix idea, consider that the heterogeneity is at its maximum value  $\epsilon = 1$  and consider the no-revenue sharing outcome. We know from Section 3 that  $t_1^* = 4\delta/3$  and  $t_2^* = 2\delta/3$ , leading to a distribution of tax base of  $2/3$  for the big and  $1/3$  for the small country, respectively (compared to 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 big 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 big country of  $1/9$ , at a negligible cost of a net transfer close to 0.

Figure 2: The impact of revenue sharing  
Equilibrium Tax Rates                      Equilibrium Revenue



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

Figure 2 shows how the tax revenue of the small and the big countries increase, and tax rates increase and converge, with  $\alpha$ , in the specific case of  $\epsilon = 1$ .<sup>19</sup>

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 big country also benefits from revenue sharing, even if its fiscal capacity is much larger. In this case the efficiency gain (i.e., relaxing harmful tax competition) from revenue sharing outweighs the cost of transferring resources to the small country.

The alternative solution to tax competition is tax harmonization. Could it be beneficial to each country? We have already established in Proposition ?? that the fully cooperative outcome is not always beneficial to the small country. We now tackle a milder form of tax harmonization, namely, of the following form:

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

with  $0 \leq \lambda \leq 1$ . So the uniform tax rate is a convex combination of the equilibrium tax rates. With high  $\lambda$  there is harmonization on the highest tax rate and with low  $\lambda$  there is harmonization on the lowest tax rate. We have the following result

**Proposition 4.4** *Suppose that  $\epsilon \leq 1$  and  $\delta \leq \bar{\delta}(\alpha)$ . Suppose there is no revenue sharing ( $\alpha = 0$ ) and there is tax harmonization in the form of convex*

<sup>19</sup>The mobility of the tax base is set to  $\delta = 0.15$ . Please note that this is just a multiplicative factor in equilibrium tax rates and fiscal revenues, and is immaterial to the results. The value used does ensure that the boundary condition (5) is respected.

*combination between the highest and lowest 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 big country is better off because it will get greater tax base, while taxing the same in equilibrium.

## 5 Conclusion

Globalization with the expansion of the reach of global corporation undermines the capacity of local governments to tax corporate income. With division in so many different countries, those corporations do not need to physically change location to get a more favorable tax treatment. They can more easily 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 tackles this issue by proposing another solution which is the revenue sharing scheme. We analyze the impact of revenue sharing on corporate tax competition between heterogeneous countries. We show that revenue sharing is desirable in a variety of settings, both for the federation as a whole as for each country individually, even for the country which is a net contributor to the system. 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 compe-

tition. Given the classical divide between the big high-tax jurisdictions and the small low-tax jurisdictions, revenue sharing can offer a way out. The big 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. In a context of increasing globalization and the development of global corporation, the capacity to restructure financial flows to exploit tax difference across location is likely to increase and the outcome where the small gets to increasingly more capital is a possibility.

## Appendices

### Appendix A – The Cournot with profit shifting equilibrium

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

$$-t_1 + t_2 + 4\delta [(\gamma_1 - \beta(q_1^a + q_1^b))q_1^a - \tilde{\pi}_1^a] = 0 \quad (9)$$

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,  $\delta$ .

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 (9), 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

$$q_1^a = \frac{\gamma_1 - \beta q_1^b}{2\beta} \quad (10)$$

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

$$q_2^a = \frac{\gamma_2 - \beta q_2^b}{2\beta} \quad (11)$$

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

$$q_1^b = \frac{\gamma_1 - \beta q_1^a}{2\beta} \quad \text{and} \quad q_2^b = \frac{\gamma_2 - \beta q_2^a}{2\beta} \quad (12)$$

Hence 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

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

and analogously for firm  $b$  we have

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

## Appendix B

**Proof of Proposition 3.2:** It is straightforward to obtain

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

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

**Proof of Proposition 4.3** Straightforward algebra allows us to obtain

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

Also,

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

. 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  $\phi(\epsilon, \alpha) > 0$ , for  $0 \leq \epsilon \leq 1$ , which is the first part of the proposition.  $\square$

**Proof of Proposition 4.4**

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

This gives the revenue under harmonization in the small country 2

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

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

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

Compared to the equilibrium revenue without harmonization

$$R_2^* = \delta \left( 1 - \frac{\epsilon}{3} \right) \left( \frac{1}{2} - \frac{\epsilon}{6} \right)$$

It follows that

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

which completes the proof.  $\square$

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