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# Taxing network products - the impact on decisions of MNEs

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# Taxing network products – the impact on decisions of MNEs\*

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Despite an ongoing increase in global revenues for network products, current discussions on tax reforms mostly neglect the specific demand pattern of these products. This paper compares tax-induced distortions of transfer prices and sales quantities for network products and traditional products. In contrast to traditional products, the customer value of network products increases in the number of co-users implying that international sales matter for domestic ones. We analyze unanticipated consequences of taxation when the specificities of network products are ignored. While sales of traditional products are not affected by corporate taxation, optimal sales quantities of network products vary with tax-rate differentials. Specifically, the network effect is intensified in the high-tax country and dampened in the low-tax country by corporate taxation. This implies that policymakers must consider the level of foreign tax rates to anticipate domestic revenue effects for network products.

JEL-Classification: C70, H26, H32, M48

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# 1. Introduction

Due to the increasing importance of global business activities, the different economic conditions of countries of residence and of market countries have become a key issue for international tax policies. Countries of residence collect a major part of taxes as they host multinational enterprises (MNEs) that act as entrepreneurs in global supply chains. In contrast, the dominant economic activity in market countries is often sales, resulting in relatively low corporate tax payments. Recent tax initiatives – both global and national – aim for an altered allocation of taxes better reflecting the market countries' contribution to revenues. These tax-related initiatives include the OECD's global tax reform,<sup>1</sup> country-by-country reporting (CbCR) within the BEPS initiative,<sup>2</sup> and the implementation of national digital service taxes.<sup>3</sup>

When discussing tax reforms with the purpose of re-allocating taxation rights one type of product deserves particular consideration – network products.<sup>4</sup> As a specific feature, they exhibit consumption externalities, i.e., the customer value of the product increases in the number of co-users (see Gallaugher and Wang (2002)). Network products have been known for decades (for early examples see Saloner and Shepard (1992); Brynjolfsson and Kemerer (1996); Gallaugher and Wang (2002); Rochet and Tirole (2003)). However, they require particular attention nowadays since network effects are a common characteristic of digital products (see Belleflamme and Peitz (2018); Hein et al. (2020); Boudreau et al. (2022)), which represent an important subset of network products. Due to the growing importance of these products, driven for instance by the revenue growth in the software industry (see, e.g., Marketline (2020)), tax reforms should account for their specificities. However, existing tax research often neglects network products and focuses on goods with traditional product characteristics.

To fill this gap, we analyze tax-induced distortions of decisions related to production and sales of network products.<sup>5</sup> Specifically, we compare optimal transfer prices

<sup>&</sup>lt;sup>1</sup>See, e.g., OECD (2021b):"Pillar One will ensure a fairer distribution of profits and taxing rights among countries with respect to the largest and most profitable multinational enterprises. It will re-allocate some taxing rights over MNEs from their home countries to the markets where they have business activities and earn profits, regardless of whether firms have a physical presence there."

<sup>&</sup>lt;sup>2</sup>See, e.g., European Commission (2016):"The main objective of the [CbCR-] proposal is to ensure that companies [...] pay their fair share of tax here. The proposal requires companies to disclose [tax-relevant information ...]. This will enable the public to see if the share of taxes paid in the EU corresponds to the share of a group's business within the EU."

<sup>&</sup>lt;sup>3</sup>For an overview, see Asen and Bunn (2021, pp. 4).

<sup>&</sup>lt;sup>4</sup>Existing literature on network effects suggests that network products have characteristics that differ significantly from traditional products, see Kauffman et al. (2000).

<sup>&</sup>lt;sup>5</sup>An extensive literature overview covering industrial organization, management, and technology aspects of network products is provided by McIntyre and Srinivasan (2017). A more recent overview is pre-

and sales quantities for network products and traditional products to investigate real effects of corporate taxation (for a review see Jacob (2022)) and the interplay with network effects. Our analysis adds to the model of Martini et al. (2012), who analyze the impact of various tax allocation procedures and managerial accounting regimes on investment and production decisions related to traditional products. Our model is based on a single-product MNE being active in two countries. We start with modeling a traditional product market; emerging market prices reflect the stand-alone value of the product. Subsequently, we investigate network products that include in addition to the stand-alone value a network value component depending on the number of co-users. Video game consoles such as Playstation or X-box can serve as ideal examples. Their stand-alone value results from playing a video game by oneself, whereas the network value component is generated by interacting in web-based competitions with co-users from all around the world.

Our analysis delivers various results. In contrast to traditional products, optimal sales quantities of network products vary with tax-rate differentials. Particularly, sales quantities of network products increase in the exporting country if it is the high-tax country. Depending on the strength of the network effect, tax effects on sales quantities in the low-tax country become ambiguous. With centralized production and the exporting country being the high-tax one, the network effect is intensified by tax effects in the high-tax country and dampened in the low-tax country. In an alternative tax regime where countries ensure their tax revenue with a sales-based benchmark, we show that real effects can be avoided in the exporting country. In contrast, in the importing country the benchmark always becomes binding.

Our results emphasize that foreign tax rates need to be taken into account to avoid unanticipated revenue effects for network products. In contrast, revenue effects of traditional products are independent from foreign tax rates. Moreover, corporate taxation (weakly) favors centralizing production for traditional products, while incentives to produce locally result for network products if the network effect is strong. Overall, taxation of network products entails product-specific real effects due to the interaction between the tax and the network effect.

The paper proceeds as follows: In section 2 we consider traditional products, i.e., sales quantities in one country are independent from sales quantities in the other country. In section 3 we explicitly consider network products for which national sales quantities are interdependent. In both sections we proceed in two steps. First, we determine entrepreneurial decisions in a world with no taxes. Resulting optimal decisions serve as a

sented in Boudreau et al. (2022).

baseline. In a second step, we integrate a current corporate tax system relying on transfer prices. This two-step procedure enables us to compare tax-induced distortions for traditional and network products. As an additional analysis, we investigate a common feature of currently discussed tax reforms in section 4. Specifically, we consider a tax regime where fiscal authorities use a sales heuristic as a benchmark to define a minimum level of tax revenues. Section 5 concludes.

# 2. Traditional products – no consumption externalities

We consider a single-product MNE being active in two countries  $i, i \in \{A, B\}$ . The MNE centralizes decisions on transfer prices t as well as on production quantities  $x_i$  and sales quantities  $s_i$ ; thus, local production does not imply decentralized decision making.<sup>6</sup> We assume a single-stage production process with production taking place either in country A (centralized production) or simultaneously in both countries (local production). The MNE always produces the globally optimal quantity; we exclude stockkeeping and backorder sales. We apply a standard linear demand function (see, e.g., Pindyck and Rubinfeld (2018, pp. 56)) that reflects characteristics of traditional product markets. That is, sales in one country do not affect sales in the other country. The local sales price  $p_i^{sep}$  is determined as:

$$p_i^{sep}(s_i) = d_i - s_i \tag{1}$$

In (1), parameter  $d_i$  denotes the customers' maximum willingness to pay. We further assume constant unit production costs,  $c_i \ge 0$  and no fixed costs. Moreover, in case of goods being exported, transaction costs of  $c_T \ge 0$  per unit apply. Transaction costs are borne by the receiving entity *B*. For convenience let  $\hat{c}_i$  represent total variable costs per unit, i.e.,  $\hat{c}_A \equiv c_A$  and  $\hat{c}_B = c_A + c_T$  (for centralized production) or  $\hat{c}_B = c_B$  (for local production). We only consider profitable sales, i.e.,  $p_i^{sep}(s_i) > \hat{c}_i$ . The difference  $d_i - \hat{c}_i$  reflects the maximum market size. As mentioned above, we assume the exporting country to be *A* (if necessary), implying that the production quantity in *A*,  $x_A$ , equals or exceeds the domestic sales quantity, i.e.  $x_A \ge s_A$ . Export quantities are indicated by  $q_B$ , and *t* reflects the transfer price per unit.<sup>7</sup> In our model, the transfer price serves tax purposes only.

First, we determine optimal production and sales quantities for a traditional product

<sup>&</sup>lt;sup>6</sup>For many MNEs, decision making procedures are nowadays centralized due to improved data availability. As an example consider Procter & Gamble's business intelligence system Business Sphere, see https: //www.pg.com/redirect.php?&folder=downloads&path=innovation/factsheet\_BusinessSphere.pdf.
<sup>7</sup>Obviously, transfer prices are needed for allocating profits only for centralized production.

in the absence of taxes. In this pre-tax regime the profit function,  $\Pi^{no,sep}(s_A, s_B, q_B)$ , reads:<sup>8</sup>

$$\Pi^{no,sep}(s_A, s_B, q_B) = (d_A - s_A)s_A + tq_B - c_A x_A + (d_B - s_B)s_B - tq_B - c_B x_B - c_T q_B(2)$$

The first three terms on the right-hand side of (2) represent the reported profit in country A; the next four terms represent the reported profit in country B. As can be easily seen in (2), transfer prices do not affect the overall profit of the *MNE* in the pre-tax regime.

Analyzing (2) yields the optimal sales quantity in the exporting country A, which is independent from the company's decision for centralized or local production.<sup>9</sup> In contrast, the optimal sales quantity in country B depends on the location decision, which follows from a simple cost comparison. Optimal sales quantities  $s_i^*$  are given by

$$s_i^* = \frac{d_i - \hat{c}_i}{2} \tag{3}$$

Production is centralized if and only iff:

$$c_A + c_T < c_B \tag{4}$$

Second, we consider a corporate tax regime with corporate tax rates  $\tau_i$ ,  $\tau_i \in ]0, 1[$ . This regime results in the total profit function  $\Pi^{tax,sep}(s_A, s_B, q_B)$ :<sup>10</sup>

$$\Pi^{tax,sep}(s_A, s_B, q_B) = \sum_i (1 - \tau_i) \left[ (d_i - s_i) s_i - c_i x_i \right] - c_T q_B (1 - \tau_B) + t q_B (\tau_B - \tau_A)$$
(5)

As known, the transfer price *t* is relevant under corporate taxation since it affects the after-tax profit of the MNE. We assume that transfer prices are accepted by the local fiscal authorities whenever the export of products has non-negative effects on the national tax base, i.e.,  $t \in [\underline{t}, \overline{t}] = [c_A, d_B - s_B - c_T]$ .<sup>11</sup>

The optimal transfer price  $t^*$  is chosen by the MNE at the upper (resale-minus) or

<sup>&</sup>lt;sup>8</sup>We index profits  $\Pi^{k,l}$ , with  $k \in \{no, tax, ben\}$  and  $l \in \{sep, net\}$ . From index k the tax regime (no - no tax, tax - corporate tax, ben - benchmark taxation), can be inferred. Index l represents the product characteristic (sep - traditional product, net - network product).

<sup>&</sup>lt;sup>9</sup>Derivations of the optimal sales quantities  $s_A^*$  and  $s_B^*$  and the optimal location decision are presented in Appendix A.1.

<sup>&</sup>lt;sup>10</sup>Proofs can be found in Appendix A.2. For ease of presentation let  $\tau_A \neq \tau_B$ .

<sup>&</sup>lt;sup>11</sup>As there exists no theoretically justified benchmark for transfer prices in true team production - for a technical proof see Alchian and Demsetz (1972) - every legally accepted transfer price is a political compromise reflecting negotiation power, fairness considerations and current development conditions of the involved countries.

lower (cost-plus) bound of the acceptable interval to shift profits to the low-tax country.<sup>12</sup> That is:

$$t^* = \left\{ \begin{array}{c} c_A \\ p_B\left(s_B^*\right) - c_T = \frac{1}{2}\left(d_B + c_A - c_T\right) \end{array} \right\} \text{ for } \left\{ \begin{array}{c} \tau_A > \tau_B \\ \tau_A < \tau_B \end{array} \right.$$
(6)

Moroever, the optimal sales quantities,  $s_i^*$  remain the same for all *i* as in (3). The condition for centralizing production changes to:

$$c_B > \left\{ \underbrace{\left(1 - \sqrt{\frac{1 - \tau_A}{1 - \tau_B}}\right)}_{<0} d_B + \sqrt{\frac{1 - \tau_A}{1 - \tau_B}} (c_A + c_T) \right\} \text{for} \left\{ \begin{array}{c} \tau_A > \tau_B \\ \tau_A < \tau_B \end{array} \right.$$
(7)

For  $\tau_A > \tau_B$  the location decision remains the one of the pre-tax regime (see (4)). As in this case *A* is the high-tax country, the transfer price is set at cost and profits from exported goods are completely taxed in *B*. Therefore, the profit is determined as under local production, and taxation does not affect the location decision.

If  $\tau_A < \tau_B$ , the threshold for centralizing production is lower under the corporate tax regime than in the pre-tax regime.<sup>13</sup> Here, centralized production allows to shift profits to the low-tax country whereas local production automatically entails domestic taxation. Hence, centralized production becomes more attractive. The negative term in condition (7) indicates that this effect becomes stronger the larger the market size in country *B*. Thus, production is centralized more often implying that country *A* is able to attract production facilities by means of lower tax rates. Due to the design of the allowed transfer price interval, tax revenues for exported products are completely shifted to the low-tax country.

Summarizing, for traditional products corporate taxation does not affect optimal sales quantities; the same is true for the location decision if the exporting country is the high-tax country. If the exporting country is the low-tax country, centralized production occurs more often.

$$c_A + c_T > \left(1 - \sqrt{\frac{1 - \tau_A}{1 - \tau_B}}\right) d_B + \sqrt{\frac{1 - \tau_A}{1 - \tau_B}} (c_A + c_T) \Leftrightarrow c_A + c_T < d_B$$

The latter inequality is true by assumption.

<sup>&</sup>lt;sup>12</sup>Note that in this setting every transfer price deviating from  $t^*$  would be either illegal or be adjusted immediately to increase the after-tax profit.

 $<sup>^{13}\</sup>text{Comparing}$  (4) with (7) yields:

# 3. Network products – consumption externalities

In this section, we consider products that are characterized by consumption externalities.<sup>14</sup> That is, the value of the product – and thus customers' willingness to pay – increases in the number of co-users. According to Katz and Shapiro (1985), this increase is due to direct and indirect effects.<sup>15</sup>

For a technical definition, we follow Gallaugher and Wang (2002) who state that the value of a network product consists of its stand-alone value and its network value; the latter depending on the number of co-users. Transferring this insight to our model implies that the inverse-demand function (1) needs to be modified by adding a term reflecting the network effect. Thus, the inverse demand function (1) can be rewritten as:<sup>16</sup>

$$p_i^{net}(s_i, s_{\neg i}) = d_i - s_i + \alpha \left( s_i + s_{\neg i} \right)$$
(8)

The total profit in the pre-tax regime,  $\Pi^{no,net}(s_i, s_{\neg i}, q_B)$ , becomes:

$$\Pi^{no,net}(\cdot) = \sum_{i} \left[ d_i - s_i + \alpha \left( s_i + s_{\neg i} \right) \right] s_i - c_i x_i - c_T q_B \tag{9}$$

Analogously, the total profit in the corporate tax regime,  $\Pi^{tax,net}(s_i, s_{\neg i}, q_B)$ , reads:

$$\Pi^{tax,net}(\cdot) = \sum_{i} (1 - \tau_i) \left\{ \left[ d_i - s_i + \alpha \left( s_i + s_{\neg i} \right) \right] s_i - c_i x_i \right\} - c_T q_B \left( 1 - \tau_B \right) + t q_B (\tau_B - \tau_A)$$
(10)

As in section 2, transfer prices within the interval between the production cost and the sales price net of transaction costs are accepted by local fiscal authorities, that is  $t \in [\underline{t}, \overline{t}] = [c_A, d_B - s_B + \alpha(s_A + s_B) - c_T].$ 

#### 3.1. Pre-tax regime

Again, we start our analysis with a pre-tax regime based on profit function (9).<sup>17</sup> As for traditional products, optimal sales quantities in country *B* depend on the choice of centralized or local production. In contrast to traditional products, optimal sales quantities

<sup>&</sup>lt;sup>14</sup>If not stated otherwise the assumptions and model settings of the previous section hold.

<sup>&</sup>lt;sup>15</sup>Direct effects imply that functionality and usefulness of a good increase in the number of co-users. As an example, consider free basic communication apps in addition to premium paid versions, see Boudreau et al. (2022). Indirect effects refer to a higher service quality being offered the higher the number of co-users. As an example consider the density of service networks in the automotive industry; for further examples see, e.g., Clements and Ohashi (2005).

<sup>&</sup>lt;sup>16</sup>Consequently, the sales quantity in country *i* is determined as  $s_i(p_i, s_{\neg i}) = (d_i - p_i + \alpha s_{\neg i})(1 - \alpha)^{-1}$ . The demand function in Belleflamme and Peitz (2018) has comparable features.

<sup>&</sup>lt;sup>17</sup>Proofs are provided in Appendix B.1.

in the exporting country *A* also depend on the production setting. The optimal sales quantities are:

$$s_{i}^{*} = \frac{(1-\alpha)\left(d_{i} - \hat{c}_{i}\right) + \alpha\left(d_{\neg i} - \hat{c}_{\neg i}\right)}{2 - 4\alpha}$$
(11)

with  $\alpha < 0.5$  .

The numerator illustrates the network effect on optimal sales quantities. They result as a linear combination of the domestic and the foreign demand, with weights  $1 - \alpha$  and  $\alpha$ . In contrast, the location decision calculus is equal to the one for traditional products. This is in line with expectations since network effects are independent from the place of production. Thus, the MNE locates production where total variable production costs are minimized.

#### 3.2. Corporate tax regime

Under corporate taxation, the *MNE* can shift profits between the countries by means of transfer pricing.

**Proposition 1.** Let  $\hat{c}_A \equiv c_A$  and  $\hat{c}_B = c_A + c_T (c_B)$  for centralized (local) production. The optimal transfer price becomes:

$$t^{*} = \begin{cases} c_{A} \\ p_{B}(s_{B}^{*}) - c_{T} = d_{B} - s_{B}^{*} + \alpha (s_{A}^{*} + s_{B}^{*}) - c_{T} \end{cases} for \begin{cases} \tau_{A} > \tau_{B} \\ \tau_{A} < \tau_{B} \end{cases}$$
(12)

For centralized production with  $\tau_A < \tau_B$  the optimal sales quantities are:

$$s_i^* = \frac{(1-\alpha)\left(d_i - \widehat{c}_i\right) + \alpha\left(d_{\neg i} - \widehat{c}_{\neg i}\right)}{2 - 4\alpha}, \text{ with } \alpha < 0.5$$
(13)

For centralized production with  $\tau_A > \tau_B$  and for local production optimal sales quantities are:

$$s_{i}^{*} = \frac{(1 - \tau_{\neg i}) \left\{ 2(1 - \alpha)(d_{i} - \hat{c}_{i})(1 - \tau_{i}) + \alpha(d_{\neg i} - \hat{c}_{\neg i})(2 - \tau_{i} - \tau_{\neg i}) \right\}}{4(1 - 2\alpha) (1 - \tau_{A}) (1 - \tau_{B}) - \alpha^{2} (\tau_{A} - \tau_{B})^{2}}, \quad (14)$$

$$\alpha < \frac{2 \left[ \sqrt{(1 - \tau_{A})(1 - \tau_{B})(2 - \tau_{A} - \tau_{B}) - 2(1 - \tau_{A})(1 - \tau_{B})} \right]}{2(1 - \tau_{A})(1 - \tau_{B})(1 - \tau_{B})}$$

with 
$$\alpha < \frac{2\left[\sqrt{(1-\tau_A)(1-\tau_B)(2-\tau_A-\tau_B)-2(1-\tau_A)(1-\tau_B)}}{(\tau_A-\tau_B)^2}\right]$$

Proof: See Appendix B.2.

Proposition 1 shows that the *MNE* chooses a transfer price at the upper end (if  $\tau_A < \tau_B$ ) or at the lower end (if  $\tau_A > \tau_B$ ) of the legally accepted interval. Thus, as for traditional products, transfer prices are used to shift profits to the low-tax country. For  $\tau_A > \tau_B$ , the transfer price is identical to the one chosen for traditional products.

For  $\tau_A < \tau_B$ , the resulting transfer price  $t^* = p_B(s_B^*) - c_T$  shifts the entire profit from the high-tax country *B* to the low-tax country *A*. Thus, the entire profits are taxed at  $\tau_A$ , see (40), implying that the tax factor  $(1 - \tau_A)$  is a multiplier to the pre-tax profit function. Accordingly, corporate taxation has no impact on the optimal sales quantities  $s_i^*$  as can be inferred from comparing (13) to (11).

For  $\tau_A > \tau_B$ , the resulting transfer price  $t^* = c_A$  implies that profits are taxed where the corresponding sales are realized. As a consequence from the network effect, increasing sales in one country boosts sales in the other country. The strength of this effect depends on both tax rates as can be inferred from equalizing the partial derivatives of (10) to zero (see (37) in the appendix):

$$s_{i} = \frac{d_{i} - \hat{c}_{i}}{2(1 - \alpha)} + \frac{\alpha}{(1 - \alpha)} s_{\neg i} \frac{2 - \tau_{i} - \tau_{\neg i}}{2(1 - \tau_{i})}$$
(15)

The first summand represents the optimal sales quantity resulting from domestic market parameters including the national network effect. This term is independent from taxes. The second summand accounts for the network effect resulting from foreign sales and is tax dependent.



#### Figure 1: Impact on optimal sales quantities for $\tau_A > \tau_B$

The figure presents the impact of corporate taxation and the strength of the network effect on optimal sales quantities. The left graph presents results for  $s_A^*$ , and the right graph shows results for  $s_B^*$ . Both graphs are based on the following parameter assumptions:  $d_A = 2.6$ ,  $d_B = 3.6$ ,  $c_A = 1$ ,  $c_T = 1$ .

The optimal sales quantity  $s_A^*$  is always higher under corporate tax than in the pre-tax regime.<sup>18</sup> For further real effects, consider the following example that highlights the tax rates' interplay with the network effect.

<sup>&</sup>lt;sup>18</sup>For a proof see Appendix B.3.

## Example:<sup>19</sup>

- 1. Let  $d_A = 2.6$ ,  $d_B = 3.6$ ,  $c_A = 1$ ,  $c_T = 1$ ,  $\alpha = 0.45$ ,  $\tau_A = \tau_B = 0$ . Then  $s_A^* = s_B^* = 8$ . Observe that the choice of  $d_i$  and  $c_T$ , i.e.,  $d_A = d_B - c_T$  creates a comparable market environment in the two countries.
- 2. Let  $d_A = 2.6$ ,  $d_B = 3.6$ ,  $c_A = 1$ ,  $c_T = 1$ ,  $\alpha = 0.45$ ,  $\tau_A = 0.2$  and  $\tau_B = 0.1$ . Then  $s_A^* = 8.2832$  and  $s_B^* = 7.8552$ . The sales quantity in the high-tax country increases, while the sales quantity in the low-tax country decreases – as compared to the pre-tax case 1. This is driven by the tax factor in (15):

$$\frac{2 - \tau_i - \tau_{\neg i}}{2(1 - \tau_i)} \begin{cases} > \\ < \end{cases} 1 \text{ for } \begin{cases} \tau_i > \tau_{\neg i} \\ \tau_i < \tau_{\neg i} \end{cases}$$
(16)

Accordingly, the network effect is intensified in the high-tax country *A* and dampened in the low-tax country *B* by corporate taxation.

3. Let  $d_A = 2.6$ ,  $d_B = 3.6$ ,  $c_A = 1$ ,  $c_T = 1$ ,  $\alpha = 0.45$ ,  $\tau_A = 0.4$  and  $\tau_B = 0.1$ . Then  $s_A^* = 9.7201$  and  $s_B^* = 8.0819$ . This example demonstrates that  $s_A^*$  and  $s_B^*$  can increase simultaneously. However, the increase in the high tax country – as compared to the pre-tax case 1. – is significantly more pronounced.

Figure 1 further illustrates these effects depending on the strength of the network effect  $\alpha$  and the size of the tax rate differential ( $\tau_A > \tau_B$ ). The continuous lines represent optimal sales quantities under the pre-tax regime. The dashed lines show optimal sales quantities under a corporate tax regime with a relatively small tax rate rate differential ( $\tau_A = 0.2, \tau_B = 0.1$ ), and the dotted lines show optimal sales quantities under a corporate tax regime with a large tax rate rate differential ( $\tau_A = 0.4, \tau_B = 0.1$ ). In line with the example, the upper figure illustrates that the optimal sales quantity  $s_A^*$  always exceeds the pre-tax level under centralized production for  $\tau_A > \tau_B$  (see (45) in the appendix for a proof). In contrast,  $s_B^*$  can be larger or smaller compared to the pre-tax case depending on the strength of the network effect and the size of the tax rate differential. Under local production, optimality conditions for sales quantities are the same as under centralized production for  $\tau_A > \tau_B$ .

Further, we look at the location decision of the MNE in a regime with corporate tax-

<sup>&</sup>lt;sup>19</sup>Assume  $c_B$  to be sufficiently high to warrant central production.

ation. The MNE opts for centralized production if

$$c_{B} > \begin{cases} c_{A} + c_{T} & \tau_{A} > \tau_{B} \\ d_{B} + \frac{\alpha(2 - \tau_{A} - \tau_{B})(d_{A} - c_{A})}{2(1 - \alpha)(1 - \tau_{B})} + \frac{c_{A} - \alpha d_{A} - (1 - \alpha)(d_{B} - c_{T})}{\sqrt{\frac{(1 - 2\alpha)(1 - \alpha)^{2}(1 - \tau_{B})^{2}}{4(1 - 2\alpha)(1 - \tau_{A})(1 - \tau_{B}) - \alpha^{2}(\tau_{A} - \tau_{B})^{2}}}} & \text{for} \quad \tau_{A} < \tau_{B} \end{cases}$$
(17)

(17) shows that this decision remains unaffected compared to the regime without taxes if  $\tau_A > \tau_B$ .

For  $\tau_A < \tau_B$ , Figure 2 illustrates that under the corporate tax regime the threshold for centralized production can be below or above the threshold from the pre-tax regime depending on the parameter setting.



Figure 2: Threshold for centralized or local production for  $\tau_A < \tau_B$ 

The figure presents thresholds of  $c_B$  under the pre-tax  $(\overline{c_B}^{no})$  and corporate tax  $(\overline{c_B}^{tax})$  regime. For all values of  $c_B$  above the respective lines centralized production is chosen. The illustration is based on the following parameter assumptions:  $d_A = 6$ ,  $d_B = 1.1875$ ,  $c_A = 1$ ,  $c_T = 0.1406$ ,  $\tau_A = 0.25$  and  $\tau_B = 0.375$ .

A comparison between traditional products and network products reveals important differences: For traditional products corporate taxation does not affect optimal sales quantities. In contrast, for network products this only holds true if  $\tau_A < \tau_B$  and production is centralized. For  $\tau_A > \tau_B$ , sales quantities change both under centralized and local production. Thereby, the sales quantity in the low-tax country *B* increases or decreases depending on the size of the network effect, implying that *B* is subject to higher uncertainty due to corporate taxation.

Regarding the location decision, for  $\tau_A > \tau_B$  the threshold under the corporate tax regime equals the one under the pre-tax regime for both types of products. In contrast, for  $\tau_A < \tau_B$ , incentives for centralizing the production of traditional products increase,

while for network products this effect depends on the parameter setting. As a consequence, production of network products in the low-tax country can increase or decrease compared to the pre-tax regime.

# 4. Alternative tax regime with sales-based benchmarking

The OECD global tax reform as well as recently introduced national digital service taxes indicate that countries strive for a fair share of taxation rights. The objective of these reforms is to account for economic contributions in market countries' national tax bases. We represent this objective by extending our corporate taxation model. This extension follows a three-step approach:<sup>20</sup>

1. The *MNE* chooses a transfer price to report separate accounting profits in both countries *i* as done in the previous sections. As  $s_B = q_B$ , the resulting national reported profits,  $\Pi_i^{rep}$  read:

$$\Pi_{A}^{rep} = [d_A - s_A + \alpha (s_A + s_B) - c_A] s_A + (t - c_A) s_B$$
(18)

$$\Pi_{B}^{rep} = [d_{B} - s_{B} + \alpha (s_{A} + s_{B}) - t - c_{T}] s_{B}$$
(19)

with  $\alpha = 0$  ( $\alpha \in [0; 0.5[$ ) for traditional (network) products.

2. Each country *i* controls unilaterally if its reported profit  $\Pi_i^{rep}$  can be considered a fair share. For this purpose the national reported profit is compared in our model to a sales-based benchmark,  $TB_i$ .<sup>21</sup> The required information about domestic and foreign sales and domestic and foreign profits can be gathered by the national fiscal authorities, for instance from CbCR. Technically this means:

$$TB_i = \varepsilon_i \frac{p_i s_i}{p_i s_i + p_{\neg i} s_{\neg i}} \left( \Pi_i^{rep} + \Pi_{\neg i}^{rep} \right)$$
(20)

The factor  $\varepsilon_i \in ]0,1[$ , represents the strictness of the national tax regime. If  $\varepsilon_i$  is close to one, a national tax regime is rather strict in ensuring a minimum national

<sup>&</sup>lt;sup>20</sup>Observe that by definition, this extension applies to centralized production only. Under local production, national profits are locally taxed.

<sup>&</sup>lt;sup>21</sup>For a discussion of sales as an allocation factor, see Radaelli and Klemm (2001). Sales are commonly regarded as less prone to manipulation than profits, total book-value of assets, etc. Using sales as allocation factor avoids discouraging effects on investment and payroll (see Andrus and Oosterhuis (2017); Goolsbee and Maydew (2000)). Further, sales factors are widely used, for example in the US for interstate profit allocation (see Clausing (2016)), and market countries currently lobby for sales-based allocations of taxation rights (see, e.g., GrantThornton (2019); OECD (2021a)).

tax level. Note that the sales benchmark is never strictly binding in both countries simultaneously, given  $\varepsilon_i \leq 1.^{22}$ 

- 3. If the reported profit in country *i* exceeds the benchmark it becomes the acceptable profit  $\Pi_i^{acp}$ . If the reported profit falls short of the benchmark, then it is adjusted unilaterally by the national fiscal authority resulting in an acceptable profit  $\Pi_i^{acp}$ . For the latter, two cases have to be distinguished:
  - a) The adjusting country *i* defines  $\Pi_i^{acp} = TB_i$ . This equality is achieved with an implicit transfer price  $t_i^{imp}$ , where  $t_i^{imp} \in [c_A, d_B s_B + \alpha (s_A + s_B) c_T]$ .
  - b) The adjusting country *i* chooses the most favorable transfer price within the allowed interval, i.e.  $t_i^f \in \{\underline{t}, \overline{t}\}$ , but  $\Pi_i^{acp} = TB_i^f < TB_i$ . Generally, the limits of the interval define the most favourable transfer prices.<sup>23</sup>

Summarizing, our approach delivers the following acceptable profit  $\Pi_i^{acp}$  for country *i*:

$$\Pi_i^{acp} = \max\{\Pi_i^{rep}, \min\{TB_i, TB_i^f\}\}$$
(21)

The after-tax profit of the MNE under a benchmarking regime  $\Pi^{ben,\cdot}$  reads:

$$\Pi^{ben,\cdot}(s_i, s_{\neg i}) = \sum_i (\Pi_i^{rep} - \Pi_i^{acp} \tau_i)$$
(22)

#### 4.1. Benchmarking for traditional products

The application of the benchmarking regime is straightforward, as the sales benchmark is never strictly binding in both countries. If benchmarking occurs, due to the MNEs' profit shifting incentives it will be the high-tax country applying it. Lemma 1 identifies the application of the benchmarking and clarifies its consequences.

Lemma 1. Assume centralized production to be given. Moreover, let

$$\widehat{\varepsilon}_{i} = \frac{(d_{i} - \widehat{c}_{i}) \left[ d_{A}^{2} - c_{A}^{2} + d_{B}^{2} - \widehat{c}_{B}^{2} \right]}{(d_{i} + \widehat{c}_{i}) \left[ (d_{A} - c_{A})^{2} + (d_{B} - \widehat{c}_{B})^{2} \right]}.$$
(23)

With  $\tau_A > \tau_B$ :

• For  $\varepsilon_A > \widehat{\varepsilon_A}$ , country A applies the sales-based benchmark. The transfer price is set to  $t^* \in ]c_A, p_B(s_B^*) - c_T[$ , which is accepted by country B.

<sup>&</sup>lt;sup>22</sup>For a proof see Appendix C.1.

<sup>&</sup>lt;sup>23</sup>Note that  $t_A^f = d_B - s_B + \alpha (s_A + s_B) - c_T$ ,  $t_B^f = c_A$ .

• For  $\varepsilon_A \leq \widehat{\varepsilon_A}$ , all results from the corporate tax regime remain unchanged.

*With*  $\tau_A < \tau_B$ *, country B always applies the sales-based benchmark:* 

- For  $\varepsilon_B > \widehat{\varepsilon_B}$ , the transfer price is set to  $t^* = c_A$ , which is accepted by country A.  $s_A^*$  and  $s_B^*$  remain constant compared to the pre-tax and the corporate tax regime.
- For  $\varepsilon_B \leq \widehat{\varepsilon_B}$ , the transfer price is set to  $t^* \in ]c_A, p_B c_T[$ , which is accepted by country *A*.

## Proof: See Appendix C.2.

Lemma 1 confirms that the effects of the benchmarking regime depend on the tax rate differential and the fiscal authorities' strictness. As only the high-tax country suffers from profit shifting, sales-based benchmarking is only applied there. Further, effects are asymmetrical depending on whether the high-tax country is exporting or importing. If the exporting country *A* has a higher tax rate, it always keeps a positive tax revenue due to domestic sales. It therefore only applies the sales-based benchmark if the national tax policy is rather strict. In contrast, if the importing country *B* is the high-tax country, it loses its entire tax revenue under a corporate tax regime due to profit shifting. Thus, it always applies the sales-based benchmark.

Figure 3 illustrates the results. It compares the optimal sales quantities  $s_i^*$ , the optimal transfer prices  $t^*$ , and the cost threshold  $\overline{c}_B$  that - if exceeded - suggests centralized production, under the benchmarking and the corporate tax regime. Panel A exhibits optimal outcomes for  $\tau_A > \tau_B$ , and Panel B illustrates optimal outcomes for  $\tau_A < \tau_B$ . Both panels show that the MNE uses both transfer pricing and adjustments of sales quantities to meet the benchmark in the high-tax country.

For  $\tau_A > \tau_B$ , Panel A.1 illustrates a downward adjustment of  $s_A$  and an upward adjustment of  $s_B$ , compared to the corporate tax setting. This adjustment is only done if  $\varepsilon_A$  exceeds the threshold. Thereby, the MNE manages the sales-based benchmark such that more profits are allocated to the low-tax country. Panel A.2 shows that the MNE gradually increases the transfer price as well once the threshold is exceeded.<sup>24</sup> Thus, the MNE adjusts both sales quantities and the transfer price to exactly meet the benchmark.

For  $\tau_A < \tau_B$ , Panel B.1 of Figure 3 illustrates that even for values below the threshold of  $\hat{\varepsilon_B}$ , the sales quantity in the high-tax country decreases and the sales quantity in the low-tax country increases compared to the corporate tax setting. Since in Panel B the

<sup>&</sup>lt;sup>24</sup>Changes in the transfer price close to the threshold  $\widehat{\epsilon_A}$  are rather small, hence they become only visible when the threshold is exceeded considerably.







importing country represents the high-tax country, Panel B.2 shows that the transfer price decreases until the threshold  $\hat{\epsilon}_B$  is met, leading to less profit shifting.

Finally, Panels A.3 and B.3 show that the cost threshold  $\bar{c}_B$  increases (weakly) monotonically; thus, central production becomes less attractive if the sales benchmark becomes binding. For  $\tau_A > \tau_B$ , Panel A.3 shows that if the benchmarking regime in the exporting (and high-tax) country A is rather lenient, the cost threshold remains unchanged compared to the corporate tax regime. For  $\tau_A < \tau_B$  Panel B.3 illustrates that central production becomes less attractive even for low values of  $\varepsilon_B$ . This finding suggests that introducing a benchmarking regime could create additional positive real effects for the importing country B by providing incentives for decentralized production. If the implicit transfer price is below the cost ( $t_B^{imp} < c_A$ ), setting the transfer price at  $t^* = c_A$  prevents abusive benchmarking. Accordingly, the MNE chooses optimal sales quantities as under the corporate tax regime. Similarly,  $c_B$  does not increase further beyond the threshold  $\varepsilon_B$ .

# 4.2. Benchmarking for network products

In this section, we investigate the effects of sales-based benchmarking on network products. Our analysis in section 3.2 shows that even under the corporate tax regime various interdependencies between tax rates and network effects exist. Due to this interplay, the direction and magnitude of sales adjustments are often ambiguous.

## Lemma 2. Assume centralized production to be given.

With  $\tau_A > \tau_B$ :

- For  $\varepsilon_A > \varepsilon_A^{net}$ , country A applies the sales-based benchmark. Compared to the corporate tax regime, the MNE increases the transfer price from  $c_A$  to  $t^* \in ]c_A$ ,  $p_B c_T[$ , which is accepted by country B.  $s_B^*$  decreases or increases compared to the corporate tax regime.
- For  $\varepsilon_A \leq \widehat{\varepsilon_A^{net}}$ , all results from the corporate tax regime remain unchanged.

With  $\tau_A < \tau_B$ :

- For  $\varepsilon_B > \widehat{\varepsilon}_B^{net}$ , country B applies the sales-based benchmark. Compared to the corporate tax regime, the MNE decreases the transfer price from  $p_B c_T$  to  $t^* = c_A$ , which is accepted by country A. The optimal sales quantities for  $s_i^*$  change with the transfer price.
- For  $\varepsilon_B \leq \widehat{\varepsilon_B^{net}}$ , country B also applies the sales-based benchmark. The MNE decreases the transfer price to  $t^* \in ]c_A, p_B c_T[$ , which is accepted by country A. The effect on  $s_A^*$  and  $s_B^*$  compared to the corporate tax regime is ambiguous.





#### Proof: See Appendix C.3.

Some results from Lemma 2 parallel our findings presented in Lemma 1. For instance, if the exporting country *A* has a higher tax rate, it will only apply the benchmark if the threshold  $\widehat{e_A^{net}}$  is exceeded. As for traditional products, country B always applies the benchmark if it has a higher tax rate. This implies that the asymmetric impact of the threshold remains valid, too. In contrast, changes in sales quantities depend on product characteristics. Differently from traditional products, sales are adjusted upwards or downwards for network products even if transfer prices at the limits of the allowed interval are chosen.

Figure 4 illustrates the results in detail. Panel A.1 shows that both sales quantities vary more than for traditional products. This holds true for  $s_B$ , especially in settings where the importing country B is the high-tax country. In line with our findings for traditional products, Panel B.1 shows that for lenient tax authorities, i.e.,  $\varepsilon_B \leq \varepsilon_B^{net}$ , the sales-based benchmark is binding. Accordingly, the MNE increases taxable profits in B by decreasing the transfer price (book-based tax effect). Regarding sales quantities there is an incentive to manage downward the tax benchmark by reducing the sales quantity in B (real effect) which can be overcompensated by the network effect; in Figure 4 the tax effect is the stronger one. For strict tax authorities, i.e.,  $\varepsilon_B > \varepsilon_B^{net}$ , the high-tax country B cannot enforce a transfer price below  $c_A$  (see also Panel B.2). Thus, benchmarking creates no longer an incentive effect and the MNE chooses the optimal sales quantities for  $t = c_A$  from the corporate tax setting. This explains the sudden jump in sales quantities.

Figure 4, Panels A.3 and B.3 provide numerical analyses regarding the location decision: For  $\varepsilon_B > \hat{\varepsilon_B}$  the results known from the corporate tax setting for a transfer price  $t = c_A$  hold (see (17), upper equation). Here, benchmarking re-instates the pure cost comparison from the pre-tax regime and abolishes incentives created by corporate taxation. In general, benchmarking restricts the leeway of the MNE to optimize the transfer price, thus central production looses its attractiveness for tax planning purposes.

Overall, sales quantities can increase or decrease in both countries compared to the corporate tax regime if *B* is the high-tax country. This contrasts findings for traditional products emphasizing again the specificity of network products. Similar to traditional products, sales-based benchmarking only becomes binding in the high-tax country.

# 5. Conclusion

Tax policy debates rest on scientific and anecdotal knowledge gained from traditional products. However, in the recent past the economic importance of network products

has increased significantly. For appropriate decisions, policy makers need a sound understanding of tax effects on network products. Accordingly, our paper analyzes theoretically tax-based distortions of an MNE's decisions on sales quantities, transfer prices and production location.

Our analysis emphasizes that corporate taxation of network products induces unexpected consequences. Whilst for traditional products sales quantities are never distorted by corporate taxation, both book-based and real effects occur for network products. First, sales quantities are always higher in the exporting high-tax country; adjustments for sales quantities in the importing low-tax country are ambiguous. Second, local production is favoured especially when the network effect is strong.

The most prominent results for the benchmarking regime are: i) benchmarking is only applied in the high-tax country, ii) exporting (importing) countries apply benchmarking if they are very strict (always), iii) sales quantities for network products can develop in opposing directions compared to traditional products; that is, for example, sales are increasing in one country for traditional products but are decreasing for network products. That is especially true for strong network effects. Finally, our results show how the mere threat to be taxed on the basis of a sales-based profit allocation results in adjustments of MNEs' production location, sales quantities, and transfer prices.

For empirical research the results of our study have to be interpreted against the background of the model assumptions. For instance, we solely focus on variable costs. Moreover, we consider a wide range of acceptable transfer prices, as we require non-negative contribution margins. In real world settings fiscal authorities might be stricter by demanding positive profits. Lastly, the difference between traditional and network products is reflected completely in the respective inverse demand functions. Nevertheless, our study provides fundamental insights in real effects of taxation for network products. Policy makers should consider these insights when reforming international tax regimes. Our study also provides a theoretical basis for future empirical studies. For example, based on an international panel empirical analyses could investigate whether sales quantities for traditional and network products react differently to changes in international tax rates.

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# Appendix

# A. Proofs for section 2

# A.1. Pre-tax regime

We determine optimal sales quantities,  $s_A^*$  and  $s_B^*$ , for a) centralized and b) local production. We then c) compare the resulting profits and determine the threshold for centralized production.

a) With *centralized* production, i.e.,  $x_A = s_A + s_B$ ,  $x_B = 0$ ,  $q_B = s_B$ ,  $\hat{c}_A \equiv c_A$  and  $\hat{c}_B = c_B + c_T$  the total profit function (2) simplifies to:

$$\Pi^{no,sep}(s_i) = \sum_i (d_i - s_i - \hat{c}_i) s_i \tag{24}$$

Equalizing the first partial derivatives of (24) to zero gives:<sup>25</sup>

$$\frac{\delta\Pi^{no,sep}(s_i)}{\delta s_i} = d_i - \hat{c}_i - 2s_i = 0 \Leftrightarrow s_i^* = \frac{d_i - \hat{c}_i}{2}$$
(25)

- b) With *local* production, i.e.,  $x_i = s_i \forall i$  and  $\hat{c}_B = c_B$ , expressions for total profit (24) and optimal sales quantities (25) remain unchanged.
- c) As profit is increasing monotonically in sales quantities, *centralized* production is preferred iff  $c_B > c_A + c_T$ .

## A.2. Corporate tax regime

We determine 1.) the optimal transfer price,  $t^*$ . Then we separately analyze the cases 2.)  $\tau_A > \tau_B$  and 3.)  $\tau_A < \tau_B$ . Within these cases, we further distinguish a) centralized and b) local production.

1. For determining the optimal transfer price the total profit function under centralized production (5) can be simplified by exploiting  $q_B = s_B$ :

$$\Pi^{tax,sep}(s_A, s_B) = \sum_i (1 - \tau_i) \left[ (d_i - s_i) s_i - c_i x_i \right] - c_T s_B (1 - \tau_B) + t s_B (\tau_B - \tau_A)$$
(26)

 $<sup>^{25}</sup>$ Checking the Hessian matrix – not displayed here – ensures that  $s_A^*$  and  $s_B^*$  are maximizers.

The first partial derivative of (26) with respect to the transfer price *t* yields:

$$\frac{\delta \Pi^{tax,sep}(s_A, s_B)}{\delta t} = s_B \left( \tau_B - \tau_A \right) \left\{ \begin{array}{c} > 0 \\ < 0 \end{array} \right\} \text{ for } \left\{ \begin{array}{c} \tau_B > \tau_A \\ \tau_B < \tau_A \end{array} \right.$$
(27)

Thus, the *MNE* always chooses a transfer price  $t^*$  at the upper (lower) end of the interval that is accepted by the fiscal authorities. This delivers (6).

- 2. Let  $\tau_A > \tau_B$ :
  - a) Under *centralized* production, i.e.,  $x_A = s_A + s_B$  and  $q_B = s_B$ , the optimal transfer price is  $c_A$ . Let  $\hat{c}_A = c_A$  and  $\hat{c}_B = c_A + c_T$ , then the profit function (26) further simplifies to:

$$\Pi^{tax,sep}(s_i, s_{\neg i}) = \sum_i \left( d_i - s_i - \widehat{c}_i \right) s_i \left( 1 - \tau_i \right)$$
(28)

Equalizing the partial derivatives of (28) to zero gives:

$$\frac{\delta \Pi^{tax,sep}(s_i, s_{\neg i})}{\delta s_i} = (d_i - 2s_i - \hat{c}_i) (1 - \tau_i) = 0 \Leftrightarrow s_i^* = \frac{d_i - \hat{c}_i}{2}$$
(29)

- b) With *local* production, i.e.,  $x_i = s_i \forall i$  and  $\hat{c}_B = c_B$ , expressions for total profit (28) and optimal sales quantities (29) remain unchanged.
- c) With  $\tau_A > \tau_B$  local production is preferred iff  $c_B < c_A c_T$ .
- 3. Let  $\tau_A < \tau_B$ :
  - a) Assume centralized production, i.e.,  $x_A = s_A + s_B$  and  $q_B = s_B$ . Further, the optimal transfer price becomes  $t^* = p_B(s_B^*) c_T$ . Inserting into (26) yields:

$$\Pi^{tax,sep}(s_A, s_B) = (1 - \tau_A) \sum_i (d_i - s_i - \hat{c}_i) s_i$$
(30)

Accordingly (29) and thus optimal sales quantities remain unchanged. The resulting transfer price is  $t^* = p_B(s_B^*) - c_T = \frac{d_B - \hat{c}_B}{2}$ .

- b) For local production (29) and thus sales quantities remain unchanged, too.
- c) Comparing profits from centralized and local production gives the optimal location decision. Centralized production is preferred iff (31) holds true:

$$(1 - \tau_A) \sum_{i} \left(\frac{d_i - \hat{c}_i}{2}\right)^2 > \sum_{i} (1 - \tau_i) \left(\frac{d_i - \hat{c}_i}{2}\right)^2$$
$$\Leftrightarrow c_B > \left(1 - \sqrt{\frac{1 - \tau_A}{1 - \tau_B}}\right) d_B + \sqrt{\frac{1 - \tau_A}{1 - \tau_B}} (c_A + c_T)$$
(31)

# B. Proofs for section 3

# B.1. Pre-tax regime

We determine optimal sales quantities,  $s_A^*$  and  $s_B^*$ , for a) centralized and b) local production. We then c) compare the resulting profits and determine the threshold for centralized production.

a) With *centralized* production, i.e,  $x_A = s_A + s_B$  and  $q_B = s_B$ , the total profit function (9) simplifies to:

$$\Pi^{no,net}(s_i, s_{\neg i}) = \sum_i \left[ d_i - s_i + \alpha \left( s_i + s_{\neg i} \right) \right] s_i - \widehat{c}_i s_i \tag{32}$$

Equalizing the first partial derivatives of (32) to zero gives:

$$\frac{\delta\Pi^{no,net}(\cdot)}{\delta s_i} = d_i - \hat{c}_i - 2(1-\alpha)s_i + 2\alpha s_{\neg i} = 0 \Leftrightarrow s_i = \frac{d_i - \hat{c}_i + 2\alpha s_{\neg i}}{2(1-\alpha)}$$
(33)

Simultaneously solving (33) for all i gives the optimal sales quantities:<sup>26</sup>

$$s_i^* = \frac{(1-\alpha)(d_i - \widehat{c}_i) + \alpha(d_{\neg i} - \widehat{c}_{\neg i})}{2 - 4\alpha}$$
(34)

- b) Under *local* production, i.e.,  $x_i = s_i \forall i$ , total profit function (32) and optimal sales quantities (34) remain unchanged.
- c) As profit is increasing monotonically in sales quantities, *centralized* production is preferred iff  $c_B > c_A + c_T$ .

# B.2. Corporate tax regime (Proof of Proposition 1)

We start with determining the optimal transfer price,  $t^*$ . In the next step, we consider the cases 1.)  $\tau_A > \tau_B$  and 2.)  $\tau_A < \tau_B$  separately. Within these cases we further distinguish a) centralized and b) local production.

<sup>&</sup>lt;sup>26</sup>The Hessian proofs concavity for  $\alpha < \frac{1}{2}$ .

Deriving the total profit function (10) with respect to the transfer price *t* yields:

$$\frac{\delta \Pi^{tax,net}(\cdot)}{\delta t} = q_B \left(\tau_B - \tau_A\right) \tag{35}$$

(35) indicates that the *MNE's* after-tax profit is strictly increasing (decreasing) in *t* if  $\tau_B > (<)\tau_A$ . Thus, a transfer price  $t^*$  at the upper (lower) end of the interval that fiscal authorities accept is always optimal, as displayed in Proposition 1.

- 1. Let  $\tau_A > \tau_B$ :
  - a) Assume *centralized* production, i.e.,  $x_A = s_A + s_B$ ,  $q_B = s_B$  and  $t^* = c_A$ . The total profit function (10) becomes:

$$\Pi^{tax,net}(s_i, s_{\neg i}) = \sum_i (1 - \tau_i) [d_i - s_i + \alpha(s_i + s_{\neg i}) - \widehat{c}_i] s_i$$
(36)

Equalizing the partial derivatives of (36) to zero gives:

$$\frac{\delta \Pi^{tax,net}(\cdot)}{\delta s_{i}} = (1 - \tau_{i})[d_{i} - \hat{c}_{i} - 2(1 - \alpha)s_{i} + \alpha s_{\neg i}] + \alpha s_{\neg i}(1 - \tau_{\neg i}) = 0$$

$$\Leftrightarrow s_{i} = \frac{(1 - \tau_{i})(d_{i} - \hat{c}_{i}) + \alpha s_{\neg i}(2 - \tau_{i} - \tau_{\neg i})}{2(1 - \alpha)(1 - \tau_{i})}$$
(37)

Simultaneously solving (37) for all i yields:<sup>27</sup>

$$s_{i}^{*} = \frac{(1 - \tau_{\neg i}) \left[2(d_{i} - \hat{c}_{i})(1 - \alpha)(1 - \tau_{i}) + \alpha(d_{\neg i} - \hat{c}_{\neg i})(2 - \tau_{i} - \tau_{\neg i})\right]}{4(1 - 2\alpha) \left(1 - \tau_{A}\right) \left(1 - \tau_{B}\right) - \alpha^{2} \left(\tau_{A} - \tau_{B}\right)^{2}}$$
(38)

The nominator of (38) is strictly positive. Thus, to ensure positive  $s_i$  the denominator must be positive as well. This requires:

$$\alpha^{2} + \alpha \frac{8(1 - \tau_{A})(1 - \tau_{B})}{(\tau_{A} - \tau_{B})^{2}} - \frac{4(1 - \tau_{A})(1 - \tau_{B})}{(\tau_{A} - \tau_{B})^{2}} < 0$$

This holds for:

$$\alpha < \frac{2\left[\sqrt{(1-\tau_{A})(1-\tau_{B})}(2-\tau_{A}-\tau_{B})-2(1-\tau_{A})(1-\tau_{B})\right]}{(\tau_{A}-\tau_{B})^{2}}$$
(39)

b) With *local* production, i.e.,  $x_i = s_i$ ,  $\forall i$  and  $q_B = 0$ , expressions for total profit (36) and optimal sales quantities (38) remain unchanged.

 $<sup>^{27}(38)</sup>$  displays maximizers as the Hessian is negative definite for all reasonable combinations of tax rates.

- c) The formula for the optimal production quantity  $s_B^*$  is identical for centralized and local production. Thus, *centralized* production is beneficial whenever  $c_B > c_A + c_T$ .
- 2. Let  $\tau_A < \tau_B$ .
  - a) Assume *centralized* production, i.e.,  $x_A = s_A + s_B$ ,  $q_B = s_B$  and  $t^* = p_B(s_B^*) c_T$ . The total profit function (10) becomes:

$$\Pi^{tax,net}(s_i, s_{\neg i}) = (1 - \tau_A) \sum_i [d_i - s_i + \alpha(s_i + s_{\neg i}) - \widehat{c}_i] s_i$$
(40)

The partial derivatives of (40) with respect to  $s_i$  for all *i* are:

$$\frac{\delta \Pi^{tax,net}(\cdot)}{\delta s_i} = (1 - \tau_A) \left[ d_i - 2(1 - \alpha) s_i + 2\alpha s_{\neg i} - \hat{c}_i \right] = 0$$

$$\Leftrightarrow s_i = \frac{d_i - \hat{c}_i + 2\alpha s_{\neg i}}{2(1 - \alpha)}$$
(41)

Simultaneously solving (41) for all *i* yields:

$$s_{i}^{*} = \frac{d_{i} - \hat{c}_{i} + \alpha \left( d_{\neg i} - d_{i} - c_{T} \right)}{2 - 4\alpha}$$
(42)

Thus,  $p_B^*(s_B^*) = \frac{1}{2}(d_B + \hat{c}_B)$ .

- b) For *local* production expressions for total profit (36) and optimal sales quantities (38) remain unchanged, as in 1*b*.
- c) Comparing the resulting profits under centralized and local production gives the threshold for  $c_B$ . Let  $s_{i,c}^*(s_{i,l}^*)$  denote optimal sales quantities under centralized (local) production. Then, for  $\tau_A < \tau_B$  centralized production is optimal iff:

$$(1 - \tau_A) \sum_{i} [d_i - s^*_{i,c} + \alpha(s^*_{i,c} + s^*_{\neg i,c}) - \widehat{c}_i] s^*_{i,c}$$

$$> \sum_{i} (1 - \tau_i) [d_i - s^*_{i,l} + \alpha(s^*_{i,l} + s^*_{\neg i,l}l) - \widehat{c}_i] s^*_{i,l}$$

$$(43)$$

Solving for  $c_B$  and replacing  $s^*_{A,c}$  and  $s^*_{B,c}$  with the optimal sales quantities from (42) and  $s^*_{A,l}$  and  $s^*_{B,l}$  with the optimal sales quantities from (38), we

find that centralized production is beneficial whenever

$$c_{B} > d_{B} + \frac{\alpha \left(2 - \tau_{A} - \tau_{B}\right) \left(d_{A} - c_{A}\right)}{2(1 - \alpha) \left(1 - \tau_{B}\right)} + \frac{c_{A} - \alpha d_{A} - (1 - \alpha) \left(d_{B} - c_{T}\right)}{\sqrt{\frac{(1 - 2\alpha)(1 - \alpha)^{2}(1 - \tau_{B})^{2}}{4(1 - 2\alpha)(1 - \tau_{A})(1 - \tau_{B}) - \alpha^{2}(\tau_{A} - \tau_{B})^{2}}}}$$
(44)

# B.3. Comparison of optimal sales quantities

Comparing the optimal sales quantities from the pre-tax case (11) with the one under corporate taxation for  $\tau_A > \tau_B$  as depicted in (14)gives :

$$\frac{\frac{(1-\alpha)(d_{A}-\hat{c}_{A})}{2-4\alpha}}{\frac{2-4\alpha}{a}} + \frac{\alpha(d_{B}-\hat{c}_{B})}{\frac{2-4\alpha}{b}} + \frac{\alpha(d_{B}-\hat{c}_{B})}{\frac{2-4\alpha}{b}} + \frac{\alpha(d_{B}-\hat{c}_{B})(2-4\alpha)}{\frac{2-4\alpha}{b}} + \frac{\alpha(d_{B}-\hat{c}_{B})(2-4\alpha)}{\frac{2-4\alpha}{b}} + \frac{\alpha(d_{B}-\hat{c}_{B})(2-4\alpha)}{\frac{2-4\alpha}{b}} + \frac{\alpha(d_{B}-\hat{c}_{B})(2-4\alpha)}{(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)} + \frac{\alpha(d_{B}-\hat{c}_{B})\frac{(2-4\alpha)(2-4\alpha)}{(1-4\alpha)(1-4\alpha)(1-4\alpha)}}{(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)} + \frac{\alpha(d_{B}-\hat{c}_{B})\frac{(2-4\alpha)(2-4\alpha)(1-4\alpha)}{2(1-4\alpha)(1-4\alpha)(1-4\alpha)(1-4\alpha)}}{(2-4\alpha)(1-4$$

A pairwise comparison of the summands *a* with *c* and *b* with *d* shows that a < c and b < d. Thus, the expression in the first line is always smaller than the expression in the last line.

# C. Proofs of section 4

# C.1. Application of benchmarking

By definition, sales-based benchmarking applies to centralized production only. Further, benchmarking is never (strictly) binding in both countries simultaneously. Assume the opposite, i.e.,  $\Pi_A^{rep} < \epsilon_A \frac{p_A s_A}{p_A s_A + p_B s_B} (\Pi_A^{rep} + \Pi_B^{rep})$  and  $\Pi_B^{rep} < \epsilon_B \frac{p_B s_B}{p_A s_A + p_B s_B} (\Pi_A^{rep} + \Pi_B^{rep})$ . Summing up delivers:

$$\Pi_{A}^{rep} + \Pi_{B}^{rep} < \left[\frac{\varepsilon_{A}p_{A}s_{A} + \varepsilon_{B}p_{B}s_{B}}{p_{A}s_{A} + p_{B}s_{B}}\right] \left[\Pi_{A}^{rep} + \Pi_{B}^{rep}\right]$$
(46)

Exploiting  $\frac{p_B s_B}{p_A s_A + p_B s_B} = 1 - \frac{p_A s_A}{p_A s_A + p_B s_B}$  yields:

$$1 < \frac{p_A s_A}{p_A s_A + p_B s_B} \varepsilon_A + \left(1 - \frac{p_A s_A}{p_A s_A + p_B s_B}\right) \varepsilon_B \tag{47}$$

The condition is never fulfilled for  $\varepsilon_i \leq 1$ .

#### C.2. Sales-based benchmarking for traditional products (Proof of Lemma 1)

The proof is presented for 1.)  $\tau_A > \tau_B$  and 2.)  $\tau_A < \tau_B$ . In both cases we proceed in three steps:

- a) Check whether optimal solutions from the corporate tax regime remain valid.
- b) As the transfer price under corporate taxation is set such that profits are shifted to the low-tax country, only the high-tax country would apply benchmarking. If necessary, apply the benchmarking in the high-tax country and check the implicit transfer price.
- c) If the implicit transfer price is out of bounds, restrict the solution following fromb) by choosing the most favorable transfer price within the allowed interval fromthe perspective of the high-tax country.
- 1. Assume  $\tau_A > \tau_B$ . Then, the optimal transfer price under corporate taxation is  $t^* = c_A$ , see (6) and optimal sales quantities are  $s_i^* = \frac{d_i \hat{c}_i}{2}$ , see (3).
  - a) Check if optimal solution is valid.

The reported profit in country *A* equals:

$$\Pi_A^{rep} = \left(\frac{d_A - c_A}{2}\right)^2 + 0 \, \frac{d_B - c_B}{2} = \frac{(d_A - c_A)^2}{4} \tag{48}$$

Calculating the benchmark according to (20) gives:

$$TB_{A} = \varepsilon_{A} \frac{\left(d_{A}^{2} - c_{A}^{2}\right) \left[\left(d_{A} - c_{A}\right)^{2} + \left(d_{B} - c_{A} - c_{T}\right)^{2}\right]}{4 \left[d_{A}^{2} + d_{B}^{2} - c_{A}^{2} - \left(c_{A}^{2} + c_{T}^{2}\right)\right]}$$
(49)

With  $\hat{c_B} = c_A + c_T$ , comparing (48) and (49) we find that  $\Pi_A^{rep}$  falls short of

the benchmark  $TB_A$  if:

$$\varepsilon_{A} > \frac{(d_{A} - c_{A}) \left[ d_{A}^{2} - c_{A}^{2} + d_{B}^{2} - \widehat{c_{B}}^{2} \right]}{(d_{A} + c_{A}) \left[ (d_{A} - c_{A})^{2} + (d_{B} - \widehat{c_{B}})^{2} \right]} = \widehat{\varepsilon_{A}}$$
(50)

Observe that requiring the right side of (50) to be smaller than one means  $d_B > d_A \left(1 + \frac{c_T}{c_A}\right)$ . If (50) does not hold true, the optimal solution from corporate taxation remains valid. Otherwise go to step b).

b) If necessary, apply benchmarking.

Given that country A applies benchmarking, the after-tax profit becomes:

$$\Pi = (d_A - s_A - c_A)s_A + (t - c_A)s_B - \varepsilon_A \frac{(d_A - s_A)s_A}{(d_A - s_A)s_A + (d_B - s_B)s_B}\tau_A \cdot [(d_A - s_A - c_A)s_A + (d_B - s_B - c_A - c_T)s_B] + (d_B - s_B - t - c_T)s_B(1 - \tau_B)$$
(51)

The first derivative with regard to the transfer price *t* yields:

$$\frac{\delta \Pi}{\delta t} = s_B \tau_B > 0 \tag{52}$$

Find the transfer price  $t^*$  that equals the reported profit  $\Pi_A^{rep}$  to the benchmark  $TB_A$ :

$$(p_{A} - c_{A}) s_{A}^{*} + (t^{*} - c_{A}) s_{B}^{*} = \varepsilon_{A} \frac{p_{A} s_{A}^{*}}{p_{A} s_{A}^{*} + p_{B} s_{B}^{*}} \left[ \sum_{i} (p_{i} - \hat{c}_{i}) s_{i}^{*} \right]$$
(53)  
$$\Leftrightarrow t^{*} = c_{A} \left( 1 + \frac{s_{A}^{*}}{s_{B}^{*}} \right) - \left[ c_{A} \left( 1 + \frac{s_{A}^{*}}{s_{B}^{*}} \right) + c_{T} \right] \varepsilon_{A} \frac{p_{A} s_{A}^{*}}{p_{A} s_{A}^{*} + p_{B} s_{B}^{*}} - \frac{p_{A} s_{A}^{*}}{s_{B}^{*}} (1 - \varepsilon_{A})$$

Observe that the optimal sales quantities are typically adjusted as well. According to (47) country *B* accepts the reported profit basing on  $t^*$  as long as  $\varepsilon_i \leq 1$ .

c) Check if the resulting transfer price is out of bounds.

For the transfer price  $t^*$  from above  $t^* < \overline{t} = p_B - c_T$  always holds true:

$$(p_{A} - c_{A}) s_{A}^{*} + (p_{B} - c_{T} - c_{A}) s_{B}^{*} > \varepsilon_{A} \frac{p_{A} s_{A}^{*}}{p_{A} s_{A}^{*} + p_{B} s_{B}^{*}} (\Pi_{A}^{rep} + \Pi_{B}^{rep})$$
with  $(\Pi_{A}^{rep} + \Pi_{B}^{rep}) = [(p_{A} - c_{A}) s_{A}^{*} + (p_{B} - c_{T} - c_{A}) s_{B}^{*}]$ 
(54)

As (54) reveals, applying the upper limit transfer price guarantees that the tax base in A always exceeds the profit resulting from benchmarking.

- 2. If  $\tau_A < \tau_B$ , the optimal transfer price under corporate income taxation is  $t^* = p_B c_T$  and optimal sales quantities are  $s_A^* = \frac{1}{2}(d_A c_A)$  and  $s_B^* = \frac{1}{2}(d_B c_A c_T)$ . We follow the same procedure as for  $\tau_A > \tau_B$ .
  - a) Check if optimal solution from corporate taxation is valid.

Under corporate taxation, the reported profit in country *B* equals

$$\Pi_{B} = \left(d_{B} - \frac{1}{2}\left(d_{B} - c_{A} - c_{T}\right)\right)\frac{1}{2}\left(d_{B} - c_{A} - c_{T}\right)$$
$$- \left(d_{B} - \frac{1}{2}\left(d_{B} - c_{A} - c_{T}\right) - c_{T}\right)\frac{1}{2}\left(d_{B} - c_{A} - c_{T}\right)$$
(55)
$$- c_{T}\frac{1}{2}\left(d_{B} - c_{A} - c_{T}\right) = 0$$

Consequently, the formula always becomes binding.

b) Apply benchmarking.

Assume the sales-based formula is applied unilaterally in country *B*. Then, the following profit function holds:

$$\Pi = \left[ (d_A - s_A) s_A + t s_B - c_A (s_A + s_B) \right] (1 - \tau_A) + \left[ (d_B - s_B) s_B - t s_B - c_T s_B \right] - \varepsilon_B \frac{(d_B - s_B) s_B}{(d_A - s_A) s_A + (d_B - s_B) s_B} \tau_B \left( \Pi_A^{rep} + \Pi_B^{rep} \right)$$
(56)

The first derivative with regard to the transfer price *t* yields

$$\frac{\delta\Pi}{\delta t} = -s_B \tau_A \tag{57}$$

The profit of the *MNE* strictly decreases in the transfer price *t* as long as the sales-based formula is unilaterally applied in country *B*.

The transfer price  $t^*$  that equals the reported profit  $\Pi_B^{rep}$  to the benchmark  $TB_B$  is:

$$(p_B - t^* - c_T) s_B^* = \varepsilon_B \frac{p_B s_B^*}{p_A s_A^* + p_B s_B^*} [(p_A - c_A) s_A^* + (p_B - c_T - c_A) s_B^*]$$
  

$$\Leftrightarrow t^* = \left(c_A \left(1 + \frac{s_A^*}{s_B^*}\right) + c_T\right) \epsilon_B \frac{p_B s_B^*}{p_A s_A^* + p_B s_B^*} + p_B (1 - \epsilon_B) - c_T \quad (58)$$

As shown in (47), the sales-based formula is never applied in both countries simultaneously as long as  $\varepsilon_i < 1$ . Thus, country *A* accepts the reported profit based on a transfer price  $t^*$ .

- c) Check if resulting transfer price is out of bounds.
  - i) One potential optimum could be  $t = c_A$ , which country *B* always accepts as it is the most favorable transfer price from its perspective. Since the closed form solutions for the optimal sales quantities resulting under sales-based benchmarking are intricate we first compute a lower bound of  $\epsilon_B$  applying the optimal sales quantities under corporate taxation. The formula (20) would allocate a higher profit to country *B* than a reported profit with  $t = c_A$ ,  $s_A^* = \frac{1}{2} (d_A c_A)$  and  $s_B^* = \frac{1}{2} (d_B c_A c_T)$  iff

$$\frac{1}{4} (d_{B} - \hat{c}_{B})^{2} < \frac{1}{4} \varepsilon_{B} \frac{\left[d_{B}^{2} - \hat{c}_{B}^{2}\right] \left[(d_{A} - c_{A})^{2} + (d_{B} - \hat{c}_{B})^{2}\right]}{d_{A}^{2} + d_{B}^{2} - c_{A}^{2} - \hat{c}_{B}^{2}} 
\Leftrightarrow \varepsilon_{B} > \frac{(d_{B} - \hat{c}_{B})^{2} \left[d_{A}^{2} + d_{B}^{2} - c_{A}^{2} - \hat{c}_{B}^{2}\right]}{\left[d_{B}^{2} - \hat{c}_{B}^{2}\right] \left[(d_{A} - c_{A})^{2} + (d_{B} - \hat{c}_{B})^{2}\right]} = \hat{\varepsilon}_{B}$$
(59)

Observe that requiring the right side of (59) to be smaller than one means  $d_B < d_A \left(1 + \frac{c_T}{c_A}\right)$ .

ii) For  $\varepsilon_B \leq \widehat{\varepsilon_B}$  the transfer price from (58) with  $t^* \in ]c_A, p_B - c_T[$  delivers a profit matching the formula in country *B*.

#### C.3. Sales-based benchmarking for network products (Proof of Lemma 2)

The proof is presented for 1.)  $\tau_A > \tau_B$  and 2.)  $\tau_A < \tau_B$ . It follows the same three-step procedure as in C.2.

1. Assume  $\tau_A > \tau_B$ : Then, the optimal transfer price under corporate income taxation is  $t^* = c_A$  and optimal sales quantities for  $s_i^*$  follow from (14).

a) Check if optimal solution is valid.

The reported profit in country *A* equals:

$$\Pi_A^{rep} = s_A^* \left[ d_A - s_A^* + \alpha (s_A^* + s_B^*) \right] - c_A s_A^* \tag{60}$$

An application of the sales formula (20) leads to the following profit being allocated to country *A*:

$$TB_{A} = \varepsilon_{A} \frac{s_{A}^{*} \left[ d_{A} - s_{A}^{*} + \alpha (s_{A}^{*} + s_{B}^{*}) \right]}{s_{A} \left[ d_{A} - s_{A}^{*} + \alpha (s_{A}^{*} + s_{B}^{*}) \right] + s_{B} \left[ d_{B} - s_{B}^{*} + \alpha (s_{A}^{*} + s_{B}^{*}) \right]} \left( \Pi_{A}^{rep} + \Pi_{B}^{rep} \right)$$
(61)

The reported profit (60) is lower than the profit according to the formula (61) if  $\varepsilon_A > \widehat{\varepsilon_A^{net}}$ .<sup>28</sup> For  $\varepsilon_A \leq \widehat{\varepsilon_A^{net}}$ , results from the corporate tax regime remain unchanged.

b) If necessary, apply benchmarking.

Assume the sales-based formula is applied unilaterally in country *A*. Then, the following profit function holds:

$$\Pi = [d_A - s_A + \alpha(s_A + s_B)] s_A + ts_B - c_A (s_A + s_B) - \varepsilon_A \frac{[d_A - s_A + \alpha(s_A + s_B)] s_A}{[d_A - s_A + \alpha(s_A + s_B)] s_A + (d_B - s_B + \alpha(s_A + s_B)) s_B} \tau_A \cdot (\Pi_A^{rep} + \Pi_B^{rep}) + [(d_B - s_B) s_B - ts_B - c_T s_B] (1 - \tau_B)$$
(62)

The first derivative with regard to the transfer price *t* yields

$$\frac{\delta \Pi}{\delta t} = s_B \tau_B \tag{63}$$

Thus, the after-tax profit of the *MNE* strictly increases in the transfer price t as long as a sales-based profit allocation is unilaterally applied in country A. Finding the transfer price  $t^*$  that equals the reported profit  $\Pi_A^{rep}$  to the benchmark  $TB_A$  delivers the same expression as in (53). Observe that the optimal sales quantities are typically adjusted as well. According to (47) country B accepts the reported profit basing on  $t^*$  as long as  $\varepsilon_i \leq 1$ .

<sup>&</sup>lt;sup>28</sup>Formulas have been explicitly calculated. For the sake of readability we do not present them here.

c) Check if the resulting transfer price is out of bounds.

As shown in (54), the resulting transfer price  $t^*$  is never out of bounds.

- 2. If  $\tau_A < \tau_B$ , the optimal transfer price under corporate income taxation is  $t^* = p_B c_T$  and optimal sales quantities are given by (13).
  - a) Check if optimal solution is valid. As the reported profit in country *B* equals zero under corporate income taxation the formula becomes always binding.
  - b) Apply benchmarking.

Assume the sales-based formula is applied unilaterally in country *B*. Then, the following profit function holds:

$$\Pi = \{ [d_A - s_A + \alpha(s_A + s_B)] s_A + ts_B - c_A (s_A + s_B) \} (1 - \tau_A) + \{ [d_B - s_B + \alpha(s_A + s_B)] s_B - ts_B - c_T s_B \} - \varepsilon_B \frac{[d_B - s_B + \alpha(s_A + s_B)] s_B}{[d_A - s_A + \alpha(s_A + s_B)] s_A + [d_B - s_B + \alpha(s_A + s_B)] s_B} \tau_B (\Pi_A^{rep} + \Pi_B^{rep})$$
(64)

The first derivative with regard to the transfer price *t* yields

$$\frac{\delta\Pi}{\delta t} = -s_B \tau_A \tag{65}$$

The profit of the MNE strictly decreases in the transfer price t as long as the sales-based formula is unilaterally applied in country B.

The transfer price  $t^*$  that equals the reported profit  $\Pi_B^{rep}$  to the benchmark  $TB_B$  is determined according to (58). As shown in (47), the sales-based formula is never applied in both countries simultaneously as long as  $\varepsilon_i < 1$ . Thus, country *A* accepts the reported profit based on a transfer price  $t^*$ .

- c) Check if resulting transfer price is out of bounds.
  - i) One potential optimum could be  $t = c_A$ , which country *B* always accepts as it is the most favorable transfer price from its perspective. (36) to (38) show that for  $t = c_A$  optimal sales quantities  $s_i^*$  are determined according to (38). The formula according to (20) would allocate a higher profit to country *B* than a reported profit with  $t = c_A$  and optimal sales quantities according to (38) if  $\varepsilon_B > \widehat{\varepsilon_B^{net}}$ .<sup>29</sup>  $\widehat{\varepsilon_B^{net}}$  represents a lower bound for the

<sup>&</sup>lt;sup>29</sup>Formulas have been explicitly calculated and are not displayed for ease of presentation.

actual threshold  $\widehat{\epsilon_B^{net}}$  as sales quantities of network products are typically adjusted as well under sales-based benchmarking. Figure (4), Panel B, illustrates that parameter settings with  $\widehat{\epsilon_B^{net}} < 1$  exist.

ii) For  $\varepsilon_B \leq \widehat{\varepsilon_B^{net}}$ , the optimal transfer price  $t^*$  according to 2.b) with  $t^* \in ]c_A, p_B - c_T[$  delivers a profit matching the formula in country *B*.

As Figure (4) illustrates that the development of  $s_A^*$  and  $s_B^*$  is ambiguous compared to the corporate tax regime depending on the parameter setting; this provides a proof of existence.

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