Harmonization of Corporate Tax Systems and its Effect on Collusive Behavior[*]

Dirk Schindler[†]   Guttorm Schjelderup[‡]

January 2007

Abstract

We study how harmonization of corporate tax systems affects the stability of international cartels. We show that tax base harmonization reinforces collusive agreements, while harmonization of corporate tax rates may destabilize or stabilize cartels. We also find that bilateral and full harmonization to a common standard is worse from society's point of view than unilateral harmonization to a minimum tax standard.

JEL Classification: H87, L1

Keywords; Corporate tax systems, tacit collusion

[†]University of Konstanz, Fach D 133, 78457 Konstanz, Germany; email: Dirk.Schindler@uni-konstanz.de; phone +49-7531-883691, fax +49-7531-884101.

[‡]Department of Finance and Management Science, Norwegian School of Economics and Business Administration and CESifo, Helleveien 30, 5045 Bergen, Norway; email: Guttorm.Schjelderup@nhh.no; phone: + 47-55959238, fax +47-55959350.

1 Introduction

The last forty years have seen a number of proposals to approximate corporate tax bases and tax rates in Europe in order to level the playing field for business competition. A recent report by the European Commission on the future of company taxation in Europe (Commission of the European Communities, 2001), points out that differences in national corporate tax systems affect location decisions of firms, impose barriers to cross-border investments, impair the efficiency in the capital market, and foster international tax planning.[1] To remedy these problems the Commission argues that there is a need for coordination of corporate tax systems among EU member states. The Commission's report shows that there is large variation in effective corporate tax rates across EU member states due to tax rate and tax base differentials. The Commission's main proposal is to move towards a consolidated tax base for European multinational companies, to be allocated across member states through a formula apportionment system. This proposal entails a certain degree of tax base harmonization. The alternative road ahead pointed out by the Commission, is one of harmonization of national tax bases and tax rates within the current system of corporate taxation systems among the EU member states.[2]

The need for a level playing field in the European Union has also been highlighted recently by the entry of new EU member states whose effective tax rates often are significantly below those of 'old' member states. Illustrative of the problem is Nicolas Sarkozy (French Secretary of the Interior and at the time minister of finance and economic affairs) who proposed to refuse payment of most EU-subsidies (i.e., from Structural Funds) to the new EU-countries, whose effective tax rates are significantly below EU-average, in order to prevent their tax advantage from creating "excessive" tax com-

---

[1] For a survey of proposals and the recent, so-called Bolkestein-report of the EU see Devereux (2004), Mintz (2004) and Sørensen (2004).

[2] Mintz (2004) argues that the focus should be on tax bases rather than tax rates.

petition.[3]

This paper argues that the discussion over tax rates and base approximation has overlooked the effects harmonization of tax bases or tax rates may have on the stability of international cartels. We show that harmonization of tax rates may increase or decrease collusive behavior, but that the most likely outcome is that it reinforces incentives to stay in cartels. Furthermore, any type of harmonization of tax bases is always undesirable from society's point of view, but bilateral and full harmonization to a common standard is worse than unilateral harmonization to a minimum tax standard.[4] The implication of our analysis is that, on the one hand, there are very clear negative effects of harmonization on collusive behavior, but on the other hand, there are benefits of a level playing field for corporate taxation systems. A full analysis of corporate tax reform needs to address these effects in a unified framework. This is a topic that is left for future research.

Collusive behavior in an international setting has been confirmed by a number of studies and many of these are summarized in Haufler and Schjelderup (2004). In short, international collusive behavior has been established in industries such as pharmaceuticals, chemicals, cars, diamonds, telecommunications, uranium yellowcake, Canadian potash, cement, plastic pipe, electronics, and wood pulp.[5] Cooperation within these industries involves price fixing schemes that in some cases have been going on for a decade or more. The costs of such activities, as documented in the empirical literature, are substantial.[6] The potential damage to the economy by cartels has been highlighted in Monti (2001); *"Estimations by the OECD in*

---

[3]See, e.g., Financial Times Deutschland, September 7, 2004, and Neue Züricher Zeitung, September 8, 2004. Countries like, i.e., Lithuania and Hungary have lowered their (effective) tax rates to 13% resp. 16% in order to attract multinationals from established member states.

[4]The latter approach has been adopted by the EU in its efforts to harmonize commodity taxes. See Haufler and Schjelderup (2004) for an analysis.

[5]See Haufler and Schjelderup (2004) for a survey.

[6]See e.g., Slade (1995), Scherer (1996), King (1997) and Steen and Sørgard (1999).

*its recent **Report on Hard Core Cartels***[7] *have provided dramatic figures. The average increase from price fixing is estimated to amount to 10% of the selling price and the corresponding reduction of output to be as high as 20%. In some recent big cases prices have been increased by the cartel participants by 30% to 50%."*[8]

The fighting of cartels has been a clear priority of the European Commission. It is therefore a paradox that no link has been made to the possible effects of tax harmonization on collusive behavior in the Commission's reports on corporation tax systems.

The issue of tax harmonization has been discussed extensively in the public finance literature in relation to fiscal externalities between countries. The canonical tax competition model predicts that competition among countries over mobile capital leads to too low tax rates and underprovision of public goods in equilibrium.[9] From this model follows the policy recommendation that tax coordination or harmonization is desirable in order to correct the fiscal externality from competition. However, this view is challenged by the Public Choice literature. Here the argument is that competition in general, and competition among governments in particular, is beneficial because it reduces government waste and disciplines politicians.[10] These studies, however, do not have competition and collusive behavior as their focal point.

Related to our study is Gendron (2001) who in a closed economy setting analyzes the effect on collusion of alternative loss offset provisions under the corporation tax. He finds that an increase in refunds of tax losses may enhance collusive behavior. More recently, Haufler and Schjelderup (2004) analyze the choice of international tax principle in commodity taxation and how it affects cartel stability. Their results are in line with the results pre-

---

[7] OECD 2000.

[8] The industries involved are graphite electrodes and citric acid.

[9] See the seminal papers by Zodrow and Mieszkowski (1986) and Wilson (1986). A survey of the literature is given in Wilson (1999).

[10] E.g., Brennan and Buchanan (1980), McLure (1986), and more recently Rauscher (1998).

sented in this paper. They find that tax harmonization strengthens collusive behavior irrespective of commodity tax principle in place. To our knowledge there are no other studies that are directly comparable to ours or to the Haufler and Schjelderup study.

Our results are brought forward by using a standard model of dynamic price competition and tacit collusion.[11] The framework is a two-country, two-firm setting, where the national product markets are of equal size and costs of production are the same for both firms in order to highlight how differences in national tax systems affect the stability of cartels. Section 2 outlines the model and section 3 analyzes cartel stability. Section 4 investigates the effects of bilateral and unilateral tax harmonization, while section 5 discusses the robustness of results and section 6 offers some concluding remarks.

2 The model

We consider two firms, labelled by $i \in \{1, 2\}$, which are located in country 1 and 2, respectively. They produce amounts x_i of an identical and homogenous good, and tacit collusion between the two firms implies that both firms refrain from exporting. Each firm is thus a monopolist in its home market. In each period, either firm may defect from this implicit agreement and export to the other market, but such action will cause future retaliation by the other firm. If firm i defects, it does so in the first period ($t = 0$) by exporting to country j. It will catch firm j by surprise and we define this as the *deviation phase* of the game. In the following period(s), however, firm j retaliates by exporting to market i. This is the *punishment phase* of the game. Furthermore, as in the literature on repeated games we assume a *trigger strategy* which implies that firm j will retaliate by exporting to market i in *all* subsequent periods.

---

[11] The same model has previously been used to study 'reciprocal dumping' in a trade context (see Pinto, 1986), to compare tariffs and quotas (Rotemberg and Saloner, 1989), to study the effects of trade liberalization as in Lommerud and Sørgard (2001), and to compare different exchange rate regimes (Meckl, 1996). Recently, Haufler and Schjelderup (2004) have studied how international principles of value-added taxation affect the stability of collusive agreements.

Hence, if one firm defects in period $t = 0$, duopoly competition prevails in both markets in $t = 1, 2, ...\infty$. Furthermore, we assume that national markets are segmented, i.e., different producer prices can be set in the two national markets under both monopolistic and duopolistic market structures.

In the following, we denote by π_i^M the profit of firm i if it acts as a monopolist in its domestic market, π_i^E is the extra profit in period 0 when firm i defects and exports into the other market, and π_i^D is the total duopoly profit (earned in both markets together) of firm i under mutual export competition. Denoting δ_i as the discount factor of firm i $(0 < \delta_i < 1)$, defection from the cartel solution is unprofitable whenever the present value of staying in the cartel forever, $\pi_i^M / (1 - \delta_i)$, is greater than or equal to the profits of defecting from the agreement, that is, $(\pi_i^M + \pi_i^E) + \pi_i^D \delta_i / (1 - \delta_i)$. Thus, we can write the "stability condition" for the collusive agreement as:

$$\theta_i \geq \bar{\theta}_i = \frac{\pi_i^E}{\pi_i^M - \pi_i^D}, \qquad \forall\, i \in \{1, 2\}, \tag{1}$$

where $\theta_i \equiv \delta_i / (1 - \delta_i)$ is the relative discount factor of firm i, and $\bar{\theta}_i$ is the size of this rate that just leaves the firm indifferent between staying in the secret cartel and defecting.

It is worth pointing out that we cannot rule out the case $\pi_i^M < \pi_i^D$ for one of the firms we consider. In this case it would always be profitable for this firm to leave the cartel, since it would gain in both the deviation and the punishment period. The focal point here, however, is on how corporate tax policy affects the stability of cartels and for the analysis to be meaningful in this sense, we will have to rule out this case and assume that $\pi_i^M > \pi_i^D$.

The critical value $\bar{\theta}_i$ differs between the two firms (as will become clear later) due to differences in the corporate tax system. In general, it is the firm with the higher critical value of $\bar{\theta}_i$, which is more likely to break the collusive arrangement, since it is this firm's $\bar{\theta}_i$ that is binding for the stability of the cartel.[12] For the analysis to come, it is useful to note that the higher

---

[12] As pointed out by Haufler and Schjelderup (2004): If firm j has the higher critical value of $\bar{\theta}$, then firm i $(i \neq j)$ could improve the stability of the collusive agreement by

6

$\bar{\theta}_i$ is under a given scenario, the lower is the likelihood that the collusive agreement is stable, since a smaller range of (common) relative discount factors θ sustains the cartel solution.

3   Profits and cartel stability

In this section we focus on differences in national tax parameters and how they affect the stability of the cartel. To that end we shall assume that the size of the market in each country is the same and that firms have the same costs. Demand functions in both markets are linear and given by $x_i = a - p_i$, where p_i is the consumer price, x_i is demand, and $a > 0$ is a market size parameter that denotes maximum sales at a price of zero which is identical for both countries.[13]

The economic profit of the firm is

$$\hat{\pi}_i = p_i x_i - c x_i, \qquad i = 1, 2.$$

where c is (constant) marginal cost.

We assume that taxable profit differs from economic profit in order to capture the idea that tax deductible costs in practice deviate from true costs. The deviation may be given various interpretations. First, it is a fact in many countries that certain categories of costs are not tax deductible. Notable examples are alcoholic drinks and bribes. Second, and more importantly, the dividing line between what is deemed an expense - which can be deducted

---

offering firm j a new contract (for example a fifty-fifty split of the two markets). Such market sharing, however, poses a problem. The reason is that it is much easier to detect a breach of agreement if a firm exports (when it should not) than if it produces beyond the agreed export quota. The cost of monitoring, therefore, provides cartels with an incentive to set up exclusive territories (see Marvel, 1982, and Tirole, 1988, pp. 183 and 185).

[13]In principle we could allow market size differences, but the purpose here is to investigate the effects of differences in corporate tax systems only, and we therefore refrain from analyzing the interaction of taxes with other parameters. The effect of differences in market size and costs on cartel stability is examined in Haufler and Schjelderup (2004) in a context of commodity taxes.

immediately - and what is deemed an investment, which is written off over time, is based on judgement that may not reflect the true economic cost. Third, one may also consider incomplete cost deductions as a proxy for the distortion imposed on firms by the inability of governments to set tax deductible depreciation rates equal to true depreciation rates.[14]

Taxable profit is given by

$$\hat{\pi}_i^\tau = p_i x_i - \gamma_i c x_i, \qquad i = 1, 2.$$

where γ_i is the share of marginal costs that is tax deductible. In principle $\gamma_i \gtreqless 1$, so if $\gamma_i < 1$, deductions are incomplete in the sense that deductions fall short of true costs, whilst if $\gamma_i > 1$ deductions are too generous. Only when $\gamma_i = 1$ are tax deductible costs equal to true costs and the corporate tax system is neutral (i.e., does not affect firm behavior).

Denoting t_i as the corporate tax rate, the per-period profits of firm i in its home market are then

$$
\begin{aligned}
\pi_i &= \hat{\pi}_i - t_i \hat{\pi}_i^\tau = (a - p_i) \left[p_i (1 - t_i) - c (1 - \gamma_i t_i) \right] \\
&= (1 - t_i)(a - p_i) \left[p_i - c \cdot \frac{1 - \gamma_i t_i}{1 - t_i} \right].
\end{aligned}
\tag{2}
$$

When each firm is a monopolist in its home market, maximization of (2) either with respect to price (as here) or quantity, yields monopoly price and quantity as well as the corresponding per-period monopoly profit in the home market as follows

$$
p_i = \frac{(a + \tilde{c}_i)}{2}, \quad x_i = \frac{(a - \tilde{c}_i)}{2}, \quad \text{and} \quad \pi_i^M = \frac{1 - t_i}{4} \alpha_i^2,
\tag{3}
$$

where $\tilde{c}_i(\gamma_i, t_i) \equiv \frac{1 - \gamma_i t_i}{1 - t_i} c \equiv \epsilon_i c$ is the effective after tax marginal cost and $\alpha_i \equiv (a - \tilde{c}_i) > 0$ for positive sales to occur. Note that ϵ_i is a tax wedge. If the tax code allows full deductibility of costs ($\gamma_i = 1$) we have that $\epsilon_i = 1$, and

---

[14] The latter problem is well known in public finance and has various effects on firm behavior. See Sinn (1987).

$\tilde{c}_i = c$. The corporate tax rate is then a tax on pure profit and does not affect the behavior of the firm. In general we shall make the common and very reasonable assumption that tax authorities do not have perfect information about the true costs of depreciation.[15] Thus the neutrality property will in general not hold.

From (2) it follows that the tax code in fact implements two taxes. First, we have a tax on pure economic profits with tax rate t_i. Second, there is a tax on costs with tax rate $\tau_i = \epsilon_i - 1$. When $\gamma_i > 1$ this implies a subsidy on costs while the opposite is true if $0 < \gamma_i < 1$.

For ease of exposition we sometimes refer to a situation where a country is a low tax country. By this we mean:

Definition 1 *Country i is a low tax country if it has a constellation of tax rate and tax deductibility rule that makes the firm located in country i a low cost firm in the following manner: $\tilde{c}_j > \tilde{c}_i \; (\Leftrightarrow \; \epsilon_j > \epsilon_i, \; i \neq j)$.*

Definition 1 implies a combination of tax rates and deductibility rules such that either condition (i) or (ii) below is satisfied:

(i) $t_i \leq t_j$ and $1 > \gamma_i \geq \gamma_j$,[16] or

(ii) $t_i \leq t_j$ and $\gamma_i \geq \gamma_j > 1$, whereby the difference in tax rates is small enough or the difference in deductibility rules is large enough to sustain $\epsilon_j > \epsilon_i$.[17]

In what follows we assume that country 1 is the low tax country and thus that firm 1 has the lowest effective marginal costs after-tax (i.e., $\tilde{c}_1 < \tilde{c}_2$).

Definition 1 states the conditions for when a country is a low tax country in the sense that it has the most generous set of tax and depreciation rules.

---

[15] The inability of governments to set correct depreciation allowances is one of the major reasons why corporate taxes introduce a tax wedge. See Sinn (1987) for a discussion.

[16] Note that $\frac{\partial \tilde{c}_i}{\partial \gamma_i} = -\frac{t_i c}{1-t_i} < 0$, thus an increase in tax deductible costs decreases the effective cost of the firm for all values of γ_i.

[17] These restrictions are necessary because $\frac{\partial \tilde{c}_i}{\partial t_i} = \frac{1-\gamma_i}{(1-t_i)^2} c < 0$ if $\gamma_i > 1$.

9

Since the tax rate interacts with the depreciation allowance in a nontrivial fashion, it is necessary to be precise in what constitutes a set of favorable tax parameter values.

3.1 Deviation from cartel agreement

If firm 1 deviates and exports to country 2 in period 1, it sets a price on its exports equal to its monopoly price in its home market. Since it is firm 1 that is the low cost firm, its monopoly price is below that of firm 2, that is, $p_1 = \frac{1}{2} (a + \tilde{c}_1) < p_2$. The monopoly price will sweep the market in country 2, and is also the profit maximizing price for firm 1 as a monopolist in country 2. As a consequence, $\pi_1^E \left(= \pi_1^M \right) > \pi_2^M$, and the profit from deviating is

$$\pi_1^E = \frac{1 - t_1}{4} \alpha_1^2. \tag{4}$$

If firm 2 deviates and exports to country 1, it cannot use its profit maximizing (monopoly) price since $p_2 > p_1$. Therefore, the best strategy for firm 2 is to slightly undercut the price of firm 1 by setting its export price just below $(a + \tilde{c}_1) / 2 (= p_1)$, thereby sweeping the market and earning a profit of[18]

$$\pi_2^E = \frac{(1 - t_2)}{4} \alpha_1 \left[\alpha_1 - 2 \left(\tilde{c}_2 - \tilde{c}_1 \right) \right]. \tag{5}$$

In the punishment phase, both firms compete over prices. Since firm 1 is located in the low tax country it has the lower effective marginal costs $(\tilde{c}_1 < \tilde{c}_2)$. Thus, it will set its price marginally below the effective marginal cost of firm 2, that is, $\tilde{c}_2$. Since goods are homogeneous, firm 1 is then the sole provider in both markets, and earns a profit in each country equal to $(a - p_1) \left[p_1 (1 - t_1) - c (1 - \gamma_1 t_1) \right]$. Total profit in both markets corresponds

---

[18]This implicitly assumes $p_1 = \frac{(a + \tilde{c}_1)}{2} > \tilde{c}_2$. If this does not hold, $\pi_2^E \leq 0$, and the high-cost firm would never break the cartel agreement, as it cannot gain anything, and $\bar{\theta}_2 = 0$.

to these expressions multiplied by 2 and can be written as

$$\pi_1^D = 2(1 - t_1)\, \alpha_2 \; (\tilde{c}_2 - \tilde{c}_1)\,.$$

In contrast, firm 2 derives profit of

$$\pi_2^D = 0,$$

in the punishment period.

The critical discount factors for the two firms are

$$\bar{\theta}_1 = \frac{\alpha_1^2}{\alpha_1^2 - 8\alpha_2(\tilde{c}_2 - \tilde{c}_1)}, \tag{6}$$

$$\bar{\theta}_2 = \frac{\alpha_1\left[\alpha_1 - 2(\tilde{c}_2 - \tilde{c}_1)\right]}{\alpha_2^2}. \tag{7}$$

Given our assumption $\pi^M - \pi^D > 0$, we have $\alpha_1^2 - 8\alpha_2(\tilde{c}_2 - \tilde{c}_1)$, and $\bar{\theta}_1$ is unambiguously positive. Equivalently, $\pi_2^E > 0$ implies $\alpha_1\left[\alpha_1 - 2(\tilde{c}_2 - \tilde{c}_1)\right] > 0$, and hence $\bar{\theta}_2 > 0$. Recall form Section 2 that it is the firm with the higher critical discount factor that is more likely to break the collusive agreement. The question now is whether this is firm 1 or firm 2. This is the topic for analysis in the next section.

3.2 National differences in corporate tax systems

In order to determine which firm is more likely to defect from the collusive agreement, we compare (6) and (7) and make use of Definition 1. Then:

Proposition 1. *It is always the firm located in the low tax country (firm 1) that is more likely to break the collusive agreement.*

Proof: From Definition 1 we have that since firm 1 is located in a low tax country, then, $(\tilde{c}_2 - \tilde{c}_1) > 0$ and $\alpha_1 = a - \tilde{c}_1 > a - \tilde{c}_2 = \alpha_2$. Thus, the numerators $(N_{\bar{\theta}_i})$ in equations (6) and (7) relate to each other as follows: $N_{\bar{\theta}_1} > N_{\bar{\theta}_2}$. For the denominators $D_{\bar{\theta}_1}$ and $D_{\bar{\theta}_2}$, we can use $\alpha_1 = \alpha_2 + (\tilde{c}_2 - \tilde{c}_1)$

and binomial rules in the denominator of (6), to get; $D_{\bar{\theta}_1} = \alpha_1^2 - 8\alpha_2(\tilde{c}_2 - \tilde{c}_1) = [\alpha_2 - (\tilde{c}_2 - \tilde{c}_1)]^2 - 4\alpha_2(\tilde{c}_2 - \tilde{c}_1)$, which shows that $D_{\bar{\theta}_1} < D_{\bar{\theta}_2} = \alpha_2^2$, as $\tilde{c}_2 > \tilde{c}_1$. Taken together we have that $N_{\bar{\theta}_1} > N_{\bar{\theta}_2}$ and $D_{\bar{\theta}_1} < D_{\bar{\theta}_2}$, which unambiguously implies $\bar{\theta}_1 > \bar{\theta}_2$. $\square$

In fact, it is always the low-cost firm that is more likely to deviate from the cartel agreement. However, Definition 1 ensures that the low-cost firm always resides in the low-tax country. Intuitively, a firm located in a low tax country can gain more than a firm located in a high tax country by defecting from the collusive agreement. The reason is that its cost advantage implies higher profit both in the deviation and in the punishment phase of the game. The low cost firm, therefore, has a smaller range of discount factors (i.e., a higher relative discount factor θ) that sustains the cartel solution.

4   Tax Harmonization

We start with the same basic premise as in the previous sections namely that country 1 is a low tax country and firm 1 is a low cost firm. Making use of the standard definition of tax harmonization we define a harmonizing company tax reform as one which narrows or eliminates the difference between tax rates and/or deductability rates. We shall refer to *unilateral harmonization* as the case where one country changes its tax parameters to a minimum standard. Unilateral harmonization has been the vehicle for harmonization of commodity taxes within the European Union. An alternative is to consider a *bilateral harmonization* process where both countries change their tax rates and/or deductability rules to a common tax and/or deductability rule.[19]

We examine the effects of harmonization by investigating tax base and tax rate harmonization separately. This is done in order to: (i) compare bilateral and unilateral harmonization to see if one is preferable over the other, and (ii) investigate whether it is better to harmonize tax bases or tax rates.

---

[19]Both bilateral and unilateral approaches to harmonization have been studied in the tax literature. See Kanbur and Keen (1993), and Keen (1987, 1989).

Underlying the discussion is an implicit view that monopoly and cartels are undesirable from society's point of view. With equal weights on consumer and producer surplus, it is well known that monopoly produces a deadweight loss that can be reduced by promoting competition.

4.1 Harmonization of corporate tax rates

Bilateral harmonization. Starting from $\gamma_1 > \gamma_2$ and $t_1 < t_2$, bilateral harmonization of tax rates to a common level implies $dt_1 > 0$ and $dt_2 < 0$, and we assume that $dt_1 = \frac{t_2 - t_1}{2}$ and $dt_2 = -\frac{t_2 - t_1}{2}$.[20] Firm 1 is the most likely firm to defect from the cartel. Let $d\bar{\theta}_1^B$ denote the change in firm 1's critical discount rate under bilateral harmonization. Then

$$d\bar{\theta}_1^B = \left(\frac{\partial \bar{\theta}_1}{\partial \tilde{c}_1} \frac{\partial \tilde{c}_1}{\partial \epsilon_1} \frac{\partial \epsilon_1}{\partial t_1} - \frac{\partial \bar{\theta}_1}{\partial \tilde{c}_2} \frac{\partial \tilde{c}_2}{\partial \epsilon_2} \frac{\partial \epsilon_2}{\partial t_2} \right) \frac{t_2 - t_1}{2}. \tag{8}$$

Although $\frac{\partial \bar{\theta}_1}{\partial \tilde{c}_1} < 0$, $\frac{\partial \tilde{c}_i}{\partial \epsilon_i} > 0$, and $\frac{\partial \bar{\theta}_1}{\partial \tilde{c}_2} > 0$ (see the Appendix), the precise effect of the tax rate on the firm's effective cost depends on the size of the tax deduction parameter γ, since

$$\frac{\partial \epsilon_i}{\partial t_i} = \frac{1 - \gamma_i}{(1 - t_i)^2} \begin{cases} > 0 & \text{if } \gamma_i < 1 \\ < 0 & \text{if } \gamma_i > 1 \end{cases}. \tag{9}$$

Using (8) and (9) we find that

$$d\bar{\theta}_1^B \begin{cases} < 0 & \text{if } \gamma_i < 1 \\ > 0 & \text{if } \gamma_i > 1 \end{cases} \tag{10}$$

When the tax code implies incomplete deductions ($\gamma_i < 1$), bilateral harmonization stabilizes the cartel. Increasing the tax rate in country 1 raises effective production costs of firm 1 and narrows the cost differential between the two firms thereby reducing the gain to the low cost firm (firm 1) from

---

[20]Of course, the effect is qualitatively the same for any $dt_1 > 0$ and $dt_2 < 0$, but this assumption allows for some analytical simplicity, and for an easy comparison with the unilateral case.

defecting. Furthermore, lowering the tax rate in country 2 reduces the profit of firm 1 in the punishment phase, since the price firm 1 can charge is a decreasing function of firm 2's effective costs ($\tilde{c}_2$). Thus, the profit of firm 1 also falls in the punishment period. In either case (increasing t_1 or lowering t_2), bilateral harmonization when $\gamma_i < 1$ increases the range of discount rates that supports the cartel solution for firm 1.

In contrast, when the tax deductibility parameter implies a subsidy on costs ($\gamma_i > 1$), bilateral harmonization destabilizes the cartel. An increase in the tax rate in country 1 enhances the cost advantage of firm 1 thereby making it more attractive to deviate. Similarly, a decrease in the tax rate in country 2 lowers the subsidy to firm 2 and increases its effective costs ($\tilde{c}_2$) allowing firm 1 to earn higher profit in the punishment phase. Consequently, firm 1 is more likely to break out of the cartel.

Unilateral harmonization. Under unilateral harmonization of corporate tax rates, only one country changes its tax rate. This is the approach taken in the European Union on commodity taxation, where the policy has been to impose a minimum rate that low tax countries must comply with. In line with this we assume that the low tax country (country 1) must adhere to a minimum tax rate $t_1^{\min}$. Given that $t_1 < t_1^{\min} < t_2$ to begin with, country 1 must increase its tax rate to $t_1^{\min}$ whilst country 2 keeps its rate constant. To make our analysis comparable to the bilateral harmonization above, we assume that minimum taxation implies an increase in the tax rate of country 1 by $dt_1 = \frac{t_2 - t_1}{2}$.

Define $d\bar{\theta}_1^U$ as the change in firm 1's critical discount rate under bilateral harmonization. Then,

$$d\bar{\theta}_1^U = \frac{\partial \bar{\theta}_1}{\partial \tilde{c}_1} \frac{\partial \tilde{c}_1}{\partial \epsilon_1} \frac{\partial \epsilon_1}{\partial t_1} \frac{t_2 - t_1}{2}, \tag{11}$$

where the sign of $d\bar{\theta}_1^U$ depends on the size of γ_i. In particular,

$$d\bar{\theta}_1^U \begin{cases} < 0 & \text{if } \gamma_i < 1 \\ > 0 & \text{if } \gamma_i > 1. \end{cases} \tag{12}$$

Qualitatively the result is the same as under bilateral harmonization. Comparing unilateral and bilateral harmonization we know from (10) and (12) that $d\bar{\theta}_1^i < (>) 0$, $i = B, U$, if $\gamma_i < (>) 1$. In particular,

$$d\bar{\theta}_1^B - d\bar{\theta}_1^U = -\frac{t_2 - t_1}{2} \left(\frac{\partial \bar{\theta}_1}{\partial \tilde{c}_2} \frac{\partial \tilde{c}_2}{\partial \epsilon_2} \frac{\partial \epsilon_2}{\partial t_2} \right) \begin{cases} < 0 & \text{if } \gamma_i < 1 \\ > 0 & \text{if } \gamma_i > 1 \end{cases} \tag{13}$$

Bilateral harmonization strengthens the collusive agreement more than unilateral harmonization when $\gamma_i < 1$, whilst bilateral harmonization weakens the cartel more than unilateral harmonization when $\gamma_i > 1$. Based on (8), (11), and (13) we may draw the following conclusions:

Proposition 2. *Bilateral and unilateral harmonization of corporate tax rates strengthens (weakens) collusive behavior if tax deductible costs are below (above) true economic costs. Bilateral harmonization strengthens the cartel solution more than unilateral harmonization when $\gamma_i < 1$, whilst bilateral harmonization weakens the cartel solution more than unilateral harmonization when $\gamma_i > 1$.*

Intuitively, when $\gamma_i < 1$, bilateral harmonization to a common rate eliminates the tax rate differential between the two countries. The incentive to defect for the firm located in the low tax country is then only provided by the more generous depreciation allowance. This is not the case under unilateral harmonization where the tax rate differential is narrowed but not eliminated. In this case both the rate and the base differential contribute to the cost advantage. This logic can be reversed and applied to the case $\gamma_i > 1$.

4.2 Harmonization of tax bases

Bilateral harmonization. We now consider the case of tax base harmonization from the starting point $t_1 < t_2$ and $\gamma_1 > \gamma_2$ with firm 1 as the low-cost firm. Bilateral harmonization to a common rate implies as before that $d\gamma_1 = -\frac{\gamma_1 - \gamma_2}{2} < 0$ and $d\gamma_2 = \frac{\gamma_1 - \gamma_2}{2} > 0$, and the change in the critical

discount factor is

$$d\bar{\theta}_1^B = \left(-\frac{\partial\bar{\theta}_1}{\partial\tilde{c}_1}\frac{\partial\tilde{c}_1}{\partial\epsilon_1}\frac{\partial\epsilon_1}{\partial\gamma_1} + \frac{\partial\bar{\theta}_1}{\partial\tilde{c}_2}\frac{\partial\tilde{c}_2}{\partial\epsilon_2}\frac{\partial\epsilon_2}{\partial\gamma_2} \right) \frac{\gamma_1 - \gamma_2}{2} \tag{14}$$

Using (see the Appendix) $\frac{\partial\bar{\theta}_1}{\partial\tilde{c}_1} < 0$, $\frac{\partial\tilde{c}_i}{\partial\epsilon_i} > 0$ and $\frac{\partial\bar{\theta}_1}{\partial\tilde{c}_2} > 0$, (14) and

$$\frac{\partial\epsilon_i}{\partial\gamma_i} = -\frac{t_i}{1 - t_i} < 0 \text{ for all } t_i \in (0,1), \tag{15}$$

we have that

$$d\bar{\theta}_1^B < 0. \tag{16}$$

Harmonizing tax bases bilaterally makes collusive agreements more stable, since it eliminates the difference in tax bases and thus shrinks the cost advantage of the low cost firm. This has the effect of reducing profit of firm 1 in both the deviation and the punishment phase.

Unilateral harmonization. Under unilateral harmonization there is a binding ceiling for depreciations implemented by $\gamma_2 < \gamma^{max} < \gamma_1$. If we again assume that the ceiling, γ^{max}, is the mean of the tax parameters, γ_1 and γ_2, this requires a change in the low-tax country tax base according to $d\gamma_1 = -\frac{\gamma_1 - \gamma_2}{2}$. This changes the critical discount factor of firm 1 as follows

$$d\bar{\theta}_1^U = -\frac{\partial\bar{\theta}_1}{\partial\tilde{c}_1}\frac{\partial\tilde{c}_1}{\partial\epsilon_1}\frac{\partial\epsilon_1}{\partial\gamma_1}\frac{\gamma_1 - \gamma_2}{2} < 0. \tag{17}$$

From the comparative static result above, it is clear that harmonization of the tax base even to a minimum level stabilizes the cartel, since profits in both phases when the low cost firm breaches the agreement fall. Comparing bilateral and unilateral harmonization by taking the difference of (16) and (17) we obtain,

$$d\bar{\theta}_1^B - d\bar{\theta}_1^U = \left(\frac{\gamma_1 - \gamma_2}{2} \right) \frac{\partial\bar{\theta}_1}{\partial\tilde{c}_2}\frac{\partial\tilde{c}_2}{\partial\epsilon_2}\frac{\partial\epsilon_2}{\partial\gamma_2} < 0. \tag{18}$$

It is clear from (18) that bilateral harmonization has a greater impact on

the critical discount factor, and we may state:

Proposition 3. *Both bilateral and unilateral harmonization of tax bases strengthens incentives for collusion, but the effect is larger under bilateral harmonization.*

Comparing Propositions 2 and 3 it is seen that cartel stability is differently affected by tax rate and tax base harmonization. Tax base harmonization (unilateral or bilateral) always reinforces incentives to stay in the cartel. The reason is that the cost advantage of the low-cost firm either shrinks (unilateral harmonization) or vanishes (bilateral harmonization). Thus, profits in both the deviation and punishment phase fall relative to the profit of being a monopolist in the home market (cartel solution).

The stability of a cartel under tax rate harmonization depends on the size of the tax deductibility rate. If $\gamma < 1$, the intuition is the same as under base harmonization. However, if the deprecation allowance is too generous ($\gamma > 1$) it is a subsidy to the firm that is enlarged by the corporate tax rate. This increases the cost advantage of the low cost firm and leads to higher profit in the deviation and punishment phases. The effect of this is that the collusive agreement is destabilized.

If we relax the assumption that marginal cost is identical in both countries all our results hold and are even enforced if the low cost firm resides in the low tax country, that is, if $\epsilon_i < \epsilon_j$ and $c_i < c_j$. Crucial for our results then is that Definition 1 is fulfilled. If the opposite constellation is present, that is, $\epsilon_i < \epsilon_j$ but $c_i > c_j$, the high cost firm is harmed by harmonization, since the cost differential is widened when the low tax country increases its effective tax burden. Harmonization then delivers a double dividend in the sense that it enhances competition and weakens the incentive for cartel formation. However, strong anecdotical evidence indicates that the latter case is less realistic. Wages and taxes in the Eastern European countries, for example, are substantially lower than in Western Europe indicating that low tax countries host low cost firms.

5 Extensions

In our model we have assumed price competition and homogenous goods. Allowing differentiated goods under price competition would increase the complexity of the model, but would not alter results in a qualitative way. One might argue that Cournot competition could be used as an alternative approach. It is worth pointing out that one difficulty with the Cournot assumption is that price is determined only indirectly from market demand, since firms do not directly set their prices. This is one reason why quantity competition is losing ground in modern Industrial Organization.[21] There is nothing in the analysis, however, that precludes us from testing our results under Cournot. It turns out that whether we have Cournot or Bertrand competition does not affect our results. A formal analysis that shows this by using the same tacit collusion model, but analysing commodity taxes, is provided by Haufler and Schjelderup (2000).

5.1 Several countries

Our analysis can be extended to the case of several countries (i.e., $n > 2$). Using the same set-up as above where differences in the tax system are the only source of variety, we focus on two cases. In case (i) country 1 is a low-tax country and there are $(n-1)$ identical high tax countries. In case (ii) there are two countries, 1 and 2, hosting firms with an identical low-cost structure, and $(n-2)$ countries hosting high-cost firms.

In both cases above, a low-cost firm i earns profit $\Pi_i^E = (n-1)\pi_i^E$ if it deviates from the cartel and exports to the other $(n-1)$ countries in period 1. As in Section 3.1 it catches its competitors by surprise and sets its monopoly price $p_i < p_j \, \forall \, j, \, j \neq i$ in the deviation phase. Profit in the deviation phase is now $(n-1)$ times higher than previously and ceteris paribus, this weakens cartel stability. However, there may be an offsetting effect (depending on assumptions) since there are more firms that can export to the home market

---

[21] "After all, firms almost always compete in prices." (Tirole, 1988, p. 224).

of the firm that breaches the collusive agreement. As a consequence, profit in the punishment phase may fall, and ceteris paribus, this effect enforces incentives to stay in the cartel. Which of these two effects dominates depends on the relative magnitudes of these effects and differs in cases (i) and (ii).

Case (i). There are $(n-1)$ identical high tax countries and profit in each of these countries in the punishment period is (as before) zero, whilst the low-cost firm earns a positive profit. Profit in the deviation phase for the low cost firm (firm 1) is $\Pi_1^D = (n-1)\pi_1^D$, and is increasing in the number of countries. Thus, the critical discount factor of the low-cost firm (denoted Θ when there are many countries) can be written as

$$\bar{\Theta}_i = \frac{\Pi_1^E}{\pi_1^M - \Pi_1^D} = \frac{(n-1)\cdot\pi_1^E}{\pi_1^M - (n-1)\cdot\pi_1^D} = \frac{\pi_1^E}{\frac{\pi_1^M}{n-1} - \pi_1^D} > \frac{\pi_1^E}{\pi_1 - \pi_1^D} = \bar{\theta}_1. \quad (19)$$

It is seen from (19) that the likelihood of firm i leaving the cartel increases in the number of high-tax countries, since the critical discount factor of the low-cost firm increases disproportionately to the number of countries. Furthermore, the inequality shows that the discount factor of firm 1 is larger when there are many countries than in the two country case $(\bar{\Theta}_i > \bar{\theta}_i)$. Given that it is the firm with the higher relative discount factor that has the strongest incentive to defect, adding countries makes the cartel more unstable.

Since marginal cost (c) is the same for both firms a change in $\tilde{c}_i$ can be interpreted as the tax system in the low tax country becoming less generous. The effect of harmonization can then be found by showing how the relative discount factor changes following an increase in the effective after-tax marginal cost $(\tilde{c}_i)$, that is

$$\frac{\partial\bar{\Theta}_i}{\partial\tilde{c}_i} = -\frac{2\alpha_i\left[\frac{\alpha_i^2}{n-1} - 8\alpha_j\left(\tilde{c}_j - \tilde{c}_i\right)\right] + \frac{\alpha_i^2}{n-1}\left[6\alpha_i - 8(\tilde{c}_j - \tilde{c}_i) + (n-2)8\alpha_2\right]}{\left[\frac{\alpha_i^2}{n-1} - 8\alpha_j\left(\tilde{c}_j - \tilde{c}_i\right)\right]^2} < 0.$$
$$(20)$$

Equation (20) shows that the relative discount factor of the firm in the low

tax country falls, reducing the likelihood of the cartel being stable.

Similarly, a reduction in the effective after-tax marginal cost in the high-tax country can be interpreted as if the high-tax country makes its tax system more generous. The effect of this on the incentive to defect is

$$\frac{\partial \bar{\Theta}_i}{\partial \tilde{c}_j} = \frac{8\alpha_i^2 \left[\alpha_i - 2\left(\tilde{c}_j - \tilde{c}_i\right)\right]}{\left[\frac{\alpha_i^2}{n-1} - 8\alpha_j \left(\tilde{c}_j - \tilde{c}_i\right)\right]^2} > 0. \tag{21}$$

which shows that the collusive agreement is weakened. In sum, it then follows from (20) and (21) that the effects of harmonizing either tax rates or tax bases are qualitatively unchanged from our previous analysis.

Case (ii). In this case there are two identical low-cost firms and it can be shown that the relevant critical discount factor changes significantly. The reason is that in the punishment phase, firm 1, which is assumed to break the collusive agreement, has to cope with the other low-cost firm and, hence, the price is driven down to equal the effective marginal cost in all markets under attack. Thus, profit in the punishment phase will be equal to zero and we get

$$\bar{\Theta}_i = \frac{\Pi_i^E}{\pi_i^M} = (n-1)\frac{\pi_i^E}{\pi_i^M} = n-1 \quad i = \{1, 2\}, \tag{22}$$

where the last step in equation (22) follows since $\pi_i^E = \pi_i^M$ from (3) and (4). Compared with the original two-country model, the rise in profit in the deviation phase leads to a higher critical discount factor, whereas the fall in profit in the punishment phase lowers the critical discount factor $\left(\bar{\Theta}_i\right)$. The effect then depends on the relative magnitudes and we cannot determine these. Furthermore, it means that we cannot compare the discount factor in equation (22) with the one in (6).

A change in the effective after-tax marginal cost $(\tilde{c}_i)$ has the following effect on the discount factor

$$\frac{\partial \bar{\Theta}_i}{\partial \tilde{c}_i} = 0 = \frac{\partial \bar{\Theta}_i}{\partial \tilde{c}_j} \quad \forall i = \{1, 2\}, j = \{3, ..., n\}. \tag{23}$$

Thus, for a low cost firm, tax harmonization (whether base or rate) does not affect the decision to leave the cartel. The intuition is that there is always another identical low-cost firm which faces the same tax rules. Thus, the change in the critical discount factor is affected only by the number of countries, since additional profits (proportionally increasing in the number of countries) only occur in the deviation phase. Hence, we conclude

Proposition 4. *Suppose the number of countries increases ($n > 2$).*

(i) *If there is one low-tax country and $(n-1)$ identical high tax countries, all results from the two-country setting are preserved qualitatively.*

(ii) *If there are at least two identical low-tax countries and $(n-2)$ high tax countries, coordination neither in tax rates nor in tax bases has any influence on cartel stability.*

5.2   Transport costs

In the previous analysis we have neglected transport costs. Although transportation costs have declined rapidly the last decade, it is still reasonable to assume that a firm has higher marginal costs if it exports to other countries. If we model transport costs (S) as Samuelson shipping costs per unit exported, firm i has effective marginal costs $\tilde{c}_i$ in its home market, but incurs $\tilde{c}_i + \tilde{S}_i$ in the foreign market, where $\tilde{S}_i = \epsilon_i \cdot S = \frac{1 - \gamma_i t_i}{1 - t_i} \cdot S$. The cost advantage in the low cost country now implies $\tilde{S}_2 > \tilde{S}_1$, since $\epsilon_2 > \epsilon_1$.

To keep the model economically interesting, we have to assume that $p_j = \frac{a + \tilde{c}_j}{2} > \tilde{c}_i + \tilde{S}_i > 0$. If not, both markets are perfectly segmented and both firms will be monopolists in their home markets. As long as $\tilde{c}_2 - \tilde{c}_1 - \tilde{S}_1 > 0$, that is, $S_1 < \tilde{c}_2 - \tilde{c}_1$, our previous analysis does not change qualitatively: it is still the firm in the low-tax country which is more likely to leave the cartel. Its critical discount factor can then be shown to take the form

$$\bar{\theta}_1^S = \frac{(\alpha_1 - \tilde{S}_1)^2}{\alpha_1^2 - 8\alpha_2(\tilde{c}_2 - \tilde{c}_1 - \frac{\tilde{S}_1}{2}) - 4\tilde{S}_2[\alpha_1 - 2(\tilde{c}_2 - \tilde{c}_1) - \tilde{S}_2]}. \tag{24}$$

Compared to the standard case of no transport costs ($S_1 = \tilde{S}_2 = 0$), the introduction of transport costs decreases profits in the deviation phase, but has an ambiguous effect on profits in the punishment phase. In its home market, the low-cost firm can set a higher price, whereas in the foreign market transport costs will decrease profits. Taken together, the overall effect cannot be signed a priori. However, the effect of tax harmonization on the discount factor remains qualitatively the same as in the previous analysis, and is, in comparison to the standard model, even magnified by transport costs because equation (8) changes to

$$d\bar{\theta}_1^{B,S} = \left(\left[\frac{\partial \bar{\theta}_1}{\partial \tilde{c}_1} \frac{\partial \tilde{c}_1}{\partial \epsilon_1} + \frac{\partial \bar{\theta}_1}{\partial \tilde{S}_1} \frac{\partial \tilde{S}_1}{\partial \epsilon_1} \right] \frac{\partial \epsilon_1}{\partial t_1} - \left[\frac{\partial \bar{\theta}_1}{\partial \tilde{c}_2} \frac{\partial \tilde{c}_2}{\partial \epsilon_2} + \frac{\partial \bar{\theta}_1}{\partial \tilde{S}_2} \frac{\partial \tilde{S}_2}{\partial \epsilon_2} \right] \frac{\partial \epsilon_2}{\partial t_2} \right) \frac{t_2 - t_1}{2}, \tag{25}$$

where $\frac{\partial \bar{\theta}_1}{\partial \tilde{S}_1} < 0$, $\frac{\partial \tilde{S}_i}{\partial \epsilon_i} > 0$, and $\frac{\partial \bar{\theta}_1}{\partial \tilde{S}_2} > 0$. Compared to equation (8) it is seen that equation (25) has an additional effect (the second terms in the squared brackets) which strengthens the argument against tax harmonization.

As shown above, as long as $\tilde{c}_2 - \tilde{c}_1 - \tilde{S}_1 > 0$ our previous analysis does not change qualitatively. However, if marginal transport costs are so high that $\tilde{c}_1 + \tilde{S}_1 - \tilde{c}_2 > 0$, the low (production) cost firm will lose the foreign market to its competitor in the punishment phase, but gain increased profits in its home market due to the higher transport costs of its foreign rival. In this case it is still the firm in the low-tax country which has the greatest incentive to defect, and its critical discount factor is

$$\bar{\theta}_1^S = \frac{(\alpha_1 - \tilde{S}_1)^2}{[\alpha_1 - 2(\tilde{c}_2 + \tilde{S}_2 - \tilde{c}_1)]^2}. \tag{26}$$

Again, we have $\frac{\partial \bar{\theta}_1}{\partial \tilde{S}_1} < 0$, $\frac{\partial \tilde{S}_i}{\partial \epsilon_i} > 0$, and $\frac{\partial \bar{\theta}_1}{\partial \tilde{S}_2} > 0$, all the other partial effects remain the same as in previous sections. Hence, we can again apply equation (25) and the conclusions that followed.

To summarize, we cannot determine unambiguously whether transport costs weaken collusive behavior. However, our focus has been on tax harmonization and the effects of tax harmonization on the critical discount factors.

As shown above the effects from harmonization are qualitatively the same as before, since the leverage effect on overall costs, $\tilde{c}_1 + S_i$, is strengthened.

5.3 Anti-cartel Action

In our discussion we have omitted the modelling of government fines and probabilities of detection and the effect such policies may have on tacit collusion. If we incorporated such a structure in our model it would still be the case that an isolated change in a tax parameter would yield the same results as in our analysis. The point then is that any tax harmonization effort is likely to stabilize tacit collusion and therefore thwart anti-cartel aims. Of course, this effect can in principle be counteracted by a simultaneous change in anti-cartel instruments. This points to the probable conclusion that tax harmonization should be limited, or should be followed by a simultaneous change in anti-cartel instruments.

A possible extension of the model that incorporates fines is as follows. The government chooses a detection probability p, which is costly (effort), and a fine F, which is a percentage of the cartel's profits that has to be paid if the cartel is revealed. The per-period monopoly profit of a risk neutral firm when it is a monopolist can be written as

$$
\begin{aligned}
\mathrm{E}[\Pi_i] &= p \cdot (1 - F) \cdot (1 - t_i)(a - p_i)[p_i - \tilde{c}_i] + (1 - p) \cdot (1 - t_i)(a - p_i)[p_i - \tilde{c}_i] \\
&= (1 - pF) \cdot (1 - t_i)(a - p_i)[p_i - \tilde{c}_i] = (1 - pF) \cdot \pi_i^M.
\end{aligned}
$$

Using the same framework for analysis as in previous sections, the critical discount factor of the low-cost firm is

$$
\bar{\theta}_i = \frac{\pi_i^E}{\mathrm{E}[\Pi_i] - \pi_i^D} = \frac{\pi_i^E}{(1 - pF)\pi_i^M - \pi_i^D}. \tag{27}
$$

In accordance with the literature on tax evasion, we assume that $pF < 1$, since there is an upper bound for the fine due to the costs of monitoring. Comparing equation (27) to equation (19) it is seen that the set up is equiva-

lent to that with several countries $(n > 2)$, i.e., Section 5.1. Our results then do not change given this type of fine structure.

6   Concluding remarks

This paper has shown that harmonization of tax rates and tax bases affects the stability of international cartels and that for the reasonable assumption of incomplete tax deductible expenses, both bilateral and unilateral harmonization stabilizes collusive agreements. Unilateral harmonization to a minimum standard is preferable to bilateral harmonization in the sense that it has a smaller effect on the incentive to stay in the cartel. Our results strengthen previous arguments against tax harmonization in the area of commodity taxation (see Haufler and Schjelderup, 2004).

An issue that has not been explicitly analyzed in this paper is how harmonization affects international cartels when one firm is located outside the harmonizing area. The answer to this question, however, follows from our analysis. Harmonization to a minimum standard, say, on average raises the tax wedge and thus the effective cost of the low tax firm in the harmonizing area, thereby reducing its incentive to defect and export into the outside firm's market. For the firm located outside the Union, the effect of harmonization depends on its cost (dis-)advantage. If it has lower costs than any firm located in the Union, harmonization makes it more attractive to export to the harmonizing area since effective costs there have gone up. Thus profit in the deviating as well as in the punishment phase of the game has risen. If the outside firm has higher costs, harmonization in the Union strengthens the incentive of the outside firm to remain in the cartel. Taken together, harmonization has a dual effect: on the one hand it stabilizes and segments cartels within the harmonizing union, but, on the other hand, it may also decrease or increase the incentive to defect in a market with firms located outside the harmonizing union. In the latter case, however, for the area that harmonizes, losing market shares to a foreign firm must be traded off against

the benefits to consumers from lower prices.

Appendix

As it is always the low-cost firm which is more likely to leave the cartel, we have to differentiate its critical discount factor,

$$\bar{\theta}_i^m = \frac{\alpha_i^2}{\alpha_i^2 - 8\alpha_j(\tilde{c}_j - \tilde{c}_i)}, \tag{28}$$

for the changes in tax rates resp. deductibility factors in order to get the effects of harmonization on cartel stability. This gives

$$d\bar{\theta}_i^m = \frac{\partial \bar{\theta}_i^m}{\partial \tilde{c}_i} \cdot \frac{\partial \tilde{c}_i}{\partial \epsilon_i} \cdot \frac{\partial \epsilon_i}{\partial t_i} \cdot dt_i + \frac{\partial \bar{\theta}_i^m}{\partial \tilde{c}_j} \cdot \frac{\partial \tilde{c}_j}{\partial \epsilon_j} \cdot \frac{\partial \epsilon_j}{\partial t_j} \cdot dt_j \tag{29}$$

and

$$d\bar{\theta}_i^m = \frac{\partial \bar{\theta}_i^m}{\partial \tilde{c}_i} \cdot \frac{\partial \tilde{c}_i}{\partial \epsilon_i} \cdot \frac{\partial \epsilon_i}{\partial \gamma_i} \cdot d\gamma_i + \frac{\partial \bar{\theta}_i^m}{\partial \tilde{c}_j} \cdot \frac{\partial \tilde{c}_j}{\partial \epsilon_j} \cdot \frac{\partial \epsilon_j}{\partial \gamma_j} \cdot d\gamma_j. \tag{30}$$

Therefore, we need

$$\frac{\partial \bar{\theta}_i^m}{\partial \tilde{c}_i} = -\frac{2\alpha_i\left[\alpha_i^2 - 8\alpha_j\left(\tilde{c}_j - \tilde{c}_i\right)\right] + \alpha_i^2\left(6\alpha_i - 8(\tilde{c}_j - \tilde{c}_i)\right)}{\left[\alpha_i^2 - 8\alpha_j\left(\tilde{c}_j - \tilde{c}_i\right)\right]^2} < 0 \tag{31}$$

$$\frac{\partial \tilde{c}_i}{\partial \epsilon_i} = c = \frac{\partial \tilde{c}_j}{\partial \epsilon_j} > 0 \tag{32}$$

$$\frac{\partial \bar{\theta}_i^m}{\partial \tilde{c}_j} = \frac{8\alpha_i^2\left[\alpha_j - (\tilde{c}_j - \tilde{c}_i)\right]}{\left[\alpha_i^2 - 8\alpha_j\left(\tilde{c}_j - \tilde{c}_i\right)\right]^2} = \frac{8\alpha_i^2\left[\alpha_i - 2\left(\tilde{c}_j - \tilde{c}_i\right)\right]}{\left[\alpha_i^2 - 8\alpha_j\left(\tilde{c}_j - \tilde{c}_i\right)\right]^2} > 0, \tag{33}$$

where the inequality in (31) and (33) holds because $\alpha_i - 2\left(\tilde{c}_j - \tilde{c}_i\right) > 0$ from $\pi^E > 0$ in equation (5).

Moreover, we have $\epsilon_i = \frac{1-\gamma_i t_i}{1-t_i}$ and thus

$$\frac{\partial \epsilon_i}{\partial \gamma_i} = -\frac{t_i}{1 - t_i} < 0 \tag{34}$$

25

and

$$\frac{\partial \epsilon_i}{\partial t_i} = \frac{1 - \gamma_i}{(1 - t_i)^2} \begin{cases} > 0 & \text{if } \gamma_i < 1 \\ < 0 & \text{if } \gamma_i > 1 \end{cases}. \tag{35}$$

References

Abreu, D., 1986. Extremal Equilibria of Oligopoly Supergames, *Journal of Economic Theory 39*, 191–225.

Brennan, G., and J. Buchanan, 1980. The Power to Tax: Analytical Foundations of a Fiscal Constitution, Cambridge University Press.

Commission of the European Communities, 2001. Towards an Internal Market Without Tax Obstacles, COM (2001), 582 final, 23.

Edwards, J., and M. Keen, 1996. Tax Competition and Leviathan, *European Economic Review 40*, 113–134.

European Commission, 1996. A Common System of Value Added Taxation. A Programme for the Internal Market, Document COM (96) 328. Brussels.

Froot, K., and P.D. Klemperer, 1989. Exchange Rate Pass-Through when Market Share Matters, *American Economic Review 79*, 637–654.

Fudenberg, D., and E. Maskin, 1986. The Folk Theorem in Repeated Games with Discounting or with Incomplete Information, *Econometrica 54*, 533–554.

Gendron, P-P., 2001. Corporation Tax Asymmetries and Cartel Unity, *International Tax and Public Finance 8*, 659–674.

Haufler, A., and G. Schjelderup, 2000. Tacit Collusion under destination- and origin-based commodity taxation. CESifo working paper No. 23, University of Munich.

Haufler, A., and G. Schjelderup, 2004. Tacit Collusion and International Commodity Taxation, *Journal of Public Economics 88*, 577–600.

Kanbur, R., and M. Keen, 1993. Jeux sans Frontières: Tax Competition and Tax Coordination when Countries Differ in Size, *American Economic Review 83*, 877–892.

Keen, M., 1987. Welfare Effects of Commodity Tax Harmonization, *Journal of Public Economics 33*, 107–114.

Keen, M., 1989. Pareto-Improving Indirect Tax Harmonization, *European Economic Review 33*, 1–12.

Keen, M., Lahiri, S., and P. Raimondos-Møller, 1998. When Is Policy Harmonization Desirable? EPRU working paper 1998/2, Copenhagen Business School.

King, S.P., 1997. National Competition Policy, *Economic Record 73*, 270–284.

Lommerud, K.E., and L. Sørgard, 2001. Trade Liberalization and Cartel Stability, *Review of International Economics 9*, 343–355.

McLure, C.E, 1986. "Tax Competition: Is What's Good for the Private Goose also Good for the Public Gander? *National Tax Journal XXXIX*, 341–346.

Martin, S., 1993. Advanced Industrial Organization, Blackwell, Mass.

Marvel, H., 1982. Exclusive Dealing, *Journal of Law and Economics 25*, 1–26.

Meckl, J., 1996. Market Power of Firms and Exchange Rate Fluctuations, *Journal of Economics 63*, 57–77.

Mintz, J., 2004. Corporate Tax Harmonization in Europe: It's All About Compliance, *International Tax and Public Finance 11*, 221–234.

Mintz, J., and H. Tulkens, 1986. Commodity Tax Competition Between Member States of a Federation: Equilibrium and Efficiency, *Journal of Public Economics 29*, 133–172.

Monti, M., 2001. Why We Should Be Concerned with Cartels and Collusive Behavior, in: Fighting Cartels - Why and How? Swedish Competition Authority Individual Chapters (ISBN 91-88566-26-9).

OECD, 2000. *Report on Hard Core Cartels.*

Pinto, B., 1986. Repeated Games and the Reciprocal Dumping Model of Trade, *Journal of International Economics 20*, 357–366.

Rauscher, M., 1998. Leviathan and Competition Among Jurisdictions: The Case of Benefit Taxation, *Journal of Urban Economics 44*, 59–67.

Rotemberg, J., and G. Saloner, 1989. Tariffs vs. Quotas with Implicit Collusion, *Canadian Journal of Economics 22*, 237–244.

Scherer, F., 1996. International Trade and Competition Policy, Discussion paper No. 96-18, Industrial Economics and International Management Series, Harvard University.

Sinn, H.W., 1987. Capital Income Taxation and Resource Allocation, North-Holland.

Slade, M., 1995. Empirical Games: The Oligopoly Case, *Canadian Journal of Economics 96*, 368–402.

Steen, F., and L. Sørgard, 1999. Semicollusion in the Norwegian Cement Market, *European Economic Review 43*, 1775–1796.

Tirole, J., 1988. The Theory of Industrial Organisation, MIT Press, Cambridge, Mass.