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Strategic Interactions between Tax and Statutory Auditors and Different Information Regimes: Implications for Tax Audit Efficiency *

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Abstract

We examine whether tax audit regimes become more efficient if (i) there are audited financial statements and (ii) tax auditors have access to the internal statutory audit report revealing information about statutory audit adjustments. Our analysis is based on a standard tax compliance game that we extend to model the strategic interaction among a firm issuing financial and tax reports, a statutory auditor, and a tax auditor. We find that the efficiency effects of additional information depend on the strength of tax auditor incentives and the weight that firms place on book income. For high-powered tax auditor incentives, we obtain no information effect on our efficiency measures. For low-powered tax auditor incentives, we find an ambiguous effect, and for medium-powered tax auditor incentives and firms that place a high weight on book income, tax audit efficiency increases if the tax auditor has access to additional information. In the latter case, we find that granting the tax auditor access to the internal statutory audit report increases firms' tax compliance, raises tax revenues, and decreases tax audit frequency.

Keywords: Tax compliance game; Tax audit; Statutory audit; Tax audit efficiency; Strategic auditing.

JEL Classifications: H26, M41, M42.

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1 Introduction

Using a game-theoretical model, this paper investigates whether (i) the existence of audited financial statements and (ii) giving tax auditors access to internal statutory audit reports[1] increases the efficiency of the tax audit regime. In many countries, tax administration budgets have declined significantly in recent years, and tax administrations, therefore, reduced their workforce. For example, the United States Internal Revenue Service reduced the number of its employees from 94,711 in 2010 to 73,518 in 2018 (IRS, 2019). Similarly, the number of employees at the U.K. tax authority, the HMRC, fell from 91,167 in 2005 to 61,370 in 2014 (Slemrod, 2016). This raises the importance of improving the audit selection process to increase tax audit efficiency.

The idea is straightforward, as far as it concerns the provision of financial statements. In general, values from financial accounting are positively correlated with values in tax accounting, meaning that financial accounting information could provide an informative signal for tax auditors (Mills and Sansing, 2000). However, at first sight, it might be surprising why providing access to internal statutory audit reports could provide an additional informative signal for tax auditors. These reports do not contain any direct information regarding tax values. The statutory audits of financial accounting statements are conducted by independent private auditors, certified public accountants. Moreover, statutory auditors are typically perceived as conservative, i.e., they are primarily interested in preventing upward earnings management but not in preventing downward earnings management, which is what firms might do to save taxes. The statutory audit report to the board, however, reveals information on whether a firm has engaged in upward earnings management of book income. As we will show in this paper, the strategic incentives to conduct upward earnings management of book income depend to some extent on a firm's taxable income. Thus, the information in the statutory audit report provides an additional informative signal to the tax auditor

[1] In this paper, the term statutory audit report stands for documented internal communication between the statutory auditor and the board or the audit committee.

with respect to the correct tax treatment. By using the information from financial accounting statements and the statutory auditor's report, tax auditors can thus improve their audit efficiency, which should in turn result in higher tax compliance. In line with this idea, firms in many countries are obliged to file their financial accounting statements together with their tax returns, e.g., in Australia, Canada, and the United Kingdom, and in some countries, firms must also file their statutory audit report with the tax administration, e.g., in Belgium, Germany, and the United Kingdom (see Table 5, appendix B). To the best of our knowledge, however, the filed statutory audit reports do not currently contain any detailed information on the audit adjustments made by the statutory auditor. In contrast, our analysis provides legislators with information as to whether it would be efficient to give tax auditors access to documented adjustments made by the statutory auditor.

Despite its potential to increase tax compliance, the usage of information from financial accounting statements and audit reports might also trigger opposing effects. Some firms may attempt to decrease detection risk and manipulate or avoid the signal, for example, by understating not only taxable income but also financial accounting income such that no book-tax-difference arises (conforming tax avoidance). Other firms may have a further increased incentive to misreport only taxable income (non-conforming tax avoidance) to align book and tax income. Contrary to intuition, the overall effect of using financial accounting information and audit reports in the tax audit selection process is therefore unclear. The aim of the current paper is to formally derive the conditions under which the usage of such additional information increases or decreases the efficiency of a tax audit in a compliance game with three strategic players: a firm, a statutory auditor, and a tax auditor.

Most previous tax compliance research explains tax evasion as taxpayers maximizing their expected utility given the detection probability and the size of the penalty (Allingham and Sandmo, 1972). However, this fails to recognize that the detection probability is in fact endogenous and the result of a game between taxpayers and the government.

Graetz et al. (1986) and Reinganum and Wilde (1986) were the first to study tax compliance as a game in which the revenue agency could not credibly commit to an audit strategy. Reinganum and Wilde (1988) introduce taxpayer uncertainty regarding the government's audit costs, and Beck and Jung (1989) consider tax liability uncertainty. In Beck et al. (1996), taxpayers are allowed to purchase tax advice to resolve all uncertainty. Erard and Feinstein (1994) modify the approach of Reinganum and Wilde (1986) to consider nonstrategic taxpayers. Rhoades (1999) analyzes the impact of component reporting on the tax compliance game. Bayer (2006) considers taxpayers' concealment costs and demonstrates that higher tax rates lead to higher tax evasion and higher concealment and audit costs. Other studies analyze the effect of a signal regarding the taxpayer's income on the audit process. Sansing (1993) examines a signal regarding the correct tax treatment of a loss. He demonstrates that this signal can result in an increased amount of tax evasion while tax revenues (before audit costs) remain unaffected. Beck et al. (2000) study the effect of voluntary disclosures regarding an uncertain tax benefit to avoid a substantial underpayment penalty if the tax return is audited. Related to the study of Beck et al. (2000), De Simone et al. (2013) investigate the benefits of "Enhanced Relationship Tax Compliance Programs". Niggemann (2018) finds that book-tax conformity restricts misreporting positive book-tax differences but may impair the accuracy of financial statements.

The two studies most related to our paper are Mills and Sansing (2000) and Mills et al. (2010). In Mills and Sansing (2000), the tax auditor observes the (correct) financial statement valuation, which results in a higher audit probability for positive book-tax differences. Mills et al. (2010) investigate the effects of disclosed uncertain tax positions according to FIN 48. Contradicting public opinion, they demonstrate that some taxpayers will actually benefit from mandatory disclosure requirements. Empirical research has confirmed that public financial accounting information can be useful for tax auditors to infer the tax aggressiveness of companies (e.g. Lisowsky et al. (2013), Bozanic et al. (2017)).

We contribute to this research by adding the interaction between strategic statutory auditors and tax auditors while allowing taxpayers to misreport both financial and tax reporting positions.

Our analysis proceeds in three steps. In our benchmark case, we assume that no information beyond the reported tax return is available. This is the standard inspection game between taxpayers and tax auditors (Graetz et al., 1986), which we label the "reduced-information regime". Firms (the taxpayers) face an asset valuation issue[2] and decide whether to report the correct tax value or evade taxes. Tax auditors decide, based on the reported tax returns, whether to conduct a tax audit.

In a second step, we add observable financial accounting statements. Firms need now to prepare a report not only for tax purposes but also for financial accounting purposes. For the sake of simplicity, the asset's tax value can be either low or high; similarly, the asset's book value can be either low or high. To reflect existing similarities between financial accounting principles and tax law, we assume a positive correlation between book and tax values. Thus, book values provide a (noisy) signal regarding a firm's correct tax value. We assume that firms have a preference for high book income and low tax income. Accordingly, firms will have an incentive to engage in upward (downward) management of book (tax) income. As with tax returns, financial statements are usually subject to an audit. Thus, statutory auditors determine, based on the reported book value, their effort in the statutory audit of the firm's asset valuation. In line with prior research, we assume a conservative statutory auditor who prefers conservative (income-decreasing) accounting choices to reduce his or her litigation and reputation risk (e.g., Francis and Krishnan, 1999; Kim et al., 2003; Cahan and Zhang, 2006). Thus, the statutory auditor challenges firms' upward, but not downward, book income management. In the subsequent tax audit, the tax auditor observes the financial accounting statements in the form in which they were prepared after the statutory audit.

[2] Alternatively, we could assume that the taxpayer makes an expenditure and must decide whether this expenditure may be expensed or must be capitalized for book and tax income purposes. See Mills and Sansing (2000).

Thus, in this "intermediate-information regime," the tax auditor has access to financial statement information but no access to the statutory audit report, which implies that the tax auditor has no information on whether the statutory auditor has required any audit adjustments regarding the firms' book values. This is the key difference from our next setting.

In a third step, we model a "high-information regime" by assuming that the statutory auditor's report to the board is also made available to the tax auditor. This report includes information on required audit adjustments on book income. Thus, the tax auditor might be informed whether the firm has engaged in upward earnings management of book income. This information helps the tax auditor to determine the correct tax treatment, because the strategic incentives to conduct upward earnings management of book income depend on a firm's taxable income. Therefore, the statutory audit report provides an additional, informative signal to the tax auditor.

The different information regimes can alter the responses of firms and both auditors. In each information regime, we determine the mixed-strategy equilibria, where the two auditors employ a probabilistic audit strategy and certain taxpayers randomize their reporting behavior.[3] In these equilibria, we compare the effects of the different information regimes on our measures of tax audit efficiency: firms' tax evasion, tax revenues and tax audit frequency.

Our findings reveal that the effect of information on tax audit efficiency depends on the tax auditors' incentives. The additional information can have no effect on efficiency, increase efficiency or have an ambiguous effect, i.e., we obtain a reduction in tax revenues and tax audit frequency or an increase in tax revenues and tax audit frequency.

In countries where tax auditors have high-powered incentives, our model predicts that the provision of the additional information neither affects firms' expected tax evasion

[3] We do not examine pure-strategy equilibria in which the tax auditor never or always audits and the taxpayer always or never evades taxes because these equilibria are rarely observed in real-world audit and reporting behavior.

nor the tax audit frequency. Consequently, tax revenues also remain unaffected. The reason for this surprising result is that highly motivated auditors do not change their audit probability with respect to the additional information. Nevertheless, firms respond to the change in the information environment because equilibrium requires that the tax auditor is indifferent between auditing and not auditing a report. To make the tax auditor indifferent, it is, for example, intuitive that firms must increase the probability of "conforming reports" that contain no book-tax difference once financial statement information becomes observable to the tax auditor. Due to the positive correlation between book and tax values, tax auditors know that "non-conforming" reports are less probable than "conforming reports." Avoiding book-tax differences implies that firms with high book values will reduce tax evasion, but firms with low book values will increase tax evasion. In equilibrium, the two effects exactly offset one another. Thus, given highly motivated tax auditors, the additional information provision neither deters tax evasion nor reduces tax audit frequency.

In contrast, for countries with low-powered and medium-powered tax auditor incentives, our findings reveal that tax audit efficiency changes if tax auditors have access to financial statements and statutory auditor reports. Due to the reduced incentives, tax auditors use different audit probabilities for reports with and without book-tax differences as well as reports with and without adjustments of the statutory auditor. If tax auditors have low-powered incentives, we find that tax revenues increase if tax auditors have access to financial statements and statutory auditor reports. However, this comes at the cost of increased tax audit frequency. We find exactly the opposite for medium-powered tax auditor incentives if firms place a much higher weight on tax than on book income. Here, tax revenues and tax audit frequency decrease with increasing information provision.

Our analysis shows that an unambiguously positive effect of additional information on efficiency requires tax auditors with medium-powered incentives and firms that place a relatively high weight on book income. In this case, the additional information

can induce higher tax revenues and a lower audit frequency. It is noteworthy that the statutory audit report is particularly informative under these circumstances, as it allows the tax auditor to decrease the audit probability to zero for specific reports without any negative effect on tax compliance.

Besides identifying the conditions for an efficiency-enhancing effect, our results also demonstrate that giving more information to tax auditors is not always helpful to enhance tax compliance (Sansing (1993)). This result is important. In many countries, firms face increasing pressure to disclose more information to the public and the tax authority to help countries effectively combat tax evasion. Examples include the disclosure of uncertain tax positions according to FIN48 and schedule UTP, the disclosure of country-by-country-reporting according to OECD-BEPS Action 13, and the mandatory disclosure rules for cross-border tax avoidance structures according to OECD-BEPS Action 12.[4] The strategic interaction between statutory auditors, tax auditors, and taxpayers that we model in this paper reveals that firms and auditors respond to these changing information environments and that the desired positive effects may depend on the specific countries' institutional environments that determine, for example, the incentives of statutory and tax auditors. Thus, the optimal tax policy will vary across countries, which might explain the large empirical variation that we observe in the obligations to file financial statements and statutory audit reports with the tax administration (Table 5, appendix B).

The remainder of this paper is organized as follows: In the second section, we present the model. In the third section, we discuss some important aspects of the equilibrium analysis of the game and introduce our efficiency measures. Sections 4, 5 and 6 investigate how the three different information environments affect the efficiency of the tax audit regime. The last section discusses the results and implications for future

[4]See Financial Accounting Standards Board [FASB] 2006, Interpretation No. 48, Accounting for Uncertainty in Income Taxes [FIN 48/ASC 740-10]. Schedule UTP (Uncertain Tax Positions) must be filed by certain US corporations with the US tax administration. The OECD has developed 15 actions to combat "Base Erosion and Profit Shifting" (BEPS); see http://www.oecd.org/tax/beps/beps-actions.htm.

research.

2 The model

We consider a multi-stage game involving three players: the manager of a firm, a statutory auditor, and a tax auditor. The manager has to release a report about both the tax and the financial statement valuation of an issue.[5] Subsequently, the statutory auditor determines her audit effort and the tax auditor has to decide whether to audit the tax report. All players are assumed to be risk neutral. A definition of all variables is presented in appendix A.

In the first stage of the game, the firm's manager (in the following denoted as the "taxpayer") faces an asset valuation issue. The asset's correct book value in the financial statements is $b \in \{\underline{b}, \overline{b}\}$. A similar valuation issue – with a potentially different outcome – arises for tax purposes, where the proper valuation is $t \in \{\underline{t}, \overline{t}\}$. We define $\Delta_b = \overline{b} - \underline{b}$ and $\Delta_t = \overline{t} - \underline{t}$ and assume $\overline{b} = \overline{t}$ and $\underline{b} = \underline{t}$. Thus, $\Delta_b = \Delta_t = \Delta$. Without loss of generality, we normalize $\Delta = 1$. We refer to the true valuations (b,t) as the taxpayer's type. Accordingly, in the game, the taxpayer can be any of the following four types: $\left\{(\underline{b},\underline{t}), \left(\overline{b},\overline{t}\right), (\underline{b},\overline{t}), \left(\overline{b},\underline{t}\right)\right\}$. At the beginning of the game, nature chooses a type for the taxpayer. Nature's move is observed only by the taxpayer such that the correct valuations (b,t) are the taxpayer's private information.[6] We assume the following common prior probability distribution over the taxpayer's type:

1. The ex ante probabilities Prob$\{\underline{t}\}$ and Prob$\{\overline{t}\}$ are 0.5.

[5] To avoid having an excessively complex model, we exclude agency conflicts from the analysis. The effect of agency problems (among shareholders or between shareholders and managers) on corporate tax avoidance is analyzed, for example, in Chen and Chu (2005), Crocker and Slemrod (2005), and Jacob et al. (2019).

[6] We do not address taxpayer's uncertainty about the correct valuations in this paper. An analysis of tax uncertainty can be found, for example, in Graetz et al. (1986), Beck and Jung (1989), Beck et al. (1996), Mills et al. (2010), or De Simone et al. (2013).

2. The conditional probabilities $\text{Prob}\{b|t\}$ are given by $\text{Prob}\{\underline{b}|\underline{t}\} = \text{Prob}\{\overline{b}|\overline{t}\} = p$ and $\text{Prob}\{\overline{b}|\underline{t}\} = \text{Prob}\{\underline{b}|\overline{t}\} = 1-p$. We assume that $0.5 < p < 1$.

The joint probabilities are $\text{Prob}\{\overline{b},\underline{t}\} = 0.5(1-p)$, $\text{Prob}\{\overline{b},\overline{t}\} = 0.5p$, $\text{Prob}\{\underline{b},\underline{t}\} = 0.5p$ and $\text{Prob}\{\underline{b},\overline{t}\} = 0.5(1-p)$. Furthermore, $\text{Prob}\{\underline{b}\} = \text{Prob}\{\overline{b}\} = 0.5$.

The parameter p is a measure of the conformity between tax and financial statement valuation. A strong conformity means $p \to 1$, and a low conformity implies $p \to 0.5$. In this sense, the assumption that $p > 0.5$ ensures that the correlation between tax and financial statement valuation is positive.

At the beginning of the game, after observing the true values b and t, the taxpayer decides the valuations $\hat{b}$ and $\hat{t}$ to be reported. We assume that the taxpayer makes simultaneous reports of book and tax income whereas in practice there is usually a time gap between the filing of annual statements and tax returns. Our simplifying assumption of simultaneous reports is based on the fact that taxpayers have to calculate the tax liability when preparing the annual accounts because otherwise they wouldn't be able to report the correct amount of deferred taxes. The taxpayer may bias the reported valuation for example because she is interested in a low asset value for tax assessment; we specify the taxpayer's objective function after we have introduced the other players of the game.

In the second stage of the game the statutory auditor conducts the annual financial statement audit after having observed the taxpayer's reported valuations $\left(\hat{b},\hat{t}\right)$. The statutory auditor determines the audit effort that can be either high $(a_S = 1)$ or low $(a_S = 0)$. The costs of the statutory audit are given by $C_S(a_S = 1) = C_S > 0$ and $C_S(a_S = 0) = 0$. For the sake of simplicity, we assume a perfect audit technology for the statutory auditor with regard to the financial statement valuation. That means that for $a_S = 1$, the statutory auditor with certainty detects an inaccurate financial statement valuation by the taxpayer. For $a_S = 0$ the statutory auditor will not detect any misreporting. The statutory auditor benefits from detecting an overstatement of the asset

	$\hat{b}=\underline{b}$	$\hat{b}=\overline{b}$
Type $\overline{b}$	$b'(1)=\underline{b}$	$b'(1)=\overline{b}$
Type $\underline{b}$	$b'(1)=\underline{b}$	$b'(1)=\underline{b}$

Table 1: Financial statement valuation $b'(a_S=1)$ after financial statement audit

value $\left(\hat{b}=\overline{b}\text{ although }b=\underline{b}\right)$ but accepts conservative (income-decreasing) accounting choices because they reduce her litigation and reputation risk. We assume that the benefit is proportional to the overstatement, $\lambda\left(\overline{b}-\underline{b}\right)$. Thus, the preferences of the statutory auditor can be characterized by

$$\max_{a_S\in\{0,1\}}\mathbb{E}\left(\lambda\max\left\{\hat{b}-b'\left(a_S\right),0\right\}-C_S\left(a_S\right)\right)$$

where $b'\left(a_S\right)$ is the final financial statement valuation after the statutory auditor's decision a_S, with $b'\left(0\right)=\hat{b}$ and $b'\left(1\right)$ as in table 1.

We need to assume that $\lambda-C_S>0$ to ensure that high effort can be induced as equilibrium behavior. The statutory auditor's audit effort decision a_S is not observable to the tax auditor who enters the game at its final stage.

The tax auditor is modeled in a very similar fashion to the statutory auditor. The tax auditor also possesses a perfect audit technology with regard to $\hat{t}$ and has to decide whether to audit $(a_T=1)$ the tax valuation $\hat{t}$ or not $(a_T=0)$. The tax auditor benefits from detecting an understated tax valuation ($\hat{t}=\underline{t}$ although $t=\overline{t}$) but earns no benefit from detecting an overstatement.[7] Denoting the tax auditor's preference parameter for detecting an understatement by δ and the personal cost of auditing actions a_T by $C_T\left(a_T\right)$, the tax auditor's objective function can be written as

$$\max_{a_T\in\{0,1\}}\mathbb{E}(\delta\max\{t'(a_T)-\hat{t},0\}-C_T(a_T)). \tag{1}$$

[7]There are typically implicit incentives for assessing additional taxes during tax audits because the effectiveness of the tax audit staff is evaluated with respect to additional taxes 'earned' from tax audits (Alissa et al., 2014). In some countries, explicit incentives also exist (Kahn et al., 2001).

Here $t'(a_T)$ denotes the final tax valuation after the tax auditor's decision a_T, with $t'(0) = \hat{t}, t'(1) = t$. We further assume $C_T(0) = 0$ and $C_T(1) = C_T > 0$.

Similar to the statutory auditor we impose the regularity condition $\delta - C_T > 0$. Figure 1 summarizes the timing of events in our model.

Figure 1: Timeline of events

We are now able to specify the taxpayer's objective function. Assuming that the taxpayer is interested in a low asset value for tax assessment and in a high asset value in the financial statements, a taxpayer of type (b,t) maximizes the following function

$$\max_{\hat{b},\hat{t}} \mathbb{E}(\omega \cdot b'(a_S) - \gamma \cdot t'(a_T) - F_T(t'(a_T)) - F_B(b'(a_S))), \tag{2}$$

F_T and F_B denote disutility from penalties due when an incorrect valuation is detected either in the tax (F_T) or in the financial statements (F_B), respectively. They are defined by

$$F_T(t') = \begin{cases} F_T, & \text{if } t' \neq \hat{t} \\ 0, & \text{else} \end{cases} \text{ and } F_B(b') = \begin{cases} F_B, & \text{if } b' \neq \hat{b} \\ 0, & \text{else.} \end{cases} \tag{3}$$

The parameters ω and γ are positive weights indicating the taxpayer's preferences for financial statement and tax valuation. In the following, we consider the case of $\gamma > \omega$, implying that the taxpayer's preferences are more sensitive to the tax than to the financial statement valuation. This is typical for firms characterized by low capital market exposure, by managers not predominantly driven by financial reporting measures and by less important outside debt financing. Thus, taxpayers with $\gamma > \omega$ can be regarded as managers of mainly private firms. Our focus on firms that give at least a small prioritization of tax outcomes over book outcomes is based on the fact that only

	Regime 1 (reduced information)	Regime 2 (intermediate information)	Regime 3 (high information)
Taxpayer observes	• true values b, t		
Tax Auditor observes	• report $\widehat{t}$	• report $\widehat{t}$ • final valuation b'	• report $\widehat{t}$ • final valuation b' • correction of $\widehat{b}$ to b'
Statutory Auditor observes	• not present	• report $\widehat{b}$ • report $\widehat{t}$	• report $\widehat{b}$ • report $\widehat{t}$

Table 2: Different informational structures considered in the game.

these firms have an incentive to conduct conforming tax avoidance. However, we will discuss the implications for firms that prioritize book over tax outcomes in section 7.

Analyzing the effect of different information environments on tax compliance, we consider three different regimes. Across the regimes, we vary the information available to the tax auditor when he or she has to select an audit strategy, see table 2.

We begin with a benchmark setting (reduced-information regime) in which no financial statements and thus no statutory auditor are present. The game is only between the taxpayer and the tax auditor, who observes the tax report. Thus, our benchmark is a standard tax compliance inspection game (Graetz et al., 1986). The second regime (the intermediate-information regime) simultaneously introduces the need for financial statement valuation and the statutory auditor. We assume that the statutory auditor observes both the report on financial statements $\hat{b}$ and that on tax valuation $\hat{t}$. The tax auditor, in contrast, observes the report on tax valuation $\hat{t}$ and the final financial statement valuation b' after the statutory auditor's effort choice. In regime 3 (the high-information regime), both auditors observe the same information as in regime 2, but the tax auditor can also observe whether the statutory auditor has corrected the taxpayer's financial statement valuation. Formally, this is equivalent to a setting where the tax auditor observes the tax report $\hat{t}$, the final valuation b' and the financial statement

report $\hat{b}$.

3 Preliminary analysis

The game described in the previous section is an inspection game with two auditors. Inspection games only have pure-strategy equilibria for extremely low or high inspection costs. Thus, the inspectors never or always audit, and the inspectee always or never reports falsely. We do not consider these equilibria because they are rarely descriptive of real-world audit and reporting behavior. Therefore, we concentrate on mixed-strategy equilibria, in which the two auditors employ a probabilistic audit strategy and some taxpayer types randomize their reporting behavior. In these equilibria, we compare the effects of the different information regimes on the efficiency measures of tax evasion, tax revenue and tax audit frequency. This section (1) describes the equilibrium in the reduced information setting, (2) eliminates dominated strategies in the intermediate- and high-information regimes, and (3) defines the efficiency measures tax evasion, lost tax revenue and tax audit frequency.

3.1 Equilibrium in the reduced-information regime

As a first step, we compute the equilibrium in the reduced information setting. In this case, the game reduces to a simple variant of the inspection game. Thus, proposition 1 replicates equilibrium strategies well known in the literature.

Proposition 1 (Reduced information regime) *If there is no financial statement valuation, the equilibrium strategies of the taxpayer and tax auditor are as follows:*

- *Taxpayer: Type $\underline{t}$ reports truthfully. Type $\bar{t}$ reports $\underline{t}$ with probability $\theta_T := \frac{C_T}{\delta - C_T}$ as long as $\theta_T \leq 1$. Type $\bar{t}$ always reports $\underline{t}$ for $\theta_T > 1$.*

- *Tax auditor: Report $\bar{t}$ is never verified. Report $\underline{t}$ is verified with probability $\alpha = \frac{\gamma}{\gamma + F_T}$ for $\theta_T \leq 1$ and never for $\theta_T > 1$.*

Proof: See appendix D.1 □

The term $\theta_T = \frac{C_T}{\delta - C_T}$ can be interpreted as a reverse measure of the tax auditor's incentives. Low values of θ_T represent low audit costs and high rewards for detecting underreporting, implying high-powered incentives. A combination of high audit costs and low rewards yields low-powered incentives for the tax auditor and a large θ_T.

Proposition 1 states that the taxpayer's misreporting probability decreases with the tax auditor's incentives. By choosing a misreporting probability amounting to θ_T, the taxpayers ensure that the tax auditor is indifferent between auditing and not auditing a report $\hat{t} = \underline{t}$, and by choosing the tax audit probability α, the tax auditor makes the taxpayers indifferent between tax evasion and honest tax reporting. The unique mixed-strategy equilibrium vanishes if incentives become very low. In this case, the taxpayer always misreports, and the tax auditor never challenges the reported tax valuation.

3.2 Dominated strategies in regimes 2 and 3 and notation

We proceed with the intermediate- and the high-information regime. In these cases, financial statements and the statutory auditor enter the scene and things become more complicated. To simplify the following analysis, it is useful to rule out actions that will never be part of any equilibrium because they are dominated by other actions.

Lemma 1 *In regimes 2 and 3, the following actions will never be played in equilibrium:*

- *The tax auditor will never audit a tax report $\bar{t}$.*
- *The statutory auditor will never audit a financial statement report $\underline{b}$ with high effort.*

- *A taxpayer of type $\overline{b},\underline{t}$ will always report truthfully.*
- *A taxpayer of type $\overline{b},\overline{t}$ will never report $\underline{b},\overline{t}$.*
- *A taxpayer of type $\underline{b},\underline{t}$ will never report $\underline{b},\overline{t}$ and $\overline{b},\overline{t}$.*

Proof: See appendix D.2. □

Intuitively, the tax and statutory auditors will never audit reports that do not offer them any potential benefits. The taxpayer will never issue reports that imply a lower payoff, even absent any detection risk, than the payoff under truthful reporting. Table 3 displays the reporting strategies for the taxpayer reports that are not dominated (see lemma 1 above).

Type	$\overline{b},\underline{t}$	$\overline{b},\overline{t}$			$\underline{b},\underline{t}$		$\underline{b},\overline{t}$			
Report	$\overline{b},\underline{t}$	$\overline{b},\underline{t}$	$\overline{b},\overline{t}$	$\underline{b},\underline{t}$	$\overline{b},\underline{t}$	$\underline{b},\underline{t}$	$\overline{b},\underline{t}$	$\overline{b},\overline{t}$	$\underline{b},\underline{t}$	$\underline{b},\overline{t}$

Table 3: The taxpayer's non dominated reporting strategies

Table 4 contains the definitions of the tax and statutory auditor's audit probabilities. The tax auditor's audit probabilities depend on whether we consider regime 2 or regime 3. While in regime 2 the tax auditor can only observe the final financial statement valuation in addition to the tax report, in regime 3 the tax auditor can make the audit probabilities also conditional on the (possible) correction by the statutory auditor.

x_1	Statutory auditor audits report $\overline{b}$ with high effort given tax report $\underline{t}$
x_2	Statutory auditor audits report $\overline{b}$ with high effort given tax report $\overline{t}$
α	Tax auditor audits $\underline{t}$ given report $\overline{b},\underline{t}$ (regimes 2 and 3)
β	Tax auditor audits $\underline{t}$ given report $\underline{b},\underline{t}$ (regime 2)
β_1	Tax auditor audits $\underline{t}$ given uncorrected report $\underline{b},\underline{t}$ (regime 3)
β_2	Tax auditor audits $\underline{t}$ given corrected report $\underline{b},\underline{t}$ (regime 3)

Table 4: Audit probabilities for the tax and statutory auditors in regimes 2 and 3

In the following, we use superscripts "R1", "R2" and "R3" to identify the three different regimes. For example, α^{R2} denotes the tax audit probability for report $\overline{b},\underline{t}$ in regime 2.

3.3 Efficiency measures

The tax evasion probability (TE) is generally defined as the unconditional probability of a low tax valuation report by the high-tax-valuation types, i.e.,

$$\text{TE} = \text{prob}\{\hat{t} = \underline{t}, \bar{t}\} = \frac{1}{2}(p \cdot \text{prob}\{\hat{t} = \underline{t} | \overline{b}, \bar{t}\} + (1-p) \cdot \text{prob}\{\hat{t} = \underline{t} | \underline{b}, \bar{t}\}). \qquad (4)$$

The following lemma shows that different information regimes do not necessarily imply a different tax evasion probability.

Lemma 2 (Constant tax evasion property) *1. Suppose that an equilibrium is characterized by $\alpha^{R1} > 0$ in the reduced-information regime 1, $\alpha^{R2}, \beta^{R2} > 0$ in the intermediate-information regime 2 and $\alpha^{R3}, \beta_1^{R3}, \beta_2^{R3} > 0$ in the high-information regime 3. This implies that $TE = \frac{1}{2}\theta_T$ independent of the information regime.*

2. Suppose that one of the audit probabilities in regime 1, 2 or 3 is equal to zero. Then, $TE < \frac{1}{2}\theta_T$.

Proof: See appendix D.3. □

Lemma 2 states that additional information does not affect tax evasion if all reports are subject to a positive tax audit probability. The reason for this result is that in equilibrium the tax auditor is indifferent between auditing and not auditing the report. Indifference on the part of the tax auditor, however, requires that the ratio of false to correct reports is identical for each type of report and set such that the tax auditor expects on average "no profit". Therefore, as long as each report with low tax values is audited by the tax auditor with a positive probability, firms' average tax evasion must remain the same in all information regimes.

In addition to tax evasion, we analyze two other measures that characterize the tax audit efficiency. These measures are defined as follows:

1. Frequency of tax audits: The audit frequency can be measured by the ex ante probability of a tax audit. In the reduced-information regime, the tax audit frequency can simply be written as

$$\mathrm{TA}^{R1} = \begin{cases} \alpha^{R1} \cdot \mathrm{prob}\{\hat{t} = \underline{t}\} & \text{if } \theta_T \leq 1 \\ 0 & \text{if } \theta_T > 1. \end{cases} \tag{5}$$

In the intermediate- and the high-information regime we define

$$\mathrm{TA}^{R2} := \alpha^{R2} \cdot \mathrm{prob}\{\hat{t} = \underline{t} | \hat{b} = \overline{b}\} + \beta^{R2} \cdot \mathrm{prob}\{\hat{t} = \underline{t} | \hat{b} = \underline{b}\} \tag{6}$$

in regime 2 and

$$\begin{aligned} \mathrm{TA}^{R3} = {} & \alpha^{R3} \cdot \mathrm{prob}\{\hat{t} = \underline{t} | \hat{b} = \overline{b}\} + \beta_1^{R3} \cdot \mathrm{prob}\{\hat{t} = \underline{t} | \hat{b} = \underline{b}, \text{no correction}\} \\ & + \beta_2^{R3} \cdot \mathrm{prob}\{\hat{t} = \underline{t} | \hat{b} = \underline{b}, \text{correction}\} \end{aligned} \tag{7}$$

in regime 3.

2. Lost tax revenue (LTR): The probability of taxing a type-$\overline{t}$ taxpayer who reports $\underline{t}$ based on a reported tax valuation $\underline{t}$ can be interpreted as "lost tax revenue". LTR measures the fraction of tax evasion that is not detected by the tax auditor and can be seen as an inverse measure of tax revenue. A low value of LTR implies a high tax revenue, and vice versa. In the reduced-information regime we obtain

$$\mathrm{LTR}^{R1} = \begin{cases} (1 - \alpha^{R1}) \mathrm{prob}\{\overline{t} | \hat{t} = \underline{t}\} & \text{if } \theta_T \leq 1 \\ \frac{1}{2} & \text{if } \theta_T > 1. \end{cases} \tag{8}$$

In the intermediate- and the high-information regimes, we define the measure as

$$\begin{aligned} \mathrm{LTR}^{R2} := {} & (1 - \alpha^{R2}) \cdot \mathrm{prob}\{\overline{t} | \hat{b} = \overline{b}, \hat{t} = \underline{t}\} \\ & + (1 - \beta^{R2}) \cdot \mathrm{prob}\{\overline{t} | \hat{b} = \underline{b}, \hat{t} = \underline{t}\} \end{aligned} \tag{9}$$

in regime 2 and

$$\begin{aligned} \text{LTR}^{R3} = &(1-\alpha^{R3}) \cdot \text{prob}\{\bar{t}|\hat{b}=\overline{b},\hat{t}=\underline{t}\} \\ &+(1-\beta_1^{R3}) \cdot \text{prob}\{\bar{t}|\hat{b}=\underline{b},\hat{t}=\underline{t},\text{no correction}\} \\ &+(1-\beta_2^{R3}) \cdot \text{prob}\{\bar{t}|\hat{b}=\underline{b},\hat{t}=\underline{t},\text{correction}\}. \end{aligned} \tag{10}$$

4 Tax auditors with high-powered incentives: no information effect

In the following three sections, we will show how the changes in the measures of the tax audit efficiency implied by variations in the information regimes critically depend on the tax and statutory auditors' incentives to provide an audit. We differentiate between high-powered incentives, medium incentives and low incentives. In our model, the incentives for both auditors are represented (1) by the rewards for a successful audit (represented by λ for the statutory auditor and δ for the tax auditor) and (2) by the audit costs (C_S and C_T). In addition to $\theta_T = \frac{C_T}{\delta - C_T}$, it is useful to define

$$\theta_S := \frac{C_S}{\lambda - C_S} \tag{11}$$

as a measure of the statutory auditor's incentives. Values of $\theta_{S,T}$ close to zero are equivalent to high-powered incentives, increasing values imply medium and even lower incentives. The following analysis reveals that θ_T and θ_S determine the equilibrium audit and reporting decisions. As a consequence, the impact of different information regimes on the efficiency measures also depends on these variables. Our analysis concentrates on the tax auditor and, therefore, we focus on variations in θ_T. We obtain different results for (1) high-powered incentives ($0 < \theta_T \leq \underline{\theta}_T(\theta_S)$, this section), (2) medium incentives ($\underline{\theta}_T(\theta_S) < \theta_T \leq 1$, section 5) and (3) lower incentives ($1 < \theta_T \leq \overline{\theta}_T(\theta_S)$, section 6), where the upper and lower bounds on θ_T depend on θ_S. We restrict θ_S such that the statutory auditor exerts high effort ($a_S = 1$) with positive

probability for at least report $\overline{b},\underline{t}$ or $\overline{b},\bar{t}$.

Our discussion starts with a setting in which both auditors have high-powered incentives. Appendices C.1.1 and C.2.1 show that for high-powered incentives the tax auditor uses the same audit probability for all reports in all information regimes - that means $\alpha^{R1} = \alpha^{R2} = \beta^{R2} = \alpha^{R3} = \beta_1^{R3} = \beta_2^{R3}$. With positive tax audit probabilities the tax evasion probability is the same in all three information regimes by lemma 2. Also the statutory auditor exerts high effort with equal probabilities $x_1^{R2} = x_2^{R2} = x_1^{R3} = x_2^{R3}$. Thus, changes in the information regime have no effect on tax revenue and audit probability when tax and statutory auditors have strong incentives. The following proposition 2 states the result.

Proposition 2 (No information effect) *There exist critical values $\underline{\theta}_T, \underline{\theta}_S(\theta_T)$ such that for $0 < \theta_S < \underline{\theta}_S$ and $0 < \theta_T < \underline{\theta}_T(\theta_S)$, the following relations hold:*

1. $LTR^{R1} = LTR^{R2} = LTR^{R3}$
2. $TA^{R1} = TA^{R2} = TA^{R3}$.

Proof: See appendix D.4 □

Note that the change from information regime 2 to regime 3 has no consequences for the composition of the taxpayer's equilibrium reporting. For example, taxpayer type $\overline{b},\bar{t}$ will report $\overline{b},\bar{t}$ and $\overline{b},\underline{t}$ with positive probability in both regimes. However, the concrete reporting probabilities will not necessarily be the same in the two regimes. Firms with $\overline{b}$ and $\bar{t}$ increase their tax compliance but firms with $\underline{b}$ and $\bar{t}$ will reduce compliant reporting - see appendix C.1.1 and C.2.1 for the details. The differences stem from the enriched tax auditor strategy: In the intermediate-information regime, the tax auditor can condition his audit on low and high financial statement valuations. The high-information regime additionally allows for a distinction between a low financial statement valuation that is corrected or uncorrected by the statutory auditor.

5 Tax auditors with medium incentives: mixed information effects

What happens if the tax auditor's incentives become weaker? First, the tax auditor uses different audit strategies for different reports. Second, the taxpayer adjusts her equilibrium reporting with respect to both financial statements and tax valuation. Finally, these adjustments also affect the statutory auditor's audit effort choice.

Tax auditors have intermediate incentives if the preference parameter δ together with the personal audit cost C_T result in θ_T such that $\underline{\theta}_T \leq \theta_T < 1$. Due to different equilibria, we consider important financial statement valuation ($\gamma < \omega + F_B$, regime 3a) and less important financial statement valuation ($\gamma > \omega + F_B$, regime 3b). The reduced incentives for the tax auditor have the following effects in the two regimes:[8]

(1) Compared to a situation with high-powered incentives, the probability of false reporting increases for all types except $\overline{b},\underline{t}$. (2) Type $\underline{b},\overline{t}$ stops reporting truthfully and type $\overline{b},\overline{t}$ starts to understate both valuations by reporting $\underline{b},\underline{t}$ with a positive probability. Both types reduce the probability of reporting $\overline{b},\overline{t}$. (3) The change in the reporting profiles also induces changes in the audit probabilities. In both information regimes the statutory auditor stops auditing reports $\overline{b},\overline{t}$ with high effort because type $\underline{b},\overline{t}$ reduces the probability for report $\overline{b},\overline{t}$ more than type $\overline{b},\overline{t}$. The tax auditor decreases the audit probability of report $\underline{b},\underline{t}$. The effect of lower tax auditor incentives on the efficiency measures in the two information regimes depends on the relative importance of the financial statement valuation for the taxpayer:

(1) Important financial statement valuation ($\gamma < \omega + F_B$, regime 3a): In regimes 2 and 3a, type $\underline{b},\overline{t}$ finds the report $\overline{b},\overline{t}$ more attractive than report $\overline{b},\underline{t}$ because the statutory auditor may downgrade $\overline{b},\underline{t}$ to $\underline{b},\underline{t}$. Thus, she sacrifices the chance of a low tax valuation to obtain a high financial statement valuation with certainty. As a consequence,

[8] See appendix C.1.2 for the intermediate-information regime, appendix C.2.2 for the high-information regime and $\gamma > \omega + F_B$ and appendix C.2.4 for the high-information regime and $\gamma < \omega + F_B$.

the probabilities for a report $\overline{b},\underline{t}$ sent by types $\overline{b},\overline{t}$ and $\underline{b},\underline{t}$ do not change from regime 2 to regime 3a because the potential senders of report $\overline{b},\underline{t}$ do not change. However, the probability of an uncorrected report $\underline{b},\underline{t}$ with false tax values has to decrease in regime 3. This is due to the observable correction activity of the statutory auditor: The tax auditor can better conclude on types $\overline{b},\overline{t}$ and $\underline{b},\overline{t}$. Therefore, both type $\overline{t}$ - taxpayers decrease the probability of report $\underline{b},\underline{t}$ in regime 3a. Taken together, more information induces lower tax evasion. Moreover, a report $\underline{b},\underline{t}$ corrected by the statutory auditor can only stem from type $\underline{b},\underline{t}$. Thus, the tax auditor can reduce the probability of auditing a corrected report $\underline{b},\underline{t}$ to zero without any negative consequences regarding tax revenues. Alltogether, lower tax evasion and lower audit acitivity in regime 3 explain the result in Proposition 3:

Proposition 3 (Efficient information effect) *Suppose* $\gamma < \omega + F_B$. *Then there exist* $\underline{\theta}_T$, $\overline{\theta}_T$, $\underline{\theta}_S(\theta_T)$, $\overline{\theta}_S(\theta_T)$ *such that for* $\underline{\theta}_T < \theta_T < \overline{\theta}_T \leq 1$ *and* $\underline{\theta}_S(\theta_T) < \theta_S < \overline{\theta}_S(\theta_T)$ *the following relations hold:*

1. $LTR^{R1} < LTR^{R3a} < LTR^{R2}$ *or* $LTR^{R3a} < LTR^{R1} < LTR^{R2}$
2. $TA^{R3a} < TA^{R2} < TA^{R1}$.

Proof: See appendix D.5. □

The important point in the proposition is that providing information about the statutory auditor's activities to the tax auditor is efficient (compared to regime 2). The additional information will induce both higher tax revenue and lower audit frequency. In the reduced-information regime 1, however, both tax audit frequency and tax evasion are higher than in regime 3. Therefore, regime 3 is not necessarily efficient with respect to the no information regime 1.

(2) Less important financial statement valuation ($\gamma > \omega + F_B$, regime 3b): In this case the taxpayer has relatively strong preferences for a low tax valuation. Therefore

type $\underline{b},\bar{t}$ reports $\overline{b},\underline{t}$ and takes the risk of being corrected to $\underline{b},\underline{t}$. This is the key difference from regimes 2 and 3a. The possibility of type $\underline{b},\bar{t}$ as a sender of report $\overline{b},\underline{t}$ dampens the reporting probabilities for a report $\overline{b},\underline{t}$ sent by types $\overline{b},\bar{t}$ and $\underline{b},\underline{t}$. Moreover, in contrast to regime 3a, the tax auditor will also audit the corrected report $\underline{b},\underline{t}$ because a high tax valuation type may be the sender. Because all tax audit probabilities for reports $\underline{t}$ are positive, lemma 2 applies. Thus, in contrast to regime 3a, tax evasion is not affected by providing access to the statutory audit report. However, tax revenues decrease because the report $\overline{b},\underline{t}$ of type $\underline{b},\bar{t}$ is corrected to $\underline{b},\underline{t}$ by the statutory auditor with positive probability and she then benefits from the lower tax audit probability (compared to report $\overline{b},\underline{t}$).

The following proposition states the effects on the efficiency measures when financial statement valuation is relatively unimportant to the taxpayer.

Proposition 4 (Negative tax revenue effect) *Suppose that $\gamma > \omega + F_B$. Then, there exist $\underline{\theta}_T$, $\overline{\theta}_T$, $\underline{\theta}_S(\theta_T)$, $\overline{\theta}_S(\theta_T)$ such that for $\underline{\theta}_T < \theta_T < \overline{\theta}_T \leq 1$ and $\underline{\theta}_S(\theta_T) < \theta_S < \overline{\theta}_S(\theta_T)$, the following relations hold:*

1. $LTR^{R1} < LTR^{R2} < LTR^{R3b}$
2. $TA^{R3b} < TA^{R2} < TA^{R1}$.

Proof: See appendix D.6 □

More information will decreases tax revenue. The tax evasion probability remains constant, but the additional information shifts the reporting decisions to reports with a lower audit probability. This also explains the decreasing audit frequency.

6 Low powered tax auditor incentives: positive tax revenue effect

We now consider lower incentives for the tax auditor that are characterized by $1 < \theta_T < \overline{\theta}_T$. Compared to medium incentives, lower incentives have the following effects:[9] (1) They increase the probability of false reporting with respect to tax and financial statement valuation. (2) We observe changes in the reporting profiles: Taxpayer type $\overline{b},\overline{t}$ stops truthful reporting in regimes 2 and 3b. In regime 3a truthful reporting is maintained due to the relative importance of financial statement valuation. Taxpayer type $\underline{b},\overline{t}$ will no longer issue the report $\overline{b},\overline{t}$ in regime 2 and 3b. Again, the profile in regime 3a does not change due to the important financial statement valuation. (3) Changes in the reporting profiles entail changes in the equilibrium audit probabilities. In regime 2, the tax auditor never audits any report $\underline{b},\underline{t}$. Although this report can be filed by two types with high tax valuation, the possibility of a true or corrected report originated by type $\underline{b},\underline{t}$ is sufficient to justify the no audit decision. This changes in both regimes 3a and 3b. In those cases, the tax auditor can observe the statutory auditor's correction of an overstated financial statement valuation. In the event of a correction, the reporting probabilities for $\overline{b},\underline{t}$ and the statutory auditor's correction probability x_1 are determined such that the tax auditor has no incentive to audit a corrected report. However, the tax auditor still prefers to audit an uncorrected report $\underline{b},\underline{t}$.

Proposition 5 demonstrates how the tax system's efficiency measures vary with the changes in the information environment.

Proposition 5 (Positive tax revenue effect) *There exist* $1 < \theta_T < \bar{\theta}_T$ *and* $\underline{\theta}_S(\theta_T) < \theta_S < \overline{\theta}_S(\theta_T)$ *such that*

1. $LTR^{R1} > LTR^{R2} > LTR^{R3a,R3b}$

[9] See appendix C.1.3 for the intermediate-information regime, appendix C.2.3 for the high-information regime and $\gamma > \omega + F_B$ and appendix C.2.4 for the high-information regime and $\gamma < \omega + F_B$.

2. $TA^{R1} < TA^{R2} < TA^{R3a,R3b}$.

Proof: See appendix D.7. □

The reduced-information scenario (regime 1) induces the highest lost tax revenue and the lowest audit frequency because the tax auditor terminates his audit activities and the taxpayer always understates his tax valuation. Providing more information to the tax auditor, as in regimes 2 and 3, allows for more elaborated audit strategies. More information has two effects on tax revenues and audit frequency that work in the same directions: (1) The tax audit probabilities increase with more information and, thus, increase audit frequency and increase tax revenue. (2) Taxpayers with high tax valuation may deviate to reporting strategies with low tax valuation but lower audit risk. Then, tax revenue and audit frequency decrease. With respect to tax revenues the first effect dominates the second. Tax revenue increases with better information independent of the relative importance of financial statement valuation. The same argument holds for the tax audit frequency in the case of important financial statement valuation. Because taxpayer types $\overline{b},\overline{t}$ and $\underline{b},\underline{t}$ report $\overline{b},\underline{t}$ with the same probability in regimes 2 and 3a, the second effect is not strong enough to outweigh increased audit probability, and thus, audit frequency increases. In regime 3b, taxpayer types $\overline{b},\overline{t}$ and $\underline{b},\underline{t}$ lower the probability of report $\overline{b},\underline{t}$ compared to regime 2. However, audit frequency still increases because of the higher audit probability for an uncorrected report $\underline{b},\underline{t}$ in regime 3b .

7 Discussion

In many countries, financial statements are subject to two kinds of audit: a statutory audit that is conducted by an independent private auditor and, usually with a time lag, a tax audit that is conducted by the country's tax administration. This raises the question of whether there is a strategic interaction between these two audits and how this affects firms' tax evasion, tax revenues, and tax audit frequency. Is it, for example,

possible to simultaneously increase tax revenues and reduce tax audit frequency simply by providing the tax auditor with access to the internal statutory audit report?

To examine this question, we integrate two novel features in a tax compliance game: In the first modification of the standard inspection game, the tax auditor can observe the financial statements that are already audited by a statutory auditor. The statutory auditor is a strategic player who acts conservatively, i.e., he or she only corrects overstatements. Thus, firms can misreport both their book and their tax income. In the second modification, we extend this model by assuming that the tax auditor additionally receives a report from the statutory auditor that contains information on audit adjustments regarding the firms' book values. The report is an informative signal about the true tax values of a firm because a firm's incentive to conduct upward management of book values depends on the respective tax value.

One might expect that a tax audit system with additional informative signals is efficient with respect to tax audit costs and tax revenue. Our results show that this intuition is not necessarily true. We find that the efficiency effects strongly depend on the tax auditors' incentives. We obtain no effect on efficiency for high-powered tax auditor incentives. Highly motivated tax auditors do not decrease their audit frequency due to the additional information, whereas firms' change their evasion behavior. Increasing the information level of the tax auditors induces some firms to engage in more tax evasion, while other firms reduce their evasion. However, in equilibrium, average tax evasion remains at the same level. Moreover, because highly motivated tax auditors do not differentiate their audit probability with respect to book-tax differences, we do not observe that firms conduct downward management of book income.

In contrast, if tax auditors have low-powered or medium-powered incentives, they change their audit probability for some reports in response to different information environments, and some firms now engage in downward management of book and tax income. We find that with low-powered tax auditor incentives, the audit frequency increases with increasing additional information. This also raises tax revenues. With

medium-powered tax auditor incentives, the efficiency effects depend on the importance that firms assign to book income. If the non-tax costs of a conforming tax evasion strategy are high (firms place high weight on book income), we indeed find that providing the tax auditor with access to the internal statutory audit report reduces tax evasion and tax audit frequency and increases tax revenues. In this case, granting access to the internal statutory audit report clearly improves the efficiency of the tax audit regime. However, if the non-tax costs of conforming tax evasion strategies are lower, then tax revenues may even decrease because tax audit frequency decreases while average tax evasion is not affected by the additional information provision.

Regarding tax policy implications, our results highlight on the one hand the potential efficiency-increasing effect that can be achieved by using financial statements and statutory audit information in tax audits. On the other hand, our study reveals that raising disclosure requirements may also backfire and lead to less tax revenues. Before giving tax auditors extended access to statutory audit information, the incentives of tax auditors in the respective country should therefore be taken into account. Moreover, countries should differentiate with respect to the type of firm, as the efficiency-increasing effect requires firms to place high weight on book income.

The focus of this study is to examine the implications of additional information on tax compliance and tax audit effectiveness. However, as we have seen, the strategic interaction between statutory auditors and tax auditors also affects firms' financial reporting. Interestingly, the observability of the statutory audit report affects both downward and upward earnings management of book income. Future research could investigate these implications in greater detail and might also consider different incentives of the statutory auditor, as we limit our analysis to conservative statutory auditors.

Moreover, our analysis concerns firms in which managers place greater weight on tax savings than on the disclosure of high book income. Although we also study variations in the importance of book income, we explicitly exclude from our analysis those firms that prioritize financial reporting over tax outcomes. Thus, our analysis does not

fully cover public firms, which prior research finds place greater emphasis on financial reporting outcomes than private firms (Mills, 1998; Mills and Newberry, 2001; Beuselinck et al., 2015; Lynch et al., 2018). Nevertheless, we can still transfer some of our considerations to those firms that prioritize financial reporting over tax outcomes. First, for tax auditors with high-powered incentives, the result that the additional information does not affect tax audit efficiency holds independent of the prioritization of book and tax outcome. Second, firms that prioritize book over tax income will not engage in downward book income management. Instead, we expect that some firms would overstate tax income to conceal upward book income management (as reported in Erickson et al. (2004) and modeled in Niggemann (2018)). This should expand the settings in which additional information increases tax audit efficiency. Third, similar to our above analysis, we expect that additional information should, in general, increase tax audit frequency and tax revenues if tax auditors have low-powered incentives.

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Appendix

A List of variables

A.1 Taxpayer types and prior probabilities

Type	Prior Probability
$\underline{b},\underline{t}$	$0.5p$
$\overline{b},\overline{t}$	$0.5p$
$\underline{b},\overline{t}$	$0.5\,(1-p)$
$\overline{b},\underline{t}$	$0.5\,(1-p)$

A.2 Objective function parameters

Taxpayer	ω	financial statement valuation	
	γ	tax valuation	
	F_B	penalty for incorrect financial stat. valuation	
	F_T	penalty for incorrect tax valuation	
Statutory auditor	λ	return from detecting overstatement	$\}\ \theta_S = \frac{C_S}{\lambda - C_S}$
	C_S	auditing cost	
Tax auditor	δ	return from detecting understatement	$\}\ \theta_T = \frac{C_T}{\delta - C_T}$
	C_T	auditing cost	

A.3 Probabilities in mixed-strategy equilibria

Taxpayer	Type	Report	Report Probability
	$\overline{b},\underline{t}$	$\overline{b},\underline{t}$	1
	$\overline{b},\overline{t}$	$\overline{b},\overline{t}$	$1-\phi_1-\phi_2$
		$\overline{b},\underline{t}$	ϕ_1
		$\underline{b},\underline{t}$	ϕ_2
	$\underline{b},\underline{t}$	$\underline{b},\underline{t}$	$1-\eta$
		$\overline{b},\underline{t}$	η
	$\underline{b},\overline{t}$	$\underline{b},\overline{t}$	$1-\nu_1-\nu_2-\nu_3$
		$\overline{b},\overline{t}$	ν_1
		$\overline{b},\underline{t}$	ν_2
		$\underline{b},\underline{t}$	ν_3
Statutory auditor	x_1	Statutory auditor audits report $\overline{b}$ with high effort given tax report $\underline{t}$	
	x_2	Statutory auditor audits report $\overline{b}$ with high effort given tax report $\overline{t}$	
Tax auditor	α	Tax auditor audits $\underline{t}$ given report $\overline{b},\underline{t}$ (reg. 2 and 3)	
	β	Tax auditor audits $\underline{t}$ given report $\underline{b},\underline{t}$ (reg. 2)	
	β_1	Tax auditor audits $\underline{t}$ given uncorrected report $\underline{b},\underline{t}$ (reg. 3)	
	β_2	Tax auditor audits $\underline{t}$ given corrected report $\underline{b},\underline{t}$ (reg. 3)	

B Legal obligations: Overview

Country	Obligation to file financial accounting statements together with the tax return	Obligation to file the audit report together with the tax return
Australia	Yes	No[3]
Austria	Yes	No
Belarus	Yes	No
Belgium	No	Yes
Brazil	Yes	No
Canada	Yes	No
China	Yes	No[3]
Czech Republic	Yes	No
Denmark	Yes	No
Estonia	No	No
Finland	Yes	No
Germany	Yes	Yes
Hong Kong	Yes	Yes
Hungary	No	No
Ireland	Yes	Yes
Italy	No	No
Yespan	Yes	No
Korea	No	No
Luxembourg	Yes	No
Netherlands	No	No
Panama	No	No
Poland	Yes[1]	Yes
Russia	Yes	No[3]
Slovakia	No	No
South Africa	Yes	Yes
Spain	Yes	No[2]
Sweden	No	No
Switzerland	Yes	No[3]
Ukraine	Yes	No
United Kingdom	Yes	Yes
Uruguay	No	No
USA	No	No
Vietnam	Yes	Yes

[1] Non-audited financial statements do not need to be filed.

[2] The audit report is a publicly available information.

[3] Survey respondents state that in practice the audit report is often enclosed along with the financial statements or that the revenue agency may request it as part of a tax audit.

Table 5: Legal obligations to file financial accounting statements and statutory auditor reports to the tax administration. Data source: Own survey conducted between March and June 2016 among tax managers, directors, and partners of PricewaterhouseCoopers.

C Equilibrium analysis in regimes 2 and 3: the details

This appendix contains the detailed equilibrium analysis for both information regimes.

C.1 Equilibrium analysis in regime 2

We begin the analysis with the derivation of the taxpayer's payoffs for those strategies that are not dominated. These are given in Table 6.

Type	Report	Payoff
$\overline{b},\underline{t}$	$\overline{b},\underline{t}$	$\omega\overline{b}-\gamma\underline{t}$
$\overline{b},\overline{t}$	$\overline{b},\overline{t}$	$\omega\overline{b}-\gamma\overline{t}$
	$\overline{b},\underline{t}$	$\omega\overline{b}-\gamma(\alpha\overline{t}+(1-\alpha)\underline{t})-\alpha F_T$
	$\underline{b},\underline{t}$	$\omega\underline{b}-\gamma(\beta\overline{t}+(1-\beta)\underline{t})-\beta F_T$
$\underline{b},\underline{t}$	$\underline{b},\underline{t}$	$\omega\underline{b}-\gamma\underline{t}$
	$\overline{b},\underline{t}$	$\omega(x_1\underline{b}+(1-x_1)\overline{b})-x_1F_B-\gamma\underline{t}$
$\underline{b},\overline{t}$	$\underline{b},\overline{t}$	$\omega\underline{b}-\gamma\overline{t}$
	$\overline{b},\overline{t}$	$\omega(x_2\underline{b}+(1-x_2)\overline{b})-x_2F_B-\gamma\overline{t}$
	$\overline{b},\underline{t}$	$\omega(x_1\underline{b}+(1-x_1)\overline{b})-x_1F_B-x_1(\gamma(\beta\overline{t}+(1-\beta)\underline{t})+\beta F_T)$ $-(1-x_1)(\gamma(\alpha\overline{t}+(1-\alpha)\underline{t})+\alpha F_T)$
	$\underline{b},\underline{t}$	$\omega\underline{b}-\gamma(\beta\overline{t}+(1-\beta)\underline{t})-\beta F_T$

Table 6: The taxpayer's payoffs in the intermediate information regime (regime 2) depending on type and report.

C.1.1 Equilibrium for high-powered tax auditor incentives

We first derive the equilibrium for low θ_T and low θ_S and present the restrictions for θ_T and θ_S under which this equilibrium will be valid.

First, high powered-incentives imply positive audit probabilities for all conditions under which an audit can take place. Therefore we conjecture $x_1 \in (0,1)$, $x_2 \in (0,1)$ as well as $\alpha \in (0,1)$ and $\beta \in (0,1)$. Under this conjecture reporting the truthful valuations will be part of the equilibrium for the taxpayer. Then, the concrete audit probabilities for both auditors can be derived from the following equilibrium conditions:

(1) The statutory auditor will set x_1 and x_2 such that

... Type $\underline{b},\underline{t}$ taxpayers are indifferent between reports $\underline{b},\underline{t}$ and $\overline{b},\underline{t}$. Equating the payoffs and rearranging yields $x_1 = \frac{\omega}{\omega+F_B}$.

... Type $\underline{b},\bar{t}$ taxpayers are indifferent between reports $\underline{b},\bar{t}$ and $\overline{b},\bar{t}$. This yields $x_2 = x_1$.

(2) The tax auditor will set α and β such that

... Type $\overline{b},\bar{t}$ is indifferent between reporting $\overline{b},\bar{t}$ and $\overline{b},\underline{t}$. Equating the respective payoffs yields $\alpha = \frac{\gamma}{\gamma+F_T}$.

... Type $\underline{b},\bar{t}$ is indifferent between $\underline{b},\underline{t}$ and $\underline{b},\bar{t}$ yielding $\beta = \alpha$. Moreover, $\alpha = \beta = \frac{\gamma}{\gamma+F_T}$ also make type $\underline{b},\bar{t}$ indifferent between reporting $\underline{b},\bar{t}$ and $\overline{b},\underline{t}$.

(3) The conjectures and considerations above have shown that the taxpayer will use an equilibrium strategy profile consisting of $\phi_1 > 0, \eta > 0, \nu_1 > 0, \nu_2 > 0$ and $\nu_3 > 0$. These probabilities will be set such that the statutory and the tax auditor are indifferent between their pure strategies. The auditors use Bayes' rule when updating their beliefs after observing a certain report. We obtain the following four equations to determine five probabilities:

- The statutory auditor is indifferent between high and low effort after observing report $\overline{b},\underline{t}$. Updating leads to $\text{prob}\{\underline{b}|\hat{b} = \overline{b},\hat{t} = \underline{t}\} = \frac{p\eta+(1-p)\nu_2}{p\eta+(1-p)\nu_2+1-p+p\phi_1}$ and

$$p\eta + (1-p)\nu_2 = \theta_S(1-p+p\phi_1). \tag{12}$$

- The statutory auditor's indifference given report $\overline{b},\bar{t}$ and updating beliefs to $\text{prob}\{\underline{b}|\hat{b} = \overline{b},\hat{t} = \bar{t}\} = \frac{\nu_1(1-p)}{\nu_1(1-p)+p(1-\phi_1)}$ yields

$$\nu_1(1-p) = \theta_S p(1-\phi_1). \tag{13}$$

- The tax auditor being indifferent given report $\overline{b},\underline{t}$ and updating to $\text{prob}\{\bar{t}|\hat{b} = \overline{b},\hat{t} = \underline{t}\} = \frac{p\phi_1+(1-p)\nu_2(1-x_1)}{p\phi_1+(1-p)\nu_2(1-x_1)+1-p+p\eta(1-x_1)}$ yields

$$p\phi_1 + (1-p)\nu_2(1-x_1) = \theta_T(1-p+p\eta(1-x_1)). \tag{14}$$

- The tax auditor being indifferent given report $\underline{b},\underline{t}$ and updating to $\text{prob}\{\bar{t}|\hat{b} = \underline{b},\hat{t} = \underline{t}\} = \frac{(1-p)(\nu_3+\nu_2x_1)}{(1-p)(\nu_3+\nu_2x_1)+p(1-\eta+\eta x_1)}$ implies

$$(1-p)(\nu_3+\nu_2x_1) = \theta_T p(1-\eta+\eta x_1). \tag{15}$$

Solving these equations for $\phi_1, \eta, \nu_1, \nu_2$ and ν_3 yields

$$\boxed{\begin{aligned}
\phi_1 &= \frac{(1-p)(\theta_T(1+\theta_S(1-x_1)) - \nu_2(1-x_1)(1+\theta_T))}{p(1-\theta_S\theta_T(1-x_1))} \\
\eta &= \frac{(1-p)(\theta_S(1+\theta_T) - \nu_2(1+\theta_S(1-x_1))}{p(1-\theta_S\theta_T(1-x_1))} \\
\nu_1 &= \frac{\theta_S((1-x_1)(1+\theta_T)(1-p)\nu_2 - \theta_T\theta_S(1-x_1) + (1+\theta_T)p - \theta_T)}{(1-p)(1-\theta_S\theta_T(1-x_1))} \\
\nu_2 &\in (\underline{\nu_2}, \overline{\nu_2}) \\
\nu_3 &= \frac{(1-p)((1-x_1)\theta_T(1+\theta_S) - x_1)\nu_2 - \theta_T((1-x_1)\theta_S(1+\theta_T-p) - p)}{(1-p)(1-\theta_S\theta_T(1-x_1))}.
\end{aligned}} \tag{16}$$

The probability ν_2 has to be set such that all other reporting probabilities are between zero and one. Note that for sufficiently small θ_T, θ_S all reporting probabilities are between zero and one for $\nu_2 = 0$. Therefore, the lower bound $\underline{\nu_2}$ will be zero. The upper bound has to be determined from $\phi_1(\overline{\nu}_2) \geq 0, \eta(\overline{\nu}_2) \geq 0, \nu_3(\overline{\nu}_2) \geq 0$ or $\nu_1(\overline{\nu}_2) + \overline{\nu}_2 + \nu_3(\overline{\nu}_2) \leq 1$.

Similar considerations yield restrictions on θ_T and θ_S defining the valid range of the equilibrium:

1. The first boundary condition ensures positive probabilities: $1 - \theta_S\theta_T(1-x_1) > 0 \Leftrightarrow \theta_T < \frac{1}{\theta_S(1-x_1)}$.

2. A taxpayer of type $\underline{b}, \bar{t}$ has the strongest incentives to deviate from truthful reporting. The report $\underline{b}, \bar{t}$ will be part of the equilibrium as long as $\nu_1 + \nu_2 + \nu_3 < 1$. Inserting and reformulating yields the implicit condition

$$\begin{aligned}
(1-x_1)(\theta_T^2\theta_S + \theta_T\theta_S^2) + (1-p)\theta_T\theta_S - p(1+\theta_T+\theta_S) + 1 \\
-(1-x_1)(1+\theta_T)(1+\theta_S)(1-p)\nu_2 > 0.
\end{aligned} \tag{17}$$

Note that both conditions provide a valid space for θ_S and θ_T for all $x_1, p \in (0,1)$. Condition 17 can be rearranged to

$$p < \frac{1 + \theta_T\theta_S + (1-x_1)(\theta_T^2\theta_S + \theta_T\theta_S^2) - (1-x_1)(1+\theta_T)(1+\theta_S)\nu_2}{1 + \theta_T\theta_S + \theta_T + \theta_S - (1-x_1)(1+\theta_T)(1+\theta_S)\nu_2} < 1 \tag{18}$$

and defines an upper bound for p. The RHS of (18) converges to 1 with $\theta_S, \theta_T \to 0$.

C.1.2 Equilibrium under medium tax auditor incentives

We conjecture $x_1 \in (0,1)$, $x_2 = 0$, $\alpha \in (0,1)$ and $\beta \in (0,1)$ as the equilibrium strategies for the statutory and tax auditors. The probabilities can be determined from the following:

(1) The statutory auditor will set x_1 such that type $\underline{b},\underline{t}$ is indifferent between reporting $\underline{b},\underline{t}$ and $\overline{b},\underline{t}$. This yields $x_1 = \frac{\omega}{\omega+F_B}$.

(2) The tax auditor will set α and β such that

... Type $\overline{b},\overline{t}$ being indifferent between $\overline{b},\overline{t}$ and $\overline{b},\underline{t}$ yields $\alpha = \frac{\gamma}{\gamma+F_T}$.

- Type $\underline{b},\overline{t}$ is indifferent between $\underline{b},\underline{t}$ and $\overline{b},\overline{t}$. This yields $\beta = \frac{(\gamma-\omega)}{\gamma+F_T}$. These probabilities imply that type $\overline{b},\overline{t}$ is also indifferent between reporting $\underline{b},\overline{t}$ and $\overline{b},\underline{t}$.

Given the conjectures above, the taxpayer will use an equilibrium reporting profile with $\phi_1,\phi_2,\eta,\nu_3 \in (0,1)$ and $\nu_1 = 1-\nu_3 \in (0,1)$. Equating the payoffs for the statutory and tax auditors for $a_S = 1,0$ and $a_T = 1,0$ and using Bayes' rule gives three equations that can be used to determine the four equilibrium reporting probabilities.

- The statutory auditor being indifferent given $\overline{b},\underline{t}$ and $\text{prob}\{\underline{b}|\hat{b} = \overline{b},\hat{t} = \underline{t}\} = \frac{p\eta}{p\eta+1-p+p\phi_1}$ yields
$$p\eta = \theta_S(1-p+p\phi_1). \tag{19}$$

- The tax auditor being indifferent given $\overline{b},\underline{t}$ and $\text{prob}\{\overline{t}|\hat{b} = \overline{b},\hat{t} = \underline{t}\} = \frac{\phi_1 p}{\phi_1 p+p\eta(1-x_1)+1-p}$ implies
$$\phi_1 p = \theta_T(p\eta(1-x_1)+1-p). \tag{20}$$

- The tax auditor being indifferent given $\underline{b},\underline{t}$ and $\text{prob}\{\overline{t}|\hat{b} = \underline{b},\hat{t} = \underline{t}\} = \frac{p\phi_2+(1-p)\nu_3}{p\phi_2+(1-p)\nu_3+p(1-\eta+\eta x_1)}$ implies
$$p\phi_2+(1-p)\nu_3 = \theta_T p(1-\eta+\eta x_1). \tag{21}$$

The solution to this system of three equations is

$$\boxed{\begin{aligned}
\phi_1 &= \frac{(1-p)\theta_T(1+\theta_S(1-x_1))}{p(1-\theta_S\theta_T(1-x_1))} \\
\phi_2 &\in (\underline{\phi}_2,\overline{\phi}_2) \\
\eta &= \frac{(1-p)\theta_S(1+\theta_T)}{p(1-\theta_S\theta_T(1-x_1))} \\
\nu_3 &= \frac{\theta_T(p-(1-x_1)\theta_S((1+\theta_T)-p))}{(1-p)(1-\theta_S\theta_T(1-x_1))} - \phi_2\frac{p}{1-p}
\end{aligned}} \tag{22}$$

The equilibrium derived above will be valid if the following conditions are fulfilled:

1. Our conjecture $x_2 = 0$ must be fulfilled. Using $\text{prob}\{\underline{b}|\hat{b} = \overline{b}, \hat{t} = \overline{t}\} = \frac{(1-p)(1-\nu_3)}{(1-\nu_3)(1-p)+p(1-\phi_1-\phi_2)}$ yields $(1-\nu_3)(1-p) < \theta_S(1-\phi_1-\phi_2)$. Inserting ν_3, ϕ_1 and $\phi_2 = 0$ yields

$$(1-x_1)(\theta_T^2\theta_S + \theta_T\theta_S^2) + (1-p)\theta_T\theta_S - p(1+\theta_T+\theta_S) + 1 < 0, \qquad (23)$$

   which replicates the LHS of condition (17) at $\nu_2 = 0$.

2. Reformulating $\nu_3 \leq 1$ using $\phi_2 = 1-\phi_1$ yields the condition $\theta_T \leq 1$.

3. Reformulating $\eta \leq 1$ yields $\theta_S \leq \frac{p}{1+\theta_T-p(1+\theta_T x_1)}$. Tedious algebra shows that this condition implies $\phi_1 \leq 1$ provided $\theta_T \in (0,1)$.

The lower and upper bounds for ϕ_2 will be determined as follows: (1) $\nu_3 \leq 1$ yields $\phi_2 \geq \frac{(1+\theta_T)p-(1+\theta_T^2\theta_S(1-x_1))}{p(1-\theta_T\theta_S(1-x_1))}$. Combining this with condition $\phi_2 \geq 0$ we obtain:

$$\underline{\phi}_2(\cdot) = \max\left\{0, \frac{(1+\theta_T)p-(1+\theta_T^2\theta_S(1-x_1))}{p(1-\theta_T\theta_S(1-x_1))}\right\}. \qquad (24)$$

(2) ϕ_2 has to be determined such that (23) holds. Inserting and rearranging leads to $\phi_2 \leq \frac{p(\theta_T+\theta_S)-(1-x_1)(\theta_T^2\theta_S+\theta_T\theta_S^2)-(1-p)(1+\theta_T\theta_S)}{p(1+\theta_S)(1-\theta_S\theta_T(1-x_1))}$. (3) Reformulating $\nu_3 \geq 0$ yields $\phi_2 \leq \frac{\theta_T(p-(1-x_1)\theta_S((1+\theta_T)-p))}{p(1-\theta_T\theta_S(1-x_1))}$. The minimum of the two expressions above determines the upper bound $\overline{\phi}_2$.

C.1.3 Equilibrium under low tax auditor incentives

Under weaker incentives, the tax auditor will not audit report $\underline{b},\underline{t}$ or $\overline{b},\underline{t}$. We conjecture that $\alpha > 0$ and $\beta = 0$ because the taxpayer has stronger incentives for the former report. We also guess $x_1 > 0$ and $x_2 = 0$. The probabilities can be determined as follows:

(1) The audit probability x_1 will make type $\underline{b},\underline{t}$ indifferent between reports $\underline{b},\underline{t}$ and $\overline{b},\underline{t}$. Therefore, $x_1 = \frac{\omega}{\omega+F_B}$.

(2) The tax audit probability α is set such that $\overline{b},\overline{t}$ is indifferent between $\overline{b},\underline{t}$ and $\underline{b},\underline{t}$. We obtain $\alpha = \frac{\omega}{\gamma+F_T}$.

(3) Given these considerations, the taxpayer's equilibrium profile will consist of $\phi_1 > 0$, $\phi_2 = 1-\phi_1$, $\eta > 0$ and $\nu_3 = 1$. We can determine the two probabilities from two equilibrium conditions:

- The statutory auditor is indifferent between $a_S = 1$ and $a_S = 0$. Using $\text{prob}\{\underline{b}|\hat{b} = \overline{b}\} = \frac{p\eta}{p\eta+1-p+p\phi_1)}$ yields

$$\eta = \frac{\theta_S(1-p+p\phi_1)}{p}. \tag{25}$$

- Tax auditor indifference and $\text{prob}\{\overline{t}|\hat{b} = \overline{b}, \hat{t} = \underline{t}\} = \frac{p\phi_1}{p\phi_1+1-p+p\eta(1-x_1)}$ imply

$$\phi_1 = \theta_T \left(\frac{1-p+p\eta(1-x_1)}{p} \right). \tag{26}$$

Solving these two equations with respect to η and ϕ_1 yields

$$\boxed{\begin{aligned} \eta &= \frac{\theta_S(1+\theta_T)(1-p)}{p(1-\theta_S\theta_T(1-x_1))} \\ \phi_1 &= \frac{\theta_T(1-p)(1+\theta_S(1-x_1))}{p(1-\theta_S\theta_T(1-x_1))}. \end{aligned}} \tag{27}$$

(4) The following equilibrium conditions have to hold:

1. Our conjecture $\beta = 0$ has to be valid. Bayesian updating leads to

$$\delta \frac{(1-\phi_1)p+1-p}{(1-\phi_1)p+1-p+p(1-\eta(1-x_1))} - C_T \leq 0 \;\Leftrightarrow\; \theta_T \geq 1. \tag{28}$$

2. $\eta > 0$ and $\phi_1 > 0$ yields $\theta_S \leq \frac{1}{\theta_T(1-x_1)}$.

3. $\eta \leq 1$ yields the stricter condition $\theta_S \leq \frac{p}{1-p+\theta_T(1-px_1)}$ and $\phi_1 \leq 1 \;\Leftrightarrow\; \theta_T \leq \frac{p}{1-p+\theta_S(1-x_1)}$ gives the upper bound for θ_T. If θ_T or θ_S exceed these upper bounds, the tax or statutory auditors will no longer audit because their incentives are too low.

C.2 Equilibrium analysis in the high-information regime

In Table 7 we present the taxpayer's payoffs for those strategies that are not dominated in information regime 3.

C.2.1 High-powered tax auditor incentives

As in regime 2, we conjecture that both auditors will exhibit positive probabilities for $a_S = 1$ and $a_T = 1$ whenever $\overline{b}$ or $\underline{t}$ is observed. Therefore, $x_1 \in (0,1)$, $x_2 \in (0,1)$, $\alpha \in (0,1)$, $\beta_1 \in (0,1)$ and $\beta_2 \in (0,1)$. We derive the following probabilities:

Type	Report	Payoff
$\overline{b},\underline{t}$	$\overline{b},\underline{t}$	$\omega\overline{b}-\gamma\underline{t}$
$\overline{b},\overline{t}$	$\overline{b},\overline{t}$	$\omega\overline{b}-\gamma\overline{t}$
	$\overline{b},\underline{t}$	$\omega\overline{b}-\gamma(\alpha\overline{t}+(1-\alpha)\underline{t})-\alpha F_T$
	$\underline{b},\underline{t}$	$\omega\underline{b}-\gamma(\beta_1\overline{t}+(1-\beta_1)\underline{t})-\beta_1 F_T$
$\underline{b},\underline{t}$	$\underline{b},\underline{t}$	$\omega\underline{b}-\gamma\underline{t}$
	$\overline{b},\underline{t}$	$\omega(x_1\underline{b}+(1-x_1)\overline{b})-x_1F_B-\gamma\underline{t}$
$\underline{b},\overline{t}$	$\underline{b},\overline{t}$	$\omega\underline{b}-\gamma\overline{t}$
	$\overline{b},\overline{t}$	$\omega(x_2\underline{b}+(1-x_2)\overline{b})-x_2F_B-\gamma\overline{t}$
	$\overline{b},\underline{t}$	$\omega(x_1\underline{b}+(1-x_1)\overline{b})-x_1F_B-x_1(\gamma(\beta_2\overline{t}+(1-\beta_2)\underline{t})+\beta_2F_T)$ $-(1-x_1)(\gamma(\alpha\overline{t}+(1-\alpha)\underline{t})+\alpha F_T)$
	$\underline{b},\underline{t}$	$\omega\underline{b}-\gamma(\beta_1\overline{t}+(1-\beta_1)\underline{t})-\beta_1F_T$

Table 7: The taxpayer's payoffs in the high-information regime (regime 3) depending on type and report

(1) The statutory auditor will set x_1 and x_2 such that

... Type $\underline{b},\underline{t}$ taxpayers are indifferent between reports $\underline{b},\underline{t}$ and $\overline{b},\underline{t}$. Equating the payoffs and rearranging yields $x_1=\frac{\omega}{\omega+F_B}$.

... Type $\underline{b},\overline{t}$ taxpayers are indifferent between reports $\underline{b},\overline{t}$ and $\overline{b},\overline{t}$. This yields $x_2=x_1$.

(2) The tax auditor will set α and β_1,β_2 such that

... Type $\overline{b},\overline{t}$ is indifferent between reporting $\overline{b},\overline{t}$ and $\overline{b},\underline{t}$. Equating the respective payoffs yields $\alpha=\frac{\gamma}{\gamma+F_T}$.

... Type $\underline{b},\overline{t}$ is indifferent between $\underline{b},\underline{t}$ and $\underline{b},\overline{t}$ yielding $\beta_1=\alpha$.

... Type $\underline{b},\overline{t}$ is also indifferent between $\overline{b},\underline{t}$ and $\underline{b},\overline{t}$. This yields

$$\begin{aligned}\omega\underline{b}-\gamma\overline{t}=&\omega(x_1\underline{b}+(1-x_1)\overline{b})-x_1F_B-x_1(\gamma(\beta_2\overline{t}+(1-\beta_2)\underline{t})+\beta_2F_T)\\&-(1-x_1)(\gamma(\alpha\overline{t}+(1-\alpha)\underline{t})+\alpha F_T)\\\Leftrightarrow\quad\gamma\overline{t}=&\gamma(\beta_2\overline{t}+(1-\beta_2)\underline{t})-\beta_2F_T\ \Leftrightarrow\ \beta_2=\beta_1=\alpha.\end{aligned}\tag{29}$$

(3) The conjectures and considerations above have shown that the taxpayer will use an equilibrium strategy profile consisting of $\phi_1>0,\eta>0,\nu_1>0,\nu_2>0$ and $\nu_3>0$. Using Bayes' rule, we obtain the following equations from the tax and the statutory auditors' indifference conditions:

- The statutory auditor is indifferent given $\overline{b},\underline{t}$. The updated probability $\text{prob}\{\underline{b}|\hat{b}=\overline{b},\hat{t}=\underline{t}\}=\frac{p\eta+(1-p)\nu_2}{p\eta+(1-p)\nu_2+1-p+p\phi_1}$ yields

$$p\eta+(1-p)\nu_2=\theta_S(1-p+p\phi_1). \tag{30}$$

- The statutory auditor being indifferent after report $\overline{b},\overline{t}$ and $\text{prob}\{\underline{b}|\hat{b}=\overline{b},\hat{t}=\overline{t}\}=\frac{\nu_1(1-p)}{\nu_1(1-p)+p(1-\phi_1)}$ implies

$$\nu_1(1-p)=\theta_S p(1-\phi_1). \tag{31}$$

- Tax auditor indifference after $\overline{b},\underline{t}$ and probability update $\text{prob}\{\overline{t}|\hat{b}=\overline{b},\hat{t}=\underline{t}\}=\frac{p\phi_1+(1-p)\nu_2(1-x_1)}{p\phi_1+(1-p)\nu_2(1-x_1)+1-p+p\eta(1-x_1)}$ result in

$$p\phi_1+(1-p)\nu_2(1-x_1)=\theta_T(1-p+p\eta(1-x_1)). \tag{32}$$

- The tax auditor is indifferent after observing $\underline{b},\underline{t}$ without corrections by the statutory auditor. The posterior probability $\text{prob}\{\overline{t}|\hat{b}=\underline{b},\hat{t}=\underline{t},\text{ no correction}\}=\frac{(1-p)\nu_3}{(1-p)\nu_3+p(1-\eta)}$ leads to

$$(1-p)\nu_3=\theta_T p(1-\eta) \tag{33}$$

- The tax auditor is indifferent between audit and not audit after report $\underline{b},\underline{t}$ is corrected from original report $\overline{b}$ to $\underline{b}$. The posterior probability $\text{prob}\{\overline{t}|\hat{b}=\underline{b},\hat{t}=\underline{t},\text{ correction}\}=\frac{(1-p)x_1\nu_2}{(1-p)x_1\nu_2+x_1p\eta}$ yields

$$(1-p)x_1\nu_2=\theta_T x_1 p\eta. \tag{34}$$

Equations (30) to (34) have the following solution:

$$\boxed{\begin{aligned}\phi_1&=\frac{1-p}{p}\theta_T\\ \eta&=\frac{1-p}{p}\theta_S\\ \nu_1&=\frac{\theta_S(p(1+\theta_T)-\theta_T)}{1-p}\\ \nu_2&=\theta_S\theta_T\\ \nu_3&=\frac{\theta_T(p(1+\theta_S)-\theta_S)}{1-p}\end{aligned}} \tag{35}$$

(4) The following conditions for θ_T and θ_S have to be met to ensure the existence of the equilibrium:

1. $\phi_1 \leq 1 \Leftrightarrow \theta_T \leq \frac{p}{1-p}$. This also implies $\nu_1 \geq 0$.

2. $\eta \leq 1 \Leftrightarrow \theta_S \leq \frac{p}{1-p}$. This implies $\nu_3 \geq 0$.

3. The condition $\nu_1 + \nu_2 + \nu_3 \leq 1$ leads to the constraint

$$\theta_T \leq \frac{1 - p(1+\theta_S)}{p(1+\theta_S) - \theta_S}. \tag{36}$$

C.2.2 Medium incentives for the tax auditor and unimportant financial statement valuation

If the tax auditor's incentives become less high powered, θ_T will increase beyond the upper bound outlined in section C.2.1. Then, the equilibrium depends on the relative magnitude of the preference parameters γ and ω. We first consider the case of $\gamma > \omega + F_B$. Since tax valuation is very important, a report of $\overline{b},\overline{t}$ will be less attractive for type $\underline{b},\overline{t}$, and therefore, we conjecture that $x_2 = 0$ and $x_1, \alpha, \beta_1, \beta_2 \in (0,1)$.

Given these conjectures, the equilibrium mixed strategy probabilities can be computed:

(1) As above, the probability $x_1 = \frac{\omega}{\omega + F_B}$ ensures that type $\underline{b},\underline{t}$ will be indifferent between reports $\underline{b},\underline{t}$ and $\overline{b},\underline{t}$.

(2) The tax auditor's equilibrium audit probabilities will be set such that

... Type $\overline{b},\overline{t}$ is indifferent between reporting $\overline{b},\overline{t}$ and $\overline{b},\underline{t}$. Equating the respective payoffs yields $\alpha = \frac{\gamma}{\gamma + F_T}$.

... Type $\underline{b},\overline{t}$ is indifferent between reports $\underline{b},\underline{t}$ and $\overline{b},\overline{t}$. This yields $\beta_1 = \frac{(\gamma - \omega)}{\gamma + F_T}$. Note that α and β_1 imply that type $\overline{b},\overline{t}$ will also be indifferent between reports $\underline{b},\underline{t}$ and $\overline{b},\overline{t}$.

... In equilibrium, β_2 will be such that type $\underline{b},\overline{t}$ is indifferent between reports $\overline{b},\underline{t}$ and $\overline{b},\overline{t}$. We obtain $\beta_2 = \frac{(\gamma x_1 - \omega)}{x_1(\gamma + F_T)}$. Note that $\beta_2 > 0 \Leftrightarrow \gamma x_1 - \omega > 0 \Leftrightarrow \gamma > \omega + F_B$.

(3) The conjectures above lead to $\phi_1, \phi_2, \eta, \nu_2, \nu_3$ and $\nu_1 = 1 - \nu_2 - \nu_3 \in (0,1)$. These probabilities have to be computed from the following four equations derived from statutory and tax auditor indifference and Bayes' rule:

$$\begin{aligned}
&p\eta + (1-p)\nu_2 = \theta_S(1 - p + p\phi_1) \\
&p\phi_1 + (1-p)\nu_2(1-x_1) = \theta_T(1 - p + p\eta(1-x_1)). \\
&(1-p)x_1\nu_2 = \theta_T x_1 p\eta. \\
&p\phi_2 + (1-p)\nu_3 = \theta_T p(1-\eta)
\end{aligned} \tag{37}$$

The solution of system (37) is given by

$$\boxed{\begin{aligned}&\phi_1 = \frac{1-p}{p}\theta_T \\ &\phi_2 \in (\underline{\phi}_2(\theta_T), \overline{\phi}_2(\theta_T)) \\ &\eta = \frac{1-p}{p}\theta_S \\ &\nu_2 = \theta_S\theta_T \\ &\nu_3 = \frac{\theta_T(p(1+\theta_S)-\theta_S)-p\phi_2}{1-p}.\end{aligned}} \tag{38}$$

(4) The following conditions ensure that the strategies computed above constitute an equilibrium:

1. The conjecture $x_2 = 0$ must hold under the given equilibrium. Using $\text{prob}\{\underline{b}|\hat{b} = \overline{b}, \hat{t} = \overline{t}\} = \frac{(1-p)(1-\nu_2-\nu_3)}{(1-p)(1-\nu_2-\nu_3)+p(1-\phi_1-\phi_2)}$ yields

   $$\lambda\,\text{prob}\{\underline{b}|\hat{b} = \overline{b}, \hat{t} = \overline{t}\} - C_S < 0 \;\Leftrightarrow\; (1-p)(1-\nu_2-\nu_3) < \theta_S p(1-\phi_1-\phi_2). \tag{39}$$

   Inserting and rearranging yields

   $$\theta_T > \frac{1-p(1+\theta_S)(1-\phi_2)}{p(1+\theta_S)-\theta_S}. \tag{40}$$

   (5) Using the lower bound $\phi_2 = 0$ reproduces the RHS of condition (36). Rearranging the inequality to ϕ_2 yields $\underline{\phi}_2(\theta_T)$.

2. Moreover, $\nu_2 + \nu_3 \leq 1$ must hold. Inserting yields

   $$\nu_2 + \nu_3 = \frac{p(\theta_T - \phi_2)}{1-p} \leq 1 \;\Leftrightarrow\; \theta_T \leq \frac{1-p}{p} + \phi_2. \tag{41}$$

   We insert the maximum value for $\phi_2 = 1 - \phi_1$ and obtain the upper bound $\theta_T \leq 1$.

C.2.3 Low incentives for the tax auditor and unimportant financial statement valuation

We now consider the case $\theta_T > 1$ and $\gamma > \omega + F_B$. We conjecture α, β_1 and $x_1 \in (0,1)$ and that $x_2 = \beta_2 = 0$. We furthermore suppose that type $\underline{b}, \overline{t}$ never reports truthfully and never reports $\overline{b}, \overline{t}$.

(1) The probability x_1 is determined as above (see section C.2.1).

(2) In equilibrium, α and β_1 will be set such that (1) type $\overline{b},\overline{t}$ is indifferent between reports $\overline{b},\underline{t}$ and $\underline{b},\underline{t}$ and (2) type $\underline{b},\overline{t}$ is indifferent between reporting $\overline{b},\underline{t}$ and $\underline{b},\underline{t}$. We obtain the two equations

$$\begin{aligned}\omega\overline{b}-\gamma(\alpha\overline{t}+(1-\alpha)\underline{t})-\alpha F_T &= \omega\underline{b}-\gamma(\beta_1\overline{t}+(1-\beta_1)\underline{t})-\beta_1 F_T \\ \omega\underline{b}-\gamma(\beta_1\overline{t}+(1-\beta_1)\underline{t})-\beta_1 F_T &= \omega(x_1\underline{b}+(1-x_1)\overline{b})-x_1F_B-x_1\gamma\underline{t} \\ &\quad -(1-x_1)(\gamma(\alpha\overline{t}+(1-\alpha)\underline{t})+\alpha F_T)\end{aligned} \tag{42}$$

and the solution

$$\alpha=\frac{\omega}{x_1(\gamma+F_T)} \quad \text{und} \quad \beta_1=\frac{1-x_1}{x_1}\frac{\omega}{\gamma+F_T}. \tag{43}$$

(3) We show that type $\underline{b},\overline{t}$ indeed prefers report $\overline{b},\underline{t}$ over $\overline{b},\overline{t}$ with α,β_1 and x_1 as given above: Inserting and rearranging (use $\omega(x_1\underline{b}+(1-x_1)\overline{b})-x_1F_B=\omega\underline{b}$ because of x_1)

$$\omega\overline{b}-\gamma\overline{t}<\omega\underline{b}-x_1\gamma\underline{t}-(1-x_1)(\gamma(\alpha\underline{t}+(1-\alpha)\overline{t})+\alpha F_T) \tag{44}$$

yields the condition $\gamma>\omega+F_B$ which is fulfilled by the assumption above.

(4) The taxpayer's reporting probabilities will be determined from

$$\begin{aligned}&\eta p+(1-p)(1-\nu_3)=\theta_S(1-p+p\phi_1),\\ &\phi_1 p+(1-p)(1-\nu_3)(1-x_1)=\theta_T(1-p+p\eta(1-x_1)),\\ &p(1-\phi_1)+(1-p)\nu_3=\theta_T p(1-\eta),\end{aligned} \tag{45}$$

and amount to

$$\boxed{\begin{aligned}\phi_1&=\frac{\theta_T(1-px_1)-(1-x_1)}{px_1}\\ \eta&=\frac{(1-p)\theta_T\theta_S+(2-p)\theta_S x_1+\theta_T-\theta_S-1}{px_1(1+\theta_T)}\\ \nu_3&=\frac{\theta_T^2\theta_S(px_1-1)+\theta_T\theta_S(px_1-2x_1+1)+x_1(1-p)(1+\theta_T)+\theta_T-1}{x_1(1-p)(1+\theta_T)}\end{aligned}} \tag{46}$$

(5) The equilibrium will be valid if the following conditions hold:

- The tax auditor will not audit in case of a report $\underline{b},\underline{t}$ (where $\underline{b}$ comes from a correction by the statutory auditor) if $\delta\text{prob}\{\overline{t}|\hat{b}=\underline{b},\hat{t}=\underline{t},\text{correction}\}-C_T<0$. Using $\text{prob}\{\overline{t}|\hat{b}=\underline{b},\hat{t}=\underline{t},\text{correction}\}=\frac{(1-p)(1-\nu_3)}{(1-p)(1-\nu_3)+p(1-\phi_1)}$ and reformulating yields $\theta_T>1$.
- Reformulating $\phi_1\leq 1$ yields $\theta_T\leq\frac{1-x_1(1-p)}{1-x_1p}>1$.

- Reformulating $\nu_3 \leq 1$ yields $\theta_S \geq \frac{\theta_T - 1}{\theta_T(\theta_T + 2x_1 - 1 - px_1(1+\theta_T))}$

C.2.4 Medium and low incentives for the tax auditor and important financial statement valuation

Important financial statement valuation for the taxpayer is represented by condition $\gamma < \omega + F_B$. Our equilibrium conjecture for the two auditors is as in section C.2.3, which means $\alpha, \beta_1, x_1 \in (0,1)$ and $x_2 = \beta_2 = 0$. The taxpayer's preferences induce an important difference: If the financial statement valuation is important for the taxpayer, he will have incentives to avoid a strict statutory audit. Therefore, due to $x_2 = 0$ type $\underline{b}, \bar{t}$ will report $\overline{b}, \bar{t}$ instead of $\underline{b}, \underline{t}$. We determine the audit and reporting probabilities as follows:

(1) The statutory auditor's high effort probability x_1 is determined as above (see section C.2.1).

(2) The tax audit probability α will make type $\overline{b}, \bar{t}$ indifferent between reporting $\overline{b}, \underline{t}$ and $\overline{b}, \bar{t}$. We obtain $\alpha = \frac{\gamma}{\gamma + F_T}$. The second probability β_1 is set such that type $\underline{b}, \bar{t}$ will be indifferent between $\overline{b}, \bar{t}$ and $\underline{b}, \underline{t}$. This implies $\beta_1 = \frac{(\gamma - \omega)}{\gamma + F_T}$. Note that α and β_1 also induce indifference between $\underline{b}, \underline{t}$, $\overline{b}, \underline{t}$ and $\overline{b}, \bar{t}$.

(3) We show that type $\underline{b}, \bar{t}$ indeed prefers report $\overline{b}, \bar{t}$ over $\overline{b}, \underline{t}$ under the audit probabilities given above: Inserting yields

$$\omega \overline{b} - \gamma \bar{t} > \omega \underline{b} - x_1 \gamma \underline{t} - (1 - x_1)\gamma \bar{s} \;\Leftrightarrow\; \omega > \gamma x_1 \;\Leftrightarrow\; \gamma < \omega + F_B. \tag{47}$$

This is exactly the condition given above.

(4) The conjectures above yield $\phi_1, \phi_2, \eta, \nu_3, \nu_1 = 1 - \nu_3 > 0$. From statutory and tax auditor indifference together with Bayes' rule we obtain the following three equations to compute the concrete probabilities:

$$\begin{aligned} \eta p &= \theta_S(\phi_1 p + (1-p)) \\ \phi_1 p &= \theta_T((1 - x_1)\eta p + 1 - p) \\ (1-p)\nu_3 + p\phi_2 &= \theta_T p(1 - \eta) \end{aligned} \tag{48}$$

The solution to this system is

$$\boxed{\begin{aligned}
\phi_1 &= \frac{(1-p)\theta_T(1+\theta_S(1-x_1))}{p(1-\theta_S\theta_T(1-x_1))} \\
\phi_2 &\in (\underline{\phi}_2, \overline{\phi}_2) \\
\eta &= \frac{(1-p)\theta_S(1+\theta_T)}{p(1-\theta_S\theta_T(1-x_1))} \\
\nu_3 &= \frac{\theta_T(p-\theta_S((1+\theta_T)-p-x_1\theta_T p))}{(1-p)(1-\theta_S\theta_T(1-x_1))} - \phi_2\frac{p}{1-p}.
\end{aligned}} \tag{49}$$

(5) The following conditions ensure that the audit and reporting probabilities derived above are an equilibrium:

- $\nu_3 \leq 1 \Leftrightarrow \theta_S \geq \frac{\theta_T - 1}{\theta_T(\theta_T + 2x_1 - 1 - px_1(1+\theta_T))}$
- $\phi_1 \leq 1 \Leftrightarrow \theta_T \leq \frac{p}{1-p+\theta_S(1-x_1)}$
- $\eta \leq 1 \Leftrightarrow \theta_T \leq \frac{p-\theta_S(1-p)}{\theta_S(1-px_1)}$

D Proofs

D.1 Proof of proposition 1

The tax auditor's equilibrium audit probability can be derived from the indifference of a type-$\bar{t}$ taxpayer between truthful reporting and report $\underline{t}$. Reformulating

$$\gamma\bar{t} = \alpha^{R1}(\gamma\bar{t} + F_T) + (1-\alpha^{R1})\gamma\underline{t} \tag{50}$$

yields

$$\alpha^{R1} = \frac{\gamma}{\gamma + F_T}. \tag{51}$$

With $\text{prob}\{t = \bar{t}|\hat{t} = \underline{t}\} = \frac{\theta_T}{1+\theta_T}$ a type-$\bar{t}$ taxpayer's reporting strategy $\theta_T = \frac{C_T}{\delta - C_T}$ is obtained by rearranging

$$\frac{\theta_T}{1+\theta_T}(\delta - C_T) + \frac{1}{1+\theta_T}(-C_T) = 0. \tag{52}$$

D.2 Proof of lemma 1

The first three statements follow directly from the preferences of the tax and statutory auditors. A taxpayer of type $\overline{b},\overline{t}$ will never report $\underline{b},\overline{t}$ because this report is dominated by the (truthful) report $\overline{b},\overline{t}$. By the same argument, a taxpayer of type $\underline{b},\underline{t}$ will never report $\underline{b},\overline{t}$. The report $\overline{b},\overline{t}$ is also dominated by truth reporting, because $\omega < \gamma$. □

D.3 Proof of lemma 2

Part 1: In case of the reduced-information setting (regime R1), we obtain

$$\mathrm{TE}^{R1} = \begin{cases} \frac{1}{2}\theta_T & \text{if } \theta_T < 1 \\ \frac{1}{2} & \text{if } \theta_T \geq 1. \end{cases} \tag{53}$$

We now look at regimes 2 and 3. In a mixed-strategy equilibrium the taxpayer's equilibrium reporting strategies have to ensure that the tax auditor is indifferent between auditing and not auditing a certain report. The indifference conditions for the tax auditor in the intermediate-information regime (regime 2) yield the following two equations:

$$\begin{aligned} &\text{Indifference at report } \underline{t},\overline{b}\ (\alpha^{R2} > 0) \ \Leftrightarrow\ \delta \mathrm{prob}\{\overline{t}|\hat{b} = \overline{b}, \hat{t} = \underline{t}\} - C_T = 0. \\ &\text{Indifference at report } \underline{t},\underline{b}\ (\beta^{R2} > 0) \ \Leftrightarrow\ \delta \mathrm{prob}\{\overline{t}|\hat{b} = \underline{b}, \hat{t} = \underline{t}\} - C_T = 0. \end{aligned} \tag{54}$$

Inserting the probabilities

$$\mathrm{prob}\{\overline{t}|\hat{b} = \overline{b}, \hat{t} = \underline{t}\} = \frac{\mathrm{prob}\{\overline{t}, \hat{t} = \underline{t}|\hat{b} = \overline{b}\}}{\mathrm{prob}\{\overline{t}, \hat{t} = \underline{t}|\hat{b} = \overline{b}\} + \mathrm{prob}\{\underline{t}, \hat{t} = \underline{t}|\hat{b} = \overline{b}\}} \tag{55}$$

and

$$\mathrm{prob}\{\overline{t}|\hat{b} = \underline{b}, \hat{t} = \underline{t}\} = \frac{\mathrm{prob}\{\overline{t}, \hat{t} = \underline{t}|\hat{b} = \underline{b}\}}{\mathrm{prob}\{\overline{t}, \hat{t} = \underline{t}|\hat{b} = \underline{b}\} + \mathrm{prob}\{\underline{t}, \hat{t} = \underline{t}|\hat{b} = \underline{b}\}} \tag{56}$$

yields the following two equations (again with $\theta_T = \frac{C_T}{\delta - C_T}$):

$$\begin{aligned} \mathrm{prob}\{\overline{t}, \hat{t} = \underline{t}|\hat{b} = \overline{b}\} &= \theta_T \mathrm{prob}\{\underline{t}, \hat{t} = \underline{t}|\hat{b} = \overline{b}\} \\ \mathrm{prob}\{\overline{t}, \hat{t} = \underline{t}|\hat{b} = \underline{b}\} &= \theta_T \mathrm{prob}\{\underline{t}, \hat{t} = \underline{t}|\hat{b} = \underline{b}\} \end{aligned} \tag{57}$$

Summing these two equations yields[10]

$$\mathrm{prob}\{\overline{t}, \hat{t} = \underline{t}\} = \mathrm{TE}^{R2} = \theta_T \mathrm{prob}\{\underline{t}\} = \frac{1}{2}\theta_T. \tag{58}$$

[10]Note that $\mathrm{prob}\{\underline{t}, \hat{t} = \underline{t}|\hat{b} = \underline{b}\} + \mathrm{prob}\{\underline{t}, \hat{t} = \underline{t}|\hat{b} = \overline{b}\} = \mathrm{prob}\{\underline{t}, \hat{t} = \underline{t}\} = \mathrm{prob}\{\underline{t}\}$ because type $\underline{t}$ will never overstate the tax valuation, see lemma 1.

In regime 3 the conditional probability of $\bar{t}$ given a tax report $\underline{t}$ and a financial statement valuation $\underline{b}$ depends on the statutory auditor's work observable to the tax auditor. The financial statement valuation may be corrected from $\overline{b}$ to $\underline{b}$ as a result of the statutory auditor's pressure ("correction"') or not ("no correction"). We obtain the probabilities

$$\begin{aligned}
\text{prob}\{\bar{t}|\hat{b}=\overline{b},\hat{t}=\underline{t}\} &= \frac{\text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\overline{b}\}}{\text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\overline{b}\}+\text{prob}\{\underline{t},\hat{t}=\underline{t}|\hat{b}=\overline{b}\}} \\
\text{prob}\{\bar{t}|\hat{b}=\underline{b},\hat{t}=\underline{t},\text{ no corr.}\} &= \frac{\text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ no corr.}\}}{\text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ no corr.}\}+\text{prob}\{\underline{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ no corr.}\}} \\
\text{prob}\{\bar{t}|\hat{b}=\underline{b},\hat{t}=\underline{t},\text{ corr.}\} &= \frac{\text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ corr.}\}}{\text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ corr.}\}+\text{prob}\{\underline{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ corr.}\}}
\end{aligned} \tag{59}$$

Suppose again that the tax auditor is indifferent between auditing and not auditing at the three possible outcomes of the audited financial statement valuation. We obtain the equations

$$\begin{aligned}
&\alpha^{R3}>0 \Leftrightarrow \text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\overline{b}\}=\theta_T\text{prob}\{\underline{t},\hat{t}=\underline{t}|\hat{b}=\overline{b}\} \\
&\beta_1^{R3}>0 \Leftrightarrow \text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ no corr.}\}=\theta_T\text{prob}\{\underline{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ no corr.}\} \\
&\beta_2^{R3}>0 \Leftrightarrow \text{prob}\{\bar{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ corr.}\}=\theta_T\text{prob}\{\underline{t},\hat{t}=\underline{t}|\hat{b}=\underline{b},\text{ corr.}\}
\end{aligned} \tag{60}$$

Summing the three equations again yields

$$\text{prob}\{\bar{t},\hat{t}=\underline{t}\}=\text{TE}^{R3}=\theta_T\text{prob}\{\underline{t}\}=\frac{1}{2}\theta_T. \tag{61}$$

Part 2: Suppose, for example, $\beta_2^{R2}=0$. In this case, the corresponding equation changes to $\delta\text{prob}\{\bar{t}|\hat{b}=\underline{b},\hat{t}=\underline{t}\}-C_T<0$. Summing both sides of the equation corresponding to $\alpha^{R2}>0$ and the inequality yields $\text{TE}<\frac{1}{2}\theta_T$. The same argument holds if α^{R1},α^{R2} or one the three audit probabilities in regime 3 are equal to zero.

□

D.4 Proof of proposition 2

The equilibrium analysis (see Appendix C) reveals that for θ_S and θ_T close to zero the equilibrium in each regime is characterized by

1. Regime 2: $\alpha^{R2}=\beta^{R2}=\frac{\gamma}{\gamma+F_T}$.
2. Regime 3: $\alpha^{R3}=\beta_1^{R3}=\beta_2^{R3}=\frac{\gamma}{\gamma+F_T}$.

Therefore, lemma 2 immediately implies that $\text{TE}^{R1} = \text{TE}^{R2} = \text{TE}^{R3} = \frac{1}{2}\theta_T$. Then we obtain $\text{TA} = \frac{1}{2}\frac{\gamma}{\gamma+F_T}(1+\theta_T)$ and $\text{TR} = \frac{1}{2}\frac{F_T}{\gamma+F_T}\theta_T$ in all three regimes.

The upper bounds $\bar{\theta}_T$ and $\bar{\theta}_S(\theta_T)$ are given in Appendix C.1.1 and C.2.1. □

D.5 Proof of proposition 3

Appendix C (see sections C.1.2 and C.2.4) provides the following properties with respect to audit and reporting probabilities for the relevant equilibria in regime 2 and regime 3a:

1. $\alpha^{R2} = \alpha^{R3a}$, $\beta^{R2} = \beta_1^{R3a}$ and $\beta_2^{R3a} = 0$.
2. $\phi_1^{R2} = \phi_1^{R3a}$, $\eta^{R2} = \eta^{R3a}$ and $\nu_2^{R2} = \nu_2^{R3a} = 0$.

Moreover, $x_1^{R2} = x_1^{R3a} =: x_1$.

Then the tax revenue measure in regime 2 and 3a can be written as

$$\text{LTR}^{R2} = \frac{1-\alpha^{R2}}{2} p\phi_1^{R2} + \frac{1-\beta_1^{R2}}{2}(2\text{TE}^{R2} - p\phi_1^{R2}) \tag{62}$$

$$\text{LTR}^{R3a} = \frac{1-\alpha^{R3a}}{2} p\phi_1^{R3a} + \frac{1-\beta_1^{R3a}}{2}(2\text{TE}^{R3a} - p\phi_1^{R3a}) \tag{63}$$

Since all parameters in the two expressions except the tax evasion probability TE are the same and $\text{TE}^{R3a} < \frac{1}{2}\theta_T = \text{TE}^{R2}$ due to lemma 2, the property $\text{LTR}^{R3a} < \text{LTR}^{R2}$ is obvious. Moreover, because $\beta^{R2} < \alpha^{R2} = \alpha^{R1}$ we also establish $\text{LTR}^{R2} > \frac{1-\alpha^{R2}}{2}(2\text{TE}^{R2}) = \frac{1-\alpha^{R2}}{2}\theta_T = \frac{1-\alpha^{R1}}{2}\theta_T = \text{LTR}^{R1}$.

The audit frequency measures in the two regimes are

$$TA^{R2} = \frac{\alpha^{R2}}{2}(1-p) + \frac{\beta^{R2}}{2}(2\text{TE}^{R2} + p) + \frac{\alpha^{R2} - \beta^{R2}}{2}(p\phi_1^{R2} + p\eta^{R2}(1-x_1)) \tag{64}$$

$$TA^{R3a} = \frac{\alpha^{R3a}}{2}(1-p) + \frac{\beta^{R3a}}{2}(2\text{TE}^{R3a} + p) + \frac{\alpha^{R3a} - \beta^{R3a}}{2}(p\phi_1^{R3a} + p\eta^{R3a}(1-x_1)) \tag{65}$$

Again, equal audit and reporting probabilities in the two regimes and the fact that $\text{TE}^{R3a} < \frac{1}{2}\theta_T = \text{TE}^{R2}$ imply $\text{TA}^{R3a} < \text{TA}^{R2}$. Moreover, because $\beta^{R2} < \alpha^{R2} = \alpha^{R1}$ we obtain $\text{TA}^{R2} < \frac{\alpha^{R1}}{2}(1+\theta_T) = \text{TA}^{R1}$. □

D.6 Proof of proposition 4

Appendix C (sections C.1.2 and C.2.2) shows that the tax auditor's audit probabilities for $\underline{\theta}_T < \theta_T < \overline{\theta}_T \leq 1$ are given by

	Regime 2	Regime 3b
α	$\frac{\gamma}{\gamma+F_T}$	$\frac{\gamma}{\gamma+F_T}$
β/β_1	$\frac{(\gamma-\omega)}{\gamma+F_T}$	$\frac{(\gamma-\omega)}{\gamma+F_T}$
β_2	-	$\frac{(\gamma x_1-\omega)}{x_1(\gamma+F_T)}$

in the intermediate- and the high-information regimes. Moreover, $x_1^{R2} = x_1^{R3b} =: x_1$. First note that $\beta_2^{R3b} < \beta_1^{R3b}$. Furthermore, lemma 2 applies because of the strictly positive audit probabilities. Therefore,

$$\begin{aligned}\text{LTR}^{R2} &= \frac{1-\alpha^{R2}}{2}(p\phi_1^{R2} + (1-p)\nu_2^{R2}(1-x_1)) + \frac{1-\beta^{R2}}{2}(2\text{TE}^{R2} - p\phi_1^{R2} - (1-p)\nu_2^{R2}(1-x_1)) \\ &= \frac{1-\beta^{R2}}{2}\theta_T - \frac{\alpha^{R2}-\beta^{R2}}{2}(p\phi_1^{R2} + (1-\nu_2^{R2})(1-x_1)).\end{aligned} \tag{66}$$

The claim $\text{LTR}^{R1} < \text{LTR}^{R2}$ follows from $\alpha^{R1} = \alpha^{R2} > \beta^{R2}$, implying

$$\text{LTR}^{R2} > \frac{1-\alpha^{R2}}{2}\theta_T = \frac{1-\alpha^{R1}}{2}\theta_T = \text{LTR}^{R1}. \tag{67}$$

Furthermore, $\text{LTR}^{R3b} > \frac{1-\beta_1^{R3b}}{2}\theta_T - \frac{\alpha^{R3b}-\beta_1^{R3b}}{2}(p\phi_1^{R3b} + (1-p)\nu_2^{R3b}(1-x_1))$ because $\beta_1^{R3b} > \beta_2^{R3b}$.

Similarly, the tax audit probability TA can be written as

$$TA^{R2} = \frac{\alpha^{R2}}{2}(1-p) + \frac{\beta^{R2}}{2}(2\text{TE}^{R2}+p) + \frac{\alpha^{R2}-\beta^{R2}}{2}(p\phi_1^{R2} + (1-p)\nu_2^{R2}(1-x_1) + p\eta^{R2}(1-x_1)). \tag{68}$$

As above, $\alpha^{R1} = \alpha^{R2}$, $\alpha^{R2} > \beta^{R2}$ and $2\text{TE}^{R2} = \theta_T$ imply

$$\text{TA}^{R2} < \frac{\alpha^{R2}}{2}(1-p) + \frac{\alpha^{R2}}{2}(\theta_T + p) = \frac{\alpha^{R1}}{2}(1+\theta_T) = \text{TA}^{R1}. \tag{69}$$

Again, $\beta_1^{R3b} > \beta_2^{R3b}$ also implies $\text{TA}^{R3} < \frac{\alpha^{R3b}}{2}(1-p) + \frac{\beta_1^{R3b}}{2}(2\text{TE}^{R3b}+p) + \frac{\alpha^{R3b}-\beta_1^{R3b}}{2}(p\phi_1^{R3b} + (1-p)\nu_2^{R3b}(1-x_1) + p\eta^{R3b}(1-x_1))$.

Obviously, $p\phi_1^{R2} + (1-p)\nu_2^{R2}(1-x_1) \geq p\phi_1^{R3b} + (1-p)\nu_2^{R3b}(1-x_1)$ and $\eta^{R2} \geq \eta^{R3b}$ is sufficient to prove $\text{LTR}^{R2} < \text{LTR}^{R3b}$ and $\text{TA}^{R2} > \text{TA}^{R3b}$.

Appendix C provides the reporting probabilities in the two regimes:

	Regime 2	Regime 3b
ϕ_1	$\frac{(1-p)\theta_T(1+\theta_S(1-x_1))}{p(1-\theta_S\theta_T(1-x_1))}$	$\frac{1-p}{p}\theta_T$
ν_2	0	$\theta_S\theta_T$
η	$\frac{(1-p)\theta_S(1+\theta_T)}{p(1-\theta_S\theta_T(1-x_1))}$	$\frac{1-p}{p}\theta_S$

The inequality $p\phi_1^{R2} + (1-p)(1-x_1)\nu_2^{R2} > p\phi_1^{R3b} + (1-p)(1-x_1)\nu_2^{R3b}$ reduces to $1 > 1 - \theta_W\theta_T(1-x_1)$ and is true for $\theta_T, \theta_S < 1$. Furthermore, $\eta^{R2} > \eta^{R3b}$ is equivalent to $\theta_T > -\theta_S\theta_T(1-x_1)$ which is clearly fulfilled because of $\theta_S, \theta_T > 0$ and $x_1 \in (0,1)$. This completes the proof. □

D.7 Proof of proposition 5

The claims $\text{LTR}^{R1} > \text{LTR}^{R2}$ and $\text{TA}^{R1} < \text{TA}^{R2}$ are obvious because the lost tax revenue measure LTR can never exceed $\frac{1}{2}$ and the audit frequency TA will never be lower than zero. However, these are the values for LTR and TA in the reduced information regime for $\theta_T > 1$.

The comparison of the intermediate- and the high-information regimes is much more intricate. Appendix C (specifically C.1.3, C.2.4, C.2.3) shows that the tax auditor's audit probabilities for $1 < \theta_T < \bar{\theta}_T$ are given by

	Regime 2	Regime 3a ($\gamma < \omega + F_B$)	Regime 3b ($\gamma \geq \omega + F_B$)
x_1	$\frac{\omega}{\omega+F_B}$	see Regime 2	see Regime 2
x_2	0	0	0
α	$\frac{\omega}{\gamma+F_T}$	$\frac{\gamma}{\gamma+F_T}$	$\frac{\omega}{x_1(\gamma+F_T)}$.
β/β_1	0	$\frac{(\gamma-\omega)}{\gamma+F_T}$	$\frac{(1-x_1)\omega}{x_1(\gamma+F_T)}$
β_2	–	0	0

We use $x_1^{R2} = x_1^{R3a} = x_1^{R3b} =: x_1$ in the following anaylsis. Appendix C (specifically C.1.3, C.2.4, C.2.3) also provides the relevant reporting probabilities as given in the following table:

	Regime 2	Regime 3a	Regime 3b
ϕ_1	$\frac{\theta_T(1-p)(1+\theta_S(1-x_1))}{p(1-\theta_S\theta_T(1-x_1))}$	see Regime 2	$\frac{\theta_T(1-px_1)-(1-x_1)}{px_1}$
ϕ_2	$1-\phi_1^{R2}$	$\phi_2^{R3a} \in (\underline{\phi}_2, \overline{\phi}_2)$	$1-\phi_1^{R3b}$
v_2	0	0	$1-v_3^{R3b}$
v_3	1	v_3^{R3a}	v_3^{R3b}
η	$\frac{\theta_S(1+\theta_T)(1-p)}{p(1-\theta_S\theta_T(1-x_1))}$	see Regime 2	$\frac{(1-p)\theta_T\theta_S+(2-p)\theta_S x_1+\theta_T-\theta_S-1}{px_1(1+\theta_T)}$

Furthermore,

$$v_3^{R3a} = \frac{\theta_T(p-\theta_S((1+\theta_T)-p-x_1\theta_T p))}{(1-p)(1-\theta_S\theta_T(1-x_1))} - \phi_2^{R3a}\frac{p}{1-p} \quad \text{and} \tag{70}$$

$$v_3^{R3b} = \frac{\theta_T^2\theta_S(px_1-1)+\theta_T\theta_S(px_1-2x_1+1)+x_1(1-p)(1+\theta_T)+\theta_T-1}{x_1(1-p)(1+\theta_T)}. \tag{71}$$

We begin with the comparison between Regime 2 and Regime 3b. LTR^{R2} can be written as

$$\frac{1-\alpha^{R2}}{2}p\phi_1^{R2} + \frac{1}{2}(1-p\phi_1^{R2}) = \frac{1}{2} - \frac{\alpha^{R2}}{2}p\phi_1^{R2}. \tag{72}$$

Using $\alpha^{R3b} = \frac{\alpha^{R2}}{x_1}$ and $\beta_1^{R3b} = \frac{(1-x_1)\alpha^{R2}}{x_1}$ the term LTR^{R3b} can be simplified to

$$\begin{aligned}
\text{LTR}^{R3b} &= \frac{1-\alpha^{R3b}}{2}(p\phi_1^{R3b}+(1-p)(1-x_1)(1-v_3^{R3b})) + \frac{1-\beta_1^{R3b}}{2}(p(1-\phi_1^{R3b})+(1-p)v_3^{R3b}) \\
&= \frac{1}{2}(p+(1-p)((1-x_1)(1-v_3^{R3b})+v_3^{R3b})) \\
&\quad - \frac{1}{x_1}\frac{\alpha^{R2}}{2}(p\phi_1^{R3b}+(1-p)(1-x_1)(1-v_3^{R3b})+(1-x_1)(p(1-\phi_1^{R3b})+(1-p)v_3^{R3b})) \\
&= \frac{1}{2}(p+(1-p)(1-x_1(1-v_3^{R3b}))) - \frac{\alpha^{R2}}{2}\left(p\phi_1^{R3b}+\frac{1-x_1}{x_1}\right)
\end{aligned} \tag{73}$$

Reformulating the claim that $\text{LTR}^{R2} > \text{LTR}^{R3b}$ yields

$$\begin{aligned}
& 1-\alpha^{R2}p\phi_1^{R2} \geq p+(1-p)(1-x_1(1-v_3^{R3b})) - \alpha^{R2}\left(p\phi_1^{R3b}+\frac{1-x_1}{x_1}\right) \\
\Leftrightarrow \quad & (1-p)x_1v_3^{R3b} \leq \alpha^{R2}\left(p\phi_1^{R3b}+\frac{1-x_1}{x_1}-p\phi_1^{R2}\right)+(1-p)x_1 \\
\Leftrightarrow \quad & v_3^{R3b} \leq 1+\frac{\alpha^{R2}}{(1-p)x_1}\left(p\phi_1^{R3b}+\frac{1-x_1}{x_1}-p\phi_1^{R2}\right).
\end{aligned} \tag{74}$$

This claim will always be true, if the term in brackets on the RHS of the inequality above is positive. Inserting and rearranging

$$p\phi_1^{R3b} + \frac{1-x_1}{x_1} - p\phi_1^{R2} > 0 \tag{75}$$

yields the claim

$$\theta_S < \frac{1}{\theta_T + x_1(1-p(1+\theta_T))}. \tag{76}$$

We now show that parameter condition (76) is implied by the equilibrium entry terms. Consider the condition $\eta^{R2} \leq 1 \Leftrightarrow \frac{\theta_S(1+\theta_T)(1-p)}{p(1-\theta_S\theta_T(1-x_1))} \leq 1$. Rearranging with respect to θ_S yields the condition

$$\theta_S \leq \frac{p}{1+\theta_T - p(1+\theta_T x_1)}. \tag{77}$$

We show that (77) is stricter than (76), because

$$\frac{p}{1+\theta_T - p(1+\theta_T x_1)} < \frac{1}{\theta_T + x_1(1-p(1+\theta_T))} \tag{78}$$

is equivalent to $\theta_T > -1$ which is clearly true. This completes the proof of the first part of the proposition.

The second part of the proposition states that $\text{LTR}^{R3b} < \text{LTR}^{R2}$ comes with $\text{TA}^{R3b} > \text{TA}^{R2}$. We can write TA^{R2} as

$$\text{TA}^{R2} = \frac{\alpha^{R2}}{2}(1-p+p\phi_1^{R2} + p(1-x_1)\eta^{R2}). \tag{79}$$

Using $\alpha^{R3b} = \frac{\alpha^{R2}}{x_1}$ and $\beta_1^{R3b} = \frac{(1-x_1)\alpha^{R2}}{x_1}$, the tax audit probability TA^{R3b} is given by

$$\begin{aligned}
\text{TA}^{R3b} &= \frac{1}{2}\frac{\alpha^{R2}}{x_1}\left(1-p+p\phi_1^{R3b} + p(1-x_1)\eta^{R3b} + (1-p)(1-x_1)(1-\nu_3^{R3b})\right) \\
&\quad + \frac{1}{2}\frac{(1-x_1)\alpha^{R2}}{x_1}\left(p(1-\phi_1^{R3b}) + p(1-\eta^{R3b}) + (1-p)\nu_3^{R3b}\right) \\
&= \frac{\alpha^{R2}}{2}\left(p\phi_1^{R3b} + \frac{2-x_1(1+p)}{x_1}\right).
\end{aligned} \tag{80}$$

Inserting ϕ_1^{R2}, ϕ_1^{R3b} and η^{R2} and rearranging $\text{TA}^{R3b} > \text{TA}^{R2}$ yields condition (76):

$$\theta_S < \frac{1}{\theta_T + x_1(1-p(1+\theta_T))}. \tag{81}$$

We have shown above that this condition is implied by the claim $\eta^{R2} < 1$.

We now proceed with the comparison between regime 2 and regime 3a. We obtain

$$\text{LTR}^{R3a} = \frac{1-\alpha^{R3a}}{2} p\phi_1^{R3a} + \frac{1-\beta_1^{R3a}}{2}((1-p)\nu_3^{R3a} + p\phi_2^{R3a}) \tag{82}$$

Since $\alpha^{R3a} < \alpha^{R2}$, $\beta_1^{R3a} < \beta$ and $\phi_1^{R2} = \phi_1^{R3a}$, a sufficient condition for $\text{LTR}^{R2} > \text{LTR}^{R3a}$ is

$$1 - p\phi_1^{R3a} \geq (1-p)\nu_3^{R3a} + p\phi_2^{R3a}. \tag{83}$$

The RHS of inequality (83) does not depend on ϕ_2^{R3a} because $\frac{1-p}{p}\phi_2^{R3a}$ is subtracted in ν_3^{R3a}. We can therefore insert $\phi_2^{R3a} = 1 - \phi_1^{R3a}$ without loss of generality and obtain

$$1 - p\phi_1^{R3a} \geq (1-p)\nu_3^{R3a}\big|_{\phi_2^{R3a}=1-\phi_1^{R3a}} + p(1-\phi_1^{R3a}) \;\Leftrightarrow\; \nu_3^{R3a}\big|_{\phi_2^{R3a}=1-\phi_1^{R3a}} \leq 1. \tag{84}$$

This is a necessary condition that has to be fulfilled in the equilibrium because ν_3^{R3a} decreases in ϕ_2^{R3a} and $\phi_2^{R3a} = 1 - \phi_1^{R3a}$ is the maximum value for ϕ_2^{R3a}. Therefore, $\text{LTR}^{R2} > \text{LTR}^{R3a}$.

The audit frequency in regime 3a is defined as

$$\text{TA}^{R3a} = \frac{\alpha^{R3a}}{2}\left[1 - p + p\phi_1^{R3a} + p(1-x_1)\eta^{R3a}\right] + \frac{\beta_1^{R3a}}{2}\left[p\phi_2^{R3a} + p(1-\eta^{R3a}) + (1-p)\nu_3^{R3a}\right]. \tag{85}$$

The claim that $\text{TA}^{R3a} > \text{TA}^{R2}$ follows from $\alpha^{R3a} > \alpha^{R2}$, $\beta_1^{R3a} > \beta$, $x_1^{R2} = x_1^{R3a}$, $\phi_1^{R2} = \phi_1^{R3a}$ and $\eta^{R2} = \eta^{R3a}$. This completes the proof. □

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