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When do firms use one set of books in an international tax compliance game?

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Abstract

This study examines how a strategic tax auditor affects a multinational firm's transfer pricing in a tax compliance game. Our model uses a divisionalized firm, in both a low-tax and a high-tax country, that decides to implement a transfer-pricing regime with either one or two sets of books. After observing its unit costs, the firm reports a compliant or non-compliant tax transfer price. In a regime with one set of books, the single transfer price coordinates the quantity decision and determines the tax payments. In a regime with two sets, different transfer prices serve those tasks. In contrast to previous studies, our analysis incorporates a strategic tax auditor, who observes the tax transfer price and decides whether to audit the firm. Real-world regulations suggest larger penalties for detected non-compliance under a two-sets-of-books transfer-pricing regime. Our analysis identifies the mixed strategy equilibria and examines how variations in the tax regulation—the tax rate difference and the penalty difference—affect the firm's tax aggressiveness. We show that a firm acts less tax aggressively with a higher tax rate difference. Additionally, the model predicts that the firm either increases or decreases

the probability of keeping one set of books for a smaller penalty difference.

Keywords. transfer pricing, two sets of books, one set of books, strategic tax auditor

JEL Classifications. H26, H87, M42

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1 Introduction

Transfer prices are necessary for computing divisional profits in a multinational firm (MNF) whenever its divisions engage in intra-firm trade. As MNFs can use divisional profit for managerial performance evaluation, transfer pricing affects internal decisions. Moreover, divisional profits determine an MNF's tax liability in its different countries. Previous research shows that MNFs keep either two sets of books (TSB) or one set of books (OSB).[1] The TSB transfer-pricing regime uses an internal transfer price that coordinates the quantity decision and a tax transfer price that determines the tax liability, respectively. Thus TSB allow the MNF to optimize the tax liability and the internal decisions. In contrast, the OSB transfer-pricing regime uses the same transfer price for those tasks and thus limits the MNC's flexibility to optimize both tasks.

To reduce their tax liability, MNFs often use tax transfer prices to shift profit from high- to low-tax countries (e.g., Jacob, 1996; Clausing, 2003; De Simone et al., 2017; Blouin et al., 2018). The tax transfer prices might not comply with tax regulation. As profit shifting deprives tax authorities of a large amount of tax income, tax authorities have their tax auditors rigorously examine MNFs' transfer pricing for non-compliance (OECD, 2015).[2] However, as tax authorities are resource constrained (e.g., Hoopes et al., 2012), tax auditors cannot scrutinize each MNF's transfer pricing. Instead, tax auditors seek to effectively deploy their available resources (OECD, 2015, p. 9), that is,

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[1] In a recent survey study among U.S.-based MNFs, Klassen et al. (2017) report that 16.3% of firms calculate different transfer prices for different purposes. Springsteel (1999), e.g., finds that 77% of a best-practice group of large firms choose TSB.

[2] According to EY's Global Transfer Pricing Survey 2013 (EY, 2013) and the EY Transfer Pricing and International Tax Survey 2019 (EY, 2019), transfer pricing constitutes a central area of disagreement between MNFs and tax auditors.

they strategically decide whether to audit an MNF's transfer pricing.

When a tax auditor challenges the tax transfer price, many MNFs fear negative consequences from keeping TSB instead of OSB.[3] Although the international transfer-pricing literature acknowledges these different consequences, the specific transfer-pricing regime choice of the MNF while it is considering the possibility of a tax audit remains largely unexplored. This omission is problematic, because it restricts scholars' and tax regulators' understanding of MNFs' profit-shifting incentives. In this study, we examine how a strategic tax auditor affects an MNF's transfer-pricing regime in a tax compliance game.

We study an MNF with an upstream division in a low-tax country and a downstream division in a high-tax country. The upstream division produces an intermediate product and transfers it to the downstream division. Our model comprises three decision-making stages. In the first stage, the MNF decides whether to implement an OSB or a TSB transfer-pricing regime (implementation decision). In the second stage, after experiencing operating conditions (i.e., high or low unit costs of the intermediate product), the MNF determines the transfer price(s). The MNF chooses a compliant or a non-compliant tax transfer price (compliance decision). In the third stage, a strategic tax auditor observes the tax transfer price and decides whether to conduct an audit, a decision that factors in his or her audit costs.

During a tax audit, the tax auditor evaluates the MNF's transfer pricing. With OSB, the tax

[3] While previous studies discuss the fear of negative consequences, they assume the transfer-pricing regime is exogenous (e.g., Halperin and Srinidhi, 1991; Narayanan and Smith, 2010; Smith, 2002; Baldenius et al., 2004; Johnson, 2006; Nielsen and Raimondos-Møller, 2012; Shunko et al., 2014; Reineke and Weiskirchner-Merten, 2021).

transfer price follows the management view,[4] thereby exhibiting economic substance. In contrast, the use of an internal transfer price different from the tax transfer price under TSB may undermine the economic substance of the tax transfer price (Narayanan and Smith, 2010; Cools and Emmanuel, 2007).[5] The lack of economic substance indicates that the MNF's primary objective for keeping TSB is tax minimization.

Many countries reduce the penalty for detected non-compliance when the MNF shows economic substance, whereas they increase the penalty if the MNF's primary objective is tax minimization. For example, in Spain, a tax auditor can reduce or eliminate the penalty when the MNF keeps OSB (KPMG, 2012, p. 202). Australia levies a penalty of 25%, which decreases to 10% when the MNF demonstrates economic substance and increases to 50% when the tax auditor shows that the dominant purpose is tax minimization (EY, 2012). In New Zealand, the penalties vary between 20% and 150% (EY, 2012), with the applied rate depending on the degree of intent to avoid tax payments in the MNF's gross negligence. In Hong Kong, the tax auditor scales the penalty upwards or downwards according to the nature of the omission and the amount of understatement of profits (EY, 2012). In sum, these real-world regulations suggest higher penalty factors for detected non-compliance as a negative consequence of keeping TSB. We incorporate this penalty difference into our model.

In our analysis, the MNF faces a trade-off between flexibility and the level of penalties. With TSB, the MNF uses the internal transfer price to affect the downstream division's quantity decision. In contrast, the tax transfer price under OSB limits the MNF's possibilities of affecting the quantity

[4] Alignment with the management view enhances the MNF's defensibility of its transfer pricing (EY, 2003).

[5] Martini (2015) notes that unrelated firms would not use two different prices for an inter-firm trade. Therefore, a tax auditor may doubt the economic substance of an MNF's keeping TSB.

decision, i.e., the MNF is less flexible. Beyond flexibility, the MNF also considers the level of penalties. With low unit costs, the MNF (hereafter, "low-cost MNF") has an incentive to mimic an MNF with high unit costs (hereafter, "high-cost MNF") and to use a non-compliant tax transfer price. If the tax auditor detects a non-compliant tax transfer price, the penalty under TSB is higher than under OSB. In other words, with the use of TSB, higher flexibility goes hand in hand with a higher level of penalties.

After identifying the mixed strategy equilibria, we find that the penalty difference determines the first-stage implementation decision about using OSB or TSB. For a large penalty difference between OSB and TSB, the advantage of OSB is high. In such a case, the MNF never implements TSB as a pure strategy but instead randomizes between OSB and TSB. While the low-cost MNF may benefit from the lower level of penalties under OSB, this advantage is irrelevant for the high-cost MNF, which always acts compliantly. Consequently, the MNF never implements OSB as a pure strategy. If the advantage of OSB is small, an equilibrium exists in which the MNF always implements TSB, due to its greater flexibility.

The second-stage decision is a choice between compliance and non-compliance. We find that when an OSB regime is in place, a low-cost MNF always reports non-compliantly. The low-cost MNF's compliance decision under a TSB regime depends on the level of the tax auditor's audit costs. For low audit costs, the tax auditor wants to conduct audits more frequently. Thus, ceteris paribus, the probability of detecting non-compliance increases: Anticipating the higher detection probability, the low-cost MNF reports compliantly with a higher probability.

Using the equilibrium strategies, we derive empirically testable predictions for tax aggressiveness. As various definitions of tax aggressiveness exist (Hanlon and Heitzman, 2010), in our model we define tax aggressiveness as non-compliant reporting under either TSB or OSB. We consider non-compliant reporting under TSB a more tax-aggressive transfer pricing than that under OSB. Our findings show that a higher tax rate difference between the countries decreases the MNF's tax aggressiveness. Because profit shifting is especially beneficial for a high tax rate difference, less tax aggressiveness appears counterintuitive. Our finding, however, is due to the presence of the strategic tax auditor. Given that a high tax rate difference causes high penalties for detected non-compliance, the tax auditor has strong incentives for conducting an audit. The MNF anticipates the stronger audit incentives and counteracts them by less tax-aggressive transfer pricing.

In addition, our model predicts that the MNF either increases or decreases the probability of keeping OSB for a smaller penalty difference. The MNF's choice in the first stage depends on its compliance decision in the second stage. Because a smaller penalty difference results in a smaller OSB advantage, an increasing probability of an MNF's keeping OSB for a decreasing penalty difference might appear surprising at first glance. The finding stems from the presence of the strategic tax auditor, who incorporates a higher penalty for detected non-compliance under OSB and the MNF's incentives for switching towards more TSB in his or her audit decision, thereby increasing audit incentives. For an intermediate level of audit costs, the MNF counteracts the stronger audit incentives by using more OSB in the first stage, because the OSB advantage still remains.

For our main analysis, we assume that the MNF chooses the transfer-pricing regime *before* observing the operating conditions. In the short term, because of implementation, user training, and other organizational issues, the MNF does not revise the transfer-pricing regime according to operating conditions (Martini et al., 2012). Nevertheless, for comparison, we also study a model in which the MNF chooses the transfer-pricing regime *after* observing the operating conditions. Our analysis shows that our findings persist in the model with the alternative timing.[6]

Our model builds on the cost-based transfer pricing setting established by Baldenius et al. (2004), while introducing the following adaptations: (1) the MNF chooses to keep either OSB or TSB; (2) the MNF can either incur high or low unit costs, so that the low-cost MNF has an incentive to choose a non-compliant tax transfer price; and (3) the tax auditor strategically decides whether to audit the MNF or not. These adaptations allow us to study the MNF's implementation and compliance decision when the MNF considers a potential tax audit.

Our paper contributes to the vast literature studying international tax transfer pricing that incorporates internal decision-making.[7] Prior research typically takes the transfer-pricing regime as given, i.e., either OSB or TSB is in place (Narayanan and Smith, 2010; Baldenius et al., 2004; Hyde and Choe, 2005; Choe and Hyde, 2007). An exception is Nielsen and Raimondos-Møller (2012), who investigate whether OSB or TSB is preferable under certain circumstances. However, they do not consider the presence of a strategic tax auditor. In contrast, rather than assuming the dominance of a specific transfer-pricing regime, we endogenize the MNF's implementation decision.

Our paper adds to the international tax transfer-pricing literature on tax audits. Kant (1988), Smith (2002), Hyde and Choe (2005), and Choe and Hyde (2007) study the impact of a penalty for non-compliance on MNF's transfer prices. However, they neither examine the presence of a strategic tax auditor nor consider whether the MNF keeps OSB or TSB.

Our paper also contributes to the strategic coordination literature that examines the benefits that MNFs accrue from keeping OSB. Schjelderup and Sorgard (1997), Arya and Mittendorf (2008),

[6] Section 6 analyzes an alternative sequence of events.

[7] Sansing (2014) provides a comprehensive overview of international transfer prices and their functions.

and Dürr and Göx (2011) illustrate that, under imperfect competition, MNFs gain benefits from keeping OSB. In their studies, OSB serves as a commitment device for softening competition in external markets. While this strand of the literature assumes that the competitors observe the MNF's transfer-pricing regime, we do not make a similar assumption for the tax auditor. Instead, and in line with previous research (Tang, 1993; Davis Jr, 1994; Bärsch et al., 2019),[8] we assume that the tax auditor observes the MNF's transfer-pricing regime during a tax audit. We complement the strategic coordination literature by showing that the MNF keeps OSB as part of the equilibrium strategy in response to the presence of a strategic tax auditor.

The paper proceeds as follows. Section 2 describes the model. Section 3 presents the MNF's internal and tax transfer prices. Section 4 identifies and describes the mixed strategy equilibria. Section 5 depicts comparative statics. Section 6 shows that our main findings do not depend on the timing of the game. Section 7 concludes.

2 Model Description

We study an MNF operating an upstream division in a low-tax country and a downstream division in a high-tax country, where transfer prices evaluate intra-firm trade. In the low-tax country, an income tax rate t prevails, whereas the high-tax country taxes income at a rate $t+h$, with $0 \leq t, h \leq 1$ and $t+h \leq 1$. The parameter h captures the tax rate difference between the low- and high-tax countries. We assume taxation in terms of the separate entity approach and that each division has additional

[8] In Germany, e.g., a firm must provide all documents related to a specific transaction to the tax auditor, even if these documents are not related to tax accounts (§90 AO).

income, so that the divisional after-tax income is always positive.

In the first stage, the MNF chooses whether to implement an OSB or a TSB transfer-pricing regime (implementation decision). With OSB, the MNF uses a single transfer price to evaluate the intra-firm trade internally and to calculate the tax liability, i.e., the internal transfer price p_i equals the tax transfer price p_r. For TSB, the MNF decouples its transfer-pricing decisions and uses two different transfer prices, i.e., $p_i \neq p_r$.

The upstream division makes an intermediate product that is transformed into the final product by the downstream division, which faces monopolistic market conditions for the final product. No external market for the intermediate product exists. The upstream division faces either high unit costs c_H with probability β or low unit costs c_L with probability $1-\beta$ for producing the intermediate product, where $0 < \beta < 1$ and $0 \leq c_L < c_H$. While the probability β is common knowledge, only the MNF observes the cost realization after the implementation decision. We label the MNF with low (high) unit costs as a low-cost (high-cost) MNF.

In the second stage, after the realization of the unit costs, the MNF sets the tax transfer price using a cost-plus method, which is in line with the OECD transfer pricing guidelines and the monopolistic setting. Under this transfer pricing method, unit costs plus an appropriate markup fulfill the arm's length principle. Thus the upper bound for the tax transfer price of a low-cost MNF is given by $\underline{p_r} = c_L + m_L$, where $m_L \geq 0$ captures the accepted markup. The appropriate markup for the high-cost MNF is m_H, yielding an upper bound $\overline{p_r} = c_H + m_H$. We assume m_H and m_L such that $\overline{p_r} > \underline{p_r}$. For convenient notation, we assume that the lower bound of the arm's length range is p_{rL} (p_{rH}) for the low-cost (high-cost) MNF, where $0 \leq p_{rL} \leq p_{rH} < \underline{p_r} < \overline{p_r}$ holds. Thus the arm's length ranges are $\left[p_{rL}, \underline{p_r}\right]$ and $\left[p_{rH}, \overline{p_r}\right]$ for the low-cost and high-cost MNF, respectively. The MNF chooses either a compliant tax transfer price or a non-compliant tax transfer price that does not belong to the cost-specific arm's length range (compliance decision). In addition, with TSB, the MNF determines the internal transfer price.

The MNF evaluates the downstream division on the basis of pre-tax divisional profit Π^D,[9] so that the downstream division uses the internal transfer price for the quantity decision. Without loss of generality, the downstream division's costs for transforming the intermediate product into the final product are equal to zero. Due to monopolistic market conditions, the revenue function for the final product is $R(q) = \left(a - \frac{1}{2}q\right)q$, where q denotes the quantity. Thus the downstream division determines the quantity according to

$$q = \underset{\acute{q}}{\operatorname{argmax}} \left\{ \Pi^D = \left(a - \frac{1}{2}\acute{q}\right)\acute{q} - p_i\acute{q} \right\} = a - p_i. \tag{1}$$

In the third stage, the tax auditor observes the tax transfer price and decides to conduct an audit. The tax auditor is located in the high-tax country, i.e., the home country of the downstream division.[10] We assume that the tax auditor maximizes the additional income that he or she generates for the tax authority while facing personal audit costs K_a if he or she conducts an audit.

In line with empirical findings (Cools et al., 2008; Cools and Slagmulder, 2009) and the extensive documentation requirements imposed on MNFs, we assume that if a tax audit occurs, the tax auditor observes the realized unit costs, the transfer-pricing regime (i.e., OSB or TSB), and, for TSB, the

[9] Other studies assume that the divisions maximize their after-tax profits. This assumption is also ad hoc in the transfer pricing setting. Baldenius et al. (2004) explicitly highlight this fact. For further discussion of the advantages of pre-tax vs. after-tax profit maximization for divisional performance measurement, see Nielsen and Raimondos-Møller (2012).

[10] We do not consider tax audits in the low-tax country, which anticipates the MNF incentives to shift profits to it, so that profit shifting does not deprive it of tax income. Therefore, the low-tax country cannot generate additional tax income by auditing the MNF's transfer pricing.

internal transfer price.

If non-compliance is detected, the tax auditor enforces a compliant transfer price, where $\underline{p_r}$ ($\overline{p_r}$) is the enforced transfer price for a low-cost (high-cost) MNF. The tax auditor asks the MNF to pay the previously unpaid taxes, which are the difference between the tax payment that the tax auditor determines using the enforced transfer price p_a and the tax transfer price p_r. Moreover, the tax auditor levies an additional penalty, captured by a linear penalty factor $\delta \in \{\delta_{OSB}, \delta_{TSB}\}$ applied to the previously unpaid taxes (Yitzhaki, 1974).[11] In line with real-world regulations (EY, 2003, 2012; KPMG, 2012), we assume $1 \leq \delta_{OSB} < \delta_{TSB}$. Thus depending on its transfer-pricing regime, the MNF faces the following payment:

$$S = \begin{cases} (t+h)\, q\delta \cdot \max\{p_r - p_a, 0\} & \text{if an audit takes place,} \\ 0 & \text{if no audit takes place.} \end{cases} \tag{2}$$

Hereafter, we refer to S as the penalty.[12] Thus the tax auditor's payoff is as follows:

$$\Pi^{TA} = \begin{cases} S - K_a & \text{if an audit takes place,} \\ 0 & \text{if no audit takes place.} \end{cases} \tag{3}$$

[11] While we assume that the tax auditor enforces the upper bound of the arm's length range, in some countries (e.g., the U.S.), the enforced transfer price is the median of the arm's length range. By enforcing the median instead of the upper bound, the tax auditor additionally punishes a non-compliant MNF. If a country enforces the median of the arm's length range, we assume that this additional punishment is included in the penalty factor δ.

[12] A transfer-pricing adjustment by the tax auditor in the high-tax country leads to double taxation. We assume that the low-tax country does not pay any refunds that may result from double taxation agreements.

After the third stage, the MNF obtains the following global after-tax profit:

$$\Pi = q\left[(1-t-h)\left(a-\frac{1}{2}q\right)-(1-t)c+hp_r\right]-S, \tag{4}$$

with $c \in \{c_L, c_H\}$. The MNF maximizes its global after-tax profit and incorporates tax savings due to the tax rate difference and the possibly resulting penalty.

Figure 1 shows the timing of the game.

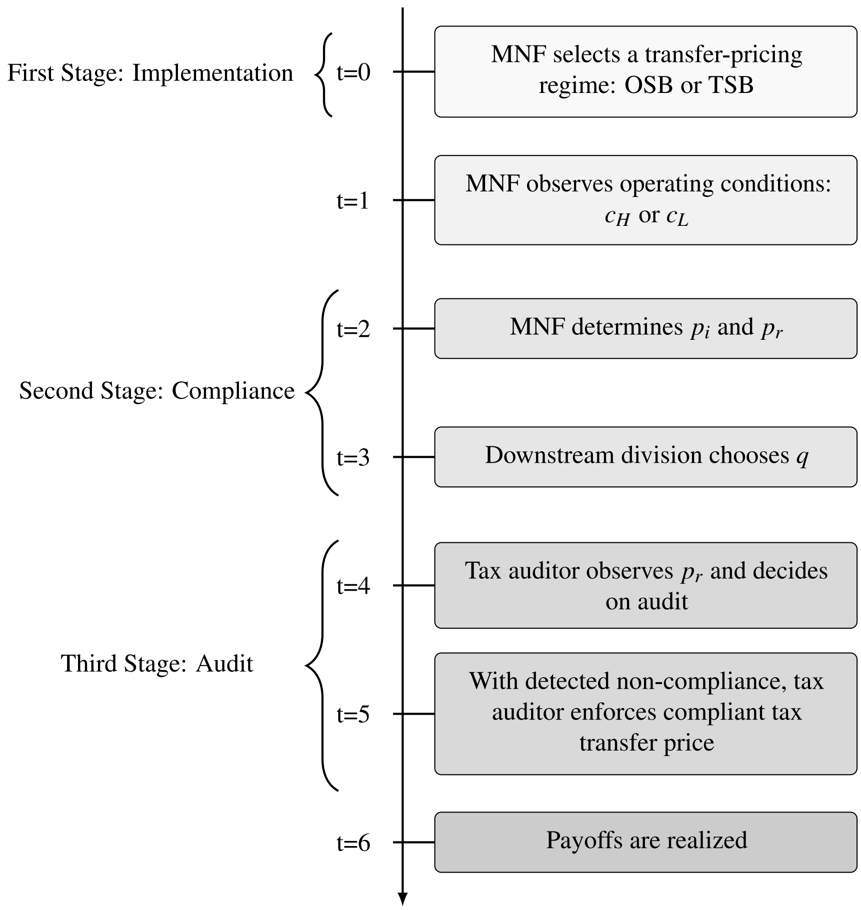

Figure 1: Timeline

3 Internal and Tax Transfer Prices

This section shows that the MNF reports $p_r \in \{\underline{p_r}, \overline{p_r}\}$ if the reservation price a is sufficiently large. Furthermore, it demonstrates how the internal transfer price p_i is adjusted for tax payments and tax audit risk.

The MNF may choose an arbitrary tax transfer price $p_r > 0$. A tax transfer price $p_r > \overline{p_r}$ is evidence of non-compliance for the tax auditor, even without a tax audit. Because obvious non-compliance with tax regulation is beyond dispute, we assume that the tax auditor punishes obvious non-compliance without facing substantial audit costs. Thus neither the high-cost nor the low-cost MNF reports $p_r > \overline{p_r}$.

The high-cost MNF minimizes the tax payment with a tax transfer price $\overline{p_r}$. Therefore, the high-cost MNF uses $\overline{p_r}$ with TSB. The high-cost MNF using OSB considers a trade-off between tax savings and quantity distortion. Given $q = a - p_r$, the optimal tax transfer price fulfills

$$\frac{d\Pi}{dp_r} = \frac{\partial \Pi}{\partial p_r} + \frac{\partial \Pi}{\partial q} \cdot \frac{dq}{dp_r} = \underbrace{h\,(a - p_r)}_{\text{tax savings}} + \underbrace{(1-t)\,(p_r - c_H) \cdot (-1)}_{\text{quantity distortion}} = 0, \tag{5}$$

rearranging yields

$$p_r = \frac{1}{1 - t + h}\left[(1-t)\,c_H + ah\right].$$

Despite the trade-off, for a sufficiently large reservation price a the MNF chooses $\overline{p_r}$ as the tax transfer price—unit costs plus markup. When choosing the quantity, the downstream division considers both the tax transfer price and the reservation price. By internalizing the markup as costs, the downstream division distorts the quantity downwards (standard double marginalization problem). Because the downstream division internalizes the reservation price as the MNF does, the negative quantity distortion is constant in a (see equation (5)). As a large reservation price results in a large quantity, which in turn causes a high marginal benefit from the tax savings, a large a makes the tax savings more important than the quantity distortion. Consequently, the MNF seeks a high tax transfer price and thus implements $\overline{p_r}$.

The low-cost MNF may choose a non-compliant tax transfer price, i.e., $p_r > \underline{p_r}$. As the tax auditor anticipates that a high-cost MNF will always report $\overline{p_r}$, reporting a tax transfer price in the range $(\underline{p_r}, \overline{p_r})$ immediately identifies the low-cost MNF as non-compliant. Therefore, the non-compliant low-cost MNF chooses $p_r = \overline{p_r}$ for both OSB (for sufficiently high a) and TSB. If, instead, the low-cost MNF decides not to mimic the high-cost MNF and reports compliantly, to minimize the tax payment, the low-cost MNF uses the highest compliant arm's length price $\underline{p_r}$ under TSB. Likewise, as with the high-cost MNF, a sufficiently large reservation price ensures that $\underline{p_r}$ is optimal for a compliant low-cost MNF that keeps OSB. Lemma 1 summarizes:

Lemma 1. *Assume a sufficiently large reservation price a.*

1. *A high-cost MNF reports the compliant tax transfer price $p_r = \overline{p_r}$ for TSB and OSB.*
2. *A non-compliant low-cost MNF reports $p_r = \overline{p_r}$ for TSB and OSB.*
3. *A compliant low-cost MNF reports $p_r = \underline{p_r}$ for TSB and OSB.*

Proof. See appendix. □

With TSB, to maximize global after-tax profits, the MNF additionally determines an internal transfer price. The compliant MNF uses tax-adjusted unit costs as the internal transfer price (see Baldenius et al., 2004). This transfer price induces the downstream division to make the optimal quantity decision. In the non-compliance case, the low-cost MNF also considers the costs following a potential tax audit. Thus when the low-cost MNF considers a strategic tax auditor, the non-compliant low-cost MNF uses tax- and audit-adjusted unit costs to induce the optimal quantity decision. Lemma 2 summarizes:

Lemma 2. *Given that the MNF has installed a TSB regime in the first stage, and the tax auditor audits with probability η, the MNF determines the internal transfer price as follows:*

A non-compliant low-cost MNF adopts tax- and audit-adjusted unit costs as internal transfer price p_{iL1}:

$$p_{iL1} = \frac{1}{1-t-h}\left[(1-t)c_L - h\overline{p_r} + \eta\delta_{TSB}(t+h)(\overline{p_r} - \underline{p_r})\right]. \quad (6)$$

In case of compliance, the high- and low-cost MNFs adopt tax-adjusted unit costs c_H and c_L as internal transfer prices p_{iH} and p_{iL2}, respectively:

$$p_{iH} = \frac{1}{1-t-h}\left[(1-t)c_H - h\overline{p_r}\right] \quad (7)$$

and

$$p_{iL2} = \frac{1}{1-t-h}\left[(1-t)c_L - h\underline{p_r}\right].$$

Proof. See appendix. □

The game tree in Figure 2 displays those strategies (for the MNF and the tax auditor) that are not dominated by another strategy. The tax auditor never audits a tax transfer price $p_r = \underline{p_r}$ because $p_r = \underline{p_r}$ indicates a compliant low-cost MNF.

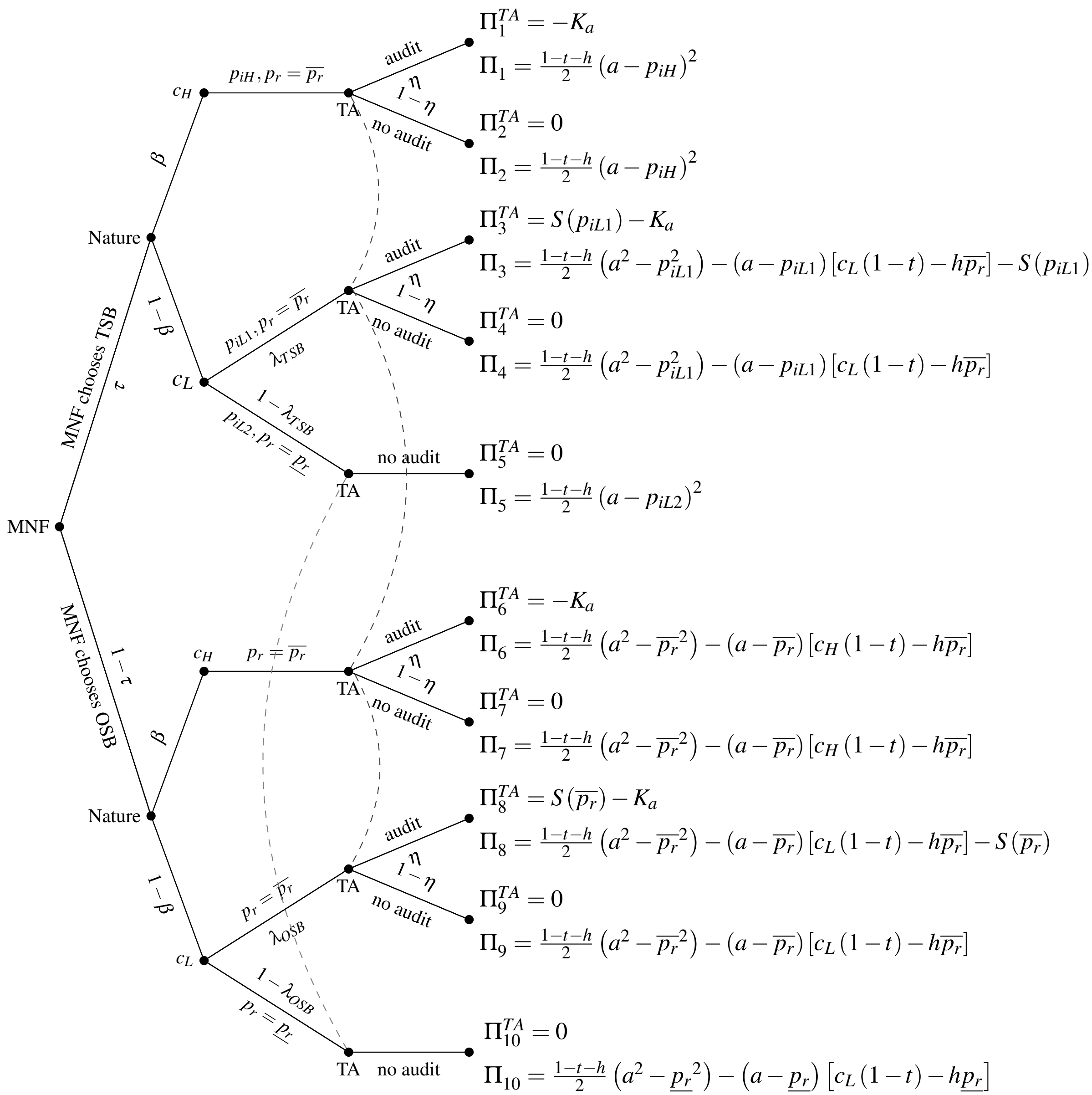

Figure 2: Game tree without dominated strategies [The MNF implements TSB (OSB) with probablility τ $(1-\tau)$. After observing the unit costs, the low-cost MNF chooses $\overline{p_r}$ $\left(\underline{p_r}\right)$ with probability λ_j $\left(1-\lambda_j\right)$, $j \in \{TSB, OSB\}$. The tax auditor (TA) conducts an audit with probability η.]

4 Transfer Pricing Regimes and Compliance

Our model is a tax compliance game, with the audit decision depending on the tax transfer price. Pure strategy equilibria exist for extremely high or low audit costs in combination with low or high penalties for a detected non-compliance. In such cases, the MNF selects TSB or OSB in the first stage and then either always or never chooses a compliant tax transfer price in the second stage. The tax auditor either never or always audits the MNF. Given that pure strategy equilibria cannot explain why compliance and non-compliance and non-trivial tax audit strategies appear simultaneously in reality, we concentrate our analysis on mixed strategy equilibria.

In our model, randomization may appear at three stages: First, the MNF may randomize between TSB and OSB. We denote the corresponding implementation probability of TSB (OSB) by τ $(1-\tau)$. Second, after observing the unit costs, the low-cost MNF chooses the non-compliant tax transfer price $\overline{p_r}$ with probability λ_j, $j \in \{TSB, OSB\}$, and the compliant tax transfer price $\underline{p_r}$ with probability $1-\lambda_j$. We refer to λ_j as the non-compliance probability. Third, after observing the tax transfer price $\overline{p_r}$, the tax auditor decides whether to audit the MNF (probability η) or not (probability $1-\eta$).

The strategies τ, λ_{TSB}, λ_{OSB}, and η constitute an equilibrium if the following conditions hold:

1. First Stage: Implementation

$$\tau \in \underset{\acute{\tau}}{\operatorname{argmax}} \, E_{t=0} \left[\Pi \left(\acute{\tau}, \lambda_{TSB}, \lambda_{OSB}, \eta \right) \right]$$

2. Second Stage: Compliance

$$\lambda_{TSB} \in \underset{\acute{\lambda}_{TSB}}{\operatorname{argmax}} \, E_{t=2} \left[\Pi \left(\acute{\lambda}_{TSB}, \eta \right) \middle| \text{TSB} \right] \text{ and}$$

$$\lambda_{OSB} \in \underset{\acute{\lambda}_{OSB}}{\operatorname{argmax}} \, E_{t=2} \left[\Pi \left(\acute{\lambda}_{OSB}, \eta \right) \middle| \text{OSB} \right]$$

3. Third Stage: Audit

$$\eta \in \underset{\acute{\eta}}{\operatorname{argmax}} E_{t=4}\left[\Pi^{TA}\left(\tau, \lambda_{TSB}, \lambda_{OSB}, \acute{\eta}\right) \middle| p_r = \overline{p_r}\right]$$

In a mixed strategy equilibrium, each player—in our model, the MNF and the tax auditor—has to be indifferent between all the pure strategies that the player plays with positive probability. The MNF's strategy comprises the implementation decision in the first stage and the compliance decision in the second stage. Randomization in both stages requires indifference between OSB and TSB, and between compliance and non-compliance. The tax auditor, however, has only the audit probability for inducing indifference. Therefore, the MNF randomizes at either the implementation or the compliance stage.[13] Proposition 1 exhibits the mixed strategy equilibria of our model:

Proposition 1. *Assume a sufficiently large reservation price a. The following three mixed-strategy equilibria exist:*

1. *Equilibrium I: For $\delta_{OSB} \geq \overline{\delta}_{OSB}$ and $K_a < K_{a2}(\eta_I)$, the MNF always implements TSB. After the realization of the unit costs, the high-cost MNF reports the compliant tax transfer price $\overline{p_r}$ and the low-cost MNF reports the non-compliant tax transfer price $\overline{p_r}$ (compliant tax transfer price $\underline{p_r}$) with probability $\lambda_{TSB,I}$ $(1-\lambda_{TSB,I})$. The tax auditor audits $\overline{p_r}$ with audit probability η_I.*

2. *Equilibrium II: For $K_a < K_{a1}(\delta_{OSB})$, the MNF implements TSB (OSB) with probability τ_{II} $(1-\tau_{II})$. After the realization of the unit costs, the high-cost MNF reports the compliant tax transfer price $\overline{p_r}$ and the low-cost MNF reports the compliant tax transfer price $\underline{p_r}$ under*

[13] We do not consider knife-edge cases where the MNF randomizes at both stages.

TSB and the non-compliant tax transfer price $\overline{p_r}$ under OSB. The tax auditor audits $\overline{p_r}$ with probability η_{II}.

3. *Equilibrium III: For $K_{a1}(\delta_{OSB}) < K_a < K_{a2}(\eta_{III})$, the MNF chooses TSB (OSB) with probability τ_{III} $(1-\tau_{III})$. After the realization of the unit costs, the high-cost MNF reports the compliant tax transfer price $\overline{p_r}$ and the low-cost MNF chooses the non-compliant tax transfer price $\overline{p_r}$ under TSB and under OSB. The tax auditor audits $\overline{p_r}$ with probability η_{III}.*

Proof. All proofs, equilibrium probabilities, and thresholds appear in the appendix. □

Figure 3 depicts the findings of proposition 1 and shows that the equilibrium in our model is unique if the penalty factor δ_{OSB} is sufficiently low. For a fixed penalty factor δ_{TSB}, a low penalty factor δ_{OSB} corresponds to a large penalty difference. In such a case, the MNF randomizes between TSB and OSB. After the realization of the unit costs, the high-cost MNF always reports compliantly while the audit costs determine the compliance decision of the low-cost MNF under TSB. In other words, both TSB and OSB can be part of the equilibrium strategy.

This finding is in line with both empirical and anecdotal evidence from Klassen et al. (2017) and Springsteel (1999). We observe that the equilibrium—where the MNF randomizes between OSB and TSB in the first stage and the low-cost (high-cost) MNF always reports a non-compliant (compliant) tax transfer price (equilibrium III)—appears if δ_{OSB} is low and K_a is high. This finding is intuitive: A low penalty factor under OSB together with high audit costs, implies weak audit incentives. Therefore, the low-cost MNF chooses TSB with non-compliance instead of TSB with compliance. For a small penalty difference, the deterministic implementation of TSB and random compliance (equilibrium I) coexists with equilibria II and III.

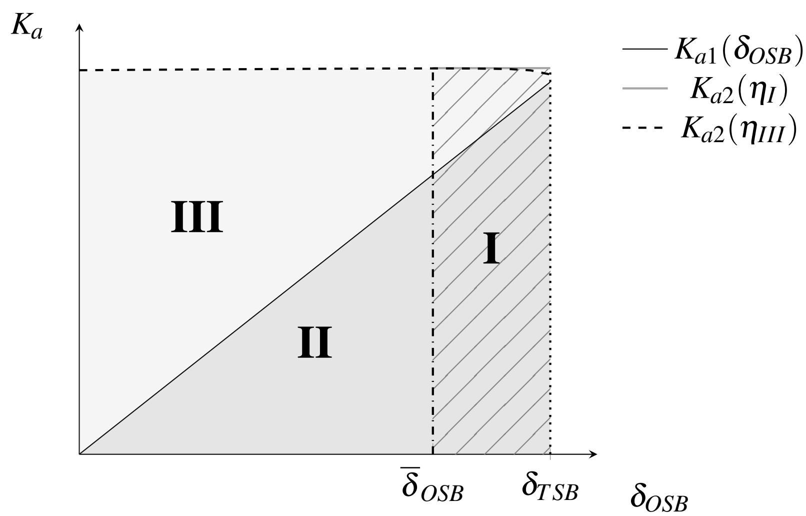

Figure 3: Equilibrium areas depending on K_a and δ_{OSB}. Area I shows equilibrium I, where the MNF always implements TSB. After the realization of the unit costs, the low-cost MNF randomizes between compliant and non-compliant reporting. Area II shows equilibrium II, where the MNF implements TSB with probability τ_{II} and OSB with probability $1-\tau_{II}$. After the realization of the unit costs, the low-cost MNF reports compliantly (non-compliantly) under TSB (OSB). Area III shows equilibrium III, where the MNF implements TSB (OSB) with probability τ_{III} $(1-\tau_{III})$. After the realization of the unit costs, the low-cost MNF always reports non-compliantly. Values: $a = 10,000$, $c_H = 100$, $c_L = 60$, $t = 0.2$, $h = 0.1$, $\beta = 0.8$, $\overline{p_r} = 120$, $\underline{p_r} = 70$, $\delta_{TSB} = 1.2$

The deterministic implementation of TSB (equilibrium I) is an equilibrium strategy for a small penalty difference. The intuition for this finding is as follows: With the deterministic implementation of TSB, the quantity is optimal, and the low-cost MNF randomizes between compliance and non-compliance. For a small penalty difference, the disadvantage of TSB is small. In contrast, for a large penalty difference, the MNF prefers to deviate to OSB in the first stage so that the deterministic implementation of TSB does not occur.

When the MNF randomizes between TSB and OSB in the first stage, the high-cost MNF always chooses compliance in the second stage, and the low-cost MNF conditions its compliance decision in the second stage on the audit costs. This randomization occurs in equilibria II and III. In the case of low audit costs, the MNF expects frequent tax audits. In the second stage, the low-cost MNF thus chooses OSB with the non-compliant tax transfer price $\overline{p_r}$ or TSB with the compliant tax transfer price $\underline{p_r}$. With the non-compliant use of OSB, the low-cost MNF realizes tax savings. The compliant use of TSB minimizes tax payments within the legal boundaries and yields the optimal quantity decision. With high audit costs, tax audits are infrequent, and, for the low-cost MNF, reporting the non-compliant tax transfer price dominates in the second stage. While OSB implies lower penalties if non-compliance is detected for the low-cost MNF, both types of the MNF benefit from separating internal and tax transfer prices under TSB. Consequently, neither OSB nor TSB dominates in the first stage.

Furthermore, proposition 1 shows that we do not observe an equilibrium in which the low-cost MNF reports a compliant tax transfer price under OSB because, given the quantity distortion under OSB, any equilibrium with OSB and a compliant tax transfer price as part of a mixed strategy implies a strictly lower payoff for the low-cost MNF than with TSB and compliance.

5 Effects of Increases in Tax Rate Difference and Penalties

Equipped with the equilibrium strategies of both the MNF and the tax auditor, we analyze how variations in the tax regulation affect the MNF's decisions on quantity, compliance, and the implementation of transfer-pricing regimes. The regulatory parameters of interest are the tax rate difference and the penalty factors for detected non-compliance.

5.1 Tax rate difference

For each equilibrium determined in section 4, proposition 2 shows how the internal transfer price and the non-compliance or implementation probability change with an increase in the tax rate difference h.[14]

Proposition 2. *Assume a sufficiently large reservation price a. An increase in the tax rate difference* h

1. *decreases the internal transfer price under TSB in all equilibria;*
2. *decreases the probability of a non-compliant tax transfer price in equilibrium I* ($\lambda_{TSB,I}$)*;*
3. *increases the probability of using TSB in equilibrium II* (τ_{II})*, where the low-cost MNF uses a compliant tax transfer price with TSB;*
4. *decreases the probability of using TSB in equilibrium III* (τ_{III})*, where the low-cost MNF uses a non-compliant tax transfer price with TSB.*

Proof. See appendix. □

Proposition 2, part 1, states that the MNF boosts the quantity for a higher tax rate difference whenever the MNF uses TSB. A higher tax rate difference increases the MNF's profit-shifting benefits. With TSB the tax transfer price is already set to optimally exploit the tax rate difference.

[14] Alternative possibilities for modeling the tax rate difference exist. Nevertheless, because all results hold for the entire range of t and h, our specification is without loss of generality when we conduct comparative statics with respect to h.

Thus the MNF exploits the increasing tax rate difference by selling a larger quantity. Because the low-cost non-compliant MNF that implements TSB uses tax- and audit-adjusted unit costs as the internal transfer price (see Lemma 2), the low-cost non-compliant MNF additionally incorporates the tax auditor's reaction to a higher tax rate difference. Nevertheless, we show that the low-cost non-compliant MNF also lowers the internal transfer price for an increasing tax rate difference.

The non-compliance and implementation results in proposition 2, parts 2 to 4, have an instructive interpretation in terms of tax aggressiveness. In our model, we define tax aggressiveness as non-compliant reporting under either TSB or OSB. We consider non-compliant reporting under TSB more tax aggressive transfer pricing than non-compliant reporting under OSB. An increasing tax rate difference implies less frequent non-compliance in equilibria I and II, and a shift from TSB with non-compliance to less tax aggressive OSB with non-compliance in equilibrium III for the low-cost MNF. As better profit-shifting opportunities induce less tax-aggressive decisions by the MNF, this result appears counterintuitive.

The appealing intuition that a higher tax rate difference induces more tax aggressiveness due to more beneficial profit-shifting holds true when no tax audit is considered. For example, Baldenius et al. (2004, p. 600) show that the incremental gain of TSB is relatively large for a high tax rate difference. However, with a strategic tax auditor, the MNF also considers potential penalties and audit incentives. In this case, as the penalty depends on the previously unpaid taxes, an increasing tax rate difference directly increases the penalty for detected non-compliance. Additionally, in a setting with TSB, an increasing tax rate difference leads to a larger quantity, which also increases the penalty for detected non-compliance. Therefore, the tax auditor obtains a higher income when he or she detects non-compliance in a tax audit, that is, a higher penalty implies stronger audit incentives for the tax auditor. In equilibrium, to counteract the stronger audit incentives, the MNF reports less tax aggressively.

Our findings are in line with the empirical finding of Chan and Chow (1997), who show that high tax rate differences are not crucial for inducing non-compliant transfer prices. Their work demonstrates that the tax auditor is aware of an MNF's profit shifting incentives. Thus accounting for the strategic interaction with the tax auditor, the MNF is less tax aggressive with an increasing tax rate difference. Furthermore, our result is consistent with the finding of Hoopes et al. (2012) that a stricter tax enforcement is associated with less tax aggressiveness.

5.2 Penalty factors

For each equilibrium determined in section 4, proposition 3 shows how the internal transfer price, and the non-compliance or implementation probability react to changes in the penalty factors for detected non-compliance under OSB and TSB.

Proposition 3. *Assume a sufficiently large reservation price a. An increase in the penalty factor for detected non-compliance under OSB (TSB),* δ_{OSB} *(*δ_{TSB}*) has the following effects:*

1. *Neither* δ_{OSB} *nor* δ_{TSB} *affects the internal transfer prices in equilibria I and II or the internal transfer price of the high-cost MNF in equilibrium III. In equilibrium III, the internal transfer price of the low-cost MNF under TSB increases (decreases) in* δ_{OSB} *(*δ_{TSB}*).*

2. *An increasing* δ_{OSB} *(*δ_{TSB}*) does not affect (decreases) the probability that the low-cost MNF chooses a non-compliant tax transfer price* $\lambda_{TSB,I}$ *in equilibrium I.*

3. *An increasing* δ_{OSB} *(*δ_{TSB}*) increases (does not affect) the probability of using TSB* τ_{II} *in equilibrium II, where the low-cost MNF uses a compliant tax transfer price.*

4. *The probability of using TSB τ_{III} in equilibrium III, where the low-cost MNF uses a non-compliant tax transfer price, decreases in δ_{OSB} for $K_a \in (K_{a1}, K_a^c)$*[15] *and increases in δ_{OSB} for $K_a \in (K_a^c, K_{a2}(\eta_{III}))$. The probability τ_{III} decreases in δ_{TSB}.*

Proof. See appendix. □

We start with the intuition for proposition 3, part 1. Because penalty factors are irrelevant when the MNF reports compliantly, penalty factors do not affect the internal transfer price with TSB and compliance in equilibria I, II, or III. When the low-cost MNF keeps TSB with non-compliance in equilibrium I, the audit probability is such that the expected penalty equals the tax savings that the low-cost MNF obtains through non-compliance. Consequently, for the low-cost MNF, the internal transfer prices with TSB and compliance or non-compliance are equal in equilibrium I and neither δ_{OSB} nor δ_{TSB} affects the internal transfer price with TSB and non-compliance.

When the low-cost MNF keeps TSB with non-compliance in equilibrium III, the penalty factors influence the internal transfer price via the audit adjustment. First, we consider the effect of δ_{OSB}. The penalty factor δ_{OSB} affects the audit adjustment only via the audit probability η_{III}. We show that η_{III} increases in δ_{OSB}, and thus the internal transfer price increases in δ_{OSB}. The intuition is as follows: TSB with non-compliance becomes more attractive to the low-cost MNF when δ_{OSB} increases. The tax auditor counters with a higher audit probability because TSB with non-compliance implies a higher penalty than for OSB with non-compliance.

Second, we consider the effect of δ_{TSB}. The penalty factor δ_{TSB} affects the audit adjustment both directly and via the audit probability η_{III}. The direct effect increases the audit adjustment

[15] See appendix for the threshold K_a^c.

and, in turn, the internal transfer price. Because η_{III} decreases in δ_{TSB}, the effect via the audit probability works in the opposite direction. The intuition is as follows: An increase in δ_{TSB} makes TSB with non-compliance less attractive for the low-cost MNF and induces the tax auditor to audit less frequently. Our results show that the decrease in the audit probability overcompensates for the direct effect; thus, in equilibrium III, the internal transfer price of the low-cost MNF decreases with δ_{TSB}.

Part 2 of proposition 3 is intuitive: Because a higher penalty for a detected non-compliance under TSB decreases the benefit of using a non-compliant tax transfer price with TSB, the low-cost MNF reduces the non-compliance probability $\lambda_{TSB,I}$.

As the low-cost MNF reports the compliant tax transfer price under TSB in equilibrium II, changes in the TSB penalty factor δ_{TSB} do not affect the implementation probability for TSB. An increasing penalty factor δ_{OSB} reduces the attractiveness of OSB and, in an intuitively appealing way, induces the MNF to shift from OSB to TSB in equilibrium II (see proposition 3, part 3).

An increase in the penalty factor δ_{OSB} ambiguously affects the implementation probability in equilibrium III, where the low-cost MNF uses a non-compliant tax transfer price under both the TSB and OSB transfer-pricing regimes. Proposition 3, part 4, states that the MNF implements TSB less frequently for an intermediate level of audit costs, i.e., $K_a \in (K_{a1}, K_a^c)$ with $K_a^c < K_{a2}(\eta_{III})$, when δ_{OSB} increases. In this case, ceteris paribus the low-cost MNF has a stronger incentive to implement the more tax-aggressive TSB with non-compliance. The tax auditor anticipates the MNF's incentive while deciding whether to audit the MNF. Additionally, the higher penalty factor directly increases the tax auditor's audit incentives. As an advantage of OSB still remains, the MNF reacts to the tax auditor's stronger audit incentives by increasing the probability of keeping OSB for an intermediate level of audit costs. For audit costs above K_a^c, the tax auditor's audit incentives are sufficiently weak so that the low-cost MNF's incentive to switch towards more tax-aggressiveness by keeping TSB hardly affects the audit decision. Therefore, a higher penalty for detected non-compliance under OSB induces the MNF to refrain from the use of OSB.

In equilibrium III, an increase in the penalty factor δ_{TSB} makes TSB with non-compliance less attractive for the low-cost MNF, and thus, before the realization of the unit costs, the MNF implements OSB more frequently.

In sum, either an increasing penalty factor δ_{OSB} or a decreasing penalty factor δ_{TSB} cause a smaller penalty difference. Proposition 3 states that a decreasing penalty difference ambiguously affects the implementation of the transfer-pricing regime: For intermediate audit costs and a smaller penalty difference caused by an increase of δ_{OSB}, the probability of OSB increases, if TSB with non-compliance of the low-cost MNF is the alternative action in equilibrium, i.e., in equilibrium III. In all other cases of equilibrium III and in equilibrium II, the probability of OSB decreases for a smaller penalty difference.

Our findings relate to those of Klassen et al. (2017), who find that the enforcement level does not affect MNFs' transfer-pricing focus if the focus is either "tax minimization" or "lack of disputes." In our model, we interpret (1) the enforcement level as the size of the penalty factors for detected non-compliance under OSB or TSB, (2) "tax minimization" as a non-compliant tax transfer price for the low-cost MNF, and (3) the "lack of disputes" as a compliant tax transfer price. We show that the penalty factors affect the implementation decision, which is exogenous in Klassen et al. (2017). For exogenous implementation decisions, where OSB and TSB coexist, the compliance decisions and thus the transfer-pricing focuses, are deterministic. Put differently, the penalty factors do not affect MNFs' compliance. By considering both decisions, we show in proposition 3 that larger penalty factors can influence MNFs' implementation decisions, thereby affecting MNFs' compliance and thus, the transfer-pricing focus.

6 Alternative Sequence of Events

Thus far in this paper, the MNF has chosen its transfer-pricing regime, OSB or TSB, before knowing its unit costs. This timing assumes that it does not continually revise its decision to implement OSB or TSB to adjust for changes in the short-term operating conditions, such as unit costs. Nevertheless, MNFs may reconsider their decisions. For example, a new executive team might revise the previous team's decisions, or changes in tax regulation might induce an MNF to adjust its accounting system. Thus the MNF might be able to choose its transfer-pricing regime after observing the unit costs. This section discusses the potential impact of this alternative sequence of events on our findings.[16]

The model with the alternative sequence of events qualitatively yields the same results as those in propositions 1, 2, and 3. All three mixed-strategy equilibria still occur for the low-cost MNF, and no further mixed-strategy equilibria appear. Because the low-cost MNF still trades off flexibility and the level of penalties, this finding is intuitive. For the high-cost MNF, no advantage of OSB exists. Consequently, when the high-cost MNF chooses its transfer-pricing regime after observing the realized unit costs, the high-cost MNF always implements TSB. As the tax auditor cannot observe the MNF's unit costs prior to an audit, he or she audits the high tax transfer price with positive probability.

In contrast to the model with the previous timing of the game, only the low-cost MNF adapts

[16] All formal claims and proofs for the alternative sequence of events are in the Internet Appendix. The Internet Appendix is available on https://ssrn.com/abstract=3904634.

its implementation decision as response to a varying tax rate difference or changes in the penalty factors for OSB and TSB. Nevertheless, in the model with the previous timing of the game, the low-cost MNF's incentives cause the comparative static results, meaning that the results qualitatively carry over to the model with the alternative sequence of events. The low-cost MNF becomes less tax aggressive in response to a higher tax rate difference. Additionally, for an intermediate level of audit costs, the low-cost MNF keeps OSB more frequently when the penalty factor for OSB increases. In sum, our results show that the timing of the game is immaterial for obtaining our main findings.

7 Conclusion

This paper examines how a strategic tax auditor affects an MNF's transfer-pricing regime choice—TSB or OSB—and compliance decision in a tax compliance game. The MNF faces a trade-off between flexibility and the level of penalties. Our analysis identifies the mixed strategy equilibria and shows that the level of the tax auditor's audit costs and the penalty factors for detected non-compliance determine the MNF's equilibrium behavior. Specifically, our findings illustrate that OSB is part of the MNF's equilibrium strategy whenever the penalty difference is large. Put differently, strategic considerations in a tax compliance game are a potential reason for MNFs to implement OSB.

Our analysis shows that a higher tax rate difference reduces MNFs' tax aggressiveness. This result stems from the presence of the strategic tax auditor. A high tax rate difference in particular yields a high tax-savings potential for the MNF, allowing it to benefit from shifting profits to the low-tax country. At the same time, a high tax rate difference corresponds to a high penalty for detected non-compliance. The tax auditor incorporates the penalty into the audit decision, making the audit incentives strong. To counteract the stronger audit incentives, the MNF increasingly refrains from tax aggressiveness.

Furthermore, our analysis illustrates that, for an intermediate level of audit costs, the MNF increases the probability of keeping OSB when the penalty advantage for detected non-compliance under OSB decreases. Specifically, the OSB advantage decreases for an increasing OSB penalty factor. Thus the MNF's incentives for keeping non-compliant TSB increase. As with the tax rate difference finding, because the penalty for detected non-compliance under OSB increases, the tax auditor's incentives increase. The stronger audit incentives greatly diminish the MNF's incentives for keeping non-compliant TSB. Therefore, the MNF increases the probability of keeping OSB.

Our paper adds to the literature on international transfer pricing by enhancing the theoretical understanding of how a strategic tax auditor and tax regulation—in the form of the tax rate difference and the penalty factors for non-compliant reporting—affect an MNF's transfer-pricing decisions and resulting tax aggressiveness. A promising extension of our research would be to investigate how the presence of a strategic tax auditor affects an MNF's decisions in more general intra-firm relationships. For example, in a setting where the divisions decide on upfront investments to either enhance revenues or decrease unit costs, the transfer-pricing regime affects both the investment incentives and the compliance decision. Consequently, the tax auditor's incentives potentially affect the divisions' investment decisions.

8 Appendix

8.1 Proof of Lemma 1

Figure 4 depicts the MNF's possible strategies.

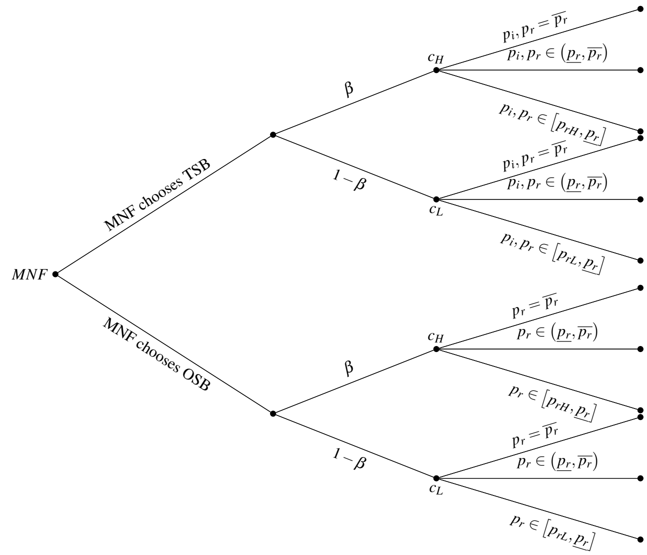

Figure 4: Possible strategy choices for an MNF with unit costs c_j, where $j = H, L$

Note that $p_r > \overline{p_r}$ is an unambiguous signal of tax evasion (punished without audit costs) so that the MNF never chooses $p_r > \overline{p_r}$.

For $p_r \leq \overline{p_r}$, a high-cost MNF is compliant. To minimize its tax payments, the high-cost MNF keeping TSB sets $p_r = \overline{p_r}$.

Under OSB, a high-cost MNF maximizes its expected profit determining a transfer price:

$$\left.\frac{d\Pi}{dp_r}\right|_{q=a-p_r} = \left[\frac{\partial \Pi}{\partial p_r} + \frac{\partial \Pi}{\partial q} \cdot \frac{dq}{dp_r}\right]_{q=a-p_r} = h(a-p_r) + (1-t)(p_r - c_H) \cdot (-1) = 0 \qquad (8)$$

$$\iff p_r = \frac{1}{1-t+h}\left[(1-t)c_H + ah\right] \geq \overline{p_r}$$

for sufficiently large a so that a high-cost MNF keeping OSB chooses $p_r = \overline{p_r}$.

A non-compliant low-cost MNF keeping TSB that reports a $p_r \in \left(\underline{p_r}, \overline{p_r}\right)$ reveals itself as a non-compliant low-cost MNF. By choosing $p_r = \overline{p_r}$, a low-cost MNF mimics a high-cost MNF. Thus a non-compliant low-cost MNF keeping TSB sets $p_r = \overline{p_r}$.

A non-compliant low-cost MNF keeping OSB chooses a transfer price $\underline{p_r} < p_r \leq \overline{p_r}$. A non-compliant low-cost MNF maximizes its expected profit by determining a transfer price, where the tax auditor audits with probability η:

$$\left.\frac{d\Pi}{dp_r}\right|_{q=a-p_r} = (1-t+h-2\eta(t+h)\delta_{OSB})(-p_r)+(1-t)c_L+ah-\eta(t+h)\delta_{OSB}(a+\underline{p_r})=0$$

$$\iff p_r = \frac{1}{1-t+h-2\eta(t+h)\delta_{OSB}}\left[(1-t)c_L+ah-\eta(t+h)\delta_{OSB}(a+\underline{p_r})\right]$$

$$\left.\frac{d^2\Pi}{dp_r^2}\right|_{q=a-p_r} = (1-t+h-2\eta(t+h)\delta_{OSB})(-1).$$

$\left.\frac{d^2\Pi}{dp_r^2}\right|_{q=a-p_r}$ is negative for $\delta_{OSB} < \frac{1-t+h}{2\eta(t+h)}$. Thus for a $\delta_{OSB} > \frac{1-t+h}{2\eta(t+h)}$ the first-order condition (FOC) determines a local minimum, and the MNF prefers a corner solution, i.e., $p_r \in \left\{\underline{p_r}, \overline{p_r}\right\}$. With $p_r = \underline{p_r}$ the MNF is compliant. Thus a non-compliant low-cost MNF keeping OSB sets $p_r = \overline{p_r}$ for $\delta_{OSB} > \frac{1-t+h}{2\eta(t+h)}$. For $\delta_{OSB} < \frac{1-t+h}{2\eta(t+h)}$ the FOC determines a local maximum. For a sufficiently large a, the MNF's FOC determines a $p_r > \overline{p_r}$ so that a non-compliant low-cost MNF keeping OSB sets $p_r = \overline{p_r}$ for $\delta_{OSB} < \frac{1-t+h}{2\eta(t+h)}$.

A compliant low-cost MNF keeping TSB minimizes its tax payments by choosing $p_r = \underline{p_r}$.

Under OSB a compliant low-cost MNF maximizes its expected profit determining a transfer price:

$$\left.\frac{d\Pi}{dp_r}\right|_{q=a-p_r} = \left[\frac{\partial\Pi}{\partial p_r}+\frac{\partial\Pi}{\partial q}\cdot\frac{dq}{dp_r}\right]_{q=a-p_r} = h(a-p_r)+(1-t)(p_r-c_L)\cdot(-1)=0$$

$$\iff p_r = \frac{1}{1-t+h}\left[(1-t)c_L+ah\right] \geq \underline{p_r}$$

for sufficiently large a. Thus a compliant low-cost MNF keeping OSB chooses $p_r = \underline{p_r}$. □

8.2 Proof of Lemma 2

Note that TSB allows the MNF to disentangle its internal from its tax transfer price. The MNF's profit with unit costs c_j and $j = H, L$ is as follows:

$$\Pi(p_i, p_r)|_{q=a-p_i} = (a-p_i)\left[(1-t-h)\left(a-\frac{1}{2}(a-p_i)\right)-(1-t)c_j+hp_r\right] \tag{9}$$
$$-\eta\delta_{TSB}(t+h)(a-p_i)(p_r-p_a).$$

The non-compliant low-cost MNF considers the consequences resulting from a tax transfer price $\overline{p_r}$ in a tax audit:

$$FOCp_i : -(1-t-h)p_i+(1-t)c_L-h\overline{p_r}+\eta\delta_{TSB}(t+h)(\overline{p_r}-\underline{p_r})=0$$

$$SOCp_i : -(1-t-h)<0.$$

Thus the FOC for p_i determines a local maximum:

$$p_i = \frac{1}{1-t-h}\left[(1-t)c_L-h\overline{p_r}+\eta\delta_{TSB}(t+h)(\overline{p_r}-\underline{p_r})\right] =: p_{iL1}.$$

The FOC for a compliant MNF reduces to

$$FOCp_i : -(1-t-h)p_i+(1-t)c_j-hp_r=0$$

$$SOCp_i : -(1-t-h)<0.$$

Thus the FOC for p_i determines a local maximum for the compliant high-cost MNF:

$$p_i = \frac{1}{1-t-h}\left[(1-t)c_H-h\overline{p_r}\right] =: p_{iH}.$$

Thus the FOC for p_i determines a local maximum for the compliant low-cost MNF:

$$p_i = \frac{1}{1-t-h}\left[(1-t)c_L-h\underline{p_r}\right] =: p_{iL2}.$$

□

8.3 Proof of Proposition 1

We examine each equilibrium. We identify the tax auditor's audit and the MNF's randomization probability. In addition, we determine the parameter constellations for K_a and δ_{OSB} so that the identified probabilities constitute an equilibrium in mixed strategies.

8.3.1 Proof of Equilibrium I

With TSB in place, the low-cost MNF randomizes between compliance and non-compliance if and only if the expected profits from both strategies are the same,i.e., $\eta\Pi_3 + (1-\eta)\Pi_4 = \Pi_5$:

$$\iff \eta \in \left\{ \frac{h}{\delta_{TSB}(t+h)}, \frac{h}{\delta_{TSB}(t+h)} + \frac{2\left[a(1-t-h) - c_L(1-t)\right]}{\delta_{TSB}(\overline{p_r} - \underline{p_r})(t+h)} \right\}.$$

The tax auditor incurs costs for conducting an audit. Thus the tax auditor audits with probability

$$0 < \eta_I = \frac{h}{\delta_{TSB}(t+h)} < 1.$$

The MNF wants to deviate to OSB with $\overline{p_r}$ in $t=0$ when $\overline{\delta}_{OSB} \leq \delta_{OSB}$. The following equation determines $\overline{\delta}_{OSB}$:

$$\beta\Pi_1 + (1-\beta)\Pi_5 = \beta\Pi_6 + (1-\beta)\left[\eta_I\Pi_8 + (1-\eta_I)\Pi_9\right]$$

$$\iff \overline{\delta}_{OSB} = \frac{1}{(\beta-1)h(a-\overline{p_r})(\overline{p_r}-\underline{p_r})} \cdot \delta_{TSB} \cdot$$

$$\Big[(1-\beta)\left[p_{iL2}\left(2c_L(1-t) - 2h\underline{p_r} - p_{iL2}(1-t-h)\right)\right] + \beta p_{iH}\left(2c_H(1-t) - p_{iH}(1-t-h) - 2h\overline{p_r}\right)$$

$$+\overline{p_r}(1-t-h-2c_H(1-t)+2h\overline{p_r}) - 2a(1-\beta)\left[(c_L-c_H)(1-t) + h(\overline{p_r}-\underline{p_r})\right]\Big].$$

When the tax auditor observes a high tax transfer price, he or she is indifferent between audit and no audit if $\beta\Pi_1^{TA} + (1-\beta)\lambda_{TSB}\Pi_3^{TA} = 0$

$$\iff \lambda_{TSB} = \frac{K_a}{(1-\beta)(t+h)\delta_{TSB}(\overline{p_r}-\underline{p_r})(a-p_{iL1})} := \lambda_{TSB,I} > 0.$$

$\lambda_{TSB,I}$ is smaller than 1 if and only if $K_a < K_{a2}(\eta_I)$, where

$$K_{a2}(\eta_I) := \delta_{TSB}(a - p_{iL1})(1-\beta)(t+h)(\overline{p_r} - \underline{p_r}). \tag{10}$$

In sum, for $\delta_{OSB} \geq \overline{\delta}_{OSB}$ and $K_a < K_{a2}(\eta_I)$, the MNF always implements TSB. After the realization of the unit costs, the high-cost MNF reports the compliant tax transfer price $\overline{p_r}$ and the low-cost MNF reports the non-compliant (compliant) tax transfer price $\overline{p_r}$ ($\underline{p_r}$) with probability $\lambda_{TSB,I}$ $(1-\lambda_{TSB,I})$. The tax auditor audits $\overline{p_r}$ with audit probability η_I.

8.3.2 Proof of Equilibrium II

The MNF randomizes the strategies OSB and TSB if

$$\beta\Pi_1 + (1-\beta)\Pi_5 = \beta\Pi_6 + (1-\beta)\left[\eta\Pi_8 + (1-\eta)\Pi_9\right]$$

$$\begin{aligned}\iff \eta = \frac{1}{(1-\beta)(a-\overline{p_r})\delta_{OSB}(t+h)(\overline{p_r}-\underline{p_r})} \\ \left[\frac{1-t-h}{2}\left[a^2 - \overline{p_r}^2 - \beta(a-p_{iH})^2 - (1-\beta)(a-p_{iL2})^2\right]\right. \\ \left. -\beta(a-\overline{p_r})(1-t)c_H - c_L(1-t)(1-\beta)(a-\overline{p_r}) + h\overline{p_r}(a-\overline{p_r})\right] := \eta_{II} > 0\end{aligned}$$

for sufficiently large a.

η_{II} is always smaller than 1 because:

$$\Pi_5 - \Pi_8 = \frac{1-t-h}{2}(\overline{p_r} - p_{iL2})^2 + (a-\overline{p_r})(\overline{p_r}-\underline{p_r})\left[\underbrace{\delta_{OSB}(t+h)-h}_{>0 \text{ for } \delta_{OSB}>1}\right] > 0,$$

$\Pi_6 < \Pi_1$, and for a sufficiently large prohibitive price a, $\Pi_9 > \Pi_5 > 0$ holds true.

The low-cost MNF might have an incentive to deviate to TSB with the non-compliant tax transfer price $\overline{p_r}$. This deviation occurs if and only if

$$\beta\Pi_1 + (1-\beta)\left[\eta_{II}\Pi_3 + (1-\eta_{II})\Pi_4\right] > \beta\Pi_1 + (1-\beta)\Pi_5$$

$$\iff \frac{1-t-h}{2}\left(p_{iL2}^2 - p_{iL1}^2\right) < a(\overline{p_r} - \underline{p_r})\left[h - \eta_{II}\delta_{TSB}(t+h)\right].$$

For a sufficiently large a, the term $[h - \eta_{II}\delta_{TSB}(t+h)]$ becomes negative so that $a\,[h - \eta_{II}\delta_{TSB}(t+h)]$ is negative. Therefore, the low-cost MNF does not want to deviate to non-compliant TSB.

When the tax auditor observes a high tax transfer price, he or she is indifferent between audit and no audit if:

$$\tau\beta\Pi_1^{TA} + (1-\tau)\left[\beta\Pi_6^{TA} + (1-\beta)\Pi_8^{TA}\right] = 0$$

$$\iff \tau = 1 - \frac{K_a}{\delta_{OSB}(1-\beta)(t+h)(\overline{p_r} - \underline{p_r})(a - \overline{p_r})} := \tau_{II} < 1.$$

τ_{II} is positive if and only if $K_a \leq K_{a1}(\delta_{OSB})$ with

$$K_{a1}(\delta_{OSB}) := \delta_{OSB}(1-\beta)(t+h)(\overline{p_r} - \underline{p_r})(a - \overline{p_r}). \tag{11}$$

In sum, for $K_a < K_{a1}(\delta_{OSB})$, the MNF implements TSB (OSB) with probability τ_{II} $(1-\tau_{II})$. After the realization of the unit costs, the high-cost MNF reports the compliant tax transfer price $\overline{p_r}$ and the low-cost MNF reports the compliant tax transfer price $\underline{p_r}$ under TSB and the non-compliant tax transfer price $\overline{p_r}$ under OSB. The tax auditor audits $\overline{p_r}$ with probability η_{II}. □

8.3.3 Proof of Equilibrium III

The MNF randomizes the strategies OSB and TSB if

$$\beta\Pi_1 + (1-\beta)\left[\eta\Pi_3 + (1-\eta)\Pi_4\right] = \beta\Pi_6 + (1-\beta)\left[\eta\Pi_8 + (1-\eta)\Pi_9\right]$$

$$\iff \eta^2 + 2B\eta + C = 0, \tag{12}$$

where

$$\begin{aligned} B = \frac{1}{\delta_{TSB}^2(\overline{p_r} - \underline{p_r})(t+h)} & [c_L\delta_{TSB}(1-t) + a(\delta_{OSB} - \delta_{TSB})(1-t-h) \\ & - \overline{p_r}(\delta_{OSB}(1-t-h) + \delta_{TSB}h)], \end{aligned} \tag{13}$$

$$C = \frac{(1-t)^2}{(1-\beta)\delta_{TSB}^2(\overline{p_r}-\underline{p_r})^2(t+h)^2}[\beta(c_H-c_L)(c_H+c_L-2\overline{p_r})+(c_L-\overline{p_r})^2] > 0. \tag{14}$$

For sufficiently large a, $B < 0$ and $B^2 - C > 0$. Thus the MNF is indifferent between OSB and TSB for

$$\eta_{III} := -B - \sqrt{B^2 - C} > 0.$$

For a sufficiently large a, η_{III} is smaller than 1.

The MNF might have an incentive to deviate to TSB and then choose the compliant tax transfer price $\underline{p_r}$ in the case of low unit costs. This deviation occurs if and only if

$$\beta\Pi_1 + (1-\beta)\Pi_5 > \beta\Pi_6 + (1-\beta)\left[\eta_{III}\Pi_8 + (1-\eta_{III})\Pi_9\right]$$

$$\iff \beta\frac{1-t-h}{2}\left((\overline{p_r}-p_{iL2})^2 - (p_{iH}-\overline{p_r})^2\right) <$$

$$\underbrace{\frac{1-t-h}{2}(\overline{p_r}-p_{iL2})^2}_{>0} + (1-\beta)(a-\overline{p_r})(\overline{p_r}-\underline{p_r})\left[\eta_{III}\delta_{OSB}(t+h)-h\right].$$

For a sufficiently large a, the term $[\eta_{III}\delta_{OSB}(t+h)-h]$ becomes negative so that $a\,[\eta_{III}\delta_{OSB}(t+h)-h]$ is negative. Therefore, the low-cost MNF never deviates to TSB with a compliant tax transfer price.

When the tax auditor observes a high tax transfer price, he or she wants to randomize between conducting and not conducting an audit if:

$$\tau\left[\beta\Pi_1^{TA} + (1-\beta)\Pi_3^{TA}\right] + (1-\tau)\left[\beta\Pi_6^{TA} + (1-\beta)\Pi_8^{TA}\right] = 0$$

$$\iff \tau = \frac{K_a - (1-\beta)(t+h)(a-\overline{p_r})(\overline{p_r}-\underline{p_r})\delta_{OSB}}{(1-\beta)(t+h)(\overline{p_r}-\underline{p_r})[(a-p_{iL1})\delta_{TSB}-(a-\overline{p_r})\delta_{OSB}]} := \tau_{III}.$$

τ_{III} is positive and smaller than 1 if and only if $K_{a1}(\delta_{OSB}) < K_a < K_{a2}(\eta_{III})$, where K_{a1} is defined in (11) and

$$K_{a2}(\eta_{III}) := \delta_{TSB}(a-p_{iL1})(1-\beta)(t+h)(\overline{p_r}-\underline{p_r}). \tag{15}$$

In sum, for $K_{a1}(\delta_{OSB}) < K_a < K_{a2}(\eta_{III})$, the MNF chooses TSB (OSB) with probability τ_{III} $(1-\tau_{III})$. After the realization of the unit costs, the high-cost MNF reports the compliant tax transfer price $\overline{p_r}$ and the low-cost MNF chooses the non-compliant tax transfer price $\overline{p_r}$ under TSB and under OSB. The tax auditor audits $\overline{p_r}$ with probability η_{III}. □

8.4 Proof of Proposition 2

An increasing tax rate difference

1. decreases the internal transfer price (see Lemma 2) under TSB in all equilibria:

$$\frac{dp_{iH}}{dh} = (-1)\frac{1}{(1-t-h)^2}\left[(1-t)m_H\right] < 0,$$

$$\frac{dp_{iL2}}{dh} = (-1)\frac{1}{(1-t-h)^2}\left[(1-t)m_L\right] < 0,$$

$$\frac{dp_{iL1}(\eta_I)}{dh} = (-1)\frac{1}{(1-t-h)^2}\left[(1-t)m_L\right] < 0,$$

$$\frac{dp_{iL1}(\eta_{III})}{dh} = \frac{(1-t)}{(1-\beta)(1-h-t)^2}\cdot$$

$$\big[-a(\beta-1)(c_L-\overline{p_r})(\delta_{OSB}-\delta_{TSB})(h+t-1)+\overline{p_r}(\overline{p_r}-c_L)(\delta_{OSB}-\delta_{TSB})(h+t-1)+$$

$$\beta\left(c_H\delta_{TSB}(1-t)(c_H-2\overline{p_r})+\overline{p_r}(c_L(\delta_{OSB}-\delta_{TSB})(h+t-1)+\overline{p_r}(\delta_{TSB}h-\delta_{OSB}(h+t-1)))\right)\big]\cdot$$

$$\Bigg[(a(\delta_{TSB}-\delta_{OSB})(1-h-t)+c_L\delta_{TSB}(t-1)+\overline{p_r}(\delta_{TSB}h-\delta_{OSB}(h+t-1)))^2+$$

$$\frac{\delta_{TSB}^2(t-1)^2\left(\beta(c_H-c_L)(c_H+c_L-2\overline{p_r})+(c_L-\overline{p_r})^2\right)}{\beta-1}\Bigg]^{-\frac{1}{2}}$$

$\frac{dp_{iL1}(\eta_{III})}{dh}$ is negative for sufficiently high a.

2. decreases the probability of a non-compliant tax transfer price in equilibrium I (see Proposition 1):

$$\frac{\partial\lambda_{TSB,I}}{\partial h} = \frac{(-1)}{(t+h)^2}\frac{K_a}{(1-\beta)\delta_{TSB}(a-p_{iL1})(\overline{p_r}-\underline{p_r})} < 0,$$

$$\frac{\partial \lambda_{TSB,I}}{\partial p_{iL1}} = \frac{K_a(a-p_{iL1})^2}{(1-\beta)(t+h)\delta_{TSB}(\overline{p_r}-\underline{p_r})} > 0.$$

Therefore,

$$\frac{d\lambda_{TSB,I}}{dh} = \underbrace{\frac{\partial \lambda_{TSB,I}}{\partial h}}_{<0} + \underbrace{\frac{\partial \lambda_{TSB,I}}{\partial p_{iL1}}}_{>0}\underbrace{\frac{dp_{iL1}}{dh}}_{<0} < 0.$$

3. increases the probability of using TSB in equilibrium II (see Proposition 1):

$$\frac{d\tau_{II}}{dh} = \frac{K_a}{(1-\beta)(t+h)^2(a-\overline{p_r})\delta_{OSB}(\overline{p_r}-\underline{p_r})} > 0.$$

4. decreases the probability of using TSB in equilibrium III (see Proposition 1):

$$\frac{\partial \tau_{III}}{\partial h} = (-1)\frac{K_a}{(1-\beta)(t+h)^2(\overline{p_r}-\underline{p_r})\left[\delta_{TSB}(a-p_{iL1})-\delta_{OSB}(a-\overline{p_r})\right]} < 0.$$

$$\frac{\partial \tau_{III}}{\partial p_{iL1}} = \delta_{TSB}\left[\delta_{TSB}(a-p_{iL1})-\delta_{OSB}(a-\overline{p_r})\right]^{-2}\left[(1-\beta)(t+h)(\overline{p_r}-\underline{p_r})\right]^{-1}\cdot$$

$$\underbrace{\left[K_a-\delta_{OSB}(a-\overline{p_r})(1-\beta)(t+h)(\overline{p_r}-\underline{p_r})\right]}_{>0 \text{ for } K_a>K_{a1}} > 0.$$

In sum,

$$\frac{d\tau_{III}}{dh} = \underbrace{\frac{\partial \tau_{III}}{\partial h}}_{<0} + \underbrace{\frac{\partial \tau_{III}}{\partial p_{iL1}}}_{>0}\underbrace{\frac{dp_{iL1}}{dh}}_{<0} < 0.$$

□

8.5 Proof of Proposition 3

An increase in δ_{OSB} or δ_{TSB} affects

1. the internal transfer prices (see Lemma 2) as follows:

$$\frac{dp_{iH}}{d\delta_{OSB}} = 0,\ \frac{dp_{iH}}{d\delta_{TSB}} = 0,\ \frac{dp_{iL2}}{d\delta_{OSB}} = 0,\ \frac{dp_{iL2}}{d\delta_{TSB}} = 0,\ \frac{dp_{iL1}(\eta_I)}{d\delta_{OSB}} = 0,\ \frac{dp_{iL1}(\eta_I)}{d\delta_{TSB}} = 0,$$

$$\frac{\partial p_{iL1}(\eta_{III})}{\partial \delta_{OSB}} = 0,\ \frac{\partial p_{iL1}(\eta_{III})}{\partial \eta_{III}} = \frac{t+h}{1-t-h}\delta_{TSB}(\overline{p_r}-\underline{p_r}) > 0,$$

$$\frac{d\eta_{III}}{d\delta_{OSB}} = \frac{(1-t-h)(a-\overline{p_r})}{\delta_{TSB}(\overline{p_r}-\underline{p_r})(t+h)} \frac{\eta_{III}}{\sqrt{B^2-C}} > 0,$$

In sum,

$$\frac{dp_{iL1}(\eta_{III})}{d\delta_{OSB}} = \underbrace{\frac{\partial p_{iL1}(\eta_{III})}{\partial \delta_{OSB}}}_{=0} + \underbrace{\frac{\partial p_{iL1}(\eta_{III})}{\partial \eta_{III}}}_{>0} \underbrace{\frac{d\eta_{III}}{d\delta_{OSB}}}_{>0} > 0.$$

$$\frac{\partial p_{iL1}(\eta_{III})}{\partial \delta_{TSB}} = \frac{t+h}{1-t-h}\eta_{III}(\overline{p_r}-\underline{p_r}) > 0,$$

$$\frac{d\eta_{III}}{d\delta_{TSB}} = \frac{1}{\sqrt{B^2-C}}\left[\frac{1}{2}\frac{(-2)(1-t)^2}{(1-\beta)\delta_{TSB}^3(\overline{p_r}-\underline{p_r})^2(t+h)^2}\left[\beta(c_H-c_L)(c_H+c_L-2\overline{p_r})+(c_L-\overline{p_r})^2\right]\right.$$
$$\left.+\frac{\eta_{III}\left[a(1-t-h)(\delta_{TSB}-2\delta_{OSB})-c_L\delta_{TSB}(1-t)+\overline{p_r}h\delta_{TSB}+2\overline{p_r}\delta_{OSB}(1-t-h)\right]}{\delta_{TSB}^3(\overline{p_r}-\underline{p_r})(t+h)}\right] < 0,$$

for sufficiently large a. In sum,

$$\frac{dp_{iL1}(\eta_{III})}{d\delta_{TSB}} = \underbrace{\frac{\partial p_{iL1}(\eta_{III})}{\partial \delta_{TSB}}}_{>0} + \underbrace{\frac{\partial p_{iL1}(\eta_{III})}{\partial \eta_{III}}}_{>0} \underbrace{\frac{d\eta_{III}}{d\delta_{TSB}}}_{<0},$$

where $\frac{dp_{iL1}(\eta_{III})}{d\delta_{TSB}}$ is negative for sufficiently large a.

2. the probability that the low-cost MNF chooses a non-compliant tax transfer price $\lambda_{TSB,I}$ in equilibrium I (see Proposition 1) as follows:

$$\frac{d\lambda_{TSB,I}}{d\delta_{OSB}} = 0, \frac{d\lambda_{TSB,I}}{d\delta_{TSB}} = \frac{-K_a}{(1-\beta)(t+h)\delta_{TSB}^2(\overline{p_r}-\underline{p_r})(a-p_{iL1})} < 0.$$

3. the probability of using TSB τ_{II} in equilibrium II (see Proposition 1) as follows:

$$\frac{d\tau_{II}}{d\delta_{OSB}} = \frac{K_a}{(1-\beta)(t+h)(a-\overline{p_r})\delta_{OSB}^2(\overline{p_r}-\underline{p_r})} > 0, \frac{d\tau_{II}}{d\delta_{TSB}} = 0.$$

4. the probability of using TSB τ_{III} in equilibrium III (see Proposition 1) as follows:

$$\frac{d\tau_{III}}{d\delta_{OSB}} = \frac{a-\overline{p_r}}{(1-\beta)(t+h)(\overline{p_r}-\underline{p_r})(\delta_{TSB}(a-p_{iL1})-\delta_{OSB}(a-\overline{p_r}))^2}\cdot$$
$$\left[K_a\left(1+\frac{\eta_{III}}{\sqrt{B^2-C}}\right)-K_{a2}(\eta_{III})\left(1+\frac{\eta_{III}}{\sqrt{B^2-C}}\frac{\delta_{OSB}(a-\overline{p_r})}{\delta_{TSB}(a-p_{iL1})}\right)\right].$$

$\frac{d\tau_{III}}{d\delta_{OSB}}$ is monotonically increasing in K_a, negative for $K_a = K_{a1}$, and positive for $K_a = K_{a2}(\eta_{III})$. Thus a $K_a^c \in (K_{a1}, K_{a2}(\eta_{III}))$ exists so that $\frac{d\tau_{III}}{d\delta_{OSB}}$ equals zero. Therefore, $\frac{d\tau_{III}}{d\delta_{OSB}}$ is negative (positive) for $K_a \in (K_{a1}, K_a^c)$ ($K_a \in (K_a^c, K_{a2}(\eta_{III}))$).

$$\frac{\partial\tau_{III}}{\partial\delta_{TSB}} = \frac{(K_{a1}-K_a)(a-p_{iL1})}{(1-\beta)(t+h)(\overline{p_r}-\underline{p_r})\left[\delta_{TSB}(a-p_{iL1})-\delta_{OSB}(a-\overline{p_r})\right]^2},$$

which is negative because equilibrium III occurs for $K_a \geq K_{a1}$. As shown in section 8.4, $\frac{\partial\tau_{III}}{\partial p_{iL1}} > 0$. In sum, for sufficiently large a,

$$\frac{d\tau_{III}}{d\delta_{TSB}} = \underbrace{\frac{\partial\tau_{III}}{\partial\delta_{TSB}}}_{<0} + \underbrace{\frac{\partial\tau_{III}}{\partial p_{iL1}}}_{>0}\underbrace{\frac{dp_{iL1}}{d\delta_{TSB}}}_{<0} < 0.$$

□

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