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Diller, Markus / Lorenz, Johannes / Schneider, Georg / Sureth-Sloane, Caren

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Is Tax Transfer Pricing Harmonization a Panacea? Real Effects of Global Tax Transparency and Standards Consistency*

Markus Diller
University of Passau

Johannes Lorenz
Carl von Ossietzky University of Oldenburg

Georg Schneider
University of Graz

Caren Sureth-Sloane
Paderborn University
Vienna University of Economics and Business

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Abstract This study investigates the impact of the harmonization of tax transfer pricing across jurisdictions on multinational companies' reporting and tax authorities' auditing strategies. Applying a game-theoretical approach, we assess how enhancing standards consistency and global tax transparency influences tax avoidance and double taxation, producer and consumer surplus, and countries' tax revenue. Although increasing transparency is generally perceived to discourage tax avoidance, we show that this effect vanishes when standards are inconsistent. We demonstrate that high global tax transparency and consistent standards maximize global social welfare. However, from the perspective of multinational companies or individual countries, the optimal mix of consistency and transparency may differ. These findings highlight why transfer pricing harmonization is difficult and how single-player incentives undermine the envisioned benefits of tax harmonization. This study offers valuable insights for policymakers who aim to curb tax avoidance and mitigate the risk of double taxation.

Keywords: transfer pricing; standards inconsistency; tax harmonization; tax transparency; tax avoidance; real effects
JEL: H20, H26, C72, K34, F53

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I. INTRODUCTION

We investigate the impact of harmonizing tax transfer pricing across jurisdictions on a multinational company's (MNC's) tax reporting and tax authorities' auditing strategies and the resulting effects on the firm's production and profit, countries' tax revenues, and global welfare. Harmonizing tax transfer pricing is considered a means of mitigating tax avoidance and the risks of double taxation. Harmonization operates along two key dimensions: the standardization of rules for tax transfer pricing across countries and the enhancement of global tax transparency for tax authorities.

Standards consistency can be ensured by implementing general valuation principles, such as the arm's-length (AL) principle, and uniformly applying and interpreting these rules across countries. *Global tax transparency* can be achieved through improved sharing of tax records across countries, as underscored by the OECD's BEPS Action 13 "Transfer Pricing Documentation and Country-by-Country Reporting" (OECD, 2015).

Despite the purported benefits, the practical ramifications of tax transfer pricing harmonization for MNCs and countries remain unclear, due to the interdependent nature of the audit strategies of tax authorities and firms' responses. Greater standards consistency alters MNCs' and countries' payoffs by changing AL price standards and thus tax bases in the countries. Global tax transparency indirectly affects their payoffs by facilitating tax audits. To investigate the interplay of these forces, we employ a game-theoretical approach and examine how varying degrees of standards inconsistency (modeled as a unilateral increase in AL prices) and global tax transparency (modeled as a reduction in audit costs for tax authorities) influence an MNC's propensity to report different transfer prices across countries *(reporting inconsistency).*

As transfer pricing is a key instrument of multinational tax avoidance (Heckemeyer and Overesch, 2017), lately, intergovernmental forums, like the OECD/G20 Inclusive Framework on BEPS, have focused on ensuring consistent standards and global tax transparency. The OECD has addressed these issues in BEPS Action 13 and expects that enhanced documentation and the exchange of information will require "taxpayers to articulate consistent transfer pricing positions" (OECD, 2015, p. 9). In the light of these reforms, it is important to understand the implications of consistent transfer pricing standards and global tax transparency and why international tax reforms often fail to live up to hopes. Greater understanding can help in evaluating tax reforms.

Our anecdotal evidence from six semistructured interviews and an online survey with global heads of taxes of major German MNCs, tax transfer pricing experts (Big 4), and the German Federal Tax Office (BZSt) emphasizes the relevance of both inconsistent standards and inconsistent reporting.[2] For example, a transfer pricing expert explains:

> *So that also has nothing to do with what is an OECD country or not. This [transfer pricing standards inconsistency] is an issue for all tax authorities.*
> *—Transfer pricing partner, Big 4 tax advisory firm.*

Inconsistent tax transfer pricing regulations are also predicted theoretically (Mansori and Weichenrieder, 2001; Raimondos-Møller and Scharf, 2002) and observed empirically among OECD and non-OECD countries (Rathke, Rezende, and Watrin, 2020). Our interviewees also explain that MNCs do occasionally report inconsistent transfer prices for different reasons.[3]

[2] See Appendix A for details.

[3] Different reports might not only result from tax avoidance but from MNCs' anticipation of inconsistent standards. To be compliant in both countries, MNCs would need to file different reports to the two tax authorities. Technically, this

[A] number of taxpayers differentiate and set a different transfer price in anticipation of a discussion during the tax audit.
—Transfer pricing partner, Big 4 tax advisory firm.

You also have to see that of course the audit documents are sometimes different in the different countries.
—Transfer pricing expert, German Federal Central Tax Office.

Supported by these anecdotes, we assume that MNCs might file different and thus inconsistent tax transfer prices in two countries.

We set up a game between an MNC and two tax authorities, one from a (domestic) high-tax country and one from a (foreign) low-tax country. The MNC produces in its foreign subsidiary and sells its product to its domestic subsidiary. The AL prices of this transaction depend on the allocation of the MNC's functions, assets, and risks. They are exogenously given and can differ in both countries.[4] In the first stage, the MNC decides how much to produce. In the second, it chooses the tax transfer prices to be reported. In the third, each tax authority chooses its audit strategy, conditional on the reported prices. We assume that a specific transparency regime is in place, for example, given by a tax information exchange agreement or country-by-country reporting. The regime provides incremental information about the extent of reporting inconsistency to the tax authorities. This information then facilitates the tax authorities' ability to challenge the MNC's position and enforce AL prices, which we model as a reduction in audit cost.

We find first that, under consistent standards, producer surplus is maximized at intermediate to low levels of global tax transparency but under inconsistent standards at high levels. Intuitively, when standards are consistent, increasing global tax transparency reduces tax avoidance and thus increases firms' tax burden. In contrast, when standards are inconsistent, the level of transparency has little effect on tax avoidance, and firms even benefit from high transparency. These benefits are due to tax authorities conducting fewer audits, inducing fewer postaudit adjustments, which overall damps effective double taxation. The reduction in audit pressure depends on the AL price and is thus firm specific. Therefore, under consistent standards, some firms benefit from high global tax transparency, whereas others suffer, ultimately leading to the above-described result. Under inconsistent standards, all firms benefit, and producer surplus is maximized at high transparency.

Second, high global tax transparency maximizes consumer surplus under both consistent and inconsistent standards, but the result is more pronounced under consistent ones. So consumers and producers differ in how they benefit from transparency. This is because optimal production quantities—and hence consumer prices—depend on a firm's AL price, both directly and indirectly via the audit probabilities. Under consistent standards, firms' optimal production quantities increase with the transparency level, implying lower consumer prices. Under inconsistent standards, this effect is firm specific, positive or negative, leading to a still positive but weaker overall impact on consumer surplus.

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can be achieved by carrying out primary and secondary adjustments, e.g., by constructive dividends, constructive equity contributions, or constructive loans (c. f. OECD, 2017, Glossary).

[4]The tax authorities must conduct a costly in-depth audit of the functions, assets, and risk (FAR) profile to deduce the AL price of a given product. The exact same product can be assigned different AL prices, depending on how much risk is involved in producing or selling it. Low AL prices emerge and are appropriate if the foreign division has a routine function; they typically result from cost-based pricing rules. By contrast, high AL prices typically emerge from a resale price minus method and are applied if the foreign division has an entrepreneurial function, leaving the domestic division with a routine function (e.g., distribution unit). Consequently, intermediate AL prices generally point to a hybrid functional profile of both divisions.

Third, from a global welfare perspective, we find that high global tax transparency and consistent standards maximize the sum of consumer surplus, producer surplus, and both countries' net tax revenues. However, this does not necessarily coincide with the optima of the individual stakeholders. For example, producers, under consistent standards, may benefit from intermediate transparency, as described above, and one country might be better off under low transparency.

Studies assume that MNCs report a single transfer price to both tax authorities and that consistent (Horst, 1971; Kant, 1988; Haufler and Schjelderup, 2000; Choe and Hyde, 2007; Baumann and Friehe, 2013; Blouin, Robinson, and Seidman, 2018; Davies, Martin, Parenti, and Toubal, 2018; Koethenbuerger, Mardan, and Stimmelmayr, 2019) or inconsistent (De Waegenaere, Sansing, and Wielhouwer, 2006; De Waegenaere, Sansing, and Wielhouwer, 2007; De Waegenaere and Sansing, 2010) adaptations to the reported prices emerge only later during tax negotiations and audits. We contribute to this literature in two ways. First, we allow firms to *report inconsistently* and explore how tax authorities respond in their audit strategies. Second, we investigate how this reporting game translates into *real effects.*

Our paper relates to the work of De Waegenaere et al. (2006) and De Waegenaere et al. (2007). They investigate a setting with an MNC and two strategic tax authorities under inconsistent tax transfer pricing standards. They model *standards* inconsistency but assume consistent *reports* by the taxpayers in both countries. Although De Waegenaere et al. (2007) assume that the tax authorities can observe the taxpayer's reported transfer prices only by auditing or entering an advance pricing agreement, we, like De Waegenaere et al. (2006), assume that the tax authorities can always observe reported transfer prices and condition their strategy accordingly. Yet a key assumption in these two studies is that the MNC cannot report different (inconsistent) tax transfer prices to the two tax authorities. We relax this assumption and allow the MNC to account for double taxation or report less than worldwide income (i.e., inconsistent tax transfer prices). We thus connect the De Waegenaere et al. (2006) setting to the literature on tax evasion (Reinganum and Wilde, 1986a). In De Waegenaere et al. (2006), the tax authorities audit more heavily if the likelihood of standards inconsistency (i.e., the chance to double tax) is high. By contrast, in our model, audit strategies are primarily driven by MNC characteristics, and standards inconsistency only exerts an indirect effect, the direction of which is not generally determined. We add to the findings of De Waegenaere et al. (2006) by demonstrating how strategic auditing and reporting translate into real effects.

Our findings are important for policymakers, who should be aware of the adverse incentives countries may have during multilateral tax reform negotiations.

II. GAME THEORETIC FRAMEWORK: MNC PROFITS AND NET TAX REVENUES

We consider an MNC with divisions in two countries. The foreign division produces an intermediate product of quantity q at constant marginal costs of production c, which is sold in the domestic country.[5] The domestic division earns sales revenue $R(q)$ with $R''(q) < 0$.[6] The domestic tax rate is denoted by τ_d, whereas the foreign tax rate is τ_f, with $\tau_d > \tau_f$. We study a centralized

[5]This basic setup resembles those of Baldenius, Melumad, and Reichelstein (2004) and Choe and Hyde (2007).

[6]$R(q)$ is given by quantity times sales price. It can also be understood as gross sales revenue less the domestic division's marginal production costs other than for the intermediate product (Baldenius et al., 2004). Without loss of generality, we set such costs to zero and obtain a sales price of $R(q)/q$. $R''(q) < 0$ allows for demand that is linearly or convexly decreasing in quantity.

setting: the MNC's management is aware of $R(q)$ and can choose the optimal production quantity appropriately.[7] The production decision is referred to as Stage 1.

When making the production decision, the MNC anticipates the outcome of the sequential tax reporting and auditing game that occurs in Stages 2 and 3. In this game, it submits tax transfer price reports to both tax authorities, which then decide whether to audit. In particular, the MNC is privately informed about the product's AL prices $p_i, i \in \{d, f\}$. p_d is correct from the viewpoint of the domestic (d) and p_f from the foreign (f) jurisdiction. AL prices are distributed on the intervals $[\underline{p_i}, \overline{p_i}]$, according to the probability density functions $f_i(p_i)$.[8] A vector of AL prices (p_d, p_f) characterizes an MNC's type. Although we assume that both countries generally adhere to the AL principle, transfer pricing standards may still be inconsistent ($p_d \neq p_f$). Here we define $p_f = p_d + \delta$; that is, standards become inconsistent because the foreign country demands higher AL prices compared with the domestic country that serves as a benchmark.[9] $\delta \geq 0$ captures the amount of double taxation implied by the standards inconsistency.[10]

These inconsistencies can emerge from different applications of the AL principle (De Waegenaere et al., 2006; De Waegenaere et al., 2007; Rathke et al., 2020). Assume an example where the profit from a transaction is derived from both tangible and intangible assets. Although the allocation of the transfer price for tangible assets is straightforward, the intangible portion requires more attention. If the domestic country chooses to apply the comparable profit method, with the foreign toll manufacturer as the tested party, this approach allocates the entire profit attributed to the intangible asset to the domestic entrepreneur, resulting in a transfer price of, say, $p_d = 2$. Conversely, the foreign country might recognize a greater degree of local entrepreneurship, opting for the profit split method. This method proposes a division of the intangible asset's profit, suggesting a transfer price of, say, $p_f = 3$. In this example, the difference between the two transfer prices is $\delta = 1$.

The MNC reports transfer prices p_i^r that may deviate from AL prices p_i and can be inconsistent ($p_d^r \neq p_f^r$). In our example above ($p_d = 2, p_f = 3$), reported prices $p_d^r = p_f^r = 2$ would be *consistent* (although not complying with the foreign AL price), whereas reported prices $(p_d^r = 2, p_f^r = 3)$

[7] This can also be interpreted as a decentralized setting where the domestic division is incentivized appropriately using an internal transfer price (e. g., Baldenius et al., 2004; Choe and Hyde, 2007).

[8] In accordance with common transfer price regulations, we assume that $\underline{p_i} \geq c$. Usually, the resale price serves as an upper bound for transfer prices; however, we do not need to make this a formal assumption. Depending on the sales market features, there are cases in which products are sold by the domestic division at a (tax) loss. However, in our numerical examples (Section V), we choose parameters such that the endogenously determined resale price lies above the upper boundary of the transfer price $\overline{p}$. Furthermore, without loss of generality, we abstract from the fact that there may be an interval of accepted tax transfer prices rather than a single AL price. If there were a range of accepted AL prices, the MNC would always report at the upper or lower boundary (Baldenius et al., 2004; Choe and Hyde, 2007).

[9] Alternatively, standards inconsistency can arise from generally lower domestic AL prices. Our main results do not change when defining $p_d = p_f - \delta$; see the online appendix.

[10] De Waegenaere et al. (2006) and De Waegenaere et al. (2007) study a setting where such inconsistencies appear stochastically. In contrast, we choose the deterministic relationship $p_f = p_d + \delta$ to focus on the influence of global tax transparency on the MNC's reporting decision (see below). This functional relation is motivated by the fact that the foreign country's tax base increases in p_f, whereas the domestic country's tax base decreases in p_d. Hence, the foreign exporting (domestic, importing) country generally has an incentive to create regulations that lead to higher (lower) AL prices (e. g., Mansori and Weichenrieder, 2001; De Waegenaere et al., 2007). Still, as both countries generally adhere to the AL principle, higher prices in the domestic country coincide with higher prices in the foreign country $\left(\frac{dp_f}{dp_d} > 0\right)$.

would be *inconsistent* (although complying with both standards). The MNC submits tax transfer pricing documentation that informs tax authority i about the reported price p_i^r and quantity q.[11]

The tax authorities might additionally have access to information on the transfer price reported in the other country via mandated or voluntary supplementary tax disclosure (e.g., country-by-country reporting or sustainability reports) or tax information exchange. These (bilateral) transparency devices equip the tax authorities with incremental information that might help reveal inconsistency in reported transfer prices. However, depending on the transparency device, this information may be imperfect. For example, country-by-country reporting only provides tax information at the country level and not at transaction level. We use the term "global tax transparency" to describe the transparency generated by these bilateral transparency devices. We assume that information on inconsistent transfer price reports will facilitate the tax authorities' challenge of the MNC's position and enforce the AL price, reducing audit costs for the tax authorities. For example, a tax authority may consider the existence of two different prices as an indicator of potential noncompliance, which is also reflected in our interviews:[12]

> *[W]e have a growing exchange of information. ... So, such inconsistencies can sometimes also be perceived negatively and then lead to further seizures by the tax authorities in other countries.*
> *—Transfer pricing partner, Big 4 tax advisory firm.*

In our model, we posit that the tax authorities' audit costs are scaled by a function $\psi(p_d^r - p_f^r, \Psi) > 0$ that depends on the difference between the reported transfer prices $p_d^r - p_f^r$ and a transparency parameter Ψ. The function is normalized such that $\psi(0,\cdot) = 1$, and it is convex decreasing in $p_d^r - p_f^r$: audit costs diminish as the level of reporting inconsistency increases because a larger difference between the reported transfer prices simplifies the task for tax authorities to challenge these prices. Negative reporting inconsistencies $p_d^r - p_f^r < 0$ reflect double taxation, leading to $\psi(\cdot,\cdot) > 1$. Hence, we also capture scenarios that make it costlier for the tax authorities to enforce transfer prices that even increase double taxation. The transparency parameter Ψ captures the strength of this effect ($\psi^{(0,1)}\Big|_{p_d^r - p_f^r > 0} < 0$, $\psi^{(0,1)}\Big|_{p_d^r - p_f^r < 0} > 0, \psi^{(1,1)} < 0$). For example, low transparency values Ψ represent a situation where information on different prices is not indicative and therefore not helpful to the tax authority in challenging the reports; in this case, $\psi(\cdot,\cdot)$ is almost flat. In our numerical examples, we operationalize the function as $\psi(p_d^r - p_f^r, \Psi) = 1 - \Psi \cdot (p_d^r - p_f^r)$.[13]

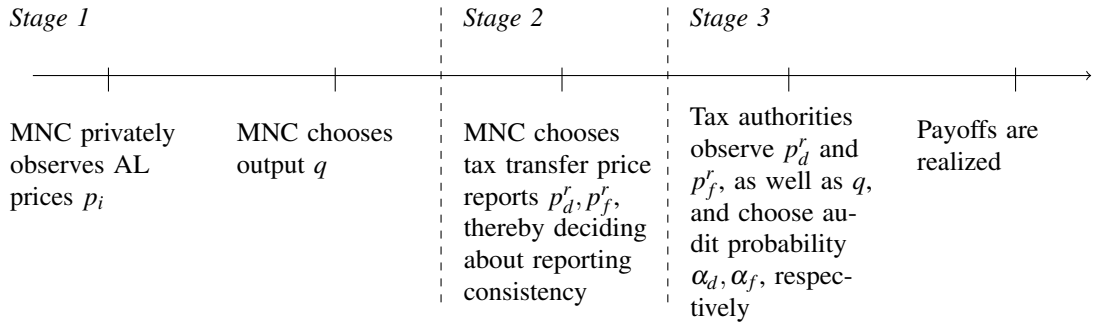
After the reports are submitted, both tax authorities decide separately on whether to audit, conditional on the reports p_d^r, p_f^r. The audit strategy of tax authority i is denoted by the scalar α_i. In general, α_i can be zero (no audit), one (audit), or between zero and one (audit with a particular probability). The separating equilibrium developed below involves mixed strategies of the tax authorities, and equilibrium audit probabilities $a_i(p_d^r, p_f^r)$ are functions of the reports; in

[11] Action 13 of OECD's BEPS action plan develops a three-tiered standardized approach to transfer pricing documentation. Tier two "requires that detailed transactional transfer pricing documentation be provided in a "local file" specific to each country, identifying material related-party transactions, the amounts involved in those transactions, and the company's analysis of the transfer pricing determinations they have made with regard to those transactions" (OECD, 2015, p. 9). Additionally, tax authorities can infer the quantity, e.g., from sales revenues (obtained from VAT returns, financial statements, or customs declarations, etc.) in combination with the publicly observable sales price.

[12] Relatedly, the existence of two different prices is also considered as triggering tax authority scrutiny in Reineke, Weiskirchner-Merten, and Wielenberg (2022), Martini (2015), and Smith (2002), who study one versus two sets of books for transfer pricing purposes.

[13] We derive our formal results using the general function. Where possible, we simply write $\psi(p_d^r - p_f^r)$.

Figure 1: Timeline of Events



After privately observing AL prices $p_d, p_f = p_d + \delta$, the MNC decides on the quantity to be produced and sold in the domestic market Stage 1. Second, the MNC sets the tax transfer prices and submits an income report alongside with a transfer pricing documentation, which informs the tax authorities about the reported tax transfer prices p_d^r and p_f^r, and quantity q (Stage 2). Subsequently, both tax authorities decide about the audit probability (Stage 3). Finally, payoffs are realized.

equilibrium, $\alpha_i = a_i(p_d^r, p_f^r)$. If a tax authority audits deviations from the AL price are penalized (e. g., Choe and Hyde, 2007; Blouin et al., 2018; Davies et al., 2018; Koethenbuerger et al., 2019). We assume a linear penalty of $\theta_i \geq 1$ times the underpaid tax (Yitzhaki, 1974).[14] Figure 1 depicts the timing of events and Figure 2 the MNC's and tax authorities' strategies.

After observing the MNC's reported transfer prices, the tax authorities choose audit probabilities α_i to maximize net tax revenues T_i as given by

$$T_d(p_d^r, p_f^r, \alpha_d, \mu_d) = \tau_d(R(q) - p_d^r q) + \alpha_d \tau_d \theta_d (p_d^r - \mu_d(p_d^r, p_f^r))q - k_d(\alpha_d \psi(p_d^r - p_f^r)) \quad (1)$$

$$T_f(p_d^r, p_f^r, \alpha_f, \mu_f) = \tau_f q(p_f^r - c) + \alpha_f \tau_f \theta_f q(\mu_f(p_d^r, p_f^r) - p_f^r) - k_f(\alpha_f \psi(p_d^r - p_f^r)), \quad (2)$$

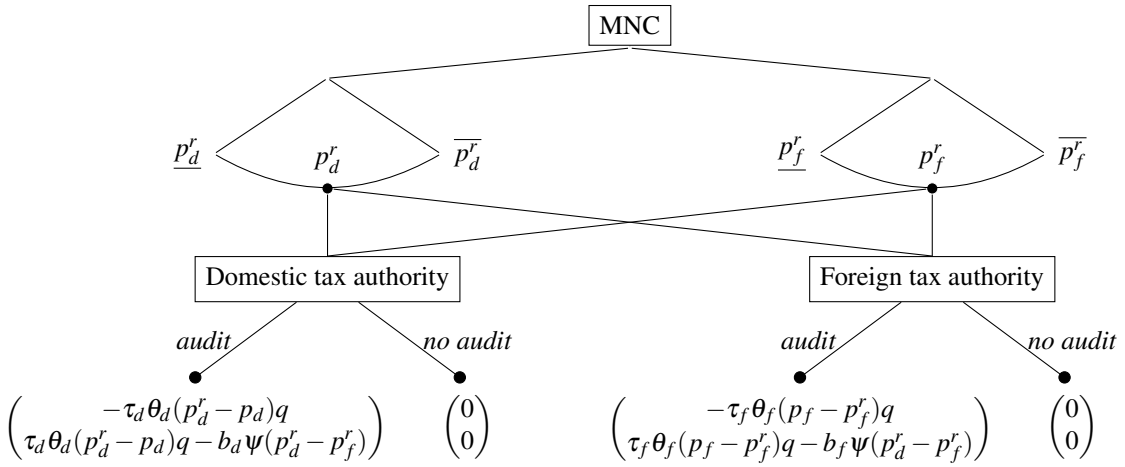
where $k_i(\cdot)$ with $k_i' > 0, k_i'' \geq 0$ denotes the audit costs. As motivated above, audit costs are monotone decreasing with an increasing level of reporting inconsistency. Finally, $\mu_i(p_d^r, p_f^r)$ is tax authority i's point belief[15] about the AL price p_i upon observing reports p_d^r, p_f^r.[16]

[14] Setting $\theta_i = 1$ captures situations where reported transfer prices that differ from AL prices are simply corrected by the tax authorities without incurring a penalty (see also Footnote 16). Results do not change qualitatively in these cases.

[15] To keep the notation simple, we use $\mu_i(p_d^r, p_f^r)$ to describe the tax authority i's expected value of the AL price p_i, given reports p_d^r, p_f^r and its beliefs, instead of the corresponding distribution function. Since, in a separating equilibrium, the distribution function is a point measure, there is a one-to-one correspondence between the expected value and the distribution function. Defining point beliefs implies that we are searching for a separating equilibrium.

[16] The assumption of governments maximizing net tax revenues is standard in the literature on tax transfer pricing (Graetz, Reinganum, and Wilde, 1986; Reinganum and Wilde, 1986a; Beck and Jung, 1989; Mills and Sansing, 2000; Sansing, 1993; Elitzur and Mintz, 1996; Mansori and Weichenrieder, 2001; De Waegenaere et al., 2006; De Waegenaere et al., 2007). Also, it is common to assume that the penalty is part of the tax authorities' revenues (e. g., Graetz et al., 1986; Beck and Jung, 1989). However, the results of our model would not change qualitatively when assuming that the tax authorities do not benefit from the penalty payment. In this case, θ_i would be set to 1 only in the tax authorities' objective functions. Furthermore, we assume no negative penalty for overpaying tax. For simplicity, we still do not formally include a max operator because, on the equilibrium path, the MNC never overstates the tax base in either country.

Figure 2: Strategies



This figure shows the strategies of the MNC and the domestic and foreign tax authorities. Given a production quantity q, the MNC chooses a vector of reported tax transfer prices (p_d^r, p_f^r) and submits an income report alongside with a transfer pricing documentation, which informs the tax authorities about the (reported) transfer prices and quantity q. The tax authority receives the reports and additional bilateral tax information provided via tax transparency devices such as Tax Information Exchange Agreements or country-by-country reporting. Subsequently, both tax authorities decide on the audit probability. Tax authorities' audit costs are reduced by $\psi(p_d^r - p_f^r, \Psi)$ depending on the level of inconsistency of the reports, and the level of global tax transparency Ψ. Payoffs are realized. For simplicity, we only depict the payoffs that are directly determined by the tax authorities' audit decisions.

The MNC maximizes its payoff Π, anticipating the equilibrium audit strategies of the tax authorities $\alpha_d = a_d(\cdot,\cdot), \alpha_f = a_f(\cdot,\cdot)$:

$$\begin{aligned}\Pi(p_d^r, p_f^r, a_d, a_f) = R(q) - cq - \tau_d\left(R(q) - qp_d^r\right) - \tau_f\left(p_f^r - c\right)q \\ - a_d(p_d^r, p_f^r)\theta_d\tau_d q\left(p_d^r - p_d\right) - a_f(p_d^r, p_f^r)\theta_f\tau_f q\left(p_f - p_f^r\right). \qquad (3)\end{aligned}$$

III. CHOICE OF REPORTED TAX TRANSFER PRICES AND AUDIT PROBABILITY

We determine the reaction functions and equilibrium outcome by backward induction. Both tax authorities strategically determine the audit probabilities α_i, given reported transfer prices p_d^r, p_f^r. Anticipating these audit probabilities, the MNC strategically determines tax transfer price reports. For this kind of game, there exists a separating equilibrium, which was first shown by Reinganum and Wilde (1986a; 1986b).[17] Based on their work, we define:

[17] The separating equilibrium was used to study tax evasion and avoidance by Reinganum and Wilde (1986a), Erard and Feinstein (1994), and Diller and Lorenz (2015). As noted in these analyses, pooling and partially pooling equilibria also emerge. They can be ruled out by modeling a portion of honest taxpayers (Erard and Feinstein, 1994) or by applying the divine equilibrium refinement (Banks and Sobel, 1987; Reinganum and Wilde, 1986b). We have elaborated on possible (partially) pooling equilibria on the special case with constant transparency ($\psi' = 0$, Appendix C) and have shown that they can be ruled out by applying the divine equilibrium concept. Due to space limitations, the explanations are not included here; they are available from the authors upon request. Also, pooling would require MNCs to choose the optimal production level of the type they imitate, since production quantities are visible to the tax authorities. We therefore focus on the separating equilibrium.

DEFINITION 1. *A separating equilibrium between the MNC and the domestic and foreign tax authorities consists of point beliefs $\mu_i(p_d^r, p_f^r)$, audit probabilities $a_i(p_d^r, p_f^r)$, and reports $p_i^{r*}(p_d, p_f)$[18] such that*

a) $a_i(p_d^r, p_f^r)$ *maximizes* $T_i(p_d^r, p_f^r, \alpha_i, \mu_i)$, *given the beliefs* $\mu_i(p_d^r, p_f^r), \forall i \in \{d, f\}$;

b) $p_d^{r*}(p_d, p_f)$ *and* $p_f^{r*}(p_d, p_f)$ *maximize* $\Pi(p_d^r, p_f^r, a_d, a_f)$, *given the audit probabilities* $a_i(p_d^r, p_f^r)$;

c) On the equilibrium path, the tax authorities' beliefs correspond to the MNC's equilibrium strategy: $\mu_i(p_d^{r*}, p_f^{r*}) = p_i, \forall i \in \{d, f\}$.

For clarity, we explicate audit costs as $k_i(\alpha_i \psi(\cdot)) = b_i \alpha_i \psi(\cdot)$: auditing costs a fixed amount b_i, which is reduced (or increased) by $\psi(\cdot)$. $\alpha_i b_i \psi(\cdot)$ thus describes the expected audit cost.[19]

Tax Authorities' Decisions (Third Stage)

After observing reported tax transfer prices, the tax authorities choose their audit probabilities so as to maximize net tax revenues. The first-order conditions yield

$$\frac{dT_d}{d\alpha_d} = \tau_d \theta_d q(p_d^r - \mu_d(p_d^r, p_f^r)) - b_d \psi(p_d^r - p_f^r) = 0; \tag{4}$$

$$\frac{dT_f}{d\alpha_f} = \tau_f \theta_f q(\mu_f(p_d^r, p_f^r) - p_f^r) - b_f \psi(p_d^r - p_f^r) = 0. \tag{5}$$

With fixed audit costs b_i, Equations (4) and (5) are indifference conditions. In equilibrium, the expected additional taxes and penalties (first terms) need to equate the expected audit costs (second terms). These equations serve two purposes. First, given that on the equilibrium path the tax authorities' beliefs are "correct" ($\mu_d = p_d, \mu_f = p_f$, Definition 1 c)),[20] they fully characterize the equilibrium reports p_d^{r*}, p_f^{r*}. In particular, the MNC chooses these reports so as to hold both tax authorities indifferent between all audit probabilities. Consequently, both tax authorities' second-order conditions equal 0 (Appendix B). Second, they are solved for μ_d and μ_f to obtain beliefs that render the tax authorities indifferent for any given combination of reports p_d^r, p_f^r. These beliefs are important to characterize the separating equilibrium in the next step.

[18] Although p_i^r is a scalar and denotes what is provided to the tax authority i, the MNC's equilibrium reporting strategy, given AL price p_i, is denoted as $p_i^{r*}(p_d, p_f)$. Therefore, in equilibrium, $p_i^r = p_i^{r*}(p_d, p_f)$.

[19] Erard and Feinstein (1994) note that, if the audit costs were to decrease or increase slightly after the report was filed, the tax authority would alter its strategy to audit either all or no taxpayers. This characteristic does not arise, however, when including a budget constraint for the tax authority (Erard and Feinstein, 1994), or when audit costs are strictly convex in the audit probability (Reinganum and Wilde, 1986a). The solution of Stages 2 and 3 of our model for convex audit costs for the special case $\psi' = 0$ is available from the authors upon request.

[20] Thus, in equilibrium, the tax authorities can infer the AL price after observing the reported transfer price.

MNC's Decision (Second Stage)

The MNC chooses p_d^r and p_f^r so as to maximize profit, anticipating the tax authorities' audit strategies. This gives the first-order conditions

$$\frac{\partial \Pi}{\partial p_d^r} = \tau_d q - q\theta_d \tau_d a_d(p_d^r, p_f^r) - q(p_d^r - p_d)\theta_d \tau_d \frac{\partial a_d}{\partial p_d^r} - q(p_f - p_f^r)\theta_f \tau_f \frac{\partial a_f}{\partial p_d^r} = 0; \tag{6}$$

$$\frac{\partial \Pi}{\partial p_f^r} = -\tau_f q + q\theta_f \tau_f a_f(p_d^r, p_f^r) - q(p_d^r - p_d)\theta_d \tau_d \frac{\partial a_d}{\partial p_f^r} - q(p_f - p_f^r)\theta_f \tau_f \frac{\partial a_f}{\partial p_f^r} = 0. \tag{7}$$

The first two terms in both equations show the direct effect of increasing the reported tax transfer prices. In the domestic country, tax-deductible expenses increase, shielding part of the tax base from taxation (first term); however, in case of an audit, back taxes and penalties increase (second term). In the foreign country, the signs are reversed, as lower reported transfer prices directly decrease the tax base and thus increase after-tax profit (first term) while, at the same time, increasing expected penalties (second term). The third and fourth terms measure the marginal change in audit probability. Since both tax authorities condition their audit probability on the reported tax transfer prices in *both* countries, altering p_d^r and p_f^r affects the audit probabilities in both countries. Thus, although earlier implementations of this framework within a national context (Reinganum and Wilde, 1986a; Erard and Feinstein, 1994; Diller and Lorenz, 2015) involve ordinary differential equations, our international setting entails a coupled system of partial differential equations (PDEs).

Derivation of Equilibrium

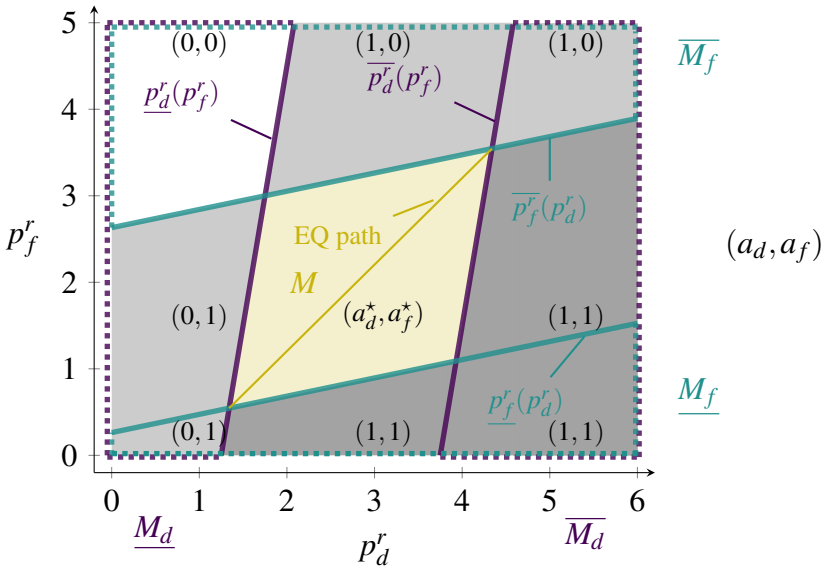
According to Definition 1 c) of the separating equilibrium, on the equilibrium path, the tax authorities' beliefs correspond to the AL prices, $\mu_d = p_d, \mu_f = p_f$. Replacing AL prices p_d and p_f in (6) and (7) with beliefs[21] μ_d and μ_f, respectively, as obtained from (4) and (5), gives the PDEs:

$$\begin{aligned} \tau_d q - q\theta_d \tau_d a_d(p_d^r, p_f^r) - b_d \psi(p_d^r - p_f^r)\frac{\partial a_d}{\partial p_d^r} - b_f \psi(p_d^r - p_f^r)\frac{\partial a_f}{\partial p_d^r} = 0; \\ -\tau_f q + q\theta_f \tau_f a_f(p_d^r, p_f^r) - b_d \psi(p_d^r - p_f^r)\frac{\partial a_d}{\partial p_f^r} - b_f \psi(p_d^r - p_f^r)\frac{\partial a_f}{\partial p_f^r} = 0. \end{aligned} \tag{8}$$

In unilateral settings (e.g., Reinganum and Wilde, 1986a), boundary conditions are specified such that the tax authority would never audit the taxpayer that reports the highest tax payment. This is justified by the belief that high (out-of-equilibrium) reports come from the taxpayer with the highest true tax base. In our bilateral setting, both tax authorities calculate beliefs given two reports (p_d^r, p_f^r).

[21] Reinganum and Wilde (1986a) observe in a first step from the consistency condition (here Definition 1 c)) that—on the equilibrium path—a taxpayer's income is identical to the tax authority's belief and equal to the inverse of the taxpayer's equilibrium report ("inverse reporting policy"). They then use the inverse reporting policy to replace the belief in the tax authority's first-order condition and the taxpayer's income in the taxpayer's first-order condition. Finally, they solve the tax authority's first-order condition for the inverse reporting policy and use this to eliminate the inverse reporting policy from the taxpayer's first-order condition (Reinganum and Wilde, 1986a, 744 f.). Inverse reporting policies in our model are $p_d(p_d^r, p_f^r) = p_d^r - \frac{b_d \psi(p_d^r - p_f^r)}{q\tau_d\theta_d}$ and $p_f(p_d^r, p_f^r) = p_f^r + \frac{b_f \psi(p_d^r - p_f^r)}{q\tau_f\theta_f}$. For simplicity, however, we refrain from making this intermediate step explicit and directly replace p_d and p_f in the first-order condition of the MNC with the beliefs μ_d and μ_f, as determined by Equations (4) and (5).

Figure 3: Equilibrium and Out-of-Equilibrium Regions



The yellow diagonal line shows the combinations of observable domestic (p_d^{r*}) and foreign reported transfer prices (p_f^{r*}) (equilibrium path). The light-yellow set M encompasses combinations of off-equilibrium reports that are audited in both countries with probabilities according to $a_d^\star$ and $a_f^\star$, respectively. The other eight sets bring both tax authorities to believe that either $\underline{p_i}$ or $\overline{p_i}$ is at hand. Darker shades of gray indicate a larger overall audit probability. Audit probabilities are shown in brackets. The areas outlined in purple (turquois) indicate the sets of reports that are too low ($\underline{M_i}$) and too high ($\overline{M_i}$) from the perspective of tax authority i. Dotted lines indicate that the sets extend to infinity.

These beliefs are obtained by solving (4) for μ_d, and (5) for μ_f. Thus, we obtain beliefs that render the tax authorities indifferent between auditing and not auditing for any combination of reports. However, tax authorities must not map reports to types that do not exist.

For example, if the lowest domestic AL price is $\underline{p_d} = 3$, when observing any combination of reports p_d^r, p_f^r, the domestic tax authority must assign a belief μ_d of at least 3. This creates a lower boundary for the domestic tax authorities' beliefs $\underline{p_d^r}(p_f^r)$ such that $\underline{p_d^r} - \frac{b_d \psi(\underline{p_d^r} - p_f^r)}{q \tau_d \theta_d} = \underline{p_d}$. We determine an upper boundary as well as the set of interior beliefs for the foreign tax authority analogously. The yellow area in the center of Figure 3 indicates the set M of combinations of reports for which both tax authorities have interior beliefs; that is, they believe that the type that is associated with the reports is between $\underline{p_i}$ and $\overline{p_i}$. The solid purple line on the left, $\underline{p_d^r}(p_f^r)$, shows combinations of reports for which the domestic tax authority believes that $\underline{p_d}$ is present and audits with probability zero. The upper solid turquoise line $\overline{p_f^r}(p_d^r)$ indicates the combinations of reports that bring the foreign tax authority to believe that $\overline{p_f}$ is present and to audit with probability zero.[22]

According to this reasoning, we specify Dirichlet boundary conditions $a_d(\underline{p_d^r}(p_f^r), p_f^r) = 0$ and $a_f(p_d^r, \overline{p_f^r}(p_d^r)) = 0$ that are justified by the tax authorities' beliefs that any report $p_d^r < \underline{p_d^r}(p_f^r)$

[22] In addition, in our bilateral case, appropriate beliefs need to be assigned for cases where a combination of reports points to an existing type (between $\underline{p_i}$ and $\overline{p_i}$) from the viewpoint of tax authority i but to a nonexisting type $< \underline{p_i}$ or $> \overline{p_i}$ from the viewpoint of the other tax authority $-i$ (sets $\underline{M_{-i}} \setminus \{\underline{M_i} \cup \overline{M_i}\}$, $\overline{M_{-i}} \setminus \{\underline{M_i} \cup \overline{M_i}\}$ in Figure 3).

comes from type $\underline{p_d}$ (domestic country, set $\underline{M_d}$, purple, left-hand side in Figure 3), and any report $p_f^r > \overline{p_f^r}(p_d^r)$ comes from type $\overline{p_f}$ (foreign country, set $\overline{M_f}$, turquoise, at the top in Figure 3).

To the best of our knowledge, an analytical solution of the system (8) is impossible. Figure 4 (left and middle panel) shows a numerical solution, i.e., the tax authorities' equilibrium audit functions, depending on the MNC's reported tax transfer prices in both countries; the black solid (dashed) line indicates the equilibrium path in the domestic (foreign) country.

The following proposition summarizes the result. The proofs for all formal statements are in Appendix B with an analytical solution of the equilibrium for the case $\psi' = 0$ in Appendix C.

PROPOSITION 1. *In the game between the MNC and the domestic and foreign tax authorities, a separating equilibrium is given by the following strategies and beliefs:*

a) The domestic and foreign tax authorities audit with probability

$$a_d(p_d^r, p_f^r) = \begin{cases} 0, & (p_d^r, p_f^r) \in \underline{M_d} \\ a_d^\star(p_d^r, p_f^r), & (p_d^r, p_f^r) \in M \\ 1, & (p_d^r, p_f^r) \in \mathbb{R}^2 \setminus \{M \cup \underline{M_d}\}, \end{cases}$$

$$a_f(p_d^r, p_f^r) = \begin{cases} 1, & (p_d^r, p_f^r) \in \mathbb{R}^2 \setminus \{M \cup \overline{M_f}\} \\ a_f^\star(p_d^r, p_f^r), & (p_d^r, p_f^r) \in M \\ 0, & (p_d^r, p_f^r) \in \overline{M_f}; \end{cases}$$

b) the MNC reports $p_d^{r*}(p_d, p_f)$ and $p_f^{r*}(p_d, p_f)$;

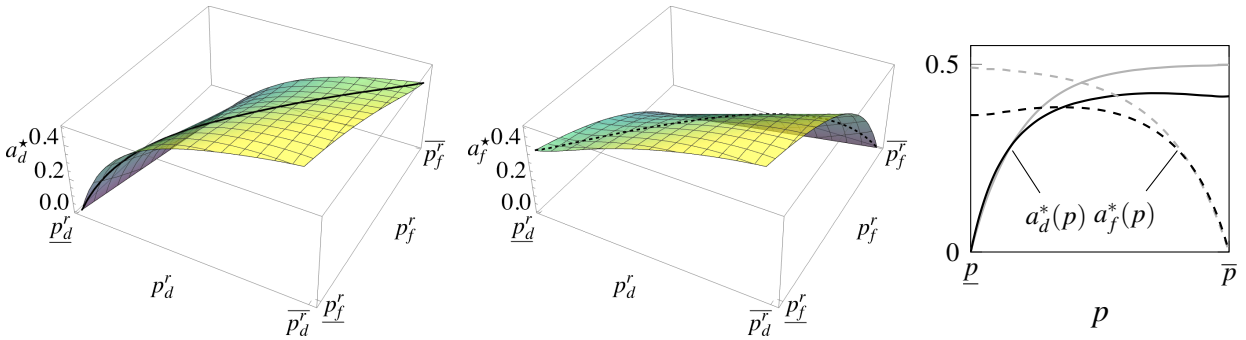
c) and the equilibrium point beliefs of the domestic and foreign tax authorities are given by

$$\mu_d(p_d^r, p_f^r) = \begin{cases} \underline{p_d}, & (p_d^r, p_f^r) \in \mathbb{R}^2 \setminus \{M \cup \overline{M_d}\} \\ p_d^r - \frac{b_d \psi(p_d^r - p_f^r)}{q \tau_d \theta_d}, & (p_d^r, p_f^r) \in M \\ \overline{p_d}, & (p_d^r, p_f^r) \in \overline{M_d}, \end{cases}$$

$$\mu_f(p_d^r, p_f^r) = \begin{cases} \underline{p_f}, & (p_d^r, p_f^r) \in \underline{M_f} \\ p_f^r + \frac{b_f \psi(p_d^r - p_f^r)}{q \tau_f \theta_f}, & (p_d^r, p_f^r) \in M \\ \overline{p_f}, & (p_d^r, p_f^r) \in \mathbb{R}^2 \setminus \{M \cup \underline{M_f}\}, \end{cases}$$

where p_d^{r*}, p_f^{r*} are solutions to (4) and (5), $a_d^\star, a_f^\star$ are solutions to the coupled system of partial differential equations (8) together with the Dirichlet boundary conditions $a_d(\underline{p_d^r}(p_f^r), p_f^r) = 0, a_f(p_d^r, \overline{p_f^r}(p_d^r)) = 0$. M is a closed set of all vectors (p_d^r, p_f^r) such that $\{\underline{p_d^r}(p_f^r) \le p_d^r \le \overline{p_d^r}(p_f^r)\} \wedge \{\underline{p_f^r}(p_d^r) \le p_f^r \le \overline{p_f^r}(p_d^r)\}$ (reports that lead to interior beliefs). $\underline{M_i}$ is the set of all vectors (p_i^r, p_{-i}^r) with $p_i^r < \underline{p_i^r}(p_{-i}^r)$ and p_{-i}^r without restriction ("too low" reports). And $\overline{M_i}$ is the set of all vectors (p_i^r, p_{-i}^r) with $p_i^r > \overline{p_i^r}(p_{-i}^r)$ and p_{-i}^r without restriction ("too high" reports). Finally, $\underline{p_d^r}(p_f^r)$, $\overline{p_d^r}(p_f^r)$, $\underline{p_f^r}(p_d^r)$, $\overline{p_f^r}(p_d^r)$ are the solutions to $p_d^r - \frac{b_d \psi(p_d^r - p_f^r)}{q \tau_d \theta_d} = \underline{p_d}$, $p_d^r - \frac{b_d \psi(p_d^r - p_f^r)}{q \tau_d \theta_d} = \overline{p_d}$, $p_f^r + \frac{b_f \psi(p_d^r - p_f^r)}{q \tau_f \theta_f} = \underline{p_f}$, $p_f^r + \frac{b_f \psi(p_d^r - p_f^r)}{q \tau_f \theta_f} = \overline{p_f}$, respectively.

Figure 4: Equilibrium Audit Functions.



Equilibrium audit functions of the domestic ($a_d^\star$, left panel) and foreign ($a_f^\star$, middle panel) tax authorities, depending on the domestic (p_d^r) and foreign report (p_f^r). The black solid (dashed) line indicates the equilibrium path in the domestic (foreign) country. We use the baseline parameter values shown in Table 3 and assume a production quantity $q = 4.42$. Right panel: Equilibrium path audit functions of the domestic (solid line) and foreign (dashed line) tax authority, depending on the AL price p. $a_d^*(p)$ and $a_f^*(p)$ are calculated given profit maximizing production quantity q as determined in Section IV. The light gray lines show the analytical solution to the audit functions for $\psi' = 0$ (Appendix B).

Proposition 1 a) characterizes the tax authorities' equilibrium audit strategies. Both audit any combination of reports in $\mathbb{R}^2 \setminus M$ with probability zero or one, whereas reports in the set M are audited with a probability according to the solution of the coupled system of PDEs (8). Figure 4 (left and middle panel) depicts a numerical solution of the tax authorities' equilibrium audit functions.

If we insert the equilibrium tax transfer price reports p_d^{r*}, p_f^{r*} from Proposition 1 b) into the equilibrium audit functions from Proposition 1 a) (equilibrium path), both functions directly depend on p_i, and we write $a_i^*(p_d, p_f) \equiv a_i^\star(p_d^{r*}, p_f^{r*})$. Given our specification on the relationship between domestic and foreign AL prices ($p_d = p, p_f = p + \delta$), the equilibrium path audit functions depend on the argument p (thus, we write $a_i^*(p)$) and the parameter δ (Figure 4, right panel).[23] Varying p implies a synchronous change in AL prices in both countries, typically caused by a change in an MNC's functions, assets, and risk allocation. In contrast, a change in δ implies a unilateral change in the foreign AL price, which is our measure of standards inconsistency.

Proposition 1 c) implies that, for all reports that occur on the equilibrium path, the MNC—in line with its incentives—overstates the domestic transfer price and understates the foreign one.

Discussion of MNC's Tax Transfer Price Reporting

Prior to exploring the MNC's optimal production quantity choice, we analyze its reporting behavior in Stage 2, for a given quantity. In particular, we investigate how standards inconsistency δ and production quantity q impact tax avoidance and reporting inconsistency and assess how these effects are moderated by the level of global tax transparency Ψ. This analysis helps identify and isolate the different underlying mechanisms, facilitating comparative statics under an endogenous production quantity in Section IV. We define the following:

[23] For notational convenience, we omit the parameter δ where possible without confusion and simply write $a_i^*(p)$.

DEFINITION 2.

a) Reporting inconsistency is the difference between the domestic and foreign report, $p_d^r - p_f^r$.

b) Tax avoidance in a country is the difference between the nominal tax payment and the tax payment based on the reports (i.e., excluding potential penalties and back taxes). That is, for the domestic country, $\tau_d q(p_d^r - p)$*, and for the foreign country,* $\tau_f q(p + \delta - p_f^r)$.

With truthful reporting, reporting inconsistency is equal to negative standards inconsistency ($p_d^r - p_f^r = -\delta$). This is also the lower boundary for reporting inconsistency. In this case, double taxation occurs. In contrast, if $p_d^r - p_f^r > 0$, this implies untaxed income.[24]

An increase in *standards inconsistency* δ means the foreign AL price increases, whereas the domestic AL price remains constant. Therefore, only the foreign tax authority's indifference condition is *directly* affected. Keeping the indifference condition balanced requires the MNC to increase the foreign report in a one-to-one ratio. This leads to an *indirect* effect, as the now higher foreign report implies less reporting inconsistency (or increases double taxation), which increases the audit costs for both tax authorities. Compensating for this, the MNC slightly decreases the foreign report and increases the domestic one. Overall, for every dollar increase in the foreign AL price, the foreign report therefore increases by less than 1 dollar, and the domestic report increases, although the domestic standard remains constant. Thus, tax avoidance increases in both countries. The higher global tax transparency Ψ (the more sensitive the tax authorities' audit costs are to changes in reporting inconsistency), the higher this secondary effect and hence the lower the decrease in reporting inconsistency and the higher the increase in tax avoidance.

Without adjustments to the strategies, an increase in *production quantity* would increase the tax authorities' gains from an audit. Since the tax authorities' audit costs in contrast to the gains are independent from quantity, auditing becomes relatively cheaper. Balancing the indifference conditions of both tax authorities therefore requires reducing the domestic report and increasing the foreign report. As a primary effect, consequently, reporting inconsistency and the under- or overstatement per product decreases with higher quantity. This in turn increases both tax authorities' audit costs. As a secondary effect, the MNC can therefore take back part of its reporting adjustment. This secondary effect causes an increase in tax avoidance in both countries.

According to this mechanism, without global tax transparency, the MNC, as a reaction to changed standards inconsistency or production quantity, adapts reports so as to keep the overall amount of tax avoidance constant, leading to a change in reporting inconsistency. With transparency, in contrast, the MNC adapts reports less intensively, causing a change in tax avoidance but damping the change in reporting inconsistency. Generally, these effects are more pronounced if transparency Ψ is high. Concerning a change in quantity, however, the moderating effect of transparency Ψ is not always distinct. Technically, when implicitly differentiating with respect to the quantity the product rule delivers two additive terms, which in turn are influenced by Ψ, possibly in different directions. Intuitively, with higher Ψ, the primary effect (relative audit cost reduction) explained above either strengthens or weakens because reports either increase or decrease in Ψ, depending on whether there is double taxation or undertaxation. The secondary effect (absolute audit cost increase due to global tax transparency), in contrast, is always stronger with higher Ψ.

The following proposition summarizes the results:

[24] Reporting inconsistency is a cross-country (bilateral) measure, whereas we measure tax avoidance unilaterally. This enables us to disentangle the effects from different standards (δ) and by the MNC's strategic reporting.

PROPOSITION 2. *Given the separating equilibrium characterized in Proposition 1 and given an exogenous production quantity q, the following applies:*

a) Both an increase in standards inconsistency δ and in production quantity q lead to a reduction in reporting inconsistency.

b) Both an increase in standards inconsistency δ and in production quantity q lead to an increase in tax avoidance in both countries.

c) Altering the level of global tax transparency Ψ affects the relationships described under a) and b) as shown in Table 1.

Table 1: Moderating effects of global tax transparency Ψ

	$\frac{\partial \delta^r}{\partial \delta}$ $(-)$	$\frac{\partial \delta^r}{\partial q}$ $(-)$	$\frac{\partial TA_i}{\partial \delta}$ $(+)$	$\frac{\partial TA_i}{\partial q}$ $(+)$
$p_d^{r*} - p_f^{r*} > 0$	$+$	$+$	$+$	?
$p_d^{r*} - p_f^{r*} < 0$	$+^{*)}$	?	$+^{*)}$	$+^{*)}$

If global transparency Ψ increases, reporting inconsistency δ^r decreases less intensively and tax avoidance increases more intensively as consequence of increasing standards inconsistency δ. If there is positive reporting inconsistency (parts of worldwide income are untaxed), increasing quantity q decreases reporting inconsistency more intensively if transparency is low. In contrast, high transparency distinctively pronounces the increase of (local) tax avoidance as a result of higher quantity only in the case of (worldwide) double taxation.
$^{*)}$ The effect is distinct if $\psi^{(2,0)}$ is not too large.

IV. CHOICE OF PRODUCTION QUANTITY (FIRST STAGE)

We now turn to the MNC's problem of choosing an optimal production quantity, anticipating the game with both tax authorities characterized above. The MNC's equilibrium profit is given by

$$\begin{aligned}\Pi^*(q;p,\delta) = {} & (1-\tau_d)R(q) + \tau_d pq - \tau_f q(p+\delta-c) - cq \\ & \underbrace{+b_d\psi(p_d^{r*} - p_f^{r*})\left(\frac{1}{\theta_d} - a_d^*(p,q)\right) + b_f\psi(p_d^{r*} - p_f^{r*})\left(\frac{1}{\theta_f} - a_f^*(p,q)\right)}_{\geq 0\text{, benefit from tax avoidance (postaudit)}}. \end{aligned} \quad (9)$$

Π^* consists of two parts. The first part (first four terms) shows the profit the MNC receives from truthfully (and inconsistently if $\delta > 0$) reporting the AL prices in both countries. The second part captures the MNC's benefit from tax avoidance. The benefit stems from reducing the tax base in both countries (last two terms of eq. (9)). The terms $\left(\frac{1}{\theta_i} - a_i^*\right)$ reflect that the yield from tax avoidance is scaled by the audit probability. If the tax authority i does not audit ($a_i = 0$), the MNC enjoys $\frac{b_i\psi}{\theta_i}$. If the audit probability approaches $\frac{1}{\theta_i}$, the MNC's benefit vanishes. Ignoring for a

moment the influence of different production quantities on the reports and audit probabilities,[25] we can get some basic insights on how changing the AL price p (synchronously in both countries) affects the MNC's profit. First, the difference between the domestic and foreign reports is constant in the AL price p (see proof of Proposition 2), and thus $\psi(\cdot)$ does not vary as p increases. However, the domestic audit probability a_d^* increases, and the foreign audit probability a_f^* decreases in p.[26] Consequently, our analysis reveals that an MNC with low AL price realizes greater tax avoidance in the domestic country compared with the foreign one. In contrast, an MNC with a higher AL price predominantly benefits from tax avoidance in the foreign country.

The MNC's profit maximizing production quantity q^* is determined by the first-order condition[27]

$$\frac{\partial \Pi^*(q)}{\partial q} = (1-\tau_d)R'(q) + p\tau_d - \tau_f(p+\delta-c) - c$$
$$+ \underbrace{\left(b_d\left(\frac{1}{\theta_d} - a_d^*\right) + b_f\left(\frac{1}{\theta_f} - a_f^*\right)\right)\psi'(\delta^r)\frac{\partial \delta^r}{\partial q}}_{\geq 0\text{, marginal benefit from tax avoidance}} - \underbrace{\left(b_d\frac{\partial a_d^*}{\partial q} + b_f\frac{\partial a_f^*}{\partial q}\right)\psi(\delta^r)}_{\text{marginal expected penalties}} = 0, \qquad (10)$$

where for convenience $\delta^r \equiv p_d^{r*} - p_f^{r*}$ denotes reporting inconsistency. The first four terms in (10) describe all influences on the production quantity decision that are unrelated to tax avoidance and are of little interest to us. The fifth term captures the benefit from tax avoidance that comes with marginally increasing the production quantity. Recall from above that $b_i\psi(\delta^r(q))\left(\frac{1}{\theta_i} - a_i^*\right)$ measures the expected benefit from tax avoidance in country i; it increases in ψ. Increasing the quantity reduces reporting inconsistency ($\frac{\partial \delta^r}{\partial q} < 0$, see Proposition 2 a)) and thus increases the tax authority's audit costs, which in turn increases the MNC's slice of the pie. Thus, the fifth term is positive. Finally, the last term in (10) captures the change in audit probability that comes with a marginally higher quantity. Although we cannot in general determine the signs of $\frac{\partial a_i^*}{\partial q}$, they are positive in the special case of $\psi' = 0$ (Appendix C) and in our numerical examples.

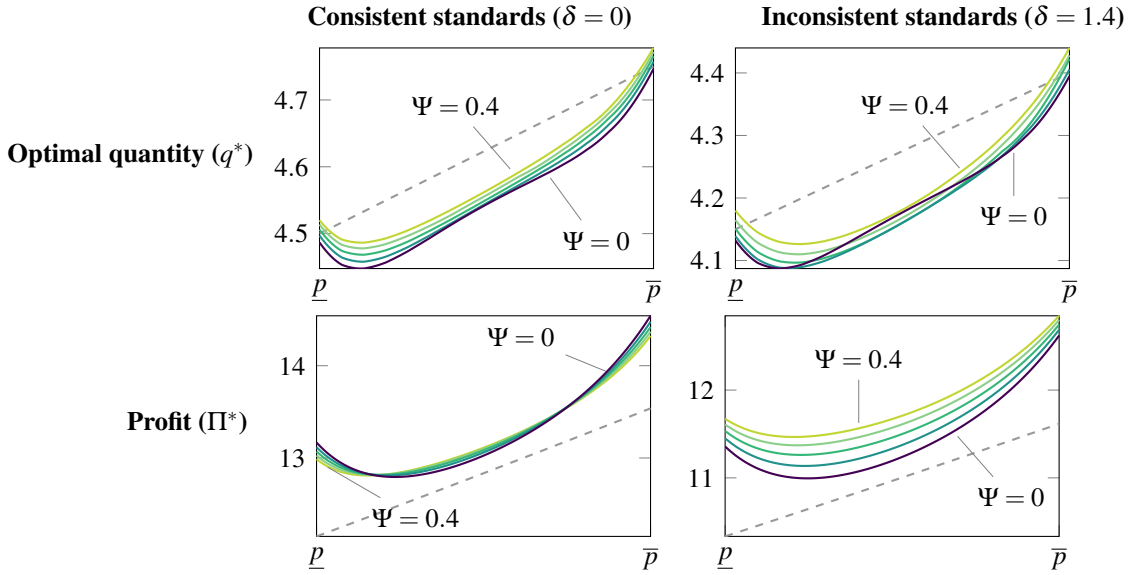
Compared with a situation without tax avoidance, the transfer price reporting effects deduced here may therefore either increase or decrease production quantity. The dashed lines in Figure 5 abstract from tax avoidance. Compared with this benchmark, in our numerical examples, the quantity is

[25] Although changing the level of production quantity q *does* affect reports (Proposition 2) and audit probabilities, it *does not* generate a switch from zero to a positive audit probability (in either country). Hence, there is no q where $\Pi^*(q)$ would not be differentiable because of a change of the audit probability from zero to positive. To see this, consider, for example, the domestic report. Given our specification $p_d = p, p_f = p + \delta$, the domestic report depends on p and q (among other parameters such as the tax rates and δ, which we can ignore for this argument); thus $p_d^{r*}(p,q)$. Likewise, the root of the audit function $a_d^*(p,q)$ moves along with q. The lowest report (the one that is associated with audit probability zero in the domestic country) is given by $p_d^{r*}(\underline{p},q)$. We know that $\frac{\partial p_d^{r*}}{\partial p} = 1 \forall q$ (see proof of Proposition 2). Thus, given any $\hat{p} > \underline{p}$, there can be no q such that there is a crossing between $p_d^{r*}(\underline{p},q)$ and $p_d^{r*}(\hat{p},q)$; in other words, the audit probability cannot be made zero by choosing q appropriately. The same kind of reasoning applies to the foreign report and audit function.

[26] For the full model, we cannot establish analytically that a_d^* (a_f^*) increases (decreases) in p. However, we show this mechanism analytically for the special case $\psi' = 0$ (Appendix C); also, our numerical examples suggest this relationship.

[27] Establishing a general condition for concavity of the profit function Π^* (and thereby uniqueness and global optimality of the quantity implicitly determined by the first-order Condition (10)) is infeasible since analytical solutions to a_d^* and a_f^* are unavailable. The second-order condition is always fulfilled in our numerical examples (Section V).

Figure 5: Firm Level Effects of AL Price, Global Tax Transparency, and Standards Inconsistency.



The figure shows firm profit (bottom row) given optimal quantity (top row), depending on the AL price p for different level of global tax transparency Ψ. The graphs are color coded, with yellow illustrating the case of high transparency ($\Psi = 0.4$). As global tax transparency decreases (Ψ increases in steps of 0.1), the graphs become darker in color. The darkest graph, depicted in a dark purple shade, represents absence of transparency $\Psi = 0$). The left panels show a situation with full standards consistency ($\delta = 0$), whereas the right panels show a situation with high standards inconsistency ($\delta = 1.4$). We obtain numerical solutions using the revenue function $R(q) = q(k - lq)$, specify the global tax transparency mechanism as $\psi(\delta^r, \Psi) = (1 - \Psi\delta^r)$, and use the parameter values shown in Table 3. The gray dashed lines indicate a benchmark situation without tax avoidance and auditing.

increased at both ends of the AL price range and reduced for intermediate AL prices p (Figure 5 top panels). Intuitively, the sum of marginal audit probabilities (and therefore marginal expected penalties) is highest for MNCs with intermediate AL prices p, which translates to lower quantity.

The following proposition summarizes the influence of benchmark AL price p, standards inconsistency δ, and global tax transparency Ψ on MNC profit.

PROPOSITION 3. *Given the separating equilibrium shown in Section III, the following applies:*

a) The MNC's profit is convex in p with a minimum at $\check{p}$ that satisfies $\tau_d q + \psi(\delta^r) b_f \left(-\frac{\partial a_f^*}{\partial p}\right) = \tau_f q + \psi(\delta^r) b_d \frac{\partial a_d^*}{\partial p}$.[28]

b) Increasing the level of standards inconsistency δ affects the MNC's profit via a negative tax rate effect, a positive tax avoidance effect induced by lower audit costs, and an audit effect with an indeterminate sign.

[28] This result assumes that the weighted sum of the equilibrium audit functions is concave ($b_d \frac{\partial^2 a_d^*}{\partial p^2} + b_f \frac{\partial^2 a_f^*}{\partial p^2} \leq 0$). The assumption is fulfilled in our numerical examples and in the special case $\psi' = 0$.

c) Increasing global tax transparency Ψ affects MNC's profit via a tax avoidance effect that is negative if some of the MNC's worldwide income is untaxed and positive if the MNC suffers double taxation and via an audit effect with indeterminate sign.

Proposition 3 a) implies that profit is minimal at the point where (expected) marginal effects of altering the AL price p in the domestic and foreign countries are equal. Intuitively, this can be explained as follows. Consider a model with (only) truthful reporting. In this model, profit increases linearly with the AL price p at a rate of $\Pi_p^{\text{"truthful"}} = q(\tau_d - \tau_f)$. This basic effect also exists in our model (with tax avoidance). Additionally, however, we account for audit probabilities, which are functions of the AL price p. Audit pressure is highest for MNCs with intermediate AL prices, which damps profits. This is because MNCs with both high and low AL prices are de facto audited in one country only. Recall that the equilibrium implies that the audit probability is zero for the lowest (highest) reported price in the domestic (foreign) country. Both audit functions are concave.[29] Increasing the AL price from $\underline{p}$, the foreign audit probability remains almost constant, whereas the domestic audit probability increases more (and *vice versa* when decreasing the AL price from $\overline{p}$). Therefore, an intermediate AL price p is audited with a relatively high probability in both countries (Figure 4, right panel).

The profit-reducing tax rate effect following an increase in standards inconsistency δ (Proposition 3 b)) reflects an increased tax base in the foreign country. As a second effect, however, the MNC benefits from exploiting the tax authorities' higher audit costs that are a result of lower reporting inconsistency δ^r due to higher standards inconsistency δ (Proposition 2 a)). Third, although we cannot determine the sign of the audit effect, it is positive in our numerical examples.

The effect of changing global tax transparency Ψ depends on whether the MNC is subject to double taxation or generates untaxed income. In the case of double taxation, an increase in transparency harms the tax authorities because it weakens their arguments to further broaden the tax base, resulting in higher audit costs, which benefits the MNC. In contrast, if some part of the worldwide tax base is untaxed, higher transparency reduces the MNC's benefit from tax avoidance and thus profit. Second, an audit effect with a generally indeterminate sign emerges that is positive in our numerical examples. Consistent with the intuition, in our numerical examples, the MNC overall benefits from greater transparency if standards are inconsistent (Figure 5, bottom right panel). In the absence of standards inconsistency (Figure 5, bottom left panel), however, only MNCs with intermediate AL prices benefit from a high level of global tax transparency, whereas those with both low and high AL prices prefer a low level. Intuitively, MNCs with intermediate AL prices are heavily audited in both countries (Figure 4) and therefore especially benefit from a reduction in audit probability that is a result of higher transparency.

Double Taxation

According to our expert interviews and online survey, double taxation is a major concern for many transfer pricing experts.[30] Here we provide a quick overview of the implications of our model for this problem. If standards are equal ($\delta = 0$), Equation (9) describes that the MNC always benefits from its ability to hide some income, as determined by the separating equilibrium (last two terms). Double taxation can only (but need not) occur if the foreign country establishes generally higher tax

[29] We show this for the special case $\psi' = 0$ (Corollary 1 in Appendix C). It is also given in our numerical examples.
[30] See Appendix A, Table A.1.

transfer prices ($\delta > 0$). In this case, nominal double taxation $\tau_f q \delta$ emerges, but effective double taxation—taking into account tax avoidance—may be lower or even negative.[31] As δ increases, reporting inconsistency decreases (Proposition 2 a)), which in turn increases audit costs and thus increases the postaudit benefit from tax avoidance. We also find in our numerical simulations that both the optimal production quantity and the audit probabilities decrease in δ, which further strengthens this effect. Overall, therefore, in the presence of a global tax transparency mechanism and strategic auditing, an increase in effective double taxation as a result of increasing the foreign standard can be partly self-damping.

V. AGGREGATE EFFECTS: TAX REVENUES AND WELFARE

Having analyzed firm-level effects, we next focus on aggregate effects, that is, countries' net tax revenues and global social welfare, which consists of consumer surplus, producer surplus, and net tax revenues. We provide numerical examples to illustrate the overall effects.

Net Tax Revenues

Introducing the MNC's equilibrium reporting policy and production decision into the tax authorities' objective functions (1) and (2), respectively, we obtain

$$\begin{aligned} T_d &= \overbrace{\tau_d \left(R(q^*) - q^* p\right)}^{\text{nominal tax revenue}} - \overbrace{b_d \psi(\delta^r) \left(\frac{1}{\theta_d} - a_d^*\right)}^{\text{postaudit tax avoidance}} - \overbrace{a_d^* b_d \psi(\delta^r)}^{\text{audit cost}} \qquad (11) \\ &= \tau_d \left(R(q^*) - q^* p\right) - \frac{b_d \psi(\delta^r)}{\theta_d}, \\ T_f &= \underbrace{\tau_f q^* (p + \delta - c)}_{\text{nominal tax revenue}} - \underbrace{b_f \psi(\delta^r) \left(\frac{1}{\theta_f} - a_f^*\right)}_{\text{postaudit tax avoidance}} - \underbrace{a_f^* b_f \psi(\delta^r)}_{\text{audit cost}} \qquad (12) \\ &= \tau_f q^* (p + \delta - c) - \frac{b_f \psi(\delta^r)}{\theta_f}. \end{aligned}$$

Tax revenues consist of three components. The first terms (nominal tax revenue) in eq. (11) and (12), respectively, capture the structure of tax revenues for truthful reporting, whereas the second terms (tax avoidance) describe the amount that is shifted from the tax authorities to the MNC. These terms (with the opposite sign) are also part of the MNC's profit function (eq. 9). The third terms (audit cost) indicate the cost of audit. When summing up the tax avoidance and the audit cost terms, the audit functions vanish. This happens because the extra taxes gained from audits in equilibrium need to match the costs of those audits.

There are situations in which reducing global tax transparency reduces production quantity,[32] and this benefits the domestic tax authority, whereas the foreign tax authority suffers. This is due to

[31] Ultimately, effective double taxation occurs when the benefit from tax avoidance (postaudit) is less than the amount of double taxation caused by higher foreign AL prices.

[32] Reducing global tax transparency Ψ in our numerical example below reduces production quantity in most cases; quantity only increases for intermediate AL prices under inconsistent standards (Figure 5, top right panel).

changes in nominal tax revenues, i.e., first terms of (11) and (12). For the domestic tax authority, lowering quantity reduces tax-deductible expenses $q^* p$ linearly, whereas sales revenues $R(q^*)$ decrease according to the concave revenue function, potentially leading to higher tax revenues.

For an intuitive explanation, suppose the revenue-maximizing domestic tax authority could determine the MNC's production quantity q (i.e., maximize (11) with respect to q). Then the optimal production quantity for the domestic tax authority often would be lower than the optimal quantity q^* from the perspective of an MNC because, *cum grano salis,* the domestic tax authority's "equivalent marginal cost of production" p would exceed the MNC's marginal cost c. This illustrates that the domestic tax authority can benefit from a lower equilibrium production quantity q^*.[33] By contrast, the foreign tax authority suffers from a reduced quantity.

The countries' tax revenues are important components of global social welfare.

Components of Global Social Welfare

We follow a common approach in the related literature to measure social welfare as the sum of consumer surplus, producer surplus/after-tax firm value, and tax revenue (Anand and Sansing, 2000; De Waegenaere and Sansing, 2010; De Waegenaere, Sansing, and Wielhouwer, 2012). We additionally study the different components of social welfare. Consumer surplus, producer surplus, and tax revenues enter the global social welfare function[34] in expected value terms (see Table 2).

The first row shows consumer surplus. In our setting, the product is sold on the domestic market only, so consumer surplus only applies to the inhabitants of the domestic country. Tax avoidance and auditing affect consumer surplus via a changed production quantity q^*. Producer surplus (second row) is affected directly by standards inconsistency δ and indirectly (via tax avoidance possibilities) by both standards inconsistency and global tax transparency (Proposition 3). Nominal tax revenue (third row) allows us to illuminate the indirect influence of standards inconsistency and global tax transparency via changed production quantity. Finally, we examine audit cost, and preaudit tax avoidance, i.e., the amount by which the MNC reduces the nominal tax payment before expected tax payment adjustments and penalties.

Numerical Examples

In this section, we provide numerical examples to explore the implications of our model, especially on domestic and foreign expected tax revenues and the different components of social welfare shown above. We model the product market using the sales revenue function $R(q) = q(k - lq)$, that

[33] Our model does not incorporate optimal MNC investment and therefore does not depict effects due to incomplete deductibility of capital costs (which is referred to as standard corporate tax distortion; for transfer pricing settings, see, e.g., Haufler and Schjelderup (2000) and Juranek, Schindler, and Schjelderup (2018)). In particular, we assume that cq is fully deductible (because we interpret this amount as production cost rather than cost of capital). Incomplete deductibility of costs generally invokes underinvestment (which would translate to lower q in our model). The tax base effect shown by us—in contrast—is due to "overdeductibility" in the domestic country because the AL price is always above marginal production cost. When assuming that c is not fully deductible in the foreign country, this would imply a c.p. lower optimal quantity. However, the "overdeductibility" in the domestic country would still be in place. The two effects are opposite. In total, our model therefore overemphasizes the tax base effect described above if c is regarded as an incomplete deductible cost of capital rather than marginal cost of production.

[34] Since we define the global social welfare function as the unweighted sum of consumer surplus, producer surplus and tax revenues, its focus is on pure efficiency. This implies that the tax rates would be zero if they were optimized within the model. Our analysis therefore has the inherent constraint that there must be a positive corporate tax rate.

Table 2: Components of Global Social Welfare

Consumer surplus	$\int_{\underline{p}}^{\overline{p}} \left(\int_0^{q^*(p)} \frac{R(q)}{q} dq - q^*(p) \frac{R(q^*(p))}{q^*(p)} \right) f(p)\, dp$	
Producer surplus	$\int_{\underline{p}}^{\overline{p}} \max_q \Pi^*(q;p) f(p)\, dp$	
	Domestic country	Foreign country
Nominal tax revenue	$\int_{\underline{p}}^{\overline{p}} \tau_d (R(q^*) - q^* p) f(p)\, dp$	$\int_{\underline{p}}^{\overline{p}} \tau_f q^* (p + \delta - c) f(p)\, dp$
Audit cost	$\int_{\underline{p}}^{\overline{p}} a_d^* b_d \psi(p_d^{r*} - p_f^{r*}) f(p)\, dp$	$\int_{\underline{p}}^{\overline{p}} a_f^* b_f \psi(p_d^{r*} - p_f^{r*}) f(p)\, dp$
Preaudit tax avoidance	$\int_{\underline{p}}^{\overline{p}} \frac{b_d}{\theta_d} \psi(p_d^{r*} - p_f^{r*}) f(p)\, dp$	$\int_{\underline{p}}^{\overline{p}} \frac{b_f}{\theta_f} \psi(p_d^{r*} - p_f^{r*}) f(p)\, dp$
	$= \int_{\underline{p}}^{\overline{p}} \tau_d q^* (p_d^{r*} - p) f(p)\, dp$	$= \int_{\underline{p}}^{\overline{p}} \tau_f q^* (p + \delta - p_f^{r*}) f(p)\, dp$
Global Social Welfare	$\overbrace{\int_{\underline{p}}^{\overline{p}} \left(R(q^*(p)) - c q^*(p) - \psi(p_d^{r*} - p_f^{r*})(b_d a_d^* + b_f a_f^*) \right) f(p)\, dp}^{\text{Sum of producer surplus (= expected MNC profit) and net tax revenue}}$	
	$+ \underbrace{\int_{\underline{p}}^{\overline{p}} \left(\int_0^{q^*(p)} \frac{R(q)}{q} dq - q^*(p) \frac{R(q^*(p))}{q^*(p)} \right) f(p)\, dp}_{\text{Consumer surplus}}$	

The table shows the different parts of social welfare. We take expected values over all AL prices p. In our setting, the product is sold on the domestic market only, therefore, the "consumer surplus" part (first row) applies to the inhabitants of the domestic country. Worldwide "producer surplus" equates expected MNC profit since we abstract from fixed production costs. "Nominal tax revenue" assumes that the tax is based on the AL price p, but the quantity q^* is affected by tax avoidance and auditing. "Audit cost" is the expected amount that the tax authority in equilibrium invests in auditing. "Preaudit tax avoidance" is the amount by which the company reduces the nominal tax payment before expected back taxes and penalties.

Regarding only the parts inside the integrals, net tax revenues as shown in Equations (11) and (12) are obtained by calculating: "nominal tax revenue" − "audit cost" − ("preaudit tax avoidance" − "audit cost") = "nominal tax revenue" − "preaudit tax avoidance".

The last row, "global social welfare", displays the sum of producer surplus, consumer surplus, and net tax revenue. Although some authors multiply tax revenues with a weight (e.g. Hebous and Keen, 2023), we follow the common approach in the tax transfer pricing literature by taking the unweighted sum (Anand and Sansing, 2000; De Waegenaere and Sansing, 2010; De Waegenaere, Sansing, and Wielhouwer, 2012).

Table 3: Symbols, Exemplary Functions and Parameter Values

Description	Symbol	Specification / Value
Exemplary functions		
Revenue function	$R(q)$	$q(k-lq)$
Global tax transparency function	$\psi(p_d^r - p_f^r, \Psi)$	$1 - \Psi \cdot (p_d^r - p_f^r)$
(Exogenous) parameters		
Domestic tax authority's marginal audit cost	b_d	2.0
Foreign tax authority's marginal audit cost	b_f	2.0
Marginal cost of production	c	1.0
Maximal sales price	k	10.0
Price sensitivity	l	1.0
Lowest AL price	$\underline{p}$	1.0
Highest AL price	$\overline{p}$	4.0
Standards inconsistency: foreign AL price markup	δ	$[0.0, 1.4]$
Penalty rate domestic country	θ_d	2.0
Penalty rate foreign country	θ_f	2.0
Tax rate domestic country	τ_d	0.4
Tax rate foreign country	τ_f	0.3
Global tax transparency	Ψ	$[0.0, 0.4]$
(Endogenous) variables / strategies		
	General	*In equilibrium*
Reported transfer prices	p_d^r, p_f^r	p_d^{r*}, p_f^{r*}
Reporting inconsistency	$p_d^r - p_f^r$	$\delta^r \equiv p_d^{r*} - p_f^{r*}$
Audit policy	α_d, α_f	$a_d(p_d^r, p_f^r), a_f(p_d^r, p_f^r)$

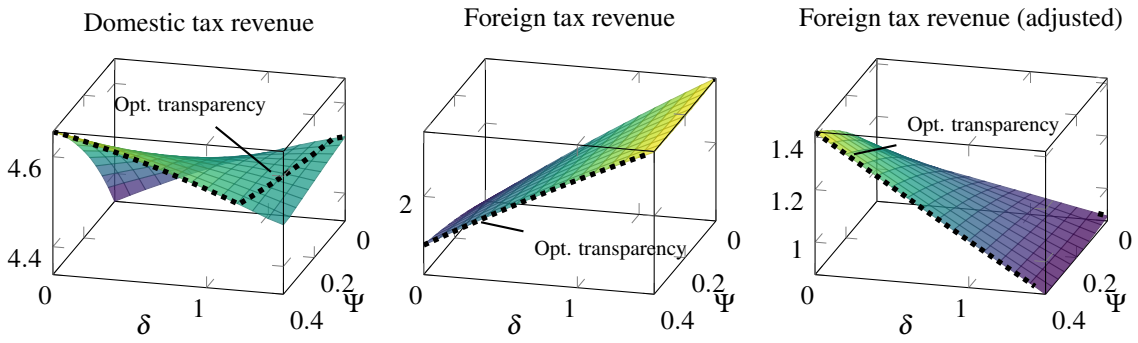
Overview over symbols, exemplary functions and baseline parameter values for the numerical examples.

is, quantity times sales price, where the sales price follows from a linear demand according to $k - lq$. k is the maximal sales price, and l denotes the price sensitivity of demand. Concerning AL prices, we assume a uniform distribution, $f(p) = \frac{1}{\overline{p}-\underline{p}}$. Finally, we model the transparency mechanism as $\psi(p_d^r - p_f^r, \Psi) = 1 - \Psi \cdot (p_d^r - p_f^r)$. Table 3 shows the baseline parameter values. Figures 6, 7, and 8 illustrate the implications of standards inconsistency and global tax transparency for expected net tax revenues and global social welfare as well as sales prices and reported prices.

Figure 6 shows the influence of global tax transparency and standards inconsistency on expected net tax revenues $E(T_d) = \int_{\underline{p}}^{\overline{p}} T_d f(p)\, dp, E(T_f) = \int_{\underline{p}}^{\overline{p}} T_f f(p)\, dp$ in the domestic (left) and foreign country (middle, right). The black dotted lines show the optimal level of global tax transparency for a given level of standards inconsistency from the viewpoint of the domestic and foreign tax authorities, respectively. We explain the result and its intuition with the aid of Figure 7, which shows the components of net tax revenue: nominal tax revenue, tax avoidance, and audit cost.

For consistent standards ($\delta \to 0$), both tax authorities benefit in terms of expected net tax revenues from high global tax transparency ($\Psi \to 0.4$). For both, this benefit mainly stems from both reduced tax avoidance and lower audit costs (Figure 7, middle left panel). As a weaker, second effect,

Figure 6: Impact of Global Tax Transparency and Standards Inconsistency on Net Tax Revenues.



The figure shows expected net tax revenue of the domestic (left) and foreign (middle, right) countries depending on the level of standards inconsistency δ and global tax transparency Ψ. For the foreign country, we show expected net tax revenues (middle) as well as adjusted expected net tax revenues that are artificially reduced by $\tau_f \delta q$ to eliminate the mechanical increase in tax revenues that comes from increasing foreign standards (right). The black dotted lines indicate the optimal level of global tax transparency for a given level of standards inconsistency from the viewpoint of the countries. By trend, if standards are consistent, both countries benefit from high transparency ($\Psi = 0.4$). As standards become more inconsistent, the domestic country prefers an intermediate level, and, eventually, is best off without transparency ($\Psi = 0$).

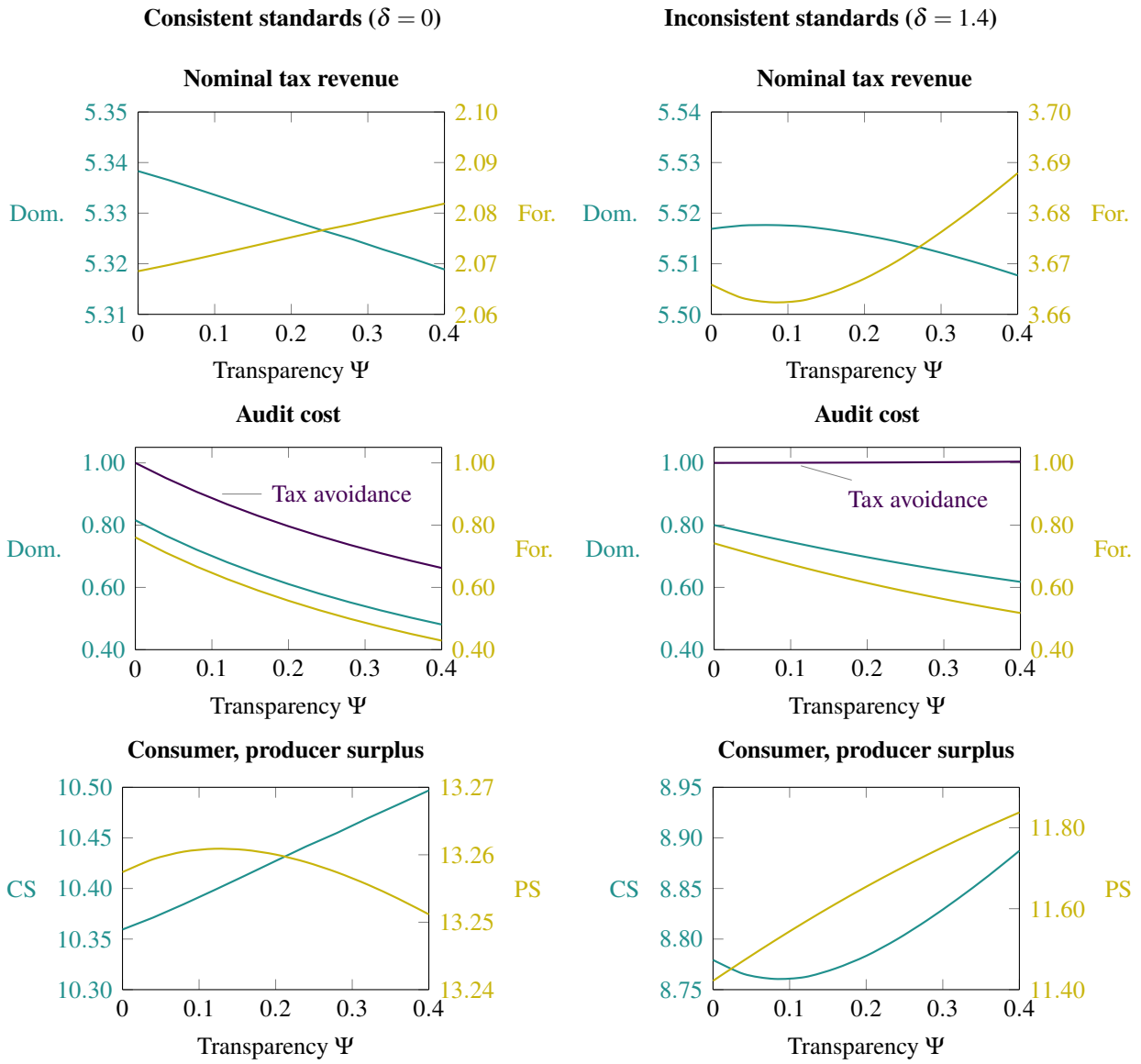
production quantity increases (Figure 5, top left panel), which benefits the foreign tax authority but hurts the domestic one (Figure 7, top left panel).

In contrast, when standards are inconsistent ($\delta \to 1.4$), the production effect gains importance relative to the tax avoidance effect. Intuitively, the MNC compensates for the inconsistent standards in such a way that the reports are approximately consistent or even anticipate double taxation, which in turn inhibits the ability of the tax authorities to challenge the reports. As a result, the level of tax avoidance remains roughly constant over all levels of global tax transparency (Figure 7, middle right panel). Production quantity decreases, however, which benefits the domestic tax authority. Thus, there are levels of standards inconsistency for which the domestic country prefers an intermediate or even low level of global tax transparency.

Consumer surplus increases with consistent standards and high global tax transparency via a higher production quantity (Figure 7, bottom panels). Notably, consumers overall benefit in our example even when domestic tax revenues are considered a part of their utility. This is because tax revenues are less sensitive toward changes in standards consistency than consumer surplus. For example, under low global tax transparency, reducing standards inconsistency from $\delta = 1.4$ to $\delta = 0$ reduces domestic tax revenues by 0.13 but increases consumer surplus by 1.60, leading to an overall increase of 1.47 (Table 4). Hence, a higher production quantity benefits consumers but not necessarily the tax authorities, as explained above.

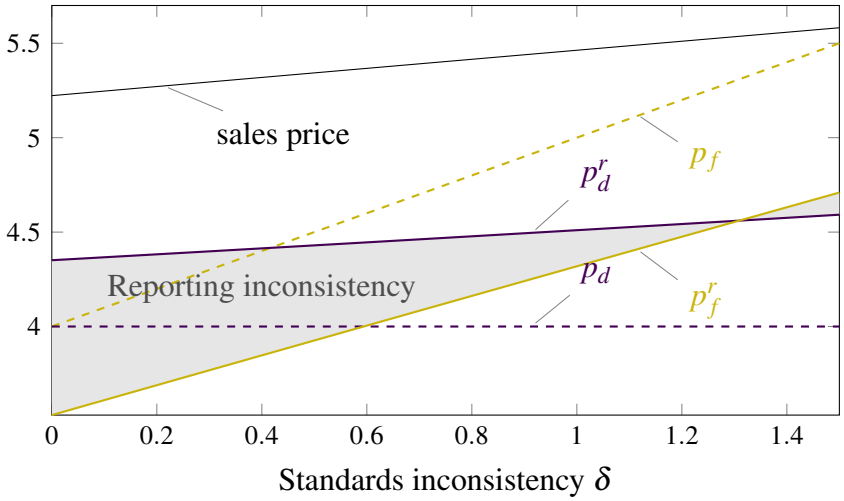
Producers, by contrast, benefit from high global tax transparency only if standards are inconsistent. Inconsistent standards motivate the MNC to anticipate some of the inconsistency in the reports. The difference between reports (gray area in Figure 8) shrinks or even implies double taxation, which in turn impedes the tax authorities from enforcing the respective AL prices. If standards are consistent, however, MNCs with intermediate AL prices benefit from high transparency (because they enjoy the lower audit probability that accompanies it), whereas those with high or low AL

Figure 7: Components of Global Social Welfare



The figure shows components of social welfare (Table 2), depending on the level of global tax transparency Ψ, for consistent ($\delta = 0$, left) and inconsistent standards ($\delta = 1.4$, right). Turquoise (yellow) lines show the results for the domestic (foreign) country. The purple lines in the middle row show preaudit tax avoidance according to Definition 2 b).

Figure 8: Sales Price, AL Prices, and Reported Prices



Reported transfer prices in the domestic (purple solid line) and foreign country (yellow solid line), depending on standards inconsistency (foreign AL price markup) δ. The light gray area shows the level of reporting inconsistency. The black line shows the sales price assuming linear demand, $k - lq^*$. The dashed lines indicate AL prices p_d and p_f. We use the baseline parameters in Table 3, $\Psi = 0.4$, and a domestic AL price $p_d = 4$. The figure shows that the results shown in Proposition 2 still hold when accounting for an endogenous production quantity. Higher standards inconsistency δ leads to less inconsistent reports, and, eventually (for $\delta \gtrsim 1.3$), to double taxation. A change in the foreign standard (i.e., a change in δ) not only affects the foreign report, but also—to a lesser extent—the domestic report.
The figure also shows that—given the chosen parameters—the reported prices are always between the marginal production cost c and the sales price.

prices benefit from low transparency (because they face a low total audit probability anyway; see the explanations on Proposition 3 for details). Given that producer surplus equates expected MNC profit, i.e., the integral over all AL prices p, the "optimal" level of global tax transparency also depends on the distribution of AL prices. In our numerical example, there is an interior maximum with low transparency (yellow line in the bottom left panel of Figure 7).

Table 4 summarizes our numerical results. The middle panel shows a benchmark scenario, where all MNCs report truthfully. We study sets of consistent-to-inconsistent standards ($\delta \in \{0, 0.7, 1.4\}$) and high-to-low global tax transparency ($\Psi \in \{0.36, 0.2, 0.04\}$).

Table 4: Numerical Example

(1) Global tax transparency	(2) Standards inconsistency	(3) Minimum sales price	(4) Quantity range	(5) Nominal tax revenue domestic / foreign	(6) Tax avoidance domestic / foreign*	(7) Audit cost domestic / foreign	(8) Net tax revenue domestic / foreign	(9) Producer Surplus	(10) Consumer Surplus	(11) Global Social Welfare
Ψ	δ	$\min_p(k - lq^*(p))$	$[\min_p q^*(p), \max_p q^*(p)]$							
Benchmark: no tax avoidance (truthful reporting)										
–	0.0	5.25	[4.50,4.75]	5.29 / 2.10	–	–	5.29 / 2.10	12.84	10.70	30.93
–	0.7	5.43	[4.33,4.58]	5.40 / 2.96	–	–	5.40 / 2.96	11.88	9.90	30.15
–	1.4	5.60	[4.15,4.40]	5.49 / 3.74	–	–	5.49 / 3.74	10.97	9.14	29.33
Separating equilibrium										
0.36	0.0	5.22	[4.48,4.78]	5.32 / 2.08	0.69	0.50 / 0.45	4.64 / 1.40	13.25	10.48	29.77
0.36	0.7	5.39	[4.30,4.61]	5.43 / 2.92	0.85	0.58 / 0.50	4.58 / 2.07	12.50	9.65	28.80
0.36	1.4	5.56	[4.12,4.44]	5.51 / 3.68	1.00	0.58 / 0.53	4.51 / 2.68	11.80	8.86	27.85
0.20	0.0	5.23	[4.47,4.77]	5.33 / 2.08	0.80	0.61 / 0.56	4.53 / 1.28	13.26	10.43	29.50
0.20	0.7	5.41	[4.28,4.59]	5.44 / 2.91	0.90	0.66 / 0.59	4.54 / 2.01	12.43	9.59	28.56
0.20	1.4	5.58	[4.10,4.42]	5.52 / 3.67	1.00	0.66 / 0.61	4.51 / 2.67	11.65	8.78	27.62
0.04	0.0	5.25	[4.45,4.75]	5.34 / 2.07	0.95	0.77 / 0.71	4.39 / 1.12	13.26	10.37	29.13
0.04	0.7	5.42	[4.27,4.58]	5.44 / 2.91	0.98	0.77 / 0.71	4.46 / 1.93	12.35	9.55	28.29
0.04	1.4	5.60	[4.09,4.40]	5.52 / 3.66	1.00	0.77 / 0.71	4.52 / 2.66	11.47	8.77	27.42

This table shows the results of our numerical example, using the baseline parameters in Table 3, and varying the level of global tax transparency Ψ, and standards inconsistency δ. The panel in the middle shows a benchmark case where the MNC truthfully (and inconsistently if $\delta > 0$) reports p_d, p_f, and the tax authorities do not audit. The panel in the bottom shows the results of our model. The results on the minimum sales price show that our choice of upper bound of AL prices $\overline{p}_d = 4, \overline{p}_f = 4 + \delta$ is reasonable in that it does not exceed the sales price.

Column (6) shows the expected value of preaudit tax avoidance (Definition 2 b)) as shown in Figure 7. This amount is reduced as a result of audits via back taxes and penalties, the sum of which is equal to audit costs. Since nominal tax revenue, tax avoidance, and audit costs are additive separable (Equations 11 and 12) expected net tax revenues are given by subtracting column (6) from column (5).

*Tax avoidance is symmetrical (the amount of tax avoidance in the domestic and foreign country is identical) if penalties and audit costs are identical in both countries $\theta_d = \theta_f$ and $b_d = b_f$, which we assume here (Table 3).

Column (3) shows the minimum sales price for different parameter constellations. In all cases, the minimum sales prices are higher than the upper bounds of the AL price range, $\overline{p_i}$, which comports with common transfer pricing regulation. Column (4) shows the minimal and maximal production quantities. Column (8) shows expected net tax revenue, and columns (5)–(7) display its components (nominal tax revenue, tax avoidance, audit cost). Finally, columns (9) and (10) show producer and consumer surplus, respectively. Consumer surplus is higher in the benchmark scenario than in the equilibrium. Although the quantity range (column (4)) is wider in the equilibrium, most MNC types reduce their production relative to the benchmark (Figure 5 and the explanation on page 17), which translates into lower consumer surplus.

Column (11) shows that overall social welfare declines as the inconsistency in standards grows. Despite this loss in social welfare, with low global tax transparency ($\Psi = 0.04$), individual countries benefit and experience an increase in net tax revenues, as indicated in column (8). Notably, this occurs even though tax avoidance, referenced in column (6), also rises.

Overall we show numerically that more global tax transparency, in most cases, benefits the foreign low-tax country, enhances total surplus, and reduces tax avoidance. The domestic high-tax country, however, may nevertheless prefer an intermediate level of global tax transparency if standards are inconsistent. Even though we cannot deduce these results analytically, in sensitivity analyses, they turn out to be robust toward parameter changes.

VI. CONCLUSIONS

We study how tax transfer pricing harmonization affects MNC's reporting and tax authorities' auditing decisions and how this translates into real effects. We investigate how enhanced consistency of transfer pricing standards among countries and enhanced global tax transparency, for example, achieved by tax information exchange agreements or country-by-country reporting, affect tax avoidance, double taxation, producer and consumer surplus, tax revenues, and global welfare. Understanding these effects is important as ongoing initiatives aim to enhance standards consistency and global tax transparency, for example, through the Inclusive Framework, complemented by technological innovations like e-invoicing and blockchain.

We analyze a separating equilibrium and find that enhanced global tax transparency and standards consistency increase consumer surplus. Producers, by contrast, benefit from low transparency if standards are consistent. However, if standards are inconsistent, enhanced global tax transparency can mitigate effective double taxation. Maximizing global social welfare requires high levels of both global tax transparency and standards consistency. Nonetheless, through the lens of either the MNC or any single tax authority, the optimal level of global tax transparency might be intermediate or low. This misalignment of interests poses substantial challenges for international reforms aiming for high global tax transparency to curb tax avoidance.

Our contribution is two-fold. First, we extend the tax transfer pricing literature by modeling an MNC that can report inconsistent transfer prices to strategically acting tax authorities. Second, we study how this strategic situation affects an MNC's production decision under different levels of global tax transparency and standards inconsistency and show how this impacts welfare.

Our research suggests that, although enhanced global tax transparency benefits global welfare, its components, such as tax revenues or producer surplus, may be maximized at low or intermediary values, leading to adverse negotiation incentives.

When interpreting our results, keep in mind that we assume an MNC's AL price is exogenously given. This implies that we describe a short-term situation where an MNC cannot alter the AL price. In the long term, however, MNCs can influence the AL price, for example, by reallocating the functions, assets, and risks associated with production. We leave this to future research.

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APPENDIX A — EVIDENCE ON TAX TRANSFER PRICING INCONSISTENCY

Anecdotal evidence made us aware that MNCs might report different transfer prices to the involved tax authorities. Since previous literature assumes that taxpayers report only one uniform tax transfer price to the tax authorities, we conducted an online survey of transfer pricing practitioners and several expert interviews[35] to back up our deviation from the usual consistency assumption.

We surveyed senior tax transfer pricing managers from major German multinational companies, distributing invitations through two professional networks[36] from December 10, 2020, to January 20, 2021. Of the 45 experts who participated anonymously, 23 completed the survey. Most have over ten years of experience in this field, primarily holding a master's degrees and 26.1 percent with a Ph.D., dedicating about 70 percent of their work time to tax transfer pricing.

The results are summarized in Table A.1. 78.3 percent of the respondents explained that they have indeed reported different tax transfer prices across countries, with 43.5 percent having reported inconsistent prices occasionally or more often. All experienced transfer pricing inconsistencies during audits, with 87 percent encountering this (very) often. Double taxation is a common issue, whereas undertaxation is rare. Most double taxation cases—but by no means all—can be mitigated through mutual agreement procedures. However, participants noted a strong increase in double taxation due to transfer pricing differences in the past five years and anticipate further escalation.

Further, we conducted six semistructured expert interviews with German multinational company representatives, Big 4 tax advisory firms, and the German Federal Central Tax Office (BZSt) emphasizing the importance of inconsistencies in transfer pricing regimes and reports. Experienced in transfer pricing, the interviewees answered our specific questions but could also provide additional context. The interviews were scheduled for 30 minutes and typically lasted 35 minutes, with one extending to 95 minutes. They were conducted over the phone by the same author. We ensured confidentiality, promising not to publish any identifying details. The candid nature of the responses is evident, and Table A.2 categorizes these by topic.

[35] The Ethics Committee of Paderborn University approved the survey and interviews on 14 July 2021.

[36] We distributed the survey via the Transfer Pricing Working Group of the German Consortium for Economic Management (German: Arbeitsgemeinschaft für wirtschaftliche Verwaltung e.V.), which covers all industries and is a nonprofit association funded by the German Federal Ministry for Economic Affairs and Climate Action. Further, the Taxation Committee of the German Chemical Industry Association (German: Verband der Chemischen Industrie, VCI.) distributed the link to more than 20 tax managers of multinational companies in the chemical industry, which represent about 30 percent of the DAX companies, as well as several M-DAX companies and multinational family businesses. Overall, these networks helped us to distribute the link to our online survey to around 60 transfer pricing experts from German multinational companies.

Table A.1: Online Survey: Results

Experience with inconsistent tax transfer prices

	Very often	Often	Occasionally	Seldom	Never
	Inconsistent tax transfer prices were . . .				
. . . reported	4.3 %	.0 %	39.1 %	34.8 %	21.7 %
. . . result of an audit	30.4 %	56.5 %	13.0 %	.0 %	.0 %
	Inconsistent tax transfer prices led to . . .				
. . . double taxation	19.0 %	47.6 %	23.8 %	9.5 %	.0 %
. . . undertaxation	.0 %	4.8 %	9.5 %	23.8 %	61.9 %
	If the sets of feasible domestic and foreign tax transfer prices intersect . . .				
. . . a single price is chosen	43.5 %	21.7 %	26.1 %	4.3 %	4.3 %
. . . different prices are chosen	8.7 %	4.3 %	8.7 %	30.4 %	47.8 %
	If the sets of feasible domestic and foreign tax transfer prices are disjunct . . .				
. . . a single price is chosen	7.2 %	18.8 %	29.0 %	20.3 %	24.6 %
. . . different prices are chosen	4.3 %	8.7 %	17.4 %	26.1 %	43.5 %

The panel shows percentage shares of a total of 23 answers, with the exception of the question on the effects (double taxation, undertaxation), where we have a total of 21 answers. Regarding Questions 3 and 4, participants were provided two examples. To simulate a situation with intersecting sets, the range of acceptable arm's-length prices was two to four from a domestic perspective and three to five from a foreign perspective (possible answers: "four in both countries"; "four in Germany, three in the foreign country"). In the situation with disjunct sets, the range of acceptable arm's-length prices was two to four from a domestic perspective and six to eights from a foreign perspective (possible answers: "four in both countries," "five in both countries," "six in both countries," "four in Germany, six in the foreign country"). Participants were then asked to choose what price would be employed in the domestic and foreign country, respectively. Participants were not provided with tax rates and the direction of the transaction.

Experience with mutual agreement procedures

Double taxation was avoided by means of a mutual agreement procedure

Always	Very often	Often	Occasionally	Seldom	Never
10.0 %	20.0 %	20.0 %	30.0 %	10.0 %	10.0 %

The panel shows percentage shares of a total of 20 answers.

Perceived and expected development of double taxation

Assessment of the development over time of the problem of double taxation

	Strong increase	Increase	No significant change	Decrease	Strong decrease
Past five years	35.0 %	60.0 %	5.0 %	.0 %	.0 %
Next five years	61.9 %	28.6 %	9.5 %	.0 %	.0 %

The panel shows percentage shares of a total of 20 answers (past five years) and 21 answers (next five years).

Table A.2: Interview: Interviewees' Quotes by Topic

Question / topic	Topic-specific responses of six tax transfer pricing experts of major German multinational corporations, Big 4 companies, or the German Federal Central Tax Office
	MNCs / Tax Advisory Companies
Transfer pricing inconsistencies in tax filing *Are there any country combinations for which you/taxpayers expect that the tax authorities will have different ideas about the level of transfer prices for a specific product or service when you/the taxpayer file your/their tax return?*	Well, the issue doesn't start in the documentation, but in the pricing. And that is simply a very difficult issue. There are already some large corporations . . . that say, for example, Brazil, there are simply unilateral regulations that prevent you from charging a license for certain things. . . . that is actually what many people do, [they] wait and see what will happen during the audit; but inconsistent pricing is dangerous in that you ultimately lose credibility in any other country.
	The answer is that a number of taxpayers differentiate and set a different transfer price in anticipation of a discussion during the tax audit.
	In other words, we are applying different transfer prices for the same business model and are thus responding to the differences in the local tax audits.
	We have said that transfer pricing is not an exact science, we have a bandwidth and we have some space to move around within that bandwidth.
	It's actually always the BRICS countries, plus countries like Italy.
	Italy, Brazil are certainly such countries. China, too. Especially when it comes to something like licenses, for example.
	You have already mentioned Brazil. In fact, there is no other way, because there is no double taxation agreement and because of the very specific regulations there is no other way to handle it.
	Tax Administration
	Of course, they now have room to maneuver and they assess individual countries differently. I am firmly convinced of that.
Transfer pricing inconsistencies after tax audit *For which country combinations have you/taxpayers experienced different transfer prices for a particular product or service as a result of an audit?*	**MNCs / Tax Advisory Companies**
	But now you have to realize that there are a few countries that always prefer to pursue their own approach, they are the usual suspects, namely China and India when it comes to service billing. So, in India no one manages to push through their normal transfer pricing system with the normal markup. At least, I don't know of anyone who can do it. It's [the markup is] much higher than almost anywhere else.
	And what I'm also noticing at the moment, so besides countries, that are the usual suspects, Brazil, Argentina and co., is Russia strangely enough.
	In principle, this can happen in all country combinations. I've seen it happen in all country combinations, and it always depends very much on the facts of the case, and you can't put it down to a specific transaction; it's simply because transfer prices are not black or white, but gray, so to say.
	I think all country combinations are possible now. It's more a question of materiality, whether you then say you're going to take this a step further. So we see many issues in Eastern Europe, because the tax authorities there take a very formalistic approach.
	So that also has nothing to do with what is an OECD country or not. This is an issue for all tax authorities.
	Well, Brazil is a special case, they have different regulations anyway.

	Tax Administration
	. . . you also have to see that of course the audit documents are sometimes different in the different countries.
	MNCs / Tax Advisory Companies
Reason for inconsistencies *What was the reason for the difference?* • *Different interpretation of the same transfer pricing method (e. g., different markup for "cost plus"; due to different data basis, different interval widths, etc.)?* • *Application of different methods?* • *Stronger evaluation of the role of the market in the context of the location of value creation?* • *Other?*	Unfortunately it is not possible to trace it back to one thing. It starts when they develop an appetite, they poke around everywhere, then they want to see the function and risk profile a little differently and question that.
	. . . you practically have to choose between a rock and a hard place; then you have a problem in Italy if you include the three percent, because the Italians then say, listen, you know very well that we don't recognize that. ... If you then say, if you cave in on the advance payment, and Italy actually only charges two percent, then you have problems in Germany, because from the point of view of the German auditor, you are foregoing one percent royalty income from Italy for reasons of proximity, and you are doing that on purpose again. And this takes us back to this issue of criminal law, and the German auditor will always say that you have to proactively show this, you voluntarily include this one percent as income in your tax return, even though you didn't receive it.
	[Europe:] . . . this is rather about technical details, such as the database studies that are used, for example, to determine the profitability that third parties could determine or achieve. The Eastern European countries are very formalistic in this respect.
	Tax Administration
	So, if you look at transfer pricing documentation and specifically at the decisive points, namely functions and risks, you often only have pages of checkboxes where certain functions are listed and then you have three crosses, four crosses, five crosses. But the other company only has two crosses or one cross. This is sometimes handled differently and what is then lacking is really the facts on both sides. What are really the functions and risks that are performed by the two companies? And if I only see one side of things, that's often not enough.
	And then, of course, there is always the tendency of every financial administration to pull in as much as possible into their own country. This means that we often do not have a solution to the double taxation cases and therefore have to carry out a mutual agreement procedure.

APPENDIX B — PROOFS

Proof of Proposition 1

In general, we proceed similar to Reinganum and Wilde (1986a, p. 750) on a unilateral situation (and for the case of constant/linear audit costs).

Since, with constant audit costs, both tax authorities are indifferent between auditing and not auditing on the equilibrium path and in the region M, their second-order conditions are equal to zero. The MNC's second-order conditions are given by

$$\frac{\partial^2 \Pi}{\partial p_d^{r2}} = -q\theta_d \tau_d \left(p_d^r - p_d\right) \frac{\partial^2 a_d}{\partial p_d^{r2}} - q\theta_f \tau_f \left(p_f - p_f^r\right) \frac{\partial^2 a_f}{\partial p_d^{r2}} - 2q\theta_d \tau_d \frac{\partial a_d}{\partial p_d^r} \leq 0,$$
$$\frac{\partial^2 \Pi}{\partial p_f^{r2}} = -q\theta_d \tau_d \left(p_d^r - p_d\right) \frac{\partial^2 a_d}{\partial p_f^{r2}} - q\theta_f \tau_f \left(p_f - p_f^r\right) \frac{\partial^2 a_f}{\partial p_f^{r2}} + 2q\theta_f \tau_f \frac{\partial a_f}{\partial p_f^r} \leq 0.$$

Since we cannot analytically solve the coupled system of PDEs, we cannot in general ensure that the MNC's second-order conditions always hold. Given the boundary conditions, $\frac{\partial a_d}{\partial p_d^r} > 0, \frac{\partial a_f}{\partial p_f^r} < 0$ needs to be true in a neighborhood of $\underline{p_d^r}$ and $\overline{p_f^r}$, respectively, and our numerical examples suggest that this holds throughout the domain of $a_d^\star$ and $a_f^\star$. The second-order conditions are fulfilled in our numerical examples. Also, $a_d' > 0$ and $a_f' < 0$ in the special case $\psi' = 0$, see (22) and (23).

If the second-order conditions hold, by construction, reports p_d^{r*}, p_f^{r*} are optimal given the tax authorities' audit functions. Thus, although both tax authorities are indifferent between auditing and not auditing for equilibrium path reports p_d^{r*}, p_f^{r*} and off-equilibrium reports $(p_d^r, p_f^r) \in M$, the MNC prefers equilibrium path reports over all reports $(p_d^r, p_f^r) \in M$ that are not (p_d^{r*}, p_f^{r*}).

Simply speaking, for reports within M the tax authorities' beliefs move along with the reports such as to keep them indifferent (light yellow set M in Figure 3). As the reports hit the boundaries of M, however, the beliefs become fixated: since it is common knowledge that $\underline{p_i}$ is the lowest existing AL price, no report can bring the domestic tax authority to belief that the report comes from a nonexistent type $< \underline{p_d}$ (and similarly for high reports, and for the foreign tax authority). Thus, for reports outside of M (white and gray areas in Figure 3), the tax authorities' beliefs become constants ($\overline{p_i}$ or $\underline{p_i}$). Inserting a constant belief μ_i^c, observe that the left-hand side of the domestic tax authority's first-order Condition (4) increases in p_d^r and the left-hand side of the foreign tax authority's first-order Condition (5) decreases in p_f^r:

$$\frac{d}{dp_d^r}\left(\tau_d \theta_d q (p_d^r - \mu_d^c) - b_d \psi(p_d^r - p_f^r)\right) = \tau_d \theta_d q - b_d \psi' > 0, \tag{13}$$
$$\frac{d}{dp_f^r}\left(\tau_f \theta_f q (\mu_f^c - p_f^r) - b_f \psi(p_d^r - p_f^r)\right) = -\tau_f \theta_f q + b_f \psi' < 0. \tag{14}$$

We will first investigate the tax authorities' optimal behavior when they observe reports in the set $\mathbb{R}^2 \setminus M$ and subsequently study the MNC's respective best responses.

Domestic Tax Authority By construction, the domestic tax authority is indifferent (equivalently, its first-order condition is zero) for reports in the area M. For reports on $\underline{p_d^r}(p_f^r)$ it is also indifferent,

and its belief is $\underline{p_d}$. If p_d^r falls below $\underline{p_d^r}(p_f^r)$, according to Equation (13), its first-order condition becomes negative, and, consequently, it audits with probability 0 (area $\underline{M_d}$). If p_d^r rises above $\underline{p_d^r}(p_f^r)$ (reports are in $\mathbb{R}^2 \setminus \{M \cup \underline{M_d} \cup \overline{M_d}\}$), the domestic tax authority's first-order condition becomes positive and it audits with probability 1. Finally, for reports on $\overline{p_d^r}(p_f^r)$, it is indifferent, and its belief is $\overline{p_d}$. If p_d^r increases (reports are in $\overline{M_d}$), its first-order condition becomes positive and it audits always.

Foreign Tax Authority The same reasoning applies. The foreign tax authority is indifferent if reports are on $\overline{p_f^r}(p_d^r)$ alongside with belief $\overline{p_f}$. Since the left-hand side of the foreign tax authority's first-order condition—given a constant belief—decreases in p_f^r (Equation 14), if p_f^r rises above $\overline{p_f^r}(p_d^r)$, the foreign tax authority's optimal action is to audit with probability zero (area $\overline{M_f}$). In contrast, if p_f^r falls (reports are in $\mathbb{R}^2 \setminus \{M \cup \overline{M_f} \cup \underline{M_d}\}$), the first-order condition becomes positive and the foreign tax authority audits. Finally, the foreign tax authority is indifferent between auditing and not auditing for reports on $p_f^r(p_d^r)$ alongside with belief $\underline{p_f}$. If p_f^r decreases further, the foreign tax authority audits with probability 1.

MNC We now show that it is not optimal for the MNC to report in the off-equilibrium region $\mathbb{R}^2 \setminus M$. We first show that Π is either continuous or jumps downward from M to $\mathbb{R}^2 \setminus M$ by comparing Π given reports on the boundary of M with Π given reports slightly outside of M. We then use the derivatives with respect to the reports to show that the MNC would not report in $\mathbb{R}^2 \setminus M$.

Consider first reports $(p_d^{r1}, p_f^{r1}) \in \underline{M_d} \cap \overline{M_f}$. Both tax authorities do not audit these reports. We have $\lim_{\varepsilon \to 0} \Pi(p_d^{rx} - \varepsilon, p_f^{rx} + \varepsilon, 0, 0) = \Pi(p_d^{rx}, p_f^{rx}, a_d^\star(p_d^{rx}, p_f^{rx}), a_f^\star(p_d^{rx}, p_f^{rx}))$ with (p_d^{rx}, p_f^{rx}) the single element of $\overline{p_f^r}(p_d^r) \cap \underline{p_d^r}(p_f^r)$, that is, Π is continuous between M and $\underline{M_d} \cap \overline{M_f}$. Verbally, (p_d^{rx}, p_f^{rx}) is the combination of reports that is located on the top left corner of M, where both tax authorities audit with probability zero. $\lim_{\varepsilon \to 0}(p_d^{rx} - \varepsilon, p_f^{rx} + \varepsilon)$ are reports that are located slightly outside M and inside $\underline{M_d} \cap \overline{M_f}$, which are also audited with probability zero. Furthermore, $\frac{\partial \Pi(p_d^{r1}, p_f^{r1}, 0, 0)}{\partial p_d^r} = \tau_d q > 0$, $\frac{\partial \Pi(p_d^{r1}, p_f^{r1}, 0, 0)}{\partial p_f^r} = -\tau_f q < 0$, thus, the MNC would like to increase the domestic report and decrease the foreign report.

Next, reports $(p_d^{r2}, p_f^{r2}) \in \overline{M_d} \cap \underline{M_f}$ are always audited by both tax authorities. If the MNC reports the single element $(p_d^{ry}, p_f^{ry}) \in \overline{p_d^r}(p_d^r) \cap \underline{p_f^r}(p_f^r)$, both tax authorities audit with a probability between 0 and 1. Reporting $(p_d^{ry} + \varepsilon, p_f^{ry} - \varepsilon)$, for small ε, causes both audit probabilities to jump to 1, and, thus MNC profit jumps downward. To conclude the argument, we have $\frac{\partial \Pi(p_d^{r2}, p_f^{r2}, 1, 1)}{\partial p_d^r} = -\tau_d q(\theta_d - 1) < 0$, $\frac{\partial \Pi(p_d^{r2}, p_f^{r2}, 1, 1)}{\partial p_f^r} = \tau_f q(\theta_f - 1) > 0$, thus, the MNC aims to decrease the domestic report and increase the foreign report. Similar reasoning applies to reports in $\overline{M_d} \setminus \{\underline{M_f} \cup \overline{M_f}\}$, and in $\underline{M_f} \setminus \{\underline{M_d} \cup \overline{M_d}\}$, which are also audited with probability 1 in both countries.

Reports $(p_d^{r3}, p_f^{r3}) \in \overline{M_f} \setminus \{\underline{M_d} \cup \overline{M_d}\}$ are audited with probability 1 (0) by the domestic (foreign) tax authority. Similar to the above reasoning, consider reports on $\overline{p_f^r}(p_d^r)$ (on the "upper border" of M). These reports are audited with probability 0 by the foreign tax authority, and with a probability between 0 and 1 by the domestic tax authority. Slightly increasing the foreign report causes the

domestic audit probability to jump to 1, implying a downward jump in Π. In addition, we have $\frac{\partial \Pi(p_d^{r3}, p_f^{r3}, 1, 0)}{\partial p_d^r} = -\tau_d q(\theta_d - 1) < 0$, $\frac{\partial \Pi(p_d^{r3}, p_f^{r3}, 1, 0)}{\partial p_f^r} = -\tau_f q < 0$, thus, the MNC would like to decrease both the domestic and foreign report. Similar reasoning applies to reports in $\overline{M_d} \cap \overline{M_f}$.

Finally, consider reports $(p_d^{r4}, p_f^{r4}) \in \underline{M_d} \setminus \{\underline{M_f} \cup \overline{M_f}\}$ that are audited with probability 1 (0) by the foreign (domestic) tax authority. Reports on $\underline{p_d^r}(p_f^r)$ (the "left border" of M) are audited with a probability between 0 and 1 by the foreign tax authority and with probability 0 by the domestic tax authority. Slightly decreasing the domestic report causes the foreign audit probability to jump to 1, hence, Π jumps downward. $\frac{\partial \Pi(p_d^r, p_f^r, 0, 1)}{\partial p_d^r} = \tau_d q > 0$, $\frac{\partial \Pi(p_d^r, p_f^r, 0, 1)}{\partial p_f^r} = \tau_f q(\theta_f - 1) > 0$ implies that the MNC aims to increase both reports. Similar reasoning applies to reports in the set $\underline{M_d} \cap \underline{M_f}$.

Thus, it is not optimal for the MNC to report in $\mathbb{R}^2 \setminus M$. Also—since we exclude negative penalties—, it cannot be optimal for the MNC to report $p_d^r < p_d$ and / or $p_f^r > p_f$, because it would always be possible to costlessly save taxes by increasing p_d^r to p_d and decreasing p_f^r to p_f. □

Proof of Proposition 2

Given the requirement $\mu_d = p_d, \mu_f = p_f$, and applying $p_d = p, p_f = p + \delta$, we obtain from Equations (4) and (5) the system

$$\begin{aligned} FOC_d &\equiv \tau_d \theta_d q(p_d^r - p) - b_d \psi(p_d^r - p_f^r, \Psi) = 0 \\ FOC_f &\equiv \tau_f \theta_f q(p + \delta - p_f^r) - b_f \psi(p_d^r - p_f^r, \Psi) = 0. \end{aligned} \tag{15}$$

Let $FOC = \begin{pmatrix} FOC_d & FOC_f \end{pmatrix}^\intercal$, $p^r = \begin{pmatrix} p_d^r & p_f^r \end{pmatrix}^\intercal$, and denote $J_{FOC} = \frac{dFOC}{dp^r}$ the Jacobian matrix of the system (15). Finally, $\frac{dFOC}{dz} = \begin{pmatrix} \frac{\partial FOC_d}{\partial z} & \frac{\partial FOC_f}{\partial z} \end{pmatrix}^\intercal$ is a vector of partial derivatives with respect to exogenous variable z (where z stands for one of the exogenous variables δ, q, Ψ). The Jacobian determinant $\det(J_{FOC}) = (b_f q \theta_d \tau_d + b_d q \theta_f \tau_f) \frac{\partial \psi}{\partial \left(p_d^r - p_f^r\right)} - q^2 \theta_d \tau_d \tau_f \theta_f < 0$ is different from zero. Thus, by the implicit function theorem, the derivatives of the equilibrium reports p_d^*, p_f^* with respect to exogenous variable z in a neighborhood of the equilibrium values are given by $-J_{FOC}^{-1} \cdot \frac{dFOC}{dz}$. The cross partial derivatives of the equilibrium reports with respect to exogenous variables z_1 and z_2 are obtained by solving the system $\frac{\partial^2}{\partial z_1 \partial z_2} FOC_d \left(p_d^{r*}, p_f^{r*}\right) = 0$, $\frac{\partial^2}{\partial z_1 \partial z_2} FOC_f \left(p_d^{r*}, p_f^{r*}\right) = 0$ for $\frac{\partial^2 p_d^{r*}}{\partial z_1 \partial z_2}$ and $\frac{\partial^2 p_f^{r*}}{\partial z_1 \partial z_2}$.

We obtain

$$\frac{\partial p_d^{r*}}{\partial \delta} = \frac{-b_d \psi^{(1,0)} \theta_f \tau_f}{x_1 - x_2 \psi^{(1,0)}} > 0, \frac{\partial p_f^{r*}}{\partial \delta} = \frac{x_1 - \left(x_2 - b_f \theta_d \tau_d\right) \psi^{(1,0)}}{x_1 - x_2 \psi^{(1,0)}} > 0,$$

$$\frac{\partial p_d^{r*}}{\partial q} = -\frac{b_d \psi \theta_f \tau_f}{q\left(x_1 - x_2 \psi^{(1,0)}\right)} < 0, \frac{\partial p_f^{r*}}{\partial q} = \frac{b_f \psi \theta_d \tau_d}{q\left(x_1 - x_2 \psi^{(1,0)}\right)} > 0,$$

$$\frac{\partial p_d^{r*}}{\partial \Psi} = \frac{b_d \psi^{(0,1)} \theta_f \tau_f}{x_1 - x_2 \psi^{(1,0)}}, \frac{\partial p_f^{r*}}{\partial \Psi} = -\frac{b_f \psi^{(0,1)} \theta_d \tau_d}{x_1 - x_2 \psi^{(1,0)}},$$

$$\frac{\partial^2 p_d^{r*}}{\partial \delta \partial \Psi} = \frac{b_d x_1 \theta_f \tau_f \left(-\psi^{(1,1)} \left(x_1 - x_2 \psi^{(1,0)}\right) - x_2 \psi^{(0,1)} \psi^{(2,0)}\right)}{\left(x_1 - x_2 \psi^{(1,0)}\right)^3},$$

$$\frac{\partial^2 p_f^{r*}}{\partial \delta \partial \Psi} = -\frac{b_f x_1 \theta_d \tau_d \left(-\psi^{(1,1)} \left(x_1 - x_2 \psi^{(1,0)}\right) - x_2 \psi^{(0,1)} \psi^{(2,0)}\right)}{\left(x_1 - x_2 \psi^{(1,0)}\right)^3},$$

$$\frac{\partial^2 p_d^{r*}}{\partial q \partial \Psi} = \frac{b_d \theta_f \tau_f \left(-\psi x_2 \psi^{(1,1)} \left(x_1 - x_2 \psi^{(1,0)}\right) - \psi^{(0,1)} \left(-x_2 x_1 \psi^{(1,0)} + \psi x_2^2 \psi^{(2,0)} + x_1^2\right)\right)}{q\left(x_1 - x_2 \psi^{(1,0)}\right)^3},$$

$$\frac{\partial^2 p_f^{r*}}{\partial q \partial \Psi} = -\frac{b_f \theta_d \tau_d \left(-\psi x_2 \psi^{(1,1)} \left(x_1 - x_2 \psi^{(1,0)}\right) - \psi^{(0,1)} \left(-x_2 x_1 \psi^{(1,0)} + \psi x_2^2 \psi^{(2,0)} + x_1^2\right)\right)}{q\left(x_1 - x_2 \psi^{(1,0)}\right)^3},$$

where, for simplicity, $x_1 = q\theta_d \tau_d \tau_f \theta_f > 0, x_2 = b_d \tau_f \theta_f + b_f \theta_d \tau_d > 0$, and superscripts in parentheses denote partial derivatives. When differentiating with respect to q, we make use of the tax authorities' first-order conditions and Definition 1 c); namely, we introduce $p = \mu_d = p_d^{r*} - \frac{b_d \psi}{q \tau_d \theta_d}, p + \delta = \mu_f = p_f^{r*} + \frac{b_f \psi}{q \tau_f \theta_f}$.

The sign of the derivatives of the domestic (foreign) report with respect to Ψ is negative (positive) iff $p_d^{r*} - p_f^{r*} > 0$. The sign of the cross partial derivative of the domestic (foreign) report with respect to δ and Ψ is positive (negative) if $\psi^{(2,0)}$ is not too large, alternatively, if $p_d^{r*} - p_f^{r*} > 0$. Finally, the cross partial derivative of the domestic (foreign) report with respect to δ and Ψ is positive (negative) if $p_d^{r*} - p_f^{r*} > 0$.

a) The impact of exogenous variable z on reporting inconsistency is given by $\frac{\partial \delta^r}{\partial z} = \frac{\partial p_d^{r*}}{\partial z} - \frac{\partial p_f^{r*}}{\partial z}$. We obtain $\frac{\partial \delta^r}{\partial \delta} = -\frac{x_1}{x_1 - x_2 \psi^{(1,0)}} < 0, \frac{\partial \delta^r}{\partial q} = -\frac{x_1 (\delta^r + \delta)}{q\left(x_1 - x_2 \psi^{(1,0)}\right)} < 0, \frac{\partial \delta^r}{\partial \Psi} = -\frac{-x_2 \psi^{(0,1)}}{x_1 - x_2 \psi^{(1,0)}} < 0 \Longleftrightarrow p_d^{r*} - p_f^{r*} > 0$.

b) Let $TA_d \equiv \tau_d q \left(p_d^{r*} - p\right), TA_f \equiv \tau_f q \left(p + \delta - p_f^{r*}\right)$ denote (local) tax avoidance. Then,

$$\frac{\partial TA_d}{\partial \delta} = \tau_d q \frac{\partial p_d^{r*}}{\partial \delta}, \frac{\partial TA_d}{\partial \Psi} = \tau_d q \frac{\partial p_d^{r*}}{\partial \Psi}, \frac{\partial TA_d}{\partial q} = \tau_d \left(p_d^{r*} - p\right) + q \tau_d \frac{\partial p_d^{r*}}{\partial q},$$

$$\frac{\partial TA_f}{\partial \delta} = \tau_f q \left(1 - \frac{\partial p_f^{r*}}{\partial \delta}\right), \frac{\partial TA_f}{\partial \Psi} = \tau_f q \frac{\partial p_f^{r*}}{\partial \Psi}, \frac{\partial TA_f}{\partial q} = \tau_f \left(p + \delta - p_f^{r*}\right) - q \tau_f \frac{\partial p_f^{r*}}{\partial q}.$$

We obtain $\forall i \in \{d, f\}$:

$$\frac{\partial TA_i}{\partial \delta} = \frac{-b_i \psi^{(1,0)} x_1}{\theta_i \left(x_1 - x_2 \psi^{(1,0)}\right)} \geq 0, \frac{\partial TA_i}{\partial q} = \frac{-b_i \psi^{(1,0)} x_1 \left(\delta^r + \delta\right)}{q \theta_i \left(x_1 - x_2 \psi^{(1,0)}\right)} \geq 0,$$
$$\frac{\partial TA_i}{\partial \Psi} = \frac{b_i \psi^{(0,1)} x_1}{\theta_i \left(x_1 - x_2 \psi^{(1,0)}\right)} < 0 \Longleftrightarrow p_d^{r*} - p_f^{r*} > 0.$$

c) Concerning reporting inconsistency, the moderating effect of Ψ is given by the cross partial derivatives $\frac{\partial^2 \delta^r}{\partial z \partial \Psi} = \frac{\partial^2 p_d^{r*}}{\partial z \partial \Psi} - \frac{\partial^2 p_f^{r*}}{\partial z \partial \Psi}$. We obtain $\frac{\partial^2 \delta^r}{\partial \delta \partial \Psi} = \frac{x_1 x_2 \left(-x_1 + x_2 \psi^{(1,0)}\right) \psi^{(1,1)} - x_2 \psi^{(0,1)} \psi^{(2,0)}}{\left(x_1 - x_2 \psi^{(1,0)}\right)^3}$, which is unambiguously positive if $p_d^{r*} - p_f^{r*} > 0$ and / or $\psi^{(2,0)}$ is not too large. Further, $\frac{\partial^2 \delta^r}{\partial q \partial \Psi} = \frac{-x_2 \psi^{(0,1)} \left(x_1^2 - x_2 x_1 \psi^{(1,0)} + \psi x_2^2 \psi^{(2,0)}\right) - x_2^2 \psi \psi^{(1,1)} \left(x_1 - x_2 \psi^{(1,0)}\right)}{q \left(x_1 - x_2 \psi^{(1,0)}\right)^3}$, which is positive if parts of the MNC's worldwide income are untaxed (sufficient condition).

Concerning tax avoidance, the moderating effect of Ψ is given by the cross partial derivatives $\frac{\partial^2 TA_d}{\partial \delta \partial \Psi} = \tau_d q \frac{\partial^2 p_d^{r*}}{\partial \delta \partial \Psi}$, $\frac{\partial^2 TA_d}{\partial q \partial \Psi} = \tau_d \frac{\partial p_d^{r*}}{\partial \Psi} + q \tau_d \frac{\partial^2 p_d^{r*}}{\partial q \partial \Psi}$, $\frac{\partial^2 TA_f}{\partial \delta \partial \Psi} = -\tau_f q \frac{\partial^2 p_f^{r*}}{\partial \delta \partial \Psi}$, $\frac{\partial^2 TA_f}{\partial q \partial \Psi} = -\tau_f \frac{\partial p_f^{r*}}{\partial \Psi} - q \tau_f \frac{\partial^2 p_f^{r*}}{\partial q \partial \Psi}$. We obtain $\frac{\partial^2 TA_i}{\partial \delta \partial \Psi} = \frac{x_1^2 b_i \left(\psi^{(1,1)} \left(-x_1 + x_2 \psi^{(1,0)}\right) - x_2 \psi^{(0,1)} \psi^{(2,0)}\right)}{\theta_i \left(x_1 - x_2 \psi^{(1,0)}\right)^3}$, which is unambiguously positive if $p_d^{r*} - p_f^{r*} > 0$ and / or $\psi^{(2,0)}$ is not too large. Concerning the combined effect of q and Ψ, we obtain $\frac{\partial^2 TA_d}{\partial q \partial \Psi} = \frac{-x_1 x_2 b_i \psi^{(0,1)} \left(\left(x_1 - x_2 \psi^{(1,0)}\right) \psi^{(1,0)} + \psi x_2 \psi^{(2,0)}\right) - x_1 x_2 b_i \psi \psi^{(1,1)} \left(x_1 - x_2 \psi^{(1,0)}\right)}{q \theta_i \left(x_1 - x_2 \psi^{(1,0)}\right)^3}$. In contrast to above, the sign is only distinct (positive) in case of double taxation ($p_d^{r*} - p_f^{r*} < 0$). This can be explained as follows. A combined change of q and Ψ affects tax avoidance via two channels. First, changing Ψ alters the reports, which affects tax avoidance. Second, changing Ψ also affects the extent to which a change in q affects the reports (and thus tax avoidance). Only in case of double taxation can both effects go into the same direction, which ultimately leads to a distinct result.

Finally, the derivatives with respect to p are $\frac{\partial p_d^{r*}}{\partial p} = \frac{\partial p_f^{r*}}{\partial p} = 1$. Thus, reporting inconsistency and tax avoidance in both countries are not affected by a synchronized change in AL prices.

□

Proof of Proposition 3

Define the value function $V(p, \delta, \Psi) \equiv \Pi^* (q^*; p, \delta, \Psi)$.

a) Using the envelope theorem, the condition for an extremum $\frac{\partial V}{\partial p} = 0$ gives $q^*(\tau_d - \tau_f) + \psi(\delta^r, \Psi) \left(-b_d \frac{\partial a_d^*}{\partial p} - b_f \frac{\partial a_f}{\partial p}\right) = 0$. Rearranging delivers the equation stated in the Proposition. Furthermore, $\frac{\partial^2 \Pi^*(q^*(p); p, \delta, \Psi)}{\partial p^2} = \Pi_{pp}^* + (q^*)'' \Pi_q^* + (q^*)' \Pi_{qp}^* + (q^*)' \left(\Pi_{qp}^* + (q^*)' \Pi_{qq}^*\right)$, where subscripts denote partial derivatives. From the first-order condition we know that $\Pi_q^*\big|_{q=q^*} = 0$; implicitly differentiating with respect to p gives $(q^*)' = -\frac{\Pi_{qp}^*}{\Pi_{qq}^*}$. Using these results gives

$\frac{\partial^2\Pi^*}{\partial p^2} = \Pi^*_{pp} - \frac{\left(\Pi^*_{qp}\right)^2}{\Pi^*_{qq}}$. If the second-order condition holds, $\Pi^*_{qq} < 0$, hence, the second term is positive. Finally, $\Pi^*_{pp} = \psi(\delta^r, \Psi)\left(-b_d \frac{\partial^2 a_d^*}{\partial p^2} - b_f \frac{\partial^2 a_f^*}{\partial p^2}\right)$. The second derivatives of the audit functions are negative for $\frac{\partial \psi}{\partial \delta^r} = 0$ (Appendix C). In our numerical simulations we have found their weighted sum to be negative.

b) Again using the envelope theorem,

$$\begin{aligned}\frac{\partial V}{\partial \delta} =& -\tau_f q + \left(b_d\left(\frac{1}{\theta_d} - a_d^*\right) + b_f\left(\frac{1}{\theta_f} - a_f^*\right)\right)\frac{\partial \psi}{\partial \delta^r}\frac{\partial \delta^r}{\partial \delta} \\ & - \left(b_d \frac{\partial a_d^*}{\partial \delta} + b_f \frac{\partial a_f^*}{\partial \delta}\right)\psi(\delta^r, \Psi).\end{aligned}$$

As a direct effect, higher foreign standards reduce profit via higher tax payments (first term). As a second effect, however, higher standards inconsistency reduces reporting inconsistency ($\frac{\partial \delta^r}{\partial \delta} < 0$, Proposition 2 a)), which in turn increases the tax authorities' audit costs ($\frac{\partial \psi}{\partial \delta^r} < 0$ by assumption). Therefore, the marginal benefit from tax avoidance increases (second term). Finally, increasing standards inconsistency affects audit probabilities (third term).

In the special case $\psi(\cdot,\cdot) = \psi_0$, we have $\frac{\partial \psi}{\partial \delta^r} = 0$, and the audit functions no longer depend on δ (Appendix C). Thus, the second and third terms vanish and the derivative is negative ($\frac{\partial V}{\partial \delta} = -\tau_f q$).

c) Recall that, per assumption, $\left.\frac{\partial \psi}{\partial \Psi}\right|_{\delta^r > 0} < 0$, $\left.\frac{\partial \psi}{\partial \Psi}\right|_{\delta^r < 0} > 0$. Using the envelope theorem, one obtains

$$\begin{aligned}\frac{\partial V}{\partial \Psi} &= \left(b_d\left(\frac{1}{\theta_d} - a_d^*\right) + b_f\left(\frac{1}{\theta_f} - a_f^*\right)\right)\left(\frac{\partial \psi}{\partial \Psi} + \frac{\partial \psi}{\partial \delta^r}\frac{\partial \delta^r}{\partial \Psi}\right) \\ &\quad - \left(b_d \frac{\partial a_d^*}{\partial \Psi} + b_f \frac{\partial a_f^*}{\partial \Psi}\right)\psi(\delta^r, \Psi) \\ &= \left(b_d\left(\frac{1}{\theta_d} - a_d^*\right) + b_f\left(\frac{1}{\theta_f} - a_f^*\right)\right)\frac{x_1 \frac{\partial \psi}{\partial \Psi}}{x_1 - x_2 \frac{\partial \psi}{\partial \delta^r}} - \left(b_d \frac{\partial a_d^*}{\partial \Psi} + b_f \frac{\partial a_f^*}{\partial \Psi}\right)\psi(\delta^r, \Psi).\end{aligned}$$

The sign of the first term depends on whether reporting inconsistency is negative ($\delta^r < 0$, i.e., double taxation), or positive. With double taxation, higher Ψ increases the tax authorities' audit costs, which is beneficial for the MNC and increases profit. If reporting inconsistency is positive (tax avoidance), higher Ψ decreases the audit costs, which reduces profit. The second term's sign depends on the audit functions and is indeterminate.

In the special case $\psi(\cdot) = \psi_0 \equiv \overline{\Psi} - \Psi$, $\frac{\partial \psi}{\partial \delta^r} = 0$, $\frac{\partial \psi}{\partial \Psi} = -1$, and getting the derivatives of the audit functions from Appendix C shows $\frac{\partial a_d^*}{\partial \Psi} > 0$, $\frac{\partial a_f^*}{\partial \Psi} > 0$, thus, $\frac{\partial V}{\partial \Psi} < 0$.

□

APPENDIX C — SPECIAL CASE: $\psi' = 0$

With $\psi' = 0$, the tax authorities' audit costs no longer depend on the size of the difference between the reports and we can write $\psi(p_d^r - p_f^r) \equiv \psi_0$. Furthermore, the domestic (foreign) tax authority's point belief and audit probability only depends on the domestic (foreign) report.

The tax authorities' first-order Conditions (4) and (5) are then given by

$$\frac{\partial T_d}{\partial \alpha_d} = \tau_d \theta_d q(p_d^r - \mu_d(p_d^r)) - \psi_0 b_d = 0, \tag{16}$$

$$\frac{\partial T_f}{\partial \alpha_f} = \tau_f \theta_f q(\mu_f(p_f^r) - p_f^r) - \psi_0 b_f = 0, \tag{17}$$

and MNC's first-order Conditions (6) and (7) are given by

$$\frac{\partial \Pi}{\partial p_d^r} = -q\theta_d \tau_d (p_d^r - p_d) a_d'(p_d^r) - q\theta_d \tau_d a_d(p_d^r) + q\tau_d = 0, \tag{18}$$

$$\frac{\partial \Pi}{\partial p_f^r} = -q\theta_f \tau_f (p_f - p_f^r) a_f'(p_f^r) + q\theta_f \tau_f a_f(p_f^r) - q\tau_f = 0. \tag{19}$$

We obtain from (16) and (17) $\mu_d(p_d^r) = p_d^r - \frac{\psi_0 b_d}{\tau_d \theta_d q}, \mu_f(p_f^r) = p_f^r + \frac{\psi_0 b_f}{\tau_f \theta_f q}$, and, setting $\mu_d = p_d, \mu_f = p_f$ (Definition 1 c)), $p_d^{r*} = p_d + \frac{\psi_0 b_d}{\tau_d \theta_d q}, p_f^{r*} = p_f - \frac{\psi_0 b_f}{\tau_f \theta_f q}$. We proceed as explained in the main text. Introducing the beliefs obtained from the tax authorities' first-order conditions into (18) and (19), we obtain the first order nonhomogeneous linear differential equations

$$-\psi_0 b_d a_d'(p_d^r) - q a_d(p_d^r)\theta_d \tau_d + q\tau_d = 0, \tag{20}$$

$$-\psi_0 b_f a_f'(p_f^r) + q\theta_f \tau_f a_f(p_f^r) - q\tau_f = 0. \tag{21}$$

We show the solution exemplary for (20). A solution can be found, e.g., by means of an integrating factor.[37] Writing for convenience $z \equiv \frac{q\tau_d}{\psi_0 b_d}$, the standard form of (20) is given by $a_d' + \theta_d z a_d = z$. Multiplying through with the integrating factor $e^{\theta_d z p_d^r}$ gives $e^{\theta_d z p_d^r} a_d' + \theta_d z e^{\theta_d z p_d^r} a_d = e^{\theta_d z p_d^r} z \Leftrightarrow \frac{d}{dp_d^r}\left(e^{\theta_d z p_d^r} a_d\right) = e^{\theta_d z p_d^r} z$. Integrating both sides delivers $e^{\theta_d z p_d^r} a_d = \frac{1}{\theta_d} e^{\theta_d z p_d^r} + C \Leftrightarrow a_d(p_d^r) = \frac{1}{\theta_d} + e^{-\theta_d z p_d^r} C$, where C is a constant. The boundary condition for this differential equation is given by $a_d(\underline{p_d^r}) = 0$. This is justified by the domestic tax authority's belief that any report $p_d^r < \underline{p_d^r}$ comes from type $\underline{p_d}$. This gives $C = -\frac{1}{\theta_d} e^{\theta_d z \underline{p_d^r}}$, and, hence, $a_d(p_d^r) = \frac{1}{\theta_d}\left(1 - e^{-\frac{\theta_d q \tau_d}{\psi_0 b_d}(p_d^r - \underline{p_d^r})}\right)$.

The solution to (21) is similar; in this case the integration constant is determined by the foreign tax authority's belief that any report $p_f^r > \overline{p_f^r}$ comes from type $\overline{p_f}$; thus, $a_f(\overline{p_f^r}) = 0$ and one obtains $a_f(p_f^r) = \frac{1}{\theta_f}\left(1 - e^{-\frac{\theta_f \tau_f q}{b_f \psi_0}\left(\overline{p_f^r} - p_f^r\right)}\right)$.

[37] This is a standard solution method for first order nonhomogeneous linear differential equations. In general terms, one multiplies through with the integrating factor $e^{\int \pi(s) ds}$, where $\pi(s)$ is the coefficient of the function one searches for (in our case the coefficient of $a_d(p_d^r)$, hence $\pi(p_d^r) = \theta_d z$), and then observes that the left-hand side can be seen as a derivative computed by the product rule.

The MNC's second-order conditions are given by

$$\frac{\partial^2 \Pi}{\partial p_d^{r2}} = -q\theta_d\tau_d\left(p_d^r - p_d\right)a_d''\left(p_d^r\right) - 2q\theta_d\tau_d a_d'\left(p_d^r\right) < 0, \tag{22}$$

$$\frac{\partial^2 \Pi}{\partial p_f^{r2}} = -q\theta_f\tau_f\left(p_f - p_f^r\right)a_f''(p_f^r) + 2q\theta_f\tau_f a_f'\left(p_f^r\right) < 0. \tag{23}$$

Introducing the tax authorities' equilibrium audit policies and the MNC's tax transfer price reports gives $\frac{\partial^2 \Pi}{\partial p_d^{r2}} = -\frac{\theta_d q^2 \tau_d^2 e^{-\frac{\theta_d q \tau_d\left(p_d - \underline{p_d}\right)}{\psi_0 b_d}}}{\psi_0 b_d} < 0, \frac{\partial^2 \Pi}{\partial p_f^{r2}} = -\frac{q^2\theta_f\tau_f^2 e^{-\frac{q\theta_f\tau_f\left(\overline{p_f} - p_f\right)}{\psi_0 b_f}}}{\psi_0 b_f} < 0$. Thus, the MNC's equilibrium report is optimal. In contrast, the tax authorities' second order conditions are equal to zero, which implies that in equilibrium they are indifferent. Checking the respective incentives of MNC and tax authorities for out-of-equilibrium reports is similar as shown in Proof of Proposition 1.

COROLLARY 1. *With fixed audit costs and $\psi(\cdot) = \psi_0$, the domestic audit function increases and the foreign audit function decreases in the reported transfer price. Both audit functions are concave in the reported transfer prices. The equilibrium path audit functions $a_i(p_i^{r*})$ increase in q.*

Proof. Differentiating with respect to the reported transfer prices gives $\frac{\partial a_d}{\partial p_d^r} = \frac{q\tau_d e^{-\frac{q\theta_d\tau_d\left(p_d^r - \underline{p_d^r}\right)}{\psi_0 b_d}}}{\psi_0 b_d} > 0, \frac{\partial a_f}{\partial p_f^r} = -\frac{q\tau_f e^{-\frac{q\theta_f\tau_f\left(\overline{p_f^r} - p_f^r\right)}{\psi_0 b_f}}}{\psi_0 b_f} < 0, \frac{\partial^2 a_d}{\partial (p_d^r)^2} = -\frac{q^2\theta_d\tau_d^2 e^{-\frac{q\theta_d\tau_d\left(p_d^r - \underline{p_d^r}\right)}{\psi_0 b_d}}}{\psi_0^2 b_d^2} < 0, \frac{\partial^2 a_f}{\partial (p_f^r)^2} = -\frac{q^2\theta_f\tau_f^2 e^{\frac{q\theta_f\tau_f\left(p_f^r - \overline{p_f^r}\right)}{b_f\psi_0}}}{b_f^2\psi_0^2} < 0$. Differentiating with respect to quantity q gives $\frac{\partial a_d(p_d^{r*})}{\partial q} = \frac{\tau_d(p-\underline{p})e^{-\frac{q\theta_d\tau_d(p-\underline{p})}{\psi_0 b_d}}}{\psi_0 b_d} > 0, \frac{\partial a_f(p_f^{r*})}{\partial q} = \frac{\tau_f(\overline{p}-p)e^{-\frac{q\theta_f\tau_f(\overline{p}-p)}{\psi_0 b_f}}}{\psi_0 b_f} > 0$. □

ONLINE APPENDIX

Standards inconsistency exists if the arm's-length (AL) prices from the viewpoint of the domestic and foreign tax authority differ. Throughout the main article, we specify standards inconsistency as $p_d \equiv p; p_f = p + \delta$; that is, we assume that foreign AL prices are generally higher. Here we study an alternative and assume that domestic AL prices are generally lower; i.e., $p_f \equiv p; p_d = p - \delta$. Generally, there is a one-to-one relationship of both modelling choices. However, a change of δ has a different interpretation. Now an increase of δ reduces the transfer price in the domestic country, while the transfer price in foreign country remains unchanged. In contrast, in our main model, an increase of δ increases the transfer price in the foreign country, while the transfer price in domestic country remains unchanged.

Since Proposition 1 is formulated for general p_d, p_f, it is unaffected.

We alter Definition 2 b) to match the alternative specification:

DEFINITION 2 b)*. *Tax avoidance in a country is the difference between the nominal tax payment and the tax payment based on the reports (i.e., excluding potential penalties and back taxes), that is, for the domestic country, $\tau_d q(p_d^r + \delta - p)$, and for the foreign country, $\tau_f q(p - p_f^r)$.*

We show briefly that Proposition 2 is unaffected by this alternative specification. From the tax authorities' first-order conditions, we obtain:

$$\begin{aligned} FOC_d &\equiv \tau_d \theta_d q(p_d^r + \delta - p) - b_d \psi(p_d^r - p_f^r, \Psi) = 0; \\ FOC_f &\equiv \tau_f \theta_f q(p - p_f^r) - b_f \psi(p_d^r - p_f^r, \Psi) = 0. \end{aligned} \tag{15*}$$

Again let $FOC = \begin{pmatrix} FOC_d & FOC_f \end{pmatrix}^\intercal$ and $p^r = \begin{pmatrix} p_d^r & p_f^r \end{pmatrix}^\intercal$. Denote $J_{FOC} = \frac{dFOC}{dp^r}$ the Jacobian matrix of the system (15*), and denote $\frac{dFOC}{dz} = \begin{pmatrix} \frac{\partial FOC_d}{\partial z} & \frac{\partial FOC_f}{\partial z} \end{pmatrix}^\intercal$ a vector of partial derivatives with respect to exogenous variable z (where z stands for one of the exogenous variables δ, q, Ψ). Proceeding as in the Proof of Proposition 2, we obtain

$$\frac{\partial p_d^{r*}}{\partial \delta} = -\frac{x_1 - b_f \psi^{(1,0)} \theta_d \tau_d}{x_1 - x_2 \psi^{(1,0)}} < 0, \frac{\partial p_f^{r*}}{\partial \delta} = -\frac{-b_f \psi^{(1,0)} \theta_d \tau_d}{x_1 - x_2 \psi^{(1,0)}}, \frac{\partial p_d^{r*}}{\partial q} = -\frac{\psi b_d \theta_f \tau_f}{q\left(x_1 - x_2 \psi^{(1,0)}\right)} < 0,$$
$$\frac{\partial p_f^{r*}}{\partial q} = \frac{b_f \psi \theta_d \tau_d}{q\left(x_1 - x_2 \psi^{(1,0)}\right)} > 0, \frac{\partial p_d^{r*}}{\partial \Psi} = \frac{\psi^{(0,1)} b_d \theta_f \tau_f}{x_1 - x_2 \psi^{(1,0)}}, \frac{\partial p_f^{r*}}{\partial \Psi} = -\frac{b_f \psi^{(0,1)} \theta_d \tau_d}{x_1 - x_2 \psi^{(1,0)}},$$

where $x_1 = q\theta_d \tau_d \tau_f \theta_f > 0, x_2 = b_d \tau_f \theta_f + b_f \theta_d \tau_d > 0$. The cross partial derivatives $\frac{\partial^2 p_i^{r*}}{\partial \delta \partial \Psi}, \frac{\partial^2 p_i^{r*}}{\partial q \partial \Psi}$ are similar to those in the proof of Proposition 2. With the alternative specification, both reports fall in δ, which implies more tax avoidance (in the foreign country, due to the mere fall in the report, and in the domestic country because the report falls less than it "should" due to the lower domestic standards).

Concerning reporting inconsistency, tax avoidance, and moderating effects of Ψ, we obtain results identical to Proof of Proposition 2 a), b), and c).

Stage 1

The MNC's equilibrium profit is given by

$$\Pi^*(q;p,\delta) = (1-\tau_d)R(q) + \tau_d(p-\delta)q - \tau_f q(p-c) - cq \\ \underbrace{+b_d\psi(p_d^{r*} - p_f^{r*})\left(\frac{1}{\theta_d} - a_d^*(p,q)\right) + b_f\psi(p_d^{r*} - p_f^{r*})\left(\frac{1}{\theta_f} - a_f^*(p,q)\right)}_{\geq 0\text{, benefit from tax avoidance (post audit)}}, \qquad (9^*)$$

and the first-order condition is

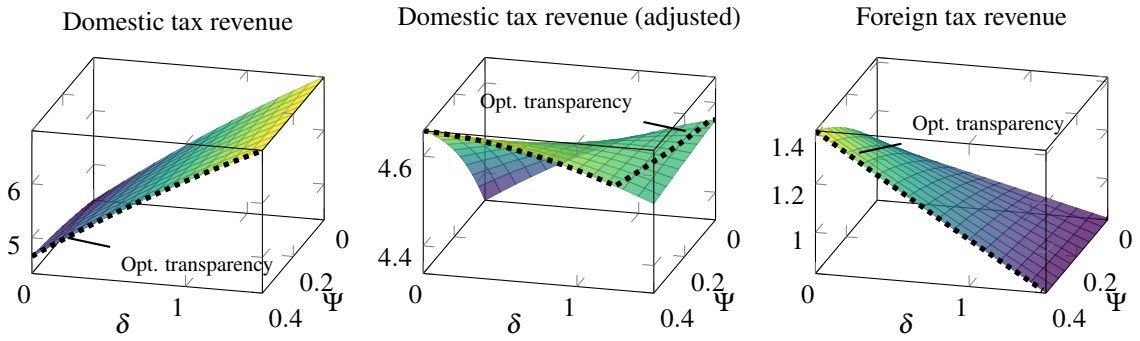
$$\frac{\partial \Pi^*(q)}{\partial q} = (1-\tau_d)R'(q) + (p-\delta)\tau_d - \tau_f(p-c) - c \\ + \underbrace{\left(b_d\left(\frac{1}{\theta_d} - a_d^*\right) + b_f\left(\frac{1}{\theta_f} - a_f^*\right)\right)\psi'(\delta^r)\frac{\partial \delta^r}{\partial q}}_{\geq 0\text{, marginal benefit from tax avoidance}} - \underbrace{\left(b_d\frac{\partial a_d^*}{\partial q} + b_f\frac{\partial a_f^*}{\partial q}\right)\psi(\delta^r)}_{\text{marginal expected penalties}} = 0. \qquad (10^*)$$

Proceeding as in the Proof of Proposition 3, it is easy to see that Proposition 3 is unaffected by this alternative specification of AL prices. The only structural change lies in the adjustment of the tax rate effect mentioned in Proposition 3 b), now expressed as $-\tau_d q$ in lieu of $-\tau_f q$.

Below we show Figures 6* and 7*, given the alternative specification. Figure 7* shows that the alternative specification does not qualitatively affect audit cost, tax avoidance, consumer surplus, producer surplus, and both countries' nominal tax revenue for consistent standards. It does affect, however, the impact of global tax transparency and standards inconsistency on unadjusted domestic net tax revenues (Figure 6* left) and the domestic country's nominal tax revenues under inconsistent standards (turquoise line in Figure 7* top right). These figures suggest that the domestic country, in terms of net tax revenues, now prefers high global tax transparency under inconsistent standards. This can be explained as follows. Higher standards inconsistency in the alternative specification implies lower domestic AL prices and thus a higher tax base in the domestic country. Specifically, standards inconsistency δ implies a mechanical increase of domestic expected net tax revenues of $\int_{\underline{p}}^{\overline{p}} \tau_d \delta q f(p)\,dp$. This increase increases in q. Overall this means that the domestic tax authority now benefits from a larger production volume. A larger production volume, on the other hand, can be achieved with inconsistent standards through greater transparency. If we eliminate the mechanical tax base increase, expected net tax revenues are still maximized at intermediary-to-low transparency under inconsistent standards (Figure 6* middle).

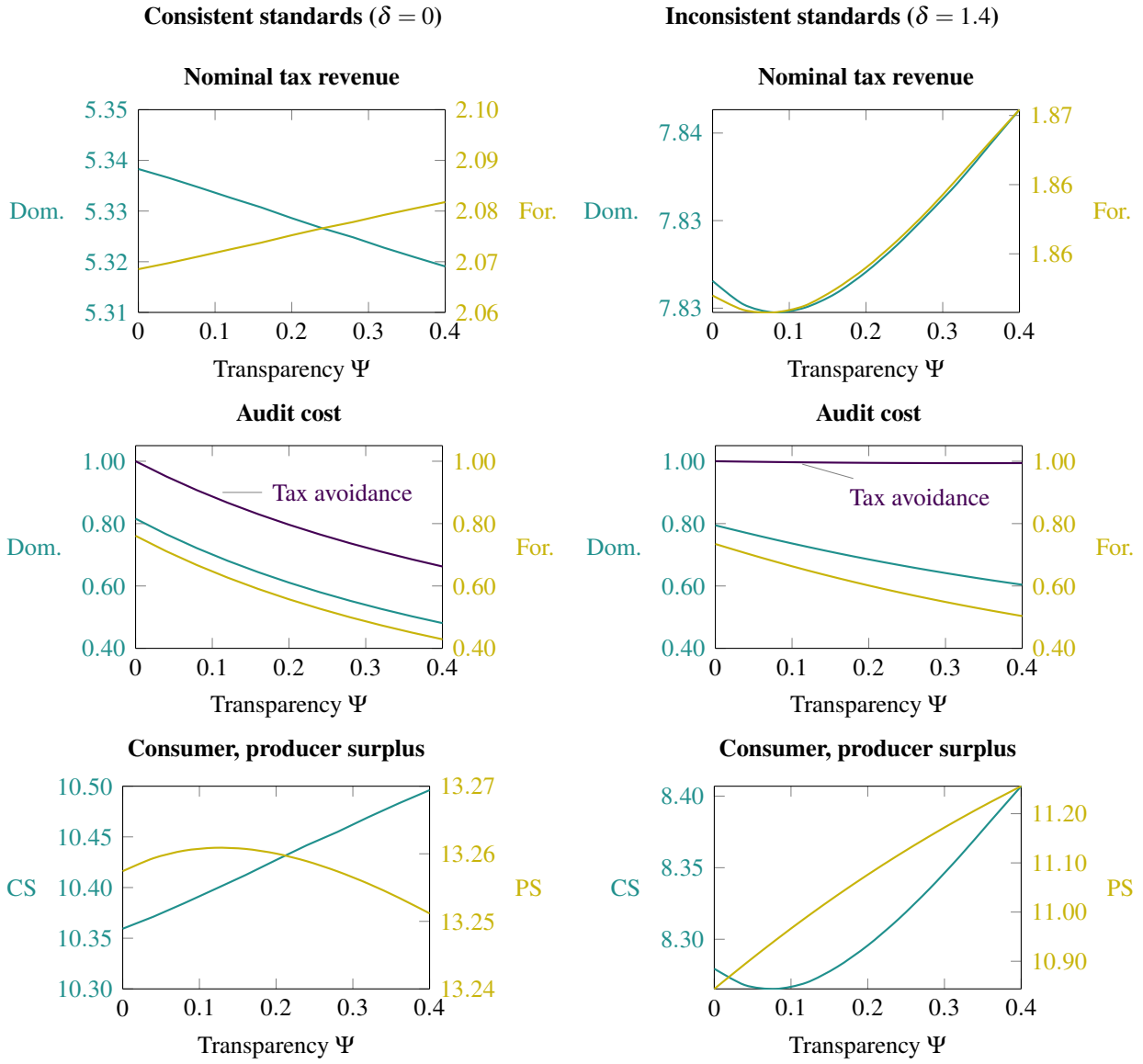
Table 4* displays the numerical results for the alternative specification.

Figure 6*: Impact of Global Tax Transparency and Standards Inconsistency on Net Tax Revenues (Alternative Specification of Standards Inconsistency: $p_d = p_f - \delta$)



Note: The figure shows expected net tax revenue of the domestic (left, middle) and foreign (right panel) countries, depending on the level of standards inconsistency δ and global tax transparency Ψ. For the domestic country, we show expected net tax revenues (left) as well as *adjusted* expected net tax revenues that are artificially reduced by $\tau_d \delta q$ to eliminate the mechanical increase in domestic tax revenues that comes from increasing standards inconsistency (middle). The black dotted lines indicate the optimal level of global tax transparency for a given level of standards inconsistency from the viewpoint of the domestic and foreign countries.

Figure 7*: Components of Global Social Welfare (Alternative Specification of Standards Inconsistency: $p_d = p_f - \delta$)



Note: The figure shows components of social welfare (Table 2), depending on the level of global tax transparency Ψ, for consistent ($\delta = 0$, left) and inconsistent standards ($\delta = 1.4$, right). Turquoise (yellow) lines show the results for the domestic (foreign) country. The purple lines in the middle row show pre-audit tax avoidance according to Definition 2 b)*.

Table 4*: Numerical Example

(1) Global tax trans-parency	(2) Standards inconsis-tency	(3) Minimum sales price	(4) Quantity range	(5) Nominal tax revenue domestic / foreign	(6) Tax avoidance domestic / foreign*	(7) Audit cost domestic / foreign	(8) Net tax revenue domestic / foreign	(9) Producer Surplus	(10) Consumer Surplus	(11) Global Social Welfare
Ψ	δ	$\min_p(k - lq^*(p))$	$[\min_p q^*(p), \max_p q^*(p)]$							
Benchmark: no tax avoidance (truthful reporting)										
–	0	5.25	[4.50,4.75]	5.29 / 2.10	–	–	5.29 / 2.10	12.84	10.70	30.93
–	0.7	5.48	[4.27,4.52]	6.66 / 2.00	–	–	6.66 / 2.00	11.58	9.65	29.88
–	1.4	5.72	[4.03,4.28]	7.86 / 1.89	–	–	7.86 / 1.89	10.38	8.65	28.78
Separating equilibrium										
0.36	0	5.22	[4.48,4.78]	5.32 / 2.08	0.69	0.50 / 0.45	4.64 / 1.40	13.25	10.48	29.77
0.36	0.7	5.45	[4.24,4.55]	6.67 / 1.97	0.84	0.57 / 0.50	5.83 / 1.13	12.19	9.39	28.54
0.36	1.4	5.68	[4.00,4.32]	7.84 / 1.86	0.99	0.62 / 0.52	6.85 / 0.87	11.22	8.38	27.32
0.2	0	5.23	[4.47,4.77]	5.33 / 2.08	0.80	0.61 / 0.56	4.53 / 1.28	13.26	10.43	29.50
0.2	0.7	5.47	[4.22,4.53]	6.67 / 1.96	0.90	0.65 / 0.59	5.78 / 1.07	12.13	9.33	28.30
0.2	1.4	5.70	[3.98,4.30]	7.83 / 1.85	0.99	0.69 / 0.60	6.84 / 0.86	11.08	8.30	27.07
0.04	0	5.25	[4.45,4.75]	5.34 / 2.07	0.95	0.77 / 0.71	4.39 / 1.12	13.26	10.37	29.13
0.04	0.7	5.48	[4.21,4.52]	6.68 / 1.96	0.98	0.77 / 0.71	5.70 / 0.99	12.04	9.29	28.02
0.04	1.4	5.72	[3.97,4.28]	7.83 / 1.85	1.00	0.77 / 0.70	6.83 / 0.85	10.89	8.27	26.85

Note: This table shows the results of our numerical example, using the baseline parameters in Table 3, and varying the level of global tax transparency Ψ, and standards inconsistency δ. The panel in the middle shows a benchmark case where the MNC truthfully (and inconsistently if $\delta > 0$) reports p_d, p_f and the tax authorities do not audit. The panel in the bottom shows the results of our model. The results on the minimum sales price show that our choice of upper bound of AL prices $\overline{p}_d = 4 - \delta, \overline{p}_f = 4$ is reasonable in that it does not exceed the sales price.
Column (6) shows the expected value of pre-audit tax avoidance (Definition 2 b)*), as shown in Figure 7*. This amount is reduced as a result of audits via back taxes and penalties, the sum of which is equal to audit costs. Since nominal tax revenue, tax avoidance, and audit costs are additive separable (Equations 11, 12) expected net tax revenues is given by subtracting column six from column (5).
*Tax avoidance is symmetrical (the amount of tax avoidance in the domestic and foreign country is identical) if penalties and audit costs are identical in both countries $\theta_d = \theta_f$ and $b_d = b_f$, which we assume here (Table 3).