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Diskussionsbeitrag Nr. B-29-17

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Do Tax Information Exchange Agreements Curb Transfer Pricing-Induced Tax Avoidance?*

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March, 2017

Abstract

We propose a game theoretical model where a multinational company with divisions in two countries and the respective tax authorities interact with each other. Prior to an audit the functional profile of the divisions is unknown to the tax authorities. In equilibrium, tax avoidance emerges in both countries. It turns out that the audit pressure is highest for firms with a hybrid functional profile, dampening their production and reducing their after-tax profit.

We find that introducing a bilateral Tax Information Exchange Agreement reduces tax avoidance by aggressive transfer pricing in the high-tax ("domestic") country and precludes tax avoidance in the low-tax ("foreign") country. The volume of production increases. The foreign tax authority discontinues its audit activities, while the domestic tax

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authority audits less often at least if the foreign division is a toll manufacturer ("routine function"). While the expected net tax revenues increase in the foreign country, they may decrease in the domestic country.

Keywords: transfer pricing, tax evasion, cooperation
JEL classification: H26, F23, K34

1 Introduction

Western high-tax countries are confronted with tax losses due to multinational companies shifting their profits into low-tax countries. Popularized as "base erosion and profit shifting" (BEPS), this process has led to institutional counteractions, the most prominent one being the OECD's "Action Plan on Base Erosion and Profit Shifting". International co-operation through exchange of information is thought to be a key measure to address harmful tax practices. In 2015 the OECD Committee on Fiscal Affairs approved a Model Protocol to the existing Model Agreement on Exchange of Information in Tax Matters (Model TIEA) which allows for implementing an automatic exchange of information. But do both countries indeed benefit from a bilateral TIEA? What is the impact on multinational companies? In the light of present efforts to curb profit shifting by concluding TIEAs, providing answers to these questions is imperative. For example, if a TIEA between a high-tax country A and a low-tax country B is concluded to prevent profit shifting from A to B, one might suspect that country B would not be interested in concluding the TIEA. Surprisingly, our model suggests the opposite: the low-tax country always benefits from a TIEA whereas under certain circumstances, it is the high-tax country that suffers tax losses due to shrinking production by the multinational. This shows that—due to the strategic interaction taking place—the effects of a TIEA are not straightforward but rather deserve careful analysis.

Since transfer pricing is one of the main instruments for multinational companies to shift their profits to countries with low tax rates, we examine the effects of a bilateral TIEA which implements an automatic information exchange of transfer price reports between a high-tax country and a low-tax country.

The original purpose of transfer prices is to incentivize decentralized subdivisions to run their business in an appropriate way rather than to avoid taxes. There is a major stream of literature on these "internal" transfer prices in both accounting and economics research. Hirshleifer (1956) derives the basic result that in the absence of taxes, the internal transfer price should equal the marginal cost of production. Baldenius, Melumad, and Reichelstein (2004) show that if taxes are taken into consideration, a goal-congruent internal transfer price should exceed (be lower than) the marginal cost of production if the maximum allowable tax transfer price is higher (lower) than the marginal costs. There is also ample literature on whether multinationals should keep one or two sets of books (i. e., whether or not they keep different transfer prices for internal incentive purposes and tax purposes).[1]

If transfer prices are part of the tax base, companies may benefit from a tax base differential between countries. Then, they have an incentive to modify transfer prices such as to reduce tax payments. As a basic result, Horst (1971) shows that multinationals would then choose either the highest or the lowest possible price. Subsequent literature includes concealment costs for deviating from the arm's length price (e. g. Kant, 1988; Haufler & Schjelderup, 2000). Baumann and Friehe (2013) consider that multinationals may take into account differences in tax enforcement across countries. Thus, they introduce "effective tax rates", balancing nominal tax rates with the applicable extent of tax enforcement. As a result, effective tax rates may differ across countries even if the nominal tax rates are identical. Eventually, profit shifting may occur even if there is no tax rate differential. Moreover, Baumann and Friehe (2013) find that multinationals may even shift profits into countries with *higher* nominal tax rates if their tax enforcement regime is sufficiently weak. In a situation with two sets of books, Choe and Hyde (2007) examine the relationship between internal and external (tax) transfer prices in the presence of an exogenous penalty. They find that the goal-congruent incentive transfer price is increased to account for the marginal effect of a penalty for tax evasion.

In fact, the probability of an audit by both the domestic and the foreign tax authority may be subject to strategic considerations. Multinational companies, in turn, may anticipate the probability of an audit by the tax authorities and choose their tax transfer price, internal transfer price, and quantity of production accordingly. Existing literature focuses on situations in which the participating countries directly set the tax rates or transfer pricing regulations. Elitzur and Mintz (1996) provide a model with four players: a multinational, a manager of the multinational's foreign subsidiary, and a domestic and a foreign

[1] See, e. g., Hyde and Choe (2005); Dürr and Göx (2011).

country. Given equilibrium choices of the multinational and the manager, the authors construct a Nash equilibrium of effective tax rates chosen by the two (revenue-maximizing) countries. They focus on effective tax rates, which—in their model—can be derived by taking into account nominal tax rates and transfer pricing regulations. By contrast, in the model of Mansori and Weichenrieder (2001) tax rates and transfer pricing regulations are not perfect substitutes. Also, they argue that it may be easier for governments to change transfer pricing rules than to alter tax rates. As a main finding, Mansori and Weichenrieder (2001) state that two competing governments will set transfer pricing regulations such that the multinational's profits are taxed twice. Møller and Scharf (2002) propose a model where a domestic company maintains a subsidiary in a foreign country and sells products on a perfectly competitive market there. Again, the two governments compete by setting transfer price regulations. They find that a "race to the top" in transfer price regulation emerges. Coordination between the governments—e. g., applying the arm's length standard—may not be pareto-improving. De Waegenaere, Sansing, and Wielhouwer (2007) examine how taxable income is allocated across two countries. Their game theoretical model involves three parties: a domestic country, a foreign country, and the taxpayer. The tax authorities also have to perform an audit to enforce their legitimate tax claims. However, De Waegenaere et al. (2007) focus on whether an advance pricing agreement is feasible and if so under what circumstances. Further, they do not take into account quantity reactions. Becker and Davies (2014) suggest that the multinational's transfer price report is audited and may be changed by the high-tax country; subsequently, the low-tax country can challenge the high-tax country's decision and enter into costly negotiations. As a part of an equlibrium, the transfer price depends on the bargaining power of the high-tax country. For reasons of simplification, Becker and Davies (2014) choose a model in which the quantity of production is not affected by the transfer price.

Summing up, there is ample literature on the effect of *endogenous* concealment costs; also, many papers deal with the strategic interaction between governments regarding the determination of the transfer price itself. TIEAs heavily affect the tax authorities' audit scope. However, we are not aware of a model that assumes that governments use audit probabilities as strategic variables. To account for this strategic component we set up a game between a multinational company and two countries of residence, referred to henceforth as "domestic" and "foreign". We assume that prior to an audit, the tax authorities are not aware of the arm's length price of the multinational's product. However, they have beliefs with commonly known probability distributions.[2] In a basic setting we assume that there is no information exchange between the two tax authorities. We construct a Nash equilibrium which consists of the multinational choosing a pure strategy (the number of units produced and the reported tax transfer price) and the tax authorities choosing mixed strategies (i. e., particular audit probabilities that depend on the reported tax transfer price). We then extend the model to include a TIEA between the two tax authorities, implying that both tax authorities automatically share all the information they have prior to an audit, namely, the reported transfer price.

The paper proceeds as follows. The basic model is outlined in Section 2. In Section 3 we alter the model by introducing a Tax Information Exchange Agreement. In Section 4 we elaborate on the effects of the TIEA, while Section 5 closes with a brief summary.

2 Basic Model

The notation closely follows Baldenius et al. (2004) and Choe and Hyde (2007). A foreign division produces an intermediary product of quantity q at constant marginal costs of production c which is sold in the domestic country.[3] The domestic division earns $R(q)$. The tax rate in the foreign country is given by τ_f whereas the tax rate in the domestic country is denoted by τ_d. Throughout this article we assume that $\tau_d > \tau_f$.

Further, we assume that the multinational is aware of the (certain) true arm's length transfer price[4] in the domestic and the foreign jurisdiction.[5] However,

[2] These probability distributions reflect the different transfer price regulations in both countries; see Section 2.

[3] If the foreign division also sells intermediary products of quantity q_f in the foreign market, earning $R_f(q_f)$, the optimal quantity q_f^* would be determined by the condition $R_f'(q_f) = c$. The optimal internal or tax transfer prices would not be affected (Choe & Hyde, 2007). Thus, in order to keep the notation simple, we ignore this case in the following analysis.

[4] Below, the terms "arm's length price" or "true transfer price" are used to describe the true arm's length transfer price according to the functional profile and in compliance with the law. By contrast, the term "reported transfer price" captures the number that is chosen by the multinational.

[5] Without loss of generality, we abstract from the fact that in reality there may be an interval of accepted transfer prices rather than a single true transfer price in order not to confuse the investigation. If there were a range of feasible transfer prices, the multinational would

the tax authorities are not able to determine the true transfer price of a given product just by looking at its obvious features. The have to conduct a costly in-depth audit of the functional analysis, i. e., they have to examine the functions performed, risks assumed, and assets used by the different (producing or selling) units, which define the level of the arm's length transfer price. The exact same product can be assigned two different true transfer prices depending on how much risk is involved in producing or selling it. Assume a product that is produced by one unit in the foreign country and sold by another unit in the domestic country. Two contrasting scenarios are imaginable. First, the product was developed in the domestic country, all the risks are assumed there, and the unit in the foreign country acts as a mere toll manufacturer. Second, the product was developed in the foreign country and the unit in the domestic country is only a distribution company. In the latter case the true transfer price takes a value near the upper bound of possible transfer prices (sales price), while in the first case it takes a value near the lower bound (production cost). While these very boundaries are observable simply by looking at the product, the concrete (true) transfer price can only be determined by performing a costly audit of the function analysis. The true arm's length prices are denoted by p; they are distributed on the interval $[\underline{p}, \overline{p}]$ according to the probability density function $f(p)$ in the domestic country and according to the probability density function $g(p)$ in the foreign country. The different distributions correspond to different transfer pricing rules in the respective countries. As detailed above, we assume that the tax authorities are informed of these distributions including the boundaries. In accordance with common transfer price regulations we assume that $\underline{p} \geq c$. Low arm's length prices which are located close to $\underline{p}$ are given if the foreign division has a routine function; they are typically a result of cost-based pricing rules. By contrast, high arm's length prices close to $\overline{p}$—typically generated by a resale price minus method—apply if the foreign division has an entrepreneurial function, leaving the domestic division with a routine function

always report at the upper or lower boundary (see also Baldenius et al., 2004). Namely, the multinational would report at the upper boundary in the domestic country and at the lower boundary in the foreign country. Hence, even if behaving honestly, the multinational's reported transfer prices in the domestic and the foreign country would differ. At first sight, this could be an issue in Section 3, where we assume that TIEA forces the multinational to report the same transfer price. If the measure of the interval is common knowledge, however, both tax authorities could easily verify whether the multinational's report is plausible even if they observe divergent transfer prices. See also footnote 12.

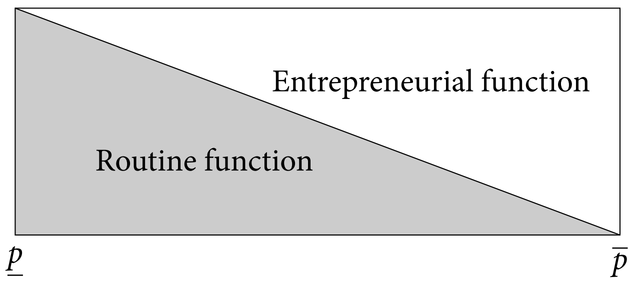

FIGURE 2.1: *Functional analysis of the foreign division: a high (low) degree of entrepreneurship determines an arm's length price close to $\overline{p}$ ($\underline{p}$). The arm's length price lies midway if the foreign division exhibits routine as well as entrepreneurial functions. The figure applies vice versa for the domestic division.*

(e. g., distribution unit). Consequently, intermediate p-values point to a hybrid functional profile of both divisions (see Figure 2.1).

The firm's reported transfer price in the domestic country is given by t_d, whereas in the foreign country the firm reports t_f. That is, in contrast to prior literature,[6] we assume that the multinational reports different tax transfer prices in the respective jurisdictions. The internal incentive transfer price is denoted by s.

The domestic tax authority audits with probability $a(t_d)$. Since $\tau_d > \tau_f$, the multinational's headquarters has an incentive to report a high transfer price t_d in order to shift profits to the foreign low-tax country. In order to avoid taxes in the foreign country, in turn, the multinational wants to report a low transfer price t_f, facing an audit probability $\alpha(t_f)$. If tax avoidance is detected, we assume the penalty to be linear, that is, θ (domestic country) or ϖ (foreign country) times the underpaid tax (Yitzhaki, 1974).[7] Following Choe and Hyde (2007) we assume that the subsequent payment of taxes including penalties is

[6] E. g., Baldenius et al. (2004), Choe and Hyde (2007).

[7] We introduce a penalty for the sake of generality; in many countries, reported transfer prices which differ from the respective arm's length prices are simply corrected by the tax authorities without incurring a further penalty. This can be captured by setting θ and/or ϖ to zero; our results do not change qualitatively in these cases. Even if there is no penalty, the correction may take place several years after the initial transaction. Then, θ and ϖ can be interpreted as interest rates.

divided between the domestic division and the multinational's headquarters, with headquarters' bargaining power denoted by ν, $\nu \in [0, 1]$. $\nu = 1$ indicates that the domestic division has to bear the total subsequent payment whereas $\nu = 0$ implies that headquarters bears the full amount. As described above, in our model tax avoidance may emerge in the foreign country too. The foreign division, however, is in control of neither q nor t_f. Thus, it is not necessary to make the foreign division bear a share of possible subsequent payments.

The foreign division's after-tax profit is given by

$$\Pi_f = (s - c)q - \tau_f(t_f - c)q \tag{1}$$

and the domestic division's after-tax profit is given by

$$\Pi_d = (1 - \tau_d)R(q) - sq + \tau_d t_d q - \nu a(t_d)\theta\tau_d(t_d - p)q. \tag{2}$$

Note that the structure of the penalty component is very important to our analysis. Choe and Hyde (2007) represent the expected penalty by an exogenously given convex function which takes underpaid tax as the only argument. As they are not interested in the strategic relationship between multinational and tax authority, they abstract from the fact that a penalty only arises after an audit has taken place. Here, we specify the expected penalty component as detection probability times the penalty due, where the detection probability (audit function) is determined endogenously.

Finally, the multinational's total after-tax income is given by

$$\begin{aligned}\Pi = R(q) - cq - \tau_d\left(R(q) - qt_d\right) - \tau_f\left(t_f - c\right)q \\ - a(t_d)\theta q\tau_d\left(t_d - p\right) - \alpha(t_f)q\varpi\tau_f\left(p - t_f\right).\end{aligned} \tag{3}$$

Figure 2.2 depicts the timing of the game. First, the multinational's headquarters sets the incentive transfer price.[8] The domestic division then decides about the quantity to be sold in the domestic market. By choosing an adequate incentive transfer price, headquarters can *de facto* determine the quantity of production. The determination of the optimal quantity is referred to as *stage one*. We assume

[8] We assume that the tax authority is not informed about the internal transfer price at this stage.

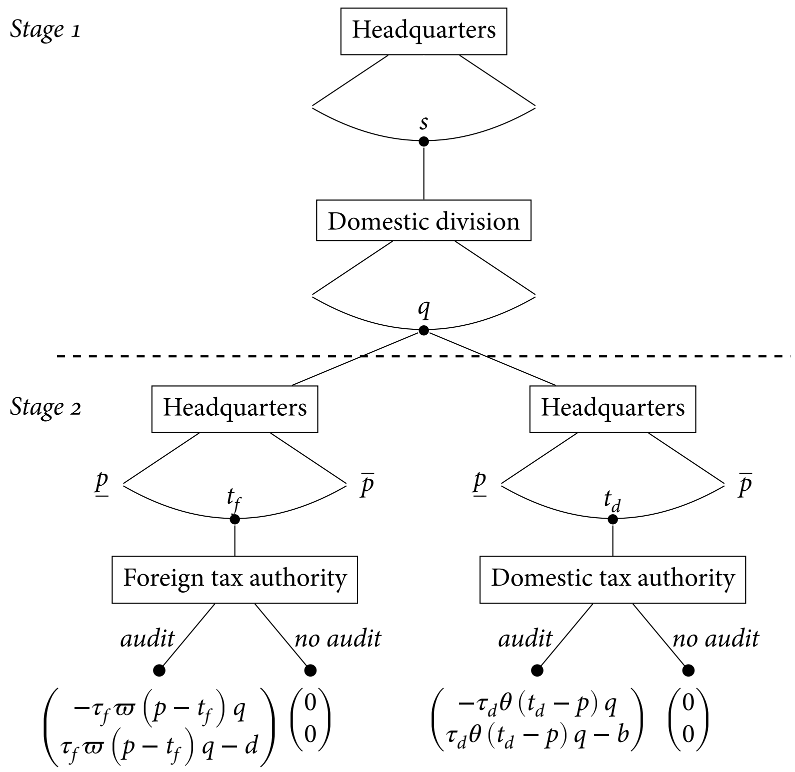

FIGURE 2.2: *Timing of the game. For clarity, we only depict the "excess payoffs" that are directly determined by the tax authorities' audit decisions.*

that the quantity is publicly observable once a decision has been made.[9] Second, headquarters sets the tax transfer price and both tax authorities decide whether or not to audit. This process is referred to as *stage two.* Any penalties are divided between the domestic division and headquarters according to v.

The game is solved via backwards induction. In the second stage of the game, the multinational and both tax authorities strategically determine tax transfer prices t_d, t_f and the audit functions $a(t_d), \alpha(t_f)$, depending on the quantity q, respectively. Headquarters' first-order conditions with respect to

[9]For example, the tax authorities can observe the quantity through VAT returns. Since VAT returns are to be submitted on a monthly basis, tax authorities should be aware of the quantity prior to a potential audit. Even more easily, the quantity can be learned from the multinational's profit and loss statement.

profit-maximizing tax transfer prices in the domestic and the foreign country are given by:

$$\frac{\partial \Pi}{\partial t_d} = -q\theta\tau_d \left(t_d - p\right) a'\left(t_d\right) - q\theta\tau_d a\left(t_d\right) + q\tau_d = 0, \tag{4}$$
$$\frac{\partial \Pi}{\partial t_f} = -q\omega\tau_f \left(p - t_f\right) \alpha'\left(t_f\right) + q\omega\tau_f \alpha\left(t_f\right) - q\tau_f = 0. \tag{5}$$

The domestic tax authority's expected tax revenue net of audit costs is given by

$$\mathrm{E}(T_d) = \int_{\underline{t_d}}^{\overline{t_d}} \left(\tau_d(R(q) - t_d q) + a(t_d)\tau_d\theta(t_d - p)q - a(t_d)b\right) f_{t_d}(t_d)\, dt_d, \tag{6}$$

where $\underline{t_d}$ ($\overline{t_d}$) is the lowest (highest) transfer price report which can possibly occur in the domestic country, $f_{t_d}(\cdot)$ is the distribution of transfer price reports associated with the respective arms length prices, and b is the domestic tax authority's marginal audit cost. The foreign tax authority's expected net tax revenue is given by

$$\mathrm{E}(T_f) = \int_{\underline{t_f}}^{\overline{t_f}} \left(\tau_f q(t_f - c) + \alpha(t_f)\tau_f\varpi q(p - t_f) - \alpha(t_f)d\right) g_{t_f}(t_f)\, dt_f, \tag{7}$$

where—correspondingly to the domestic case—$\underline{t_f}$ and $\overline{t_f}$ are the lowest and highest feasible transfer price reports, respectively, $g_{t_f}(\cdot)$ is the induced distribution of transfer price reports, and d denotes the foreign tax authority's marginal audit cost. Both tax authorities need to choose an audit function that maximizes their respective net tax revenues. Depending on q, for any p, the following (pointwise) conditions must hold true:

$$\frac{\partial \mathrm{E}(T_d)}{\partial a(t_d)} = \left(\tau_d\theta(t_d - p)q - b\right) f_{t_d}(t_d) = 0 \Longleftrightarrow t_d = p + \frac{b}{\tau_d\theta q}, \tag{8}$$
$$\frac{\partial \mathrm{E}(T_f)}{\partial \alpha(t_f)} = \left(\varpi\tau_f q(p - t_f) - d\right) g_{t_f}(t_f) = 0 \Longleftrightarrow t_f = p - \frac{d}{\tau_f\varpi q}. \tag{9}$$

Conditions (8) and (9) determine the tax transfer prices reported in the domestic and the foreign country: headquarters chooses reports in such a way as to hold the tax authorities indifferent between auditing and not auditing. Inserting the arm's length prices as obtained from (8) and (9) into headquarters' first-order conditions (4) and (5), respectively, one obtains two differential equations which allow us to construct mixed-strategy audit functions for the domestic and the foreign tax authority. We obtain:

$$a(t_d) = \frac{1}{\theta}\left(1 - e^{1-\frac{\theta\tau_d q}{b}\left(t_d - \underline{p}\right)}\right), \tag{10}$$

$$\alpha(t_f) = \frac{1}{\varpi}\left(1 - e^{1-\frac{\varpi\tau_f q}{d}\left(\overline{p} - t_f\right)}\right). \tag{11}$$

The audit functions are determined using using the boundary conditions $a(\underline{t_d}) = 0$ and $\alpha(\overline{t_f}) = 0$, that is, the domestic tax authority will audit the lowest transfer price report which the multinational can possibly make with zero probability, whereas the foreign tax authority will audit the highest transfer price report which the multinational can possibly make with zero probability.[10] $\underline{t_d}$ and $\overline{t_f}$ are given by inserting $\underline{p}$ and $\overline{p}$ into (8) and (9), respectively. If the equilibrium tax transfer price reports are inserted into (10) and (11), both audit functions directly depend on p. Note that the tax authorities are aware of headquarters' calculus and can thus infer p from t_d or t_f. For notational convenience, we will write $a^* \equiv a(t_d^*)$ and $\alpha^* \equiv \alpha(t_f^*)$. Figure 2.3 depicts the audit functions depending on the arm's length price p.

The following lemma is straightforward and follows directly from inserting (8) and (9) into (10) and (11); it is useful for the later analysis.

Lemma 2.1 $a_q^* > 0, a_{qq}^* < 0, \alpha_q^* > 0, \alpha_{qq}^* < 0.$

Subscripts denote partial derivatives. Both tax authorities increase their audit efforts with increasing quantity, which is an intuitive result since both tax and penalty revenue depend on the amount of production whereas the audit cost

[10]See Reinganum and Wilde (1986), who construct the audit function in a tax evasion setting where individuals choose a certain income report depending on their actual income. In this case, the IRS audits the highest income report with zero probability. Audit functions of this kind are also used by Erard and Feinstein (1994) in the field of tax evasion and by Diller and Lorenz (2015), who examine the relationship between uncertainty and tax aggressiveness.

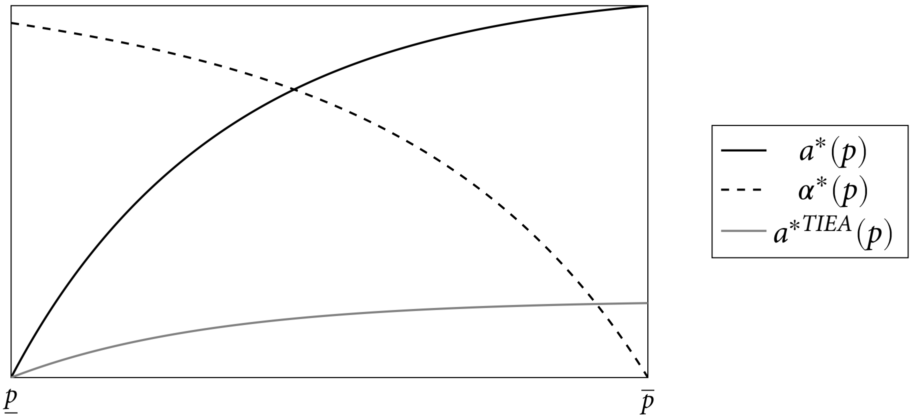

Figure 2.3: *Audit functions of the domestic and foreign tax authority depending on the arm's length price p. The gray line depicts the audit function for the TIEA setting (Section 3).*

is fixed. However, from (10) and (11) it becomes evident that an increasing quantity of production *reduces* the extent of profit shifting in both countries.

Given the equilibrium of the second stage of the game as determined by (8), (9), (10), and (11), the domestic division's problem in the first stage is to choose the quantity such as to maximize

$$\Pi_d\left(t_d^*, a^*\right) = (1-\tau_d)R(q) - sq + \tau_d pq - va^*b + \frac{b}{\theta}. \tag{12}$$

This produces the first-order condition

$$\frac{\partial \Pi_d\left(t_d^*, a^*\right)}{\partial q} = (1-\tau_d)\,R'(q) + p\tau_d - bva_q^* - s = 0. \tag{13}$$

Intuitively, the marginal after-tax revenue plus the marginal tax savings has to equate the marginal incentive transfer price plus the share of the marginal expected penalty. Headquarters, however, wants to choose the quantity such as to to maximize

$$\Pi\left(t_d^*, t_f^*, a^*, \alpha^*\right) = R(q) - cq - \tau_d\left(R(q) - qp\right) - \tau_f(p-c)q \\ - a^*b + \frac{b}{\theta} - \alpha^*d + \frac{d}{\omega}, \tag{14}$$

which produces the first-order condition

$$\frac{\partial\Pi\left(t_d^*, t_f^*, a^*, \alpha^*\right)}{\partial q} = R'(q) - c - \tau_d\left(R'(q) - p\right) - \tau_f(p-c) \\ - ba_q^* - d\alpha_q^* = 0. \tag{15}$$

Thus, in the first stage, headquarters sets the incentive transfer price such as to make the domestic division choose q according to its own first-order condition. The incentive transfer price that achieves goal congruence between the domestic division and headquarters is found by setting equal (13) and (15):[11]

$$s = (1-\tau_f)c + \tau_f p + (1-\nu)ba_q^* + d\alpha_q^*. \tag{16}$$

The last two terms of the optimal incentive transfer price account for the marginal penalty in both countries. As described by Choe and Hyde (2007) the domestic division would choose too high a quantity were it not responsible for potential costs of tax avoidance. To account for this effect, headquarters needs to increase the incentive transfer price in order to reach an overall optimal outcome. As for the marginal penalty in the domestic country, if the domestic division were to bear the whole penalty (i. e., $\nu = 1$), the multinational would not have to increase the incentive transfer price to prevent the domestic division from ordering too much. For $0 < \nu < 1$, headquarters will increase the incentive transfer price with a decreasing share of penalty borne by the domestic division. Now consider the marginal penalty for tax avoidance in the foreign country. Since the domestic division is not responsible for penalties charged by the foreign tax authority, headquarters has to increase the incentive transfer price to make the domestic division account for the whole share of the marginal penalty so the division is prevented from ordering too much.

[11] This procedure is well established in the literature, see, e. g., Hirshleifer (1956).

If headquarters sets a goal-congruent incentive transfer price, the optimal quantity q^* satisfies both (13) and (15). Headquarters' second-order condition for an optimal output is given by

$$-ba_{qq}^* - d\alpha_{qq}^* + (1-\tau_d)\,R''(q) \leq 0. \tag{17}$$

Proposition 2.2 *The optimal quantity is a U-shaped function of the arm's length price with* $\left.\frac{\partial q^*}{\partial p}\right|_{\underline{p}\leq p<\hat{p}} < 0$, $\left.\frac{\partial q^*}{\partial p}\right|_{p=\hat{p}} = 0$, *and* $\left.\frac{\partial q^*}{\partial p}\right|_{\hat{p}<p\leq\overline{p}} > 0$.

Proof Implicitly deriving (15) with respect to the arm's length price p delivers

$$\frac{\partial q^*}{\partial p} = \frac{\tau_d - \tau_f - ba_{qp}^* - d\alpha_{qp}^*}{ba_{qq}^* + d\alpha_{qq}^* - (1-\tau_d)\,R''}. \tag{18}$$

If the second-order condition (17) is fulfilled, the denominator is positive, yet the sign of the numerator is not distinct. It depends on the relationship between the tax rate differential and the sum of the cross partial derivatives of the audit functions. Taking the appropriate derivatives from (10) and (11), one obtains:

$$\operatorname{sgn}\left(a_{qp}^*\right) = \operatorname{sgn}\left(b - \theta\tau_d q(p-\underline{p})\right), \tag{19}$$

$$\operatorname{sgn}\left(\alpha_{qp}^*\right) = \operatorname{sgn}\left(-d + \varpi\tau_f q(\overline{p}-p)\right). \tag{20}$$

Setting $p = \underline{p}$, the numerator of (18) reduces to $-\tau_f - d\alpha_{qp}^*(\underline{p})$. As p increases, the signs of both a_{qp}^* and α_{qp}^* switch from positive to negative at some point. Consequently, there must exist $\hat{p}$ such that $\left.\frac{\partial q^*}{\partial p}\right|_{p=\hat{p}} = 0$. Thus, for rather high values of p equation (18) is positive and hence the quantity increases with an increasing arm's length price, whereas for low values of p the quantity *reduces* with an increasing arm's length price. ∎

Figure 2.4 depicts the course of q as p varies. The economic intuition is as follows: both very low and very high arm's length prices lead to the multinational being audited *de facto* in one country only (see Figure 2.3). Thus, because of lower marginal audit costs the multinational is induced to produce more in these areas of p. For moderate arm's length prices, however, the audit rates are significant in *both* countries, which curbs production. Interpreting the p-value as the degree of entrepreneurship of the foreign division, we can state that the

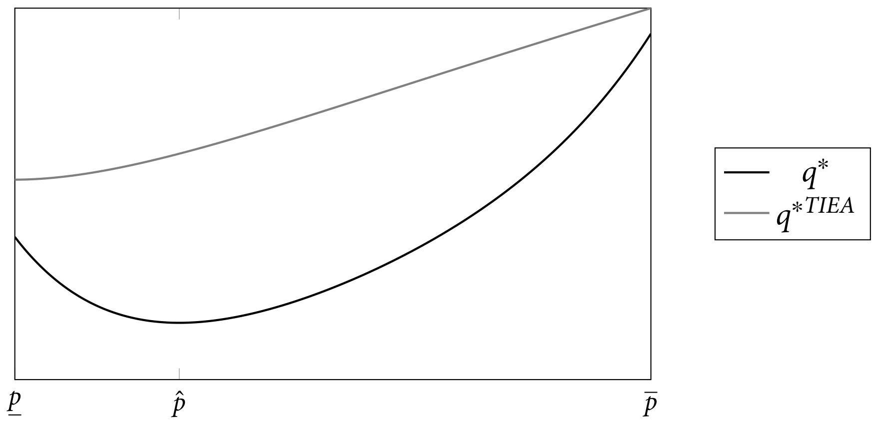

FIGURE 2.4: *Optimal quantity of output depending on the arm's length price p. The gray line depicts the optimal quantity for the TIEA setting (Section 3).*

quantity is high if the foreign division has either a routine or an entrepreneurial function, whereas the quantity is curbed if the foreign division has a hybrid functional profile.

The graph is asymmetric because of the tax rate differential. High (true) arm's length prices allow the multinational to shift more profits into the low-tax country regardless of potential penalties. Thus, the quantity is higher for $p \to \overline{p}$ than for $p \to \underline{p}$. In the numerator of (18), this effect is captured by the tax rate differential, which makes the derivative more positive.

Proposition 2.3 *The multinational's profit generated in equilibrium is a convex function of the true arm's length price with a minimum at $\check{p}$ that satisfies $\tau_d \theta a^*(\check{p}) = \tau_f \varpi \alpha^*(\check{p})$.*

Proof Define the value function $\Pi^*(p) \equiv \Pi\left(t_d^*, t_f^*, a^*, \alpha^*, q^* | p\right)$. Making use of the envelope theorem, the condition for an extremum $\frac{\partial \Pi^*}{\partial p} = 0$ delivers the equation stated in Proposition 2.3. Since $\frac{\partial a^*}{\partial p} > 0$ and $\frac{\partial \alpha^*}{\partial p} < 0$, there is a unique solution for $\check{p}$. Furthermore,

$$\left.\frac{\partial \Pi^*}{\partial p}\right|_{p=\underline{p}} = -\tau_f q^*(\underline{p}) \left(1 - e^{\frac{\omega \tau_f (\underline{p}-\overline{p}) q^*(\underline{p})}{d}}\right) < 0,$$

and,

$$\left.\frac{\partial \Pi^*}{\partial p}\right|_{p=\overline{p}} = \tau_d q(\overline{p}) \left(1 - e^{\frac{\theta \tau_d (\underline{p}-\overline{p}) q(\overline{p})}{b}}\right) > 0,$$

which proves Proposition 2.3. ■

The intuition for this result is the same as above: audit pressure is highest for divisions with a hybrid functional profile, which dampens profits. The condition for a profit minimum as stated in Proposition 2.3 implies profits are lowest if the audit probabilities weighted by tax and penalty rates in both jurisdictions are equal. To provide a more intuitive explanation, the condition can be rewritten as

$$\tau_d q^* + d\left(-\alpha^{*\prime}(\check{p})\right) = \tau_f q^* + b a^{*\prime}(\check{p}). \tag{21}$$

The left-hand side of equation (21) characterizes the tax savings in the domestic country (first term) and the decrease in expected penalty payments in the foreign country (second term) that come with a marginal increase of p. The right-hand side shows the additional tax payments in the foreign country (first term) and the increase in expected penalty payments in the domestic country (second term) that come with marginally increasing p. The firm's overall tax and penalty payment is *highest* (profits are lowest) if the marginal tax and penalty savings equate the marginal increase in tax and penalty payments.

3 Tax Information Exchange Agreement

In this section we assume that the two tax authorities share all information they have, that is, notably the respective transfer price reports. If a multinational reports different transfer prices $t_d \neq t_f$ in both jurisdictions, it is obvious that at least one of the reports is incorrect.[12] Thus, as part of an equilibrium, the tax authorities will certainly conduct an audit if the multinational reports different tax transfer prices. If the multinational is aware of the Tax Information Exchange Agreement (TIEA), consequently it will report a common tax transfer price $t_d = t_f = t$. If $\tau_d > \tau_f$ the multinational will report $t > p$ in order to shift profits to the low-tax country. The foreign tax authority anticipates this and consequently never audits. Given this setting, headquarters' problem in the second stage of the game consists of maximizing

$$\Pi = R(q) - cq - \tau_d \left(R(q) - qt\right) - \tau_f \left(t - c\right) q - a(t)\theta q \tau_d \left(t - p\right) \tag{22}$$

with respect to t, which delivers the first-order condition

$$\frac{\partial \Pi}{\partial t} = -\theta q \tau_d (t - p) a'(t) - \theta q a(t) \tau_d + q\tau_d - q\tau_f = 0. \tag{23}$$

The domestic tax authority's first-order condition is quite similar to (8):

$$\frac{\partial \mathrm{E}(T_d)}{\partial a(t)} = (\theta \tau_d q(t - p) - b) f(t) = 0 \iff t = p + \frac{b}{\theta \tau_d q}. \tag{24}$$

The same transfer price is reported to the foreign tax authority, implying a tax overpayment in the foreign jurisdiction. Again, by inserting p as obtained from (24) into (23), one obtains a differential equation with solution[13]

$$a^{TIEA}(t) = \frac{\tau_d - \tau_f}{\theta \tau_d} \left(1 - e^{1 - \frac{\theta \tau_d q}{b}\left(t - \underline{p}\right)}\right). \tag{25}$$

[12] Note that if both countries apply different transfer pricing regulations, the true arm's length price in the foreign country may differ from that in the domestic country. Given that the transfer pricing regulations in both countries are common knowledge, the multinational would need to report different transfer prices in both countries in order to avoid being audited immediately. Given an arbitrary arm's length price of x in the domestic country, assume that the corresponding arm's length price in the foreign country is given by $\psi(x)$, where the function $\psi(\cdot)$ represents the relationship between the transfer pricing regulations in the two countries. Then, if the multinational reports $x + \delta$ in the domestic country, it would need to report $\psi(x + \delta)$ in the foreign country in order to avoid immediate suspicion. We abstract from that, however, for notational convenience. As long as $\psi(x)$ is a monotonically increasing function (which we believe is appropriate), the results would not change qualitatively. Formally, we assume that $\psi(x) = x$.

[13] As above, the solution is determined by the condition $a(\underline{t}) = 0$.

Again we write $a^{*TIEA} \equiv a^{TIEA}(t^*)$. Somewhat surprisingly, although any profit that is shifted to the foreign country is taxed at τ_f, the level of profit shifting does *not* depend on the foreign tax rate. However, the audit function depends on the tax rate differential. If the foreign tax rate increases (or the domestic tax rate decreases), the probability of an audit decreases. That is, the domestic tax authority can maintain the same amount of profit shifting with less audit activity. The audit rate vanishes as the tax rate differential approaches zero. For $\tau_d = \tau_f$ the tax authority never audits; however, the equilibrium no longer holds in this case, for profit shifting is simply no longer necessary.

Inserting (25) and (24) into (22) and deriving with respect to q, one obtains the first-order condition for an optimal quantity of output in the first stage:[14]

$$\begin{aligned}\frac{\partial \Pi(t^*, a^{*TIEA})}{\partial q} &= R'(q) - c - \tau_d\,(R'(q) - p) - \tau_f(p - c) \\ &\quad - ba_q^{*TIEA} = 0. \qquad (26)\end{aligned}$$

The second-order condition is given by $(1 - \tau_d)R'' - ba_{qq}^{*TIEA} \leq 0$.

Proposition 3.1 *Under a Tax Information Exchange Agreement, the quantity produced in equilibrium is an increasing function of the arm's length price with* $\left.\frac{\partial q^*}{\partial p}\right|_{p=\underline{p}} = 0$ *and* $\left.\frac{\partial q^*}{\partial p}\right|_{p>\underline{p}} > 0$.

Proof Deriving (26) with respect to p gives

$$\frac{\partial q^*}{\partial p} = \frac{\tau_d - \tau_f - ba_{qp}^{*TIEA}}{-(1 - \tau_d)R'' + ba_{qq}^{*TIEA}}. \qquad (27)$$

Evidently, the denominator is positive if the second-order condition is fulfilled. Again, the sign of the cross partial derivative a_{qp}^{*TIEA} switches as p increases. Taking the derivative from (25) one finds that $a_{qp}^{*TIEA}(\underline{p}) = (\tau_d - \tau_f)/b$. Then, (27) is equal to zero. If p becomes larger, a_{qp}^{*TIEA} becomes smaller and turns negative at some point. Consequently, the numerator of (27) is always non-negative and the quantity produced in equilibrium increases if the arm's length price increases. ∎

[14] A goal-congruent incentive transfer price can be derived as demonstrated above. We do not calculate it here, however, for we are primarily interested in tax transfer prices.

The gray line in Figure 2.4 depicts the evolution of q as p increases. While higher arm's length prices (more entrepreneurial functions) are associated with higher audit probabilities in the domestic jurisdiction, they also allow for more profit shifting, which reduces the marginal cost of production and thus induces the multinational to produce more.

4 Effects of a Tax Information Exchange Agreement

Figures 2.3 and 2.4 suggest that the TIEA setting leads to a higher quantity of production and is preferable from the viewpoint of both tax authorities because the domestic tax authority's audit costs are much lower, and the foreign tax authority has no audit costs at all since it never audits. However, the graphs show the equilibrium for our exemplary parameters. The depicted context may thus not be general. For example, the audit function in the TIEA case (25) is reduced by the tax rate differential in the numerator. However, according to lemma 2.1 it increases with increasing quantity. Since the quantity may be higher in the TIEA setting, the overall effect is unclear. In the following, we analyze how quantity, audit rates, and expected net tax revenues change after introducing an TIEA.

4.1 Quantity

Comparing the first-order conditions (15) and (26) confirms the hypothesis regarding the quantity of production:

Proposition 4.1 *In the presence of an information exchange agreement the multinational will produce more output over the whole range of possible arm's length prices compared to the setting without an information exchange agreement.*

In the non-TIEA setting the multinational needs to account for the marginal audit probability in both countries, whereas in the TIEA setting only the domestic marginal audit probability enters the multinational's calculus. Comparing (10) and (25), one finds that

$$a^{*TIEA} = \frac{\tau_d - \tau_f}{\tau_d} a^*, \qquad a_q^{*TIEA} = \frac{\tau_d - \tau_f}{\tau_d} a_q^*.$$

The first-order conditions with respect to the quantity (15) and (26) can be written as

$$\text{non-TIEA:} \qquad \Lambda(q) = ba_q^* + d\alpha_q^*,$$
$$\text{TIEA:} \qquad \Lambda(q) = \frac{\tau_d - \tau_f}{\tau_d} ba_q^*,$$

where $\Lambda(q)$ is a decreasing function of q. Apparently, the right-hand side is lower for the TIEA setting. Hence, the q^* that solves the condition for the non-TIEA case needs to be lower than the q^{*TIEA} that solves the TIEA first-order condition.

Note, however, that a higher quantity of production does not imply a higher overall profit. The TIEA setting is beneficial for the multinational in that it cuts down on penalty costs because there are no audits in the foreign country and the audit rate in the domestic country is lower. However, the multinational pays higher taxes in the foreign country because profits are literally shifted there (there is no more tax avoidance there), thus the tax burden in the foreign country increases. The increased tax base is determined in stage two, when the multinational interacts with the domestic tax authority. Namely, the tax base difference (the tax transfer price, respectively) is chosen such as to satisfy the tax authority's indifference condition. Thus, when choosing the quantity, the multinational no longer accounts for this markup because it does not depend on the quantity. Formally, the term $-\tau_f b/(\theta\tau_d)$ drops when deriving with respect to q.

4.2 Tax Avoidance and Audit Rates

As described above, the multinational needs to report a common transfer price in the case of a TIEA. Thus, there is no more tax avoidance in the foreign country. In the domestic country, the multinational overreports the transfer price by $b/(\theta\tau_d q)$. While the structure of the formula is similar to the setting without a TIEA, the transfer price will be overstated by less since q is higher in the TIEA setting, as demonstrated in the previous subsection. Hence, the multinational pays $\tau_f b/(\theta\tau_d)$ too much in the foreign country.

Regarding the audit functions of the domestic tax authority, the analysis is slightly more complicated. The *final* functions a^{*TIEA} and a^* cannot be compared directly since they contain different equilibrium quantities of production, where q^{*TIEA} is greater than q^* according to proposition 4.1. To obtain predictions on the relationship between a^{*TIEA} and a^* it is useful to study the response of the functions as the foreign tax rate τ_f varies.

Lemma 4.2 *If the tax rate in the foreign country approaches zero, the audit probability of the foreign tax authority vanishes and the equilibrium quantities of production and the equilibrium audit function in the domestic country are the same for both the TIEA and the non-TIEA setting.*

First, note that $\lim_{\tau_f \to 0} \alpha^* = 0$. This implies that for $\tau_f \to 0$ the first-order conditions with respect to an optimal q for both the TIEA setting and the non-TIEA setting coincide. This leads directly to lemma 4.2.

Proposition 4.3 *For sufficiently low arm's length prices p, the domestic tax authority's audit probability is lower in the presence of a TIEA.*

Proof As τ_f increases, the domestic audit function *decreases* in the TIEA setting:

$$\frac{\partial a^{*TIEA}}{\partial \tau_f} = \frac{1}{\tau_d}\left(-a^* - \frac{(p-c)a_q^*\left(\tau_d - \tau_f\right)}{-\left(1-\tau_d\right)R'' + ba_{qq}^*}\right) < 0. \tag{28}$$

For the non-TIEA setting, one obtains

$$\frac{\partial a^*}{\partial \tau_f} = -\frac{a_q^*\left(p - c + d\alpha_{q\tau_f}^*\right)}{-(1-\tau_d)R'' + ba_{qq}^* + d\alpha_{qq}^*}. \tag{29}$$

The sign of (29) is ambiguous. The cross partial derivative

$$\alpha_{q\tau_f}^* = \frac{1}{d^2}(\bar{p} - p)e^{-\frac{q^*\varpi\tau_f(\bar{p}-p)}{d}}\left(d - q^*\varpi\tau_f(\bar{p} - p)\right)$$

is definitely positive for sufficiently high values of p. Then, the derivative (29) is negative. However, given lower values of p, $\alpha_{q\tau_f}^*$ becomes negative at some point, making (29) less negative. For sufficiently low values of p, equation (29) eventually becomes positive. Summing up, a^* and a^{*TIEA} coincide if $\tau_f \to 0$. Given sufficiently low arm's length prices, increasing τ_f causes a^* to increase while a^{*TIEA} decreases, which proves proposition 4.3. ∎

While we are not able to provide a formal proof, it seems plausible that the derivative of the domestic audit function with respect to the foreign tax rate is lower for the TIEA setting over the whole range of arm's length prices and thus for both routine, hybrid, and entrepreneurial functions. Assuming that (29) always exceeds (28), together with lemma 4.2 this implies that the conclusion of a Tax Information Exchange Agreement between both tax authorities always reduces the probability of an audit in the domestic country. At least, our numerical examples suggest this relationship.

4.3 Expected Net Tax Revenue

Introducing the equilibrium transfer price and the audit function into the tax authorities' expected net tax revenue functions (6) and (7), respectively, one obtains

$$\mathrm{E}(T_d) = \mathrm{E}(T_d)^{TIEA} = \int_{\underline{p}}^{\overline{p}} \left(\tau_d \left(R(q) - qp \right) - \frac{b}{\theta} \right) f(p)\, dp, \tag{30}$$

$$\mathrm{E}(T_f) = \int_{\underline{p}}^{\overline{p}} \left(\tau_f q(p-c) - \frac{d}{\varpi} \right) f(p)\, dp, \tag{31}$$

$$\mathrm{E}(T_f)^{TIEA} = \int_{\underline{p}}^{\overline{p}} \left(\tau_f q(p-c) + \tau_f \frac{b}{\theta \tau_d} \right) f(p)\, dp. \tag{32}$$

Proposition 4.4 *The foreign tax authority's expected net tax revenues increase after introducing a Tax Information Exchange Agreement, whereas the domestic tax authority's expected net tax revenues may increase or decrease.*

To begin with, let us regard equations (31) and (32). The foreign tax authority benefits from two effects. First, tax revenues increase because of a higher quantity in the TIEA setting (proposition 4.1). Second, the foreign tax authority not only cuts down on its own audit costs but also gains tax on the "overreport" which is determined by the domestic tax authority's audit cost, the domestic penalty rate, and the domestic tax rate (second term within the brackets in (32)).

On the part of the domestic tax authority, the structure of the equilibrium tax revenue (30) does not change after introducing the TIEA. The only variable that changes is the quantity of production, which is higher in the TIEA setting.

The first term inside the brackets of equation (30), $R(q) - qp$, is referred to as the "tax base" (revenue minus expenses) whereas the second term measures the (fixed) losses due to profit shifting. Whether or not an increase in q is beneficial for the domestic tax authority depends on the initial value of q, since $R(q)$ is concave whereas the expenses, qp, increase linearly. Deriving $\mathrm{E}(T_d)$ with respect to q gives

$$\frac{\partial \mathrm{E}(T_d)}{\partial q} = \tau_d \int_{\underline{p}}^{\overline{p}} (R' - p) f(p)\, dp, \tag{33}$$

where $(R' - p)$ is the marginal tax base. Since the quantity is higher in the TIEA setting it follows that the marginal revenue and the marginal tax base are *lower* in this case. Thus, the derivative is also lower. The sign of the derivative depends on the expected marginal tax base, that is, the relationship between the expected marginal revenue and the expected marginal expenses, $\mathrm{E}(p)$. Inserting R' from (15), one obtains for the non-TIEA setting

$$R' - p = \frac{c(1-\tau_f) - p(1-\tau_f) + ba_q^* + d\alpha_q^*}{1-\tau_d},$$

and for the TIEA setting

$$R' - p = \frac{c(1-\tau_f) - p(1-\tau_f) + ba_q^*}{1-\tau_d}.$$

It appears that both are positive for $p = \underline{p}$, but switch signs at some point as p increases. Figure 4.1 illustrates the situation. For low arm's length prices, the marginal tax base is lower for the TIEA setting than for the non-TIEA setting, and both are positive. This implies that both $q^*(\underline{p})$ and $q^{*TIEA}(\underline{p})$ are located in the "increasing branch" of the tax base curve. Hence, the tax base is higher in the TIEA setting. However, for sufficiently high values of p, both marginal tax bases are negative. As the quantity is still higher in the TIEA setting, this implies that the tax base is *lower* for $q^*(\overline{p})$ and $q^{*TIEA}(\overline{p})$. Which of the two effects prevails depends on the distribution of arm's length prices $f(p)$. Thus, no general prediction can be made. Figure 4.2 depicts the net tax revenue for different arm's length prices.

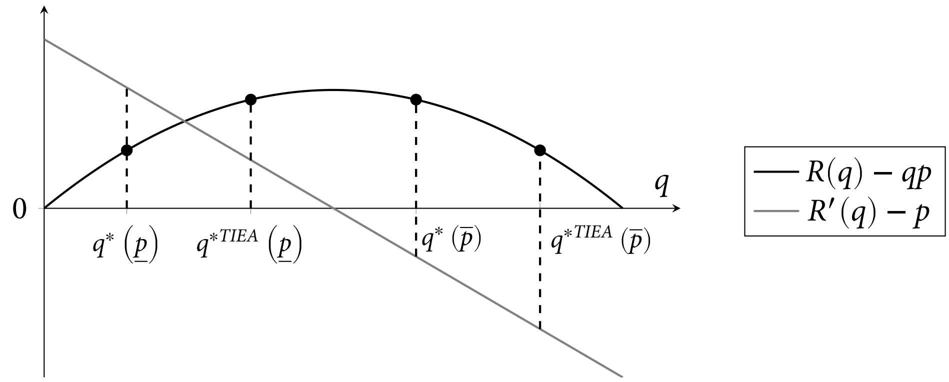

Figure 4.1: *Tax base (black line) and marginal tax base (gray line), given an arbitrary p, depending on the quantity q, for a linear demand function.*

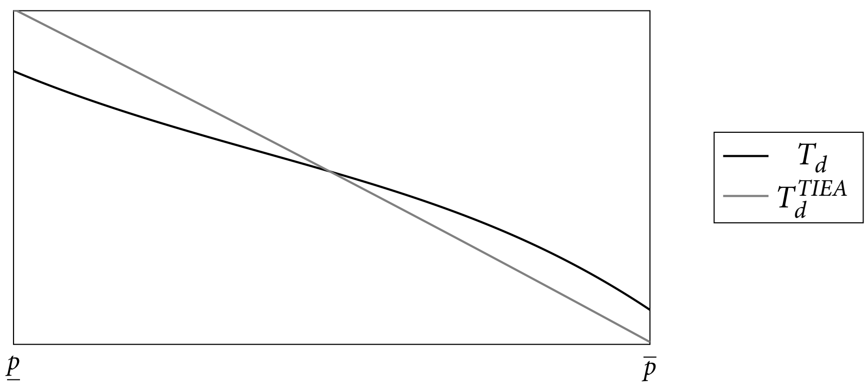

Figure 4.2: *Net tax revenue of the domestic tax authority with TIEA (gray line) and without TIEA (black line), depending on the arm's length price.*

5 Summary

We propose a model where tax transfer prices and the audit rates are given as an equilibrium in a game between the multinational and both tax authorities. Throughout the article we assume that the tax rate in the domestic country exceeds the foreign country's tax rate. This leads to the straightforward result that the multinational will tend to set a higher tax transfer price in the domestic country in order to shift profits to the low-tax foreign country, while the reported tax transfer price in the foreign country will be *lower* than the arm's length price in order to "hide" the profits from the foreign tax authority. Accordingly, the domestic tax authority's audit probability increases with increasing transfer price reports, while the foreign tax authority's audit probability increases with *decreasing* transfer price reports. The equilibrium is characterized by the multinational choosing tax transfer prices in such a manner as to keep the tax authorities indifferent between auditing and not auditing. On the other hand, the tax authorities choose the audit functions such that the multinational has no incentive to alter the transfer price reports because its respective first-order conditions are fulfilled. The chosen tax transfer prices and the according audit rates determine the quantity produced in equilibrium. We find that divisions with a hybrid functional profile produce less than (foreign) divisions with either a routine or an entrepreneurial functional profile.

Next, we examine the effects of a *Tax Information Exchange Agreement* (TIEA) between the two tax authorities. In this setting, the tax authorities cooperate with each other and exchange any information they have regarding the multinational, namely the transfer price report. This implies that the multinational is *de facto* forced to make a common tax transfer price report in both countries because any deviations would reveal that the multinational is cheating in at least one country, which would immediately attract a penalty. We find that the extent of profit shifting to the foreign low-tax country remains unchanged, while there is no more tax avoidance in the foreign country. By contrast, in the foreign country the multinational is forced to "overreport" to some extent so the foreign tax authority no longer needs to audit. The domestic tax authority audits less often—at least if the foreign division exercises a routine function—since the tax overpayment in the foreign country additionally prevents the multinational from declaring excessive transfer prices in the domestic country. In equilibrium, the multinational produces more since the marginal penalty costs are lower. Expected net tax revenues *increase* in the foreign country, yet may *decrease* in the domestic country after introducing a TIEA. Thus, our model suggests that high-tax countries may be reluctant to conclude bilateral information exchange agreements with low-tax countries.

Note that as a reference point, we establish the case of two completely stand-alone tax authorities (no information exchange at all) and contrast this with the case of fully shared information between two tax authorities. While our purely theoretical approach outlines two extreme cases, real-world scenarios probably can be found in between. Existing legislative action (Information Exchange Agreements, Country by Country Reporting) combined with technological innovations such as Blockchain, which are expected to further simplify information sharing in the future, clearly show a trend towards fully shared information on tax avoidance-relevant aspects. Decision-makers therefore have to be informed about the consequences of this development from a theoretical point of view.

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