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Disclosure of Corporate Tax Reports, Tax Enforcement and Insider Trading

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Abstract

In this paper, we analyze the effects of disclosing corporate tax reports on the performance of financial markets and the use of asset prices by the tax enforcement agency in order to infer the true corporate cash flows. We model the interaction between a firm and the tax auditing agency, and highlight the role played by the tax report as a public signal used by the market dealer and the role of prices as a signal used by the tax authority. We discuss the determinants of both the reporting strategy of the firm and the auditing policy of the tax authority. Our model suggests that, despite disclosure of the tax reports being beneficial for market performance (as the spreads and trading costs are smaller than under no disclosure), the tax agency might have incentives to not disclose the tax report when its objective is to maximize expected net tax collection.

***Keywords**:* Disclosure, Corporate Tax, Insider Trading

Jel codes: G12, G14

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1 Introduction

In this paper, we study whether is desirable or not to make firm's tax statements public. We analyze how the disclosure of the tax report affects both the tax agency revenue and the performance of the financial market where the shares of the firm are traded. We argue that although the disclosure of the tax report improves market performance, it might, depending on market conditions, increase or decrease the expected net revenue of the tax agency. Therefore, despite disclosure being beneficial for market performance, the tax agency might decide not to make public the tax report because the release of this report has a negative impact on its revenue.

Corporate disclosure is essential for the functioning of financial markets. However, the extent to which firms benefit from increased disclosure still remains a very controversial issue. In the United States the tax return information was public from the time of Civil War and it was restricted only in 1976, when the Tax Reform Act of 1976 made the tax return confidential. The debate on disclosure of corporate tax return information became more active after the problems of Enron, WorldCom and other important U.S. corporations. As Hanlon (2003) points out tax statements required under Generally Accepted Accounting Principles do not easily permit the users of financial statements to estimate taxable income. Thus, limited disclosure can create divergence between book and tax income because the firm may under-report to the IRS while they may over-report to the shareholders. "Book profits and tax profits can be wildly different – a divergence, by the way, that increased markedly in the 1990s" (The Corporate Reform Tax Cut, *29 January 2003, The Wall Street Journal*).

The debate reached a peak in July 2002, when the Senator Charles Grassley, the chairman of the Senate Finance Committee wrote a letter to the Secretary of the Treasury and the Chairman of the Securities and Exchange Commission (SEC) to put forward for consideration the question of whether the corporate tax returns should be made public and the effect the disclosure of the tax return would have on public welfare. The debate among academics, practitioners, government policy makers and media was very intensive. On the one hand, the disclosure of tax return information is considered to be beneficial for the well-functioning of financial markets as it encourages tax compliance due to the reputational implications of disclosure. On the other hand, the disclosure is seen to prevent tax enforcement because of the dilution of the information content of tax return due to the fact that it could also reveal information that can put the firms which are forced to disclose information at a disadvantage versus those which are not forced to disclose any information (see Lenter et al., 2003). The responses of the SEC and the Treasury Department were negative, the principal claim being that disclosure was beneficial only in certain circumstances and it does not bring about a significant improvement in the task of SEC's ability to protect investors. However, despite of the fact that this objective is not satisfied, the disclosure of corporate tax return might improve the functioning of financial markets. As a result of this debate, in 2003 a bill that asked for public disclosure of corporate tax return information was submitted to the Congress but it failed. In 2006, the accounting norms represented by Financial Accounting Standards Board (FASB) Financial Interpretation No. 48, Accounting for Uncertainty in Income Taxes (FIN 48) standardized financial reporting of tax uncertainty providing measurement of income tax reserves in financial statements and it made mandatory its public disclosure.[1]

In 2012 the *President Obama's Framework for Business Tax Reform* called for an increase in disclosure of annual corporate income tax: "Corporate tax reform should increase transparency and reduce the gap between book income, reported to shareholders, and taxable income reported to IRS. These reforms could include greater disclosure of annual corporate income tax payments."[2] As Hasegawa et al. (2013) point out, this debate took place in the complete absence of empirical evidence of taxpayers responses to income tax disclosure and in the absence of any theoretical framework that could show the effects of the public disclosure of the corporate tax report. Our paper, aims to fill in partially the lack of theoretical models that study the effect of disclosure of the tax report on financial markets and on tax compliance.

1.1 Related Literature

Our paper is connected to three strands of the literature: the literature on tax compliance/tax evasion, the literature on disclosure of information by firms, and the literature on the use of information revealed by the security prices. The literature on tax evasion points out that the way in which an individual/firm perceives his/its economic opportunities to be affected by the tax code and by the instruments of tax enforcement is extremely important because the tax system and its enforcement may induce the taxpayer to hide or misrepresent some of his activities. The taxpayer may perceive certain choices with regard to tax declaration, financial transactions, or economic activity to be potentially costly as they are subject to the threat of exposure and penalty. If so, then this perception would influence such choices and these choices will affect in

[1] See Mills et al. (2010), Blouin et al. (2010) and Lisowsky et al. (2013) for a detailed FIN 48 analysis.

[2] Other recent regulations in place are targeting specific industries. Thus, the Dodd–Frank Wall Street Reform and Consumer Protection Act, signed on July 2010, requires that SEC registrants in an extraction industry must annually report payments made by the company to the U.S. and foreign goverments by projects and by country. The payments to be disclosed include taxes, royalties, bonuses and dividends. On February 28, 2013, the European Union Parliament approved country-by-country reporting for European banks of data on employees, profits, and taxes paid.

turn the functioning of the economy in different ways.

The literature that analyzes the taxpayer compliance has as a starting point the papers that take a portfolio approach, where potential evaders face a probability of being caught and paying the corresponding penalty. Thus, Allingham and Sandmo (1972), Yitzhaki (1974) and Polinsky and Shavell (1979) consider the decision concerning evasion when all the taxpayers face a constant probability of auditing by the tax agency. This assumption was criticized by Reinganum and Wilde (1986), who point out that the tax report contains information about the true realization of the taxpayers' income and, consequently, that the probability of auditing should depend on the report made by the taxpayers. They model tax compliance as a game with incomplete information where first the tax payer reports his payoff, and then the tax auditing agency chooses the auditing probability depending on the payoff reported by the taxpayer. While the above papers incorporated the uncertainty about the tax liabilities, another strand of research was concerned with the other sources of randomness that alter the interaction between the taxpayers and the tax auditing agency. Therefore, some authors incorporated in their models the fact that the tax code is complex and can lead to involuntary mistakes even when the taxpayers want to comply with the law. For instance, Scotchmer and Slemrod (1989) consider the case where the ambiguity of the law gives place to a random auditing policy depending on the interpretation given to the law. Reinganum and Wilde (1998) incorporate in the model the taxpayers's uncertainty about auditing cost, while Caballé and Panadés (2005) allow for both mistakes made by taxpayers and uncertainty about auditing cost. Beck and Jung (1989a) examine tax compliance in an environment in which taxpayers are also uncertain regarding their tax liability (because of the tax law complexity) and by simultaneously considering different tax rate structures and risk-taking attitudes, while Beck and Jung (1989b) examine this problem taking into account that audit probabilities are endogenous. Crocker and Slemrod (2005) and Chen and Chu (2005) study also the problem of tax compliance in a principal-agent framework while Sansing (1993), Mills and Sansing (2000), Beck et al. (2000) and Mills et al. (2010) allow the tax auditing agency to observe a signal regarding the taxpayer, which affects their strategic interaction.[3]

Our work is also in line with the stream of literature that is concerned with the role of information disclosure by firms, and the consequence of the disclosure on asset prices and on traders' welfare. Disclosure can be interpreted as a choice of an accounting technique or a committed policy of making public earnings or other forecasts. In general, the research in this field focuses on the role played by disclosure in reducing the asymmetry of information

[3]For a more extended review of both theoretical and empirical tax research see Shackelford and Shevlin (2001) and Hanlon and Heitzman (2010).

among investors, which can give raise to adverse selection in the financial market, and studies its consequences on firm valuation. Thus, in a rational expectations equilibrium model with endogenous information collection, Diamond (1985) shows that the welfare of stockholders may be improved by disclosing private data. Diamond and Verrecchia (1991) complete the analysis begun in Diamond by showing that disclosure policies that reduce the asymmetry of information among investors also increase the market liquidity of a security. The increase in the liquidity of the stock is very important for firms because it reduces the cost of capital and therefore increases the value of the firm (see Amihud and Mendelson, 1986, Brennan and Subrahmanyam, 1996, and Amihud, 2002). Verrechia (2001) points out also that corporate disclosure is very important for reducing the transactions costs that result from differences in information of the investors participating in the financial market or what he calls "the information asymmetry component of the cost of capital". On one hand, it reduces the incentives of the traders to become privately informed (so it reduces the probability of informed trading) and, on the other hand, it reduces the uncertainty about the firm value and therefore the potential gains from being informed.

The previous theoretical literature gave rise to a significant empirical literature that studies the costs and the benefits of information disclosure by firms and the economic consequences of regulation disclosure and changes in regulation (most recent in the US Sarbanes-Oxley Act and the Fair Disclosure Regulation). For detailed surveys, see Core (2001), Dye (2001), Healy and Palepu (2001), Verrechia (2001), Leuz and Wysocki (2008).

The papers we have just reviewed are concerned mainly with how information about the firm is disseminated through financial reporting and how managers in charge of information disclosure affect the information environment and therefore the liquidity of the firm's stock. Though the effects of mandatory disclosure of the tax report and the value of the firm has been studied before, the literature concerned with the effects of the tax report disclosure on the performance of the financial markets has been scant. This paper provides, as far as we know, the first model to analyze how disclosure of the tax report and the strategic interaction between the firm and the tax agency affects the performance of the financial markets where the firm's shares are traded. Recent research studies the link between tax avoidance and the value of the firm (showing that tax avoidance activities can facilitate managerial opportunism, such as earnings manipulation and outright resource diversion and therefore have an effect on firm value) but not the effect of tax avoidance on the liquidity of the firm's shares. Thus, Desai et al. (2007) develop a model in which corporate tax sheltering activity and the diversion of rents by managers are interrelated. Desai and Dharmapala (2009) find that there is a positive impact of tax avoidance on firm value for firms with good governance, while Hanlon and Slemrod (2009) find a negative stock market reaction to news concerning company involvement in tax shelters. Kim et al. (2010) explores the association between the extent of a firm's tax avoidance and its future stock price crash risk. The previous papers present theoretical models and empirical evidence challenging the view that postulates that tax avoidance enhances the value of the firm since the cash savings from tax avoiding activities can be interpreted as cash flows appropriated by the firm from the tax authorities, which increases expected future cash flows. The only paper closer to our work is Lee et al. (2013) who examine empirically the relation between tax avoidance and firm's cost of equity and show that non-aggressive tax planning induce lower cost of equity capital.

Finally, our paper is also related to an even more recent literature that emphasizes the informative content of prices (see Kanodia, 2006, Bond et al., 2011, Edmans et al., 2015, Siemroth, 2015). According to this literature, the prices of financial assets reveal information that can be used for decision taking and, moreover, there is a feedback effect due to the fact that firm managers are aware of this potential use of prices and modify their actions so that the value of the firm is adjusted accordingly. In our setup, the tax agency observes the market value of the firm and can infer partially the cash flow of the firm. Then, the manager optimally reacts by manipulating the market value of the firm through the selection of the accuracy of the tax report sent to the tax enforcement agency and potentially observed by the market dealer.

1.2 Preview of the Model and Results

We model the strategic interaction between a tax enforcement agency and a firm, when there is an insider trader, which is the manager who has the possibility of trading in financial markets based on the information he possesses about the firm. Note that the presence of insider trading allows the prices of the firm's shares to contain information about the true cash flows of the firm. We also study the effects of that interaction between the manager and the tax authority on the performance of the financial market. More specifically, we are interested in understanding how tax report disclosure affects stock valuation and liquidity and how the interaction between the tax auditing agency and the firm changes the behavior of the insider while trading in the financial market. Note that the tax report strategically chosen by the manager has an effect both on the strategy of the tax enforcement agency and on the own trading strategy of the manager.

In order to understand how the tax report, which is an endogenous public signal, affects market performance and tax compliance, we model a game with incomplete information where the manager chooses the tax report and the tax auditing agency chooses its auditing effort. Since misleading tax reporting may induce misleading understanding of the financial performance of the firm, the manager is cautious about the report he files with the tax agency. Then, the manager trades in the financial market based on his private information about the realization of the firm's payoff. The trading is modeled using a dealer market model similar to Glosten and Milgrom (1985). The interaction between the manager and the tax auditing agency leads to the release of a public signal which is endogenously determined. When the tax report becomes public, the dealer uses this information in setting the prices in the trading stage; and we thus argue that the endogenous public signal plays an important role on market performance in general, and on liquidity in particular.

In this setup we find that the manager always sends false tax reports to the tax enforcement agency when the tax report is disclosed. This is so because both the noise inherent in the pricing process and the costly inspections faced by the agency make the expected profits from insider trading positive when the endogenous public signal is totally uninformative. Therefore, our result that taxpayers cheat more under disclosure is also consistent with that found in the empirical paper of Hasegawa et al. (2013). In this paper, the authors use data from individual and corporate taxpayers in Japan to find that, when there is a threshold for disclosure, taxpayers whose tax liability would otherwise be close to the threshold will underreport in order to avoid disclosure and this behavior results in lower government revenues.

Our model contributes also to the literature by answering some of the questions in the debate of the benefits of disclosure. We show that the disclosure of the endogenous signal has a beneficial effect on market performance because it reduces bid-ask spreads and trading costs. However, it is not always the case that it is beneficial for the tax agency to disclose this information as the taxpayers tend to cheat more and, therefore, the tax agency might decide not to make public the tax reports.

We also show that, unlike in Glosten and Milgrom (1985), where the liquidation value is exogenously given, the market performance depends on the tax agency efficiency measured by the value of its auditing costs. Thus, we find that market liquidity (measured by the size of the bid-ask spread) is non-monotonic with respect to the auditing cost when the report is not disclosed. On the one hand, for small auditing costs, the tax agency is able to undo the effect of misreporting by the manager. The market maker uses this information and sets a constant ask price relative to the auditing cost. On the other hand, the manager's misreporting introduces some additional noise when the market maker observes a sell (which can be the order of an uninformed trader when the manager is strategic and chooses to misreport and it is costly for the tax agency to monitor). Therefore, this noise introduced by the manager makes the market maker to set a bid price that increases with the auditing cost. When the auditing cost becomes high enough, since the tax agency is inefficient, the manager's strategy is always to misreport. As the market maker understands that the tax agency is inefficient, the manager can misreport more often and, in this case, he is more likely to trade against the informed trader so that he sets a wider bid-ask spread. However, when the tax report is disclosed, the bid-ask spread monotonically increases with the tax agency's auditing costs. This latter result is consistent with the empirical findings on the efficiency of the Internal Revenue Service (IRS) presented by El Ghoul et al. (2011) who show that a more effective IRS auditing is associated with lower cost of capital.

When we study the behavior of the spreads as a response to an increase in the probability of trading against an informed trader, we find that, when the report is not disclosed, the market maker sets a wider bid-ask spread, which is a result also found in the original Glosten-Milgrom model. However, if the report is disclosed, since the liquidation value is determined endogenously by the interaction between the manager and the tax agency, the market maker faces a trade-off between a higher probability of trading against the insider manager and a lower liquidation value induced by higher auditing intensity by the tax agency. As a result, in this case (unlike in the Glosten-Milgrom model) the market liquidity has an inverted U-shape with respect to the amount of noise trading in the financial market, which is a

Since we want to understand the capacity of the tax agency to reduce tax evasion, we also study the behavior of the expected net revenue collected by the tax agency. As in other models of tax evasion the more inefficient the tax agency, the lower its net tax revenue is. However, since the auditing strategy is contingent on the tax report of the manager, which is chosen to maximize manager's profits from the financial market, the auditing intensities depend on how often the manager is selected to trade in the financial market. The expected tax revenue increases thus with the likelihood of the manager being selected to trade since the more often he can make profits, the more incentives he has to misreport and therefore the more penalties he pays to the tax agency when caught.

The remainder of this paper is organized as follows: Section 2 presents the model. We establish the information structure and characterize the equilibrium in two situations: when the tax report is disclosed and when it is not. Section 3 analyzes the effects of the public release of the firm's tax reports. Section 4 presents the results of some comparative statics exercises for market performance and expected net tax agency's revenue, respectively. Finally, Section 5 concludes the paper. The Appendix contains the main proofs of the paper.

2 The Model

Our model is based on the classical dealer market model of Glosten and Milgrom (1985) and we augment this model with the decisions concerning optimal tax reporting by a manager and auditing by a tax enforcing agency. The interaction between the firm and the tax auditing agency makes the value of the traded security depend on the tax report submitted by the firm's manager. We consider two cases: when the tax report is made public and therefore is used by the dealer when setting the prices and when it is not. The manager is engaged in insider trading and can trade securities of his own firm using the information he has at his disposal. As the tax report affects both the value of the firm and the security prices in the financial market, the manager faces a trade-off between increasing the value of the firm and increasing the price at which he trades in the financial markets. Thus, the tax report, which is determined endogenously by that trade-off, is used as a public signal when it is disclosed to the other market participants.

We consider a firm which owns a project with an uncertain payoff or net cash flow $\widetilde{y}$. We assume, without loss of generality, that the payoff is equal to one, $y = 1$, if the project turns out to be successful, which occurs with the exogenous probability s. If the project fails, the payoff is $y = 0$, which occurs with probability $1 - s$. The manager perfectly observes the realization of the payoff associated with the project. When the project is successful, the manager can be either honest with probability m and report the true value of the project to the tax agency, i.e., he declares $\theta = 1$, where θ is the reported value sent to the tax authority; or he can be strategic with probability $1 - m$. When the manager is strategic, he chooses to report truthfully with probability p (he declares $\theta = 1$), and lies with probability $1 - p$ (he declares $\theta = 0$), where p is chosen optimally by the manager. Thus, we allow the manager to use a mixed strategy. When the payoff is $y = 0$ the manager only can declare the truth, $\theta = 0$, since due to limited liability the firm has no funds to make any tax payment.

The previous probability m of telling the truth when the project is successful is assumed to be exogenous and it can be interpreted as a measure of the tax morale of the manager or a measure of the effectiveness of corporate governance rules in inducing honest behavior by the manager concerning the fiscal duties. As we will see later on, the existence of a positive probability of honest behavior implies that the disclosure of tax reports has always an ex-ante informative content as it reveals the value of the firm that non-strategic managers observe.

If the manager reports a high outcome, $\theta = 1$, the tax auditing agency does not inspect the firm as no additional revenues would arise from the audit. Otherwise, the tax agency inspects the firm and in doing so it exerts the amount ξ of effort. When it inspects, the tax agency discovers the truth with the probability $\widehat{\iota}$. We assume for simplicity that $\widehat{\iota}$ is an increasing linear function of the amount of effort exerted by the tax agency, $\widehat{\iota} = \delta\xi$. After the eventual inspection takes place, the firm pays the corresponding taxes and penalties. We assume that the tax law establishes a flat tax rate $\tau \in (0,1)$ on the firm net cash flow. The penalty paid by the firm in case the manager misreports and is caught is $f\tau$, where the flat penalty rate f satisfies $f > 1$ and $f\tau \leq 1$. The latter inequality is imposed as a consequence of the assumed limited liability. Since the probability of discovering the truth is $\widehat{\iota}$ and the revenue collected from penalties is $f\tau$, we can define the auditing intensity as $\iota \equiv \widehat{\iota} f\tau \leq f\tau \leq 1$. Thus, when the tax agency chooses the effort ξ it chooses the probability $\widehat{\iota}$ of discovering the truth and the auditing intensity $\iota = \widehat{\iota} f\tau = \delta f\tau\xi$. Therefore, choosing the effort in order to maximize its expected net revenue is equivalent to choosing the auditing intensity ι. Notice also that the auditing intensity depends on the effort devoted to discover the truth: the higher $\widehat{\iota}$, the higher the effort or the resources devoted to auditing and therefore, the higher the costs. We assume that the auditing costs are quadratic in the effort ξ exerted by the tax agency, and they are equal to $\frac{1}{2}\hat{c}\xi^2$, with $\hat{c} > 0$. This cost function is known by both the auditor and the firm's manager. Since the probability of discovering the truth is $\widehat{\iota} = \delta\xi$ and the auditing intensity is $\iota = \widehat{\iota} f\tau$ we can rewrite the auditing costs as

$$\frac{1}{2}\hat{c}\xi^2 = \frac{1}{2}\widehat{c}\left(\frac{\widehat{\iota}}{\delta}\right)^2 = \frac{1}{2}\widehat{c}\left(\frac{\iota}{\delta f\tau}\right)^2 = \frac{1}{2}c\iota^2,$$

where we define $c \equiv \dfrac{\widehat{c}}{(\delta f\tau)^2} > 0$, which is the relevant cost parameter of the auditing cost function.

The tax agency receives the tax report and chooses the auditing intensity ι based on the information contained in the tax report. However, since the tax agency observes also the price of the transactions in the financial market, it can also use this information when setting the auditing intensity. Consequently, the auditing intensity depends on the tax report but also on the trading in the financial market.

In the financial market there are two types of investors: an insider, which is the aforementioned manager, and noise traders (or liquidity traders). The traders are only allowed to submit market orders and they can trade a single unit of the asset so that the order size is thus restricted to the set $\{-1, 1\}$. Trade in the financial market occurs after the report has been submitted and before taxes and potential penalties are paid. The liquidation value V of the asset traded in the financial market is the net payoff after taxes and penalties. It is important to stress the fact that the firm's true liquidation value is revealed after the inspection by the tax enforcement agency has taken place. Therefore, if a firm reporting a low outcome was not penalized (because either it was not inspected or the inspection did not detect the true cash flows) and its liquidation value ends up involving a high outcome, the tax agency cannot impose any penalty on the firm. This may be due, for instance, because the legal inspection period has already expired or because the final profits appear offshore and cannot be tracked any longer by the tax enforcement agency. The manager is assumed to be risk neutral and uses the information he possesses about the net payoff of the project to compute the expected liquidation value of the asset. The manager buys if his expectation about V is higher than the ask price and sells if his expectation about V is lower than the bid price. Notice that the report sent by the manager affects the inspection decision of the tax auditing agency and thus it also affects the value V through two channels: the voluntarily paid taxes and the potential penalty. Therefore, a strategic manager chooses the probability p of reporting truthfully to maximize the expected profit from trading. If the manager is not strategic (i.e., honest), he always reports the true payoff.

Trading takes place through a risk-neutral dealer who faces competition from other market-makers and therefore should make a zero expected profit in equilibrium. The dealer posts ask and bid quotes, A and B, using the information contained in the order flow ω as well as the tax report θ submitted by the manager if this report becomes public information. We assume also that the dealer cannot cross-subsidize buys with sells or vice versa and thus we can consider buys and sells separately. When a trader buys (trades at the dealer ask price), the dealer's realized profit on the trade is $A - V$ and, when the trader sells, the dealer's profit on the trade is $V - B$. In order to avoid the problem of information revelation, we assume that traders arriving in the market are drawn randomly from the population and that the probability that the manager is selected to trade is a. After the traders are randomly selected for trading and the dealer provides bid and ask quotes, the traders choose the direction of trade. The behavior of noise traders is independent of any information in the market and their trading decisions are motivated by exogenous liquidity reasons (portfolio diversification, transitory shocks, etc.). We assume that noise traders buy and sell a unit of the asset randomly with equal probability. The manager trades using instead his information about the payoff of the project. Therefore the higher a, the lower the amount of noise in the financial market is. Obviously if the payoff of the project is $y = 0$, the manager sells at the bid price, which is larger than the liquidation value expected by the manager due to all the noise introduced in the market arising from the noise traders and the noisy tax reporting process. In this case, the demand d for the asset by the manager is equal to -1. Otherwise, when the payoff is $y = 1$, he buys at the ask price offered by the dealer, which for the same reasons is lower than the liquidation value expected by the manager. In this latter case, we have $d = 1$. Thus, the profit made by the manager when he buys is $V - A$, and when he sells is $B - V$. The trader selected to trade with the dealer is obliged to trade, i.e., no-trade is not allowed. Finally, if the manager is not selected to trade, then his demand is simply $d = 0$. The event tree for trade in the financial market is represented in Figure 1.

The tax agency is risk neutral and chooses the auditing intensity ι to maximize the expected total net revenue R conditional on the manager's report and the price of the asset. The auditing is contingent therefore upon the report observed by the tax agency θ and the direction of trade in the financial market. The event three for the tax agency is represented in Figure 2.

If the payoff of the project is high, $y = 1$, and the manager reports correctly, $\theta = 1$, the tax agency does not inspect and its revenue in this case is equal to τ. Notice that this can happen in two cases: when the payoff is high and the manager is honest and when the payoff is also high and the manager is strategic but he chooses to report truthfully $\theta = 1$. In case the manager reports $\theta = 0$, the tax agency audits with intensity $\iota(1)$ when it observes a transaction at an ask price, i.e., when the the trader buys, and $\iota(-1)$ when it observes a transaction at a bid price, i.e., when the trader sells. In these cases the firm pays the penalty because the tax agency discovers that the payoff of the project undertaken by the firm was $y = 1$ but the manager reported $\theta = 0$. Finally, if the report is $\theta = 0$ but also the payoff of the project is 0, the tax agency audits also with intensity either $\iota(1)$ or $\iota(-1)$ depending on the direction of the trade. However, since the outcome of the project was indeed low, the tax agency ends up facing the auditing cost but not collecting any penalty. As a result, the expected net revenue of the tax agency when $\theta = 0$ and it observes a buy ($\omega = 1$) is

$$E(R|\ \theta = 0, \omega = 1) = \iota(1) P(y = 1|\theta = 0, \omega = 1) - \frac{1}{2}c(\iota(1))^2,$$

where $P(y|\theta, \omega)$ is the probability of the project payoff conditional both on the report and on the direction of trade (or, equivalently, on the price at which the transaction takes place). Recall also that the auditing intensity is $\iota(\omega) = \widehat{\iota}(\omega) f\tau$ so that the expected revenue arises from multiplying the expected payoff of the project $P(y|\theta, \omega)$, the probability $\widehat{\iota}(\omega)$ of discovering the truth by the tax enforcement agency, and the total penalty $f\tau$ per unit evaded.

The first-order condition for the problem of expected revenue maximization when $\theta = 0$ and $\omega = 1$ is

$$P(y = 1|\theta = 0, \omega = 1) - c\iota(1) = 0,$$

and the optimal auditing intensity $\iota(1)$ is thus

$$\iota(1) = \frac{P(y = 1|\theta = 0, \omega = 1)}{c}. \tag{1}$$

The second-order condition for this problem is $c > 0$, which is satisfied by assumption. Similarly, the tax agency chooses the auditing intensity $\iota(-1)$ to maximize the expected net revenue when $\theta = 0$ and it observes a sell, $\omega = -1$. In this case, we have

$$\iota(-1) = \frac{P(y = 1|\theta = 0, \omega = -1)}{c}. \tag{2}$$

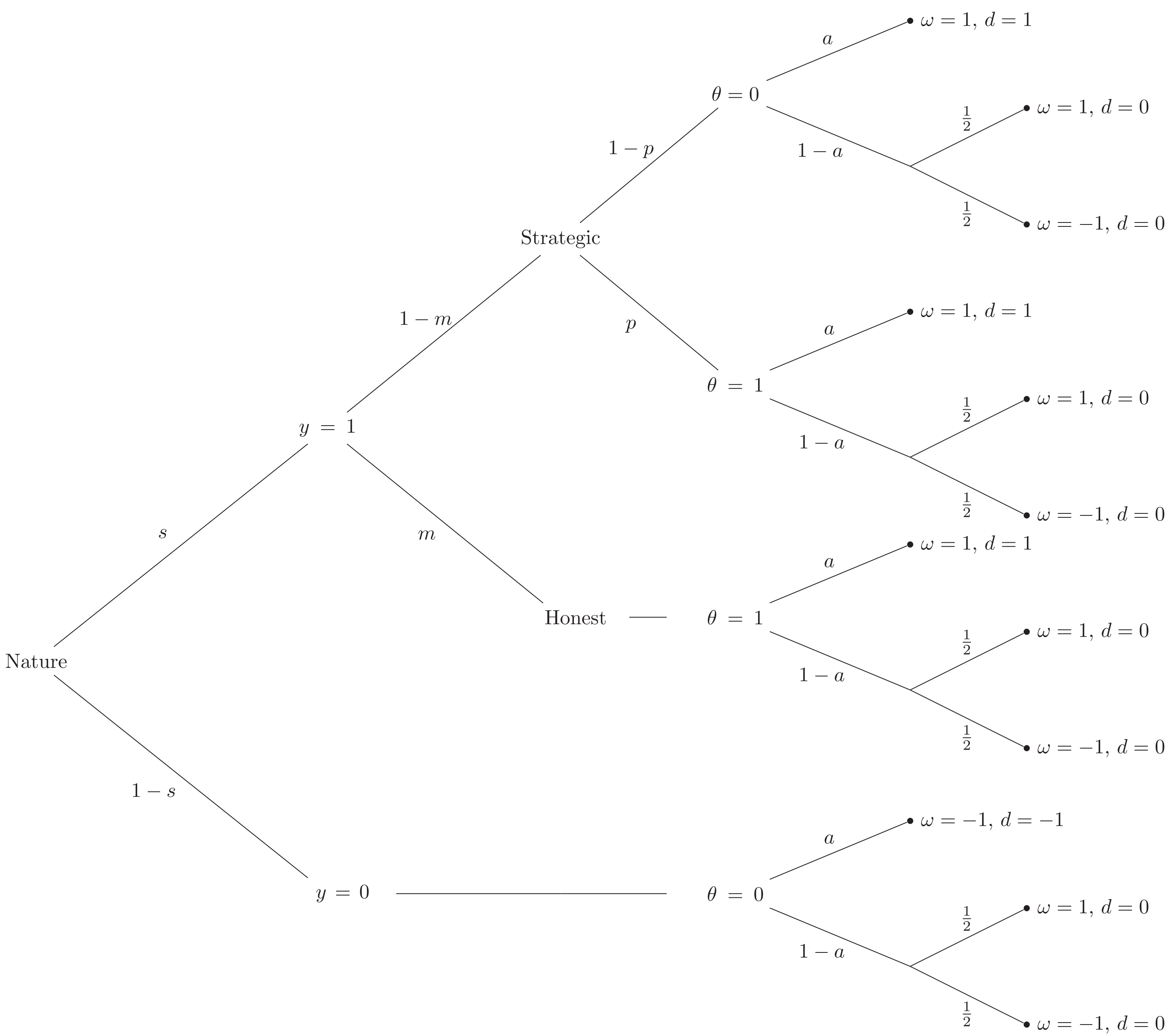

Figure 1: The tree diagram of trade

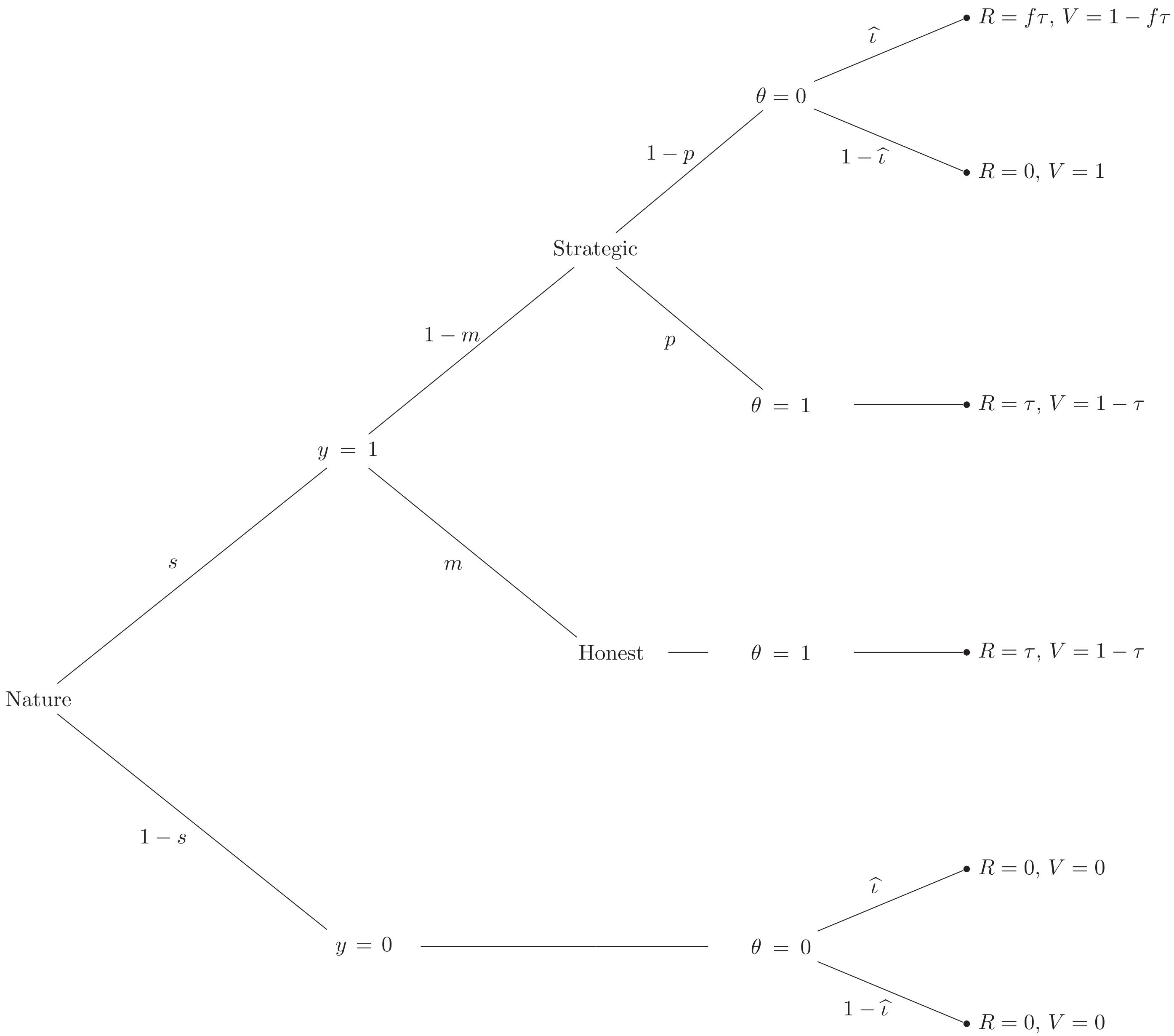

Figure 2: The tree diagram for the tax agency

Notice that both auditing intensities have to satisfy the additional constraint of being smaller or equal than $f\tau \leq 1$ since $\iota(\omega) = \widehat{\iota}(\omega) f\tau$ and $\widehat{\iota}(\omega)$ is the probability of discovering the truth by the auditors, which lies in the interval $[0, 1]$. Note that if the auditing cost c is sufficiently small this constraint is binding and the auditing intensity becomes equal to $f\tau$.

We thus summarize the timing of the model as follows:

1. The nature draws the realization of the project's payoff y. The project is successful with probability s.

2. The manager observes his private information about the firm's payoff and the nature chooses whether the manager is honest (which occurs with probability m) or strategic. In case the manager is strategic, he chooses the probability p of reporting truthfully.

3. Agents trade in the financial market.

4. The tax agency chooses, conditional on the tax report and the price of the firm in the stock market, the auditing intensity ι so as to maximize the expected net revenue R collected from taxpayers.

2.1 Disclosure of the Tax Report

Let us consider in this section the case where the tax report is made public by the tax agency. As the manager's tax report affects the intensity of the auditing by the tax agency, there are always two channels through which the report affects the net payoff of the firm. The first direct channel is associated with the voluntary payment of taxes corresponding to the tax report. The second channel arises from the link between the tax report and the inspection decision of the tax agency. Moreover, when the tax report is made public, there is a third channel affecting the manager's profits. This third channel is associated with the effect that the public tax report has on the pricing strategies of the dealer. Since the manager trades in the financial market so as to maximize the difference between the liquidation value of the firm (which is the payoff of the project net of taxes and penalties) and the price of the asset, he has to take into account these three effects when deciding his tax report.

Similarly to Glosten and Milgrom (1985), the dealer sets prices so that his expected profit is zero, which means that the potential gains by the uninformed are always compensated by the losses incurred by the informed trader and vice versa. Notice, however, that when the tax report is made public the dealer has an additional piece of information and he posts two ask prices and two bid prices depending on the realization of the tax report θ. Thus, for a buy order and a high tax report the ask price equals

$$A(1) \equiv A(\theta = 1) = E\left[V \middle|\ \omega = 1 \text{ and } \theta = 1\right],$$

while for a buy order and a low report the ask price is

$$A(0) \equiv A(\theta = 0) = E\left[V \middle|\ \omega = 1 \text{ and } \theta = 0\right].$$

Similarly the bid price for a high report is

$$B(1) \equiv B(\theta = 1) = E\left[V \middle|\ \omega = -1 \text{ and } \theta = 1\right],$$

while for a sell order and a low report the bid price is

$$B(0) \equiv B(\theta = 0) = E\left[V \middle|\ \omega = -1 \text{ and } \theta = 0\right].$$

To calculate the above prices, i.e. the conditional expectations, we need to find the corresponding conditional probabilities by using Bayes' rule. These prices depend on the probability of reporting truthfully chosen by the manager to maximize his expected profit from trading.

As we have mentioned above, the profit made by the manager is the liquidation value V minus the ask price, when he buys, and the bid price minus the liquidation value V when he sells. As it can be seen from the event tree in Figure 1, the manager buys whenever $y = 1$ and sells when $y = 0$. Therefore, when the tax report is disclosed, we can write the expected profit $E[\Pi_D]$ of the manager as a function of the probability p of truthful reporting,

$$E[\Pi_D(p)] = a\left\{s(1-m)(1-p)\left([1-\iota_D(1)] - A(0)\right) + (1-s)B(0)\right\}.$$

We use the subindex D to denote the disclosure case, i.e., the case when the tax report is made public, so that Π_D and ι_D denote the profit and the auditing intensity in the disclosure case. Note that the term $(1-\iota_D(1)) - A(0)$ is the difference between the expected liquidation value and the price at which the manager buys in case the project is successful, which occurs with probability s, he is strategic, which occurs with probability $1-m$, he misreports, which occurs with probability $1-p$, and he is selected to trade, which occurs with probability a. Moreover in case the project is unsuccessful and the manager is selected to trade, which occurs with probability $a(1-s)$, the manager sells at the price $B(0)$ an asset having zero value. Note that when the manager is not selected to trade or when the project is successful but he is not strategic or he tells the truth even if he is strategic, then the manager obtains zero profits from trading.

The optimal probability of reporting truthfully chosen by the manager is

$$p_D = \arg\max_p E[\Pi_D(p)].$$

In equilibrium, we obtain that $p_D = 0$ because always $[1 - \iota_D(1)] - A(0) > 0$, i.e., the liquidation value of the asset in the case the strategic manager wants to buy is higher than the ask price (as can be seen from the expression (3) below for $A(0)$). Obviously, when the tax report is disclosed, the manager tends to be dishonest as the only profits he can obtain as a result of tax planning appear when the report is $\theta = 0$. However, tax dishonesty comes at the price of lower liquidation value due to the potential fines and higher ask and bid prices, which results in a lower profit for the manager at every trade.

The next proposition characterizes the equilibrium in the disclosure case:

Proposition 1 *The optimal ask and bid prices quoted by the dealer when the tax report is disclosed are*

$$A(0) = \frac{[1 - \iota_D(1)]\, s(1-m)(1+a)}{s(1-m)(1+a) + (1-s)(1-a)}, \tag{3}$$

$$A(1) = 1 - \tau,$$

$$B(0) = \frac{[1 - \iota_D(-1)]\, s(1-m)(1-a)}{s(1-m)(1-a) + (1-s)(1+a)},$$

$$B(1) = 1 - \tau.$$

The equilibrium probability of telling the truth by a strategic manager when the project is successful is $p_D = 0$.

The optimal auditing intensities set by the tax agency are

$$\iota_D(1) = \frac{1}{c}\left[\frac{s(1-m)(1+a)}{s(1-m)(1+a) + (1-s)(1-a)}\right], \tag{4}$$

$$\iota_D(-1) = \frac{1}{c}\left[\frac{s(1-m)(1-a)}{s(1-m)(1-a) + (1-s)(1+a)}\right]. \tag{5}$$

Notice that the auditing intensities chosen by the tax agency, $\iota_D(1)$ and $\iota_D(-1)$ defined in (4) and (5), respectively, decrease with the auditing cost c. Thus, as expected, the higher the auditing cost, the lower the auditing intensity.

The auditing intensities depend also on the probability a of having a trade initiated by an informed trader. As the probability a of the manager being selected to trade increases, the amount of noise in the market decreases and it becomes easier for the tax agency (and the market maker) to disentangle the trades of the manager from the ones of the noise traders. Consequently, when it sees a buy, the tax agency estimates that it is more likely to be the manager who traded based on his information about the payoff and therefore it inspects more often, i.e., $\iota_D(1)$ increases with a. Similarly, when it observes a sell, the tax agency attributes a higher probability of the trade pertaining to noise traders and therefore $\iota_D(-1)$ decreases with the probability a of the manager being selected to trade.

2.2 No Disclosure of the Tax Report

We consider next the setup in which the tax report is not made public and, therefore, the market maker sets the prices without conditioning on the value of the tax report, but still conditioning on the order flow he receives. Thus the ask and bid price in this case are

$$A_{ND} = E[V|\ \omega = 1] \quad \text{and} \quad B_{ND} = E[V|\ \omega = -1].$$

Similarly to the disclosure case the manager makes profits from trading when he buys (the liquidation value minus the ask price) and when he sells (the bid price minus the liquidation value). As in the disclosure case, the manager makes a profit from buying when the payoff is $y = 1$ and he is strategic and misreports. In this case the liquidation value equals to $1 - \iota_{ND}(1)$, where $\iota_{ND}(1)$ is the auditing intensity in the no-disclosure regime and is given by (1). Note that since prices become public information after trade occurs, the tax agency still conditions on the direction of trade as in the disclosure case. However, in the no-disclosure case, since the market maker does not condition on the report, the manager makes also a profit in the case the payoff is $y = 1$, and the manager is honest or he is strategic but decides to report truthfully. In these two cases the liquidation value is $1 - \tau$. As a result, the expected profit of the manager equals to

$$\begin{aligned} E[\Pi_{ND}(p)] &= a\{s(1-p)(1-m)([1-\iota_{ND}(1)] - A_{ND}) \\ &\quad + s[p(1-m)+m](1-\tau-A_{ND}) + (1-s)B_{ND}\}. \end{aligned}$$

The optimal probability of reporting truthfully chosen by the manager in the no-disclosure regime is therefore

$$p_{ND} = \arg\max_p E[\Pi_{ND}(p)].$$

From the first-order condition with respect to p we obtain three cases. If the auditing intensity chosen by the tax agency is such that $\iota_{ND}(1) = \tau$ then the strategic manager is indifferent between telling the truth and cheating in his tax report. The manager then chooses a mixed strategy

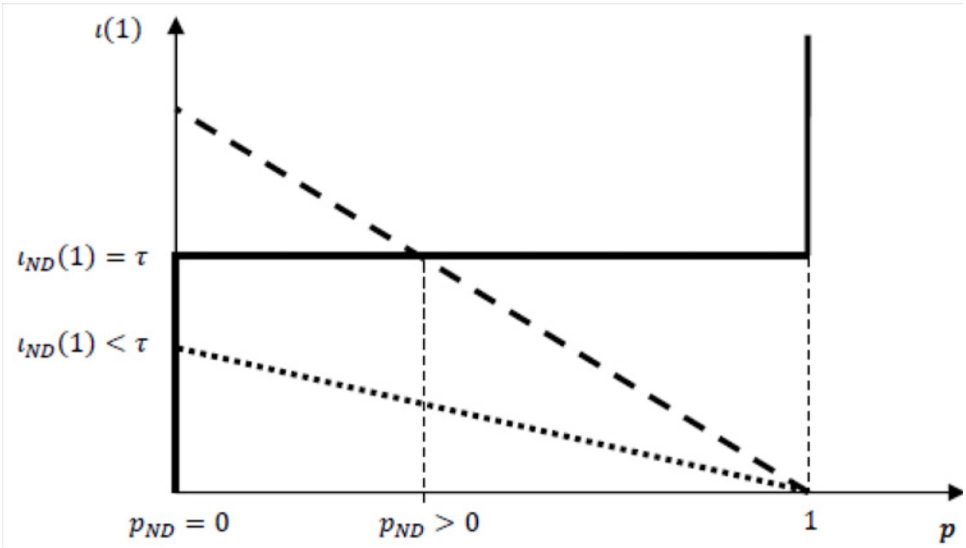

Figure 3: Reaction functions of the manager (solid line) and the tax agency (dashed and dotted lines).

concerning the probability of telling the truth whenever the market conditions allow him to do so. However, if the auditing cost c is high or there is a low probability a of the manager being selected to trade, then the auditing intensity satisfies $\iota_{ND}(1) < \tau$ and the strategic manager chooses $p_{ND} = 0$, so he always submits a false report. If the auditing intensity is such that $\iota_{ND}(1) > \tau$, then the strategic manager chooses $p_{ND} = 1$. Figure 3 shows the reaction functions for the tax agency and for the manager. The reaction function of the manager is the solid line. The reaction function for the tax agency is the dotted line if the auditing cost is very large and, thus, in equilibrium $\iota_{ND}(1) < \tau$ and the manager always cheats ($p_{ND} = 0$) or it is the dashed line if the auditing cost is not so high and, thus, the manager chooses an interior value for the probability of true reporting while the agency selects the auditing intensity $\iota_{ND}(1) = \tau$. Note that the auditing intensity selected by the tax agency decreases with the probability of a truthful report since a low value of p_{ND} results in a larger expected revenue from penalties on evaded profits accruing from the inspection.

The following proposition characterizes the equilibrium in the no-disclosure regime. We use the subindex ND to denote the case where the tax report is not disclosed.

Proposition 2 *The optimal ask and bid prices quoted by the dealer when the tax report is not disclosed are*

$$A_{ND} = \frac{(1+a)\, s\, \{[1-\iota_{ND}(1)]\,(1-m) + (1-\tau)\, m\}}{(1+a)\, s + (1-a)\,(1-s)},$$

$$B_{ND} = \frac{(1-a)\, s\, \{[1-\iota_{ND}(-1)]\,(1-p_{ND})\,(1-m) + (1-\tau)\,(p_{ND}\,(1-m) + m)\}}{(1-a)\, s + (1+a)\,(1-s)}.$$

The equilibrium probability of telling the truth of the strategic manager is

$$p_{ND} = \begin{cases} 1 - c\tau \left[1 + \dfrac{(1-a)\,(1-s)}{(1-m)\, s\,(1+a)}\right] & \textit{if } c\tau \left[1 + \dfrac{(1-a)\,(1-s)}{(1-m)\, s\,(1+a)}\right] < 1, \\ 0 & \textit{otherwise.} \end{cases} \tag{6}$$

The auditing intensities are

$$\iota_{ND}(1) = \begin{cases} \tau & \textit{if } p_{ND} > 0, \\ \dfrac{1}{c}\left[\dfrac{s\,(1-m)\,(1+a)}{s\,(1-m)\,(1+a) + (1-s)\,(1-a)}\right] & \textit{if } p_{ND} = 0, \end{cases} \tag{7}$$

$$\iota_{ND}(-1) = \begin{cases} \dfrac{\tau\,(1-a)}{(1+a)}\left[\dfrac{(1+a)\,(1-m)\, s + (1-a)\,(1-s)}{(1-a)\,(1-m)\, s + (1+a)\,(1-s)}\right] & \textit{if } p_{ND} > 0, \\ \dfrac{1}{c}\left[\dfrac{s\,(1-m)\,(1-a)}{s\,(1-m)\,(1-a) + (1-s)\,(1+a)}\right] & \textit{if } p_{ND} = 0. \end{cases} \tag{8}$$

Note from (6) that for high values of a the probability of telling the truth is high as the manager puts more weight on the potential gains from trading in the financial market than from tax evasion. Moreover, for low values of the auditing cost c, the strategic manager tends to lie less as in this case the audit intensity exerted by the tax authority is higher. However, despite of the fact that the manager plays a mixed reporting strategy, the tax agency and the market maker together are able to undo the effect of his mixed strategy and the maximum expected profit he makes when he buys does not depend on p_{ND} and is just equal to $s\,(1-\tau-A_{ND})$. Therefore, his incentives for tax planning are smaller as this activity increases his profits only through the uncertainty that introduces in the financial market, which is embedded in asset prices but not in the likelihood of getting these profits.

Notice that $p_{ND} > 0$ implies that $\iota_D(1) > \iota_{ND}(1)$ and $\iota_D(-1) > \iota_{ND}(-1)$ for all values of the parameters of the model. When $p_{ND} = 0$, tax reports are totally non-informative so that the auditing intensities are obviously equal in the disclosure and in the no-disclosure regimes. As it can be seen from (7) in the case where the manager chooses $p_{ND} > 0$, the auditing intensity in case of observing a buy does not depend on the other parameters of the model. However, the auditing intensity in the case of observing a sell given in (8) does depend on the amount of noise trading. The tax agency can in this case inspect less when the noise in the market is low because it can infer now that it is more unlikely to face a strategic informed trader who sells. However, the auditing intensity in this case does not depend on the inefficiency arising from the auditing cost c.

2.3 The Performance of the Financial Market

In this subsection, we consider two indicators of performance of the financial market: the bid-ask spreads and the insider's expected profits. Note that the bid-ask spread measures the liquidity (or depth) of the market since a large spread means that prices are very sensitive to the direction of trade so that buyers end up paying a large price while sellers end up getting a low price. Obviously, a large spread is detrimental for the noise traders as their expected cost of trading becomes also large. Once we have determined the optimal reporting strategy of a strategic manager, we proceed first to calculate the expected bid-ask spread and the expected profit of the manager. These two market indicators are characterized in the following corollary:

Corollary 3 *(a) The expected spread and the manager's expected profit when the tax report is disclosed are*

$$\begin{aligned} E(S_D) &= \left[\frac{[1-\iota_D(1)](1+a)}{(1-m)s(1+a)+(1-s)(1-a)} - \frac{[1-\iota_D(-1)](1-a)}{(1-m)s(1-a)+(1-s)(1+a)}\right] \\ &\quad \times (1-m)s[(1-m)s+(1-s)], \end{aligned}$$

$$E(\Pi_D) = a\{(1-m)s[(1-\iota_D(1))-A(0)]+(1-s)B(0)\}.$$

(b) The spread and the manager's expected profit when the tax report is not disclosed are

$$S_{ND} = A_{ND} - B_{ND},$$

$$E(\Pi_{ND}) = a[s(1-\tau-A_{ND})+(1-s)B_{ND}],$$

where $\iota_D(1)$, $\iota_D(-1)$, $A(0)$, $B(0)$, A_{ND}, and B_{ND} are defined in the previous Propositions 1 *and* 2.

2.4 The Tax Agency's Expected Revenue

In this subsection we provide the expected net revenue collected by the tax agency. We consider all the components of the tax revenue, that is, voluntarily paid taxes plus penalties net of auditing costs. From Propositions 1 and 2 we can find the expected net revenues collected by the agency, which are given in the next corollary:

Corollary 4 *The expected net revenue of the tax agency when the tax report is disclosed is*

$$\begin{aligned} E\left(R_D\right) &= ms\tau + \frac{\left[\left(1-m\right)s\left(1+a\right)\right]^2}{4c\left[\left(1+a\right)\left(1-m\right)s + \left(1-a\right)\left(1-s\right)\right]} \\ &\quad + \frac{\left[\left(1-m\right)s\left(1-a\right)\right]^2}{4c\left[\left(1-a\right)\left(1-m\right)s + \left(1+a\right)\left(1-s\right)\right]}, \end{aligned}$$

and the expected net revenue of the tax agency when the tax report is not disclosed is

$$\begin{aligned} E\left(R_{ND}\right) &= \left[m + p_{ND}\left(1-m\right)\right]s\tau + \frac{\left[\left(1-p_{ND}\right)\left(1-m\right)s\left(1+a\right)\right]^2}{4c\left[\left(1+a\right)\left(1-m\right)s + \left(1-a\right)\left(1-s\right)\right]} \\ &\quad + \frac{\left[\left(1-p_{ND}\right)\left(1-m\right)s\left(1-a\right)\right]^2}{4c\left[\left(1-a\right)\left(1-m\right)s + \left(1+a\right)\left(1-s\right)\right]}, \end{aligned}$$

where p_{ND} is defined in Proposition 2.

In the next section we will make explicit the trade-off between market performance and expected net revenues raised by the tax agency. In particular, if a revenue maximizing tax agency has to decide whether to make public the tax reports or not, it might select a non-disclosure policy in spite of being detrimental for the performance of financial market. However, depending on the parameter values of the model, disclosure could be optimal from the tax agency viewpoint so that in this case the maximization of expected net tax revenues is compatible with a better functioning of the financial market.

3 Endogenous Disclosure of Tax Reports

The tax report sent by the firm to the tax enforcing agency is an endogenous signal about the state of the nature faced by the firm. This signal can be disclosed by the tax enforcement agency and, thus, used by the market maker in order to make a better prediction about the firm's value when setting the price. Moreover, if the report is made public then the insider's trading strategy is affected accordingly. To understand the effect of public disclosure of the tax report signal, we compare the market performance and the tax agency's expected net revenue in two economies with and without the tax report being disclosed.

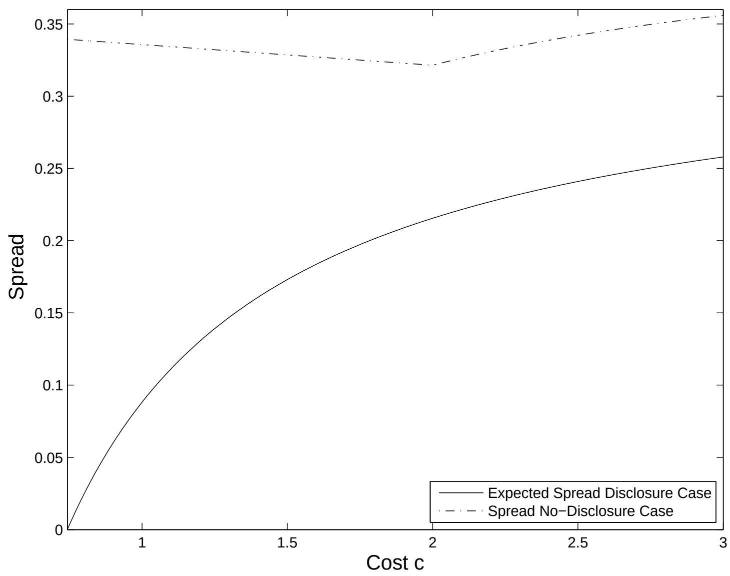

Figure 4: Spread Comparison. Parameter Values: $m = 0.5$, $s = 0.5$, $a = 0.5$, $\tau = 0.3$.

3.1 Market Performance Comparison

As before, we consider two measures of market performance: market liquidity and expected profit of the insider trader. As explained above, we measure market liquidity using the expected bid-ask spread. We find that in the disclosure case, the ask price is lower the bid price is higher than in the no-disclosure case. Obviously, the disclosure of the tax reports results in a reduction in the degree of asymmetric information between the insider and the market maker and, thus, the market maker lowers the spread, which is the instrument he uses to protect himself against bad trades with the insider. Note that even if the insider always cheats under tax report disclosure, there is a probability m of having an honest manager reporting the true cash flow of the firm and, thus, the publicly released tax report has a relevant informative content. Therefore, as expected, when more information is disclosed the market maker sets a expected spread that is lower than the spread when there is no disclosure (see Figure 4 for a spread comparison under a particular parametric example).

Note that, if there were no honest managers in the economy ($m = 0$), the disclosure of the tax reports would not contain information about the firm's value. However, this does not imply that the spreads under disclosure and no disclosure coincide when $m = 0$. This is so because under no disclosure the tax agency inspects more intensively the firm if a transaction occurs at the ask price (i.e., if the trader buys) as this raises the probability of a high payoff and, thus, a larger expected revenue would arise from the inspection. This more intensive auditing results in a lower expected net value for the firm and, thus, the market maker anticipates this by lowering the posted ask

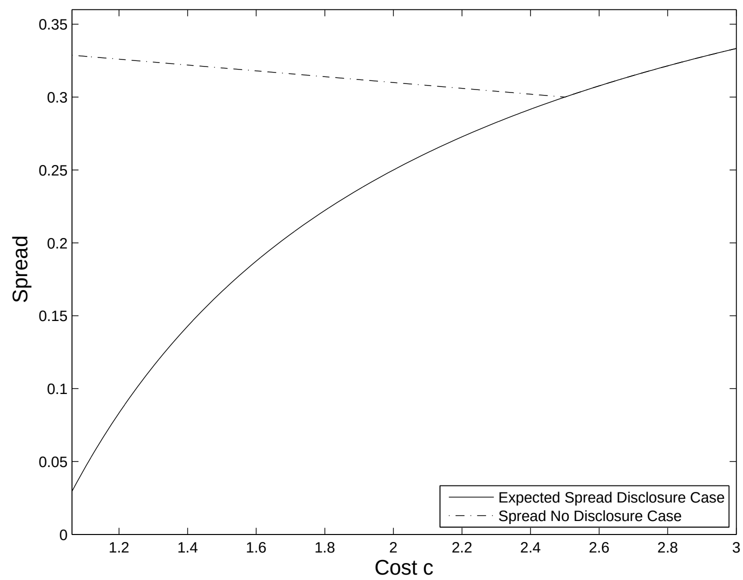

Figure 5: Spread Comparison. Parameter Values: $m = 0$, $s = 0.5$, $a = 0.5$, $\tau = 0.3$.

price. This means that the expected bid-ask spread becomes smaller under disclosure even if the tax reports are completely uninformative. In Figure 5 we illustrate the spread comparison when $m = 0$ and we see that the expected spread under disclosure is smaller than the spread under no disclosure when the auditing cost c faced by the tax enforcement agency is small and, thus, the manager chooses a positive probability p of reporting a high profit. Obviously, when the value c of the auditing cost is sufficiently high then the manager always reports a low profit and then the spreads under disclosure and no disclosure coincide.

We obtain a similar situation when we compare the manager's expected profit from trading in the disclosure regime and in the no-disclosure regime: the expected profit is higher under no disclosure. This is due to the fact that in the no-disclosure regime, when the manager chooses the report endogenously, he is able to hide better his inside information than in the disclosure regime. Thus, it is more difficult for the market maker to disentangle the manager's order from that of a noise trader in the case where the tax report is not disclosed and, consequently, the manager's expected profit is higher in the no-disclosure case. Notice that, since the expected profit of the manager is higher in the no-disclosure case, the trading costs (i.e., the expected profit of the noise traders) are lower in this case. Therefore, policymakers may conclude that the disclosure of the tax report is beneficial for market performance because it reduces both the spread and trading costs. Figures 6 and 7 display the expected profits of the manager for the cases where there is a positive fraction of honest taxpayers ($m > 0$) and when all the taxpayers are strategic ($m = 0$), respectively.

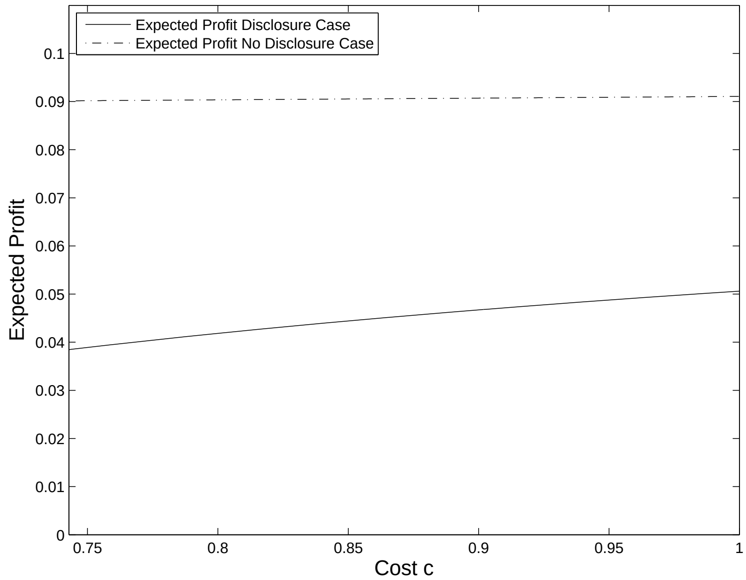

Figure 6: Comparison of manager's expected profits. Parameter Values: $m = 0.5$, $s = 0.5$, $a = 0.5$, $\tau = 0.3$.

3.2 Expected Tax Revenue Comparison

We are now interested in analyzing whether disclosure of the tax report is also beneficial for the tax agency from the point of view of the expected net revenues that it can collect. The following corollary tells us that, when the tax report is disclosed, the reporting strategy of the manager is affected in such a way that the effect on expected net tax collection is ambiguous.

Corollary 5 *The expected net tax revenue collected by the tax agency may be smaller or larger when the tax report is disclosed than when the tax report is not disclosed. In particular, there exist two values of the auditing cost c,* $\underline{c}$ *and* $\overline{c}$*, such that* $E(R_D) = E(R_{ND})$ *for* $c \geq \overline{c}$*,* $E(R_D) < E(R_{ND})$ *for* $c \in (\underline{c}, \overline{c})$ *, and* $E(R_D) > E(R_{ND})$ *for* $c < \underline{c}$*.*

As the Figure 8 illustrates, when the auditing cost c is very large, the manager in the no-disclosure regime never tells the truth, $p_{ND} = 0$. We consider the case of the auditing cost but the discussion regarding the other parameters is very similar. Notice that when the probability a of informed trading is small the manager in the no-disclosure regime never tells the truth ($p_{ND} = 0$) and the proof is similar. Let us define

$$\overline{c} \equiv \frac{1}{\tau}\left[\frac{s(1-m)(1+a)}{s(1-m)(1+a)+(1-s)(1-a)}\right],$$

such that for any $c < \overline{c}$, $p_{ND} > 0$ and for any $c \geq \overline{c}$, $p_{ND} = 0$, as it follows from (6). As explained above, the expected net return of the tax agency has two components: the taxes voluntarily paid

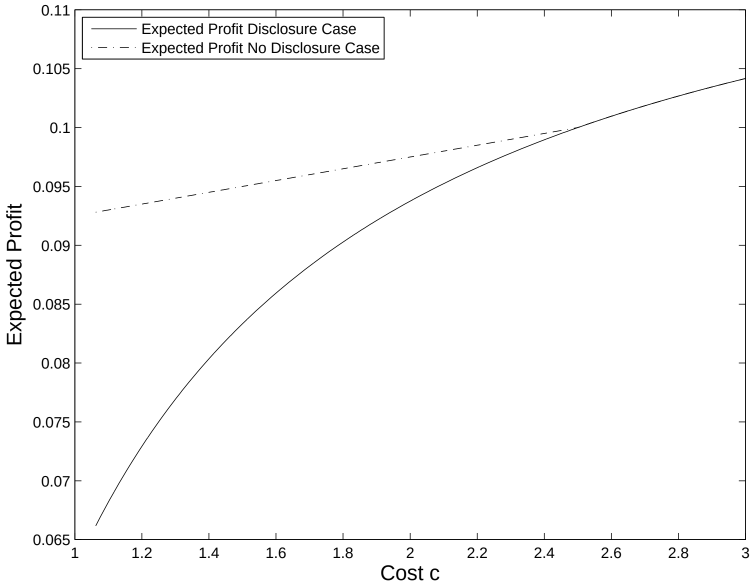

Figure 7: Comparison of manager's expected profits. Parameter Values: $m = 0$, $s = 0.5$, $a = 0.5$, $\tau = 0.3$.

arising from the tax report and the penalties net of auditing cost collected in case of inspection. Notice that the taxes voluntarily paid increase with the probability p_{ND} of telling the truth when the manager is strategic, while the penalties decrease with p_{ND}. Note also that for $c \geq \overline{c}$ there is no difference between the disclosure and the no-disclosure regimes concerning the strategy followed by the strategic manager, as he always misreports, $p_D = 0$. However, when the auditing cost c becomes slightly smaller than $\overline{c}$, the manager starts telling the truth with positive probability under the no-disclosure regime whereas he keeps misreporting under disclosure. Therefore, the positive direct effect on voluntary tax collection results in larger expected net revenues for the tax authority. In this case, the tax agency does not have incentives to disclose the tax report. However, notice that when the auditing cost is very small (or the manager's probability a of being selected to trade is very high) the tax agency prefers to disclose the signal. For instance, if the value of the auditing cost c is very low then the tax agency can audit almost all the low reports (the ones with $\theta = 0$). In this case, under no disclosure the manager always tells the truth as p_{ND} converges to 1 as c approaches zero so that the expected tax revenue converges to $s\tau$, which is the maximum amount of tax that can be collected under universal truth-telling. However, under disclosure, the manager always reports $\theta = 0$ and, if all those reports are audited, then the expected tax revenue becomes $ms\tau + (1-m)sf\tau$, where the first term of the sum are the taxes paid by the honest manager and the second are the fines paid by the strategic manager. Since $f > 1$, the expected tax revenue is higher when the tax report is disclosed. Consequently, depending on

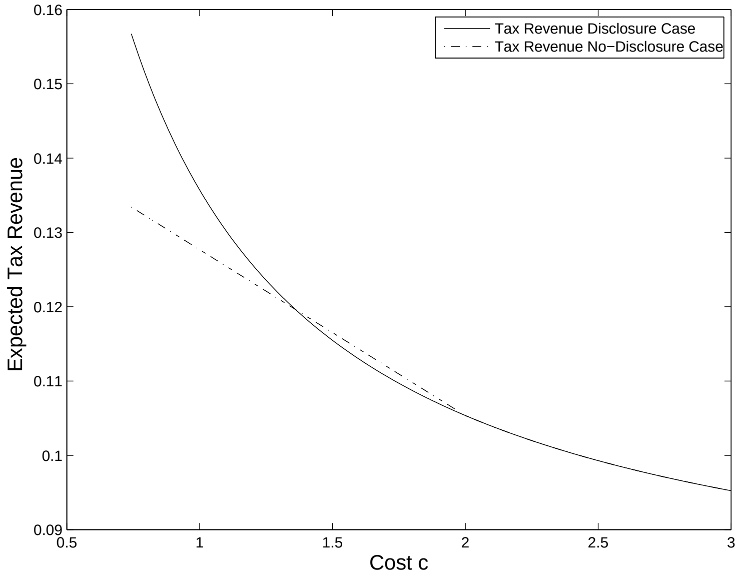

Figure 8: Expected Tax Revenue. Parameter Values: $s = 0.5$, $m = 0.5$, $a = 0.5$, $\tau = 0.3$.

the parameter values characterizing our economy, it might or might not be beneficial for the tax agency to disclose the tax report.

4 The Effects of Auditing Cost and Uncertainty on Market Performance and Tax Agency Revenue

To understand the performance of the financial markets and the expected tax revenue, we will perform in this section a comparative statics exercise with respect to the inefficiency of the tax enforcement agency, measured by the value c of the auditing cost and the lack of noise of the market, measured by probability a of the manager being selected to trade.

4.1 The Effect of Auditing Cost on Market Performance

First, we analyze how the auditing cost affects market performance. Notice first that, in the case where the tax report is disclosed, for small values of the auditing cost c, and when the market maker observes $\theta = 0$, he sets an ask price lower than the bid price. This is due to the fact that for small values of the auditing cost, it is not costly to inspect and hence the auditing intensity might reach its maximum value $f\tau$. Thus, there exist two values of the auditing cost, c_- and c_+ with $c_- < c_+$, such that for any $c < c_-$ we have $\iota_D(-1) = f\tau$ and for any $c < c_+$ we have that

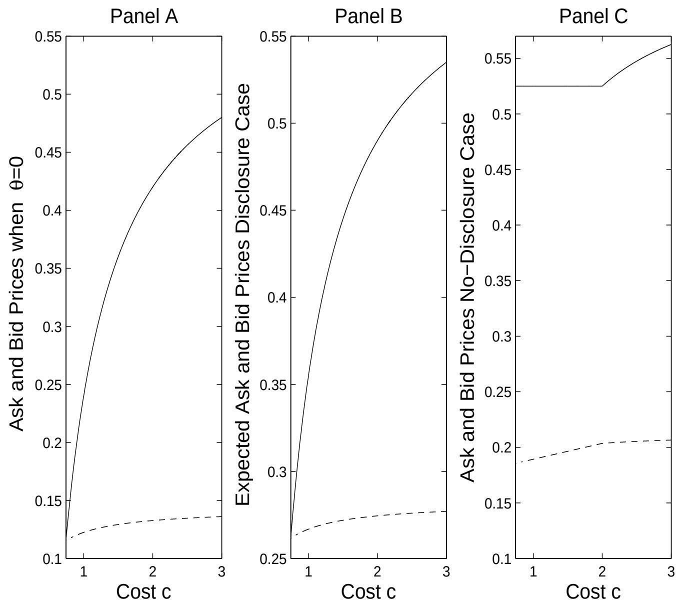

Figure 9: Ask and Bid Prices. Parameter Values: $s = 0.5$, $m = 0.5$, $a = 0.5$, $\tau = 0.3$.

$\iota_D(1) = f\tau$. Therefore, there exists a value of the auditing cost

$$c^* \equiv \frac{2s(1-m)\left(1 - sm + a^2(1-s-as)\right)}{((1-m)s(1+a)+(1-s)(1-a))((1-m)s(1-a)+(1-s)(1+a))} \in (c_+, 1),$$

such that for $c \geq c^*$ the market maker sets an ask price $A(0) > B(0)$. From now on we consider in our analysis only the cases where $c \geq c^*$ so as to ensure that the ask price is higher than the bid price.

We showed above that, under public disclosure, the relationship between the auditing intensities $\iota_D(1)$ and $\iota_D(-1)$ and the auditing cost c is monotonically decreasing. However, if the tax report is not publicly disclosed and $p_{ND} > 0$ then the auditing intensities $\iota_{ND}(1)$ and $\iota_{ND}(-1)$ do not depend on the auditing cost c while, if $p_{ND} = 0$, then the auditing intensities $\iota_{ND}(1)$ and $\iota_{ND}(-1)$ decrease with c. Notice that the auditing cost does not affect the expectations of the market maker about trading against the manager but they do affect the expected liquidation value of the asset to be traded in the financial market through the auditing intensity. In the case where the report is disclosed, when the market maker observes a sell or a buy together with $\theta = 0$, the liquidation value of the firm depends negatively on $\iota_D(1)$ and $\iota_D(-1)$, respectively. Moreover, since these auditing intensities both decrease with c, it results that both the ask price $A(0)$ and $B(0)$ increase with the auditing cost c (see Figure 9, Panel A). Thus, the inefficiency of the tax agency is transmitted to the financial market and the spread becomes wider as the auditing cost increases. Since if $\theta = 1$ the market maker knows for sure that he trades against the informed manger, he sets the ask price equal to the bid price and equal to the expected value of

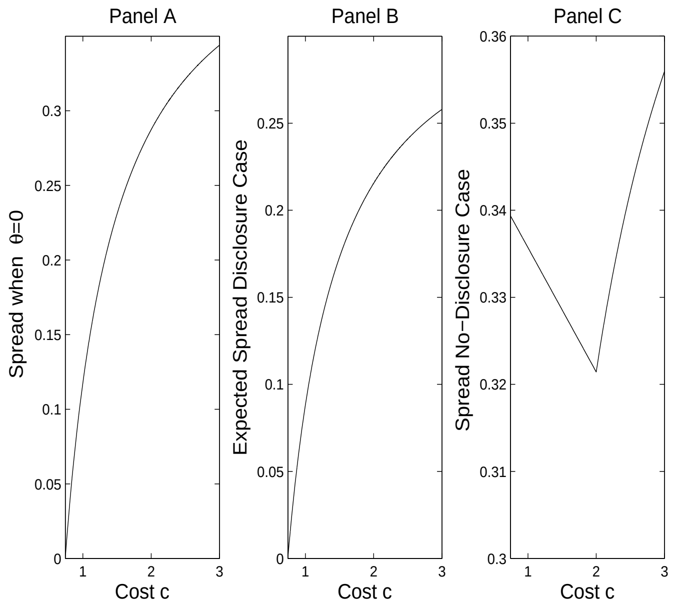

Figure 10: Spreads. Parameter Values: $s = 0.5$, $m = 0.5$, $a = 0.5$, $\tau = 0.3$.

the firm $1-\tau$. As the probability of observing a low report, $\theta_0 \equiv \Pr(\theta = \theta_0) = (1-m)\,s + (1-s)$, does not depend on the auditing cost, the expected ask and bid price have a similar behavior as the ask and bid price in the case $\theta = 0$ when the auditing cost varies (see Figure 9, Panel B). The same effect is found when $p_{ND} = 0$ in the no-disclosure regime (see Figure 9, Panel C). However, when $p_{ND} > 0$ the auditing intensities do not depend on the auditing cost and therefore neither the liquidation value does. When the market maker observes a buy, he understands that the expected liquidation value is the same in the case of paying taxes honestly and when the manager is strategic, reports $\theta = 0$, and he is inspected by the tax enforcement agency, i.e., the liquidation value is equal to $1-\tau$ as follows from the fact that $\iota_{ND}(1) = \tau$. Hence, the probability of telling the truth does not affect the expectation of the market maker when he observes a buy and this implies that the ask price in this case does not depend on the auditing cost. However, since $\iota_{ND}(-1) < \tau$, if the market maker receives a sell order he understands that it is more likely that the order comes from a noise trader than from a strategic manager reporting $\theta = 0$. Since this happens with the probability $1 - p_{ND}$, and p_{ND} decreases monotonically with c, it results that the bid price increases with the auditing cost c. Notice that, if the value of the auditing cost reaches the level

$$c^{**} \equiv \frac{1}{\tau}\left[\frac{(1-m)\,s\,(1+a)}{(1-m)\,s\,(1+a) + (1-a)\,(1-s)}\right],$$

then for any $c \geq c^{**}$ we have that $p_{ND} = 0$ and, therefore, the behavior of the spread is similar under disclosure.

Notice that in the disclosure regime when c increases, it is more costly for the tax auditing

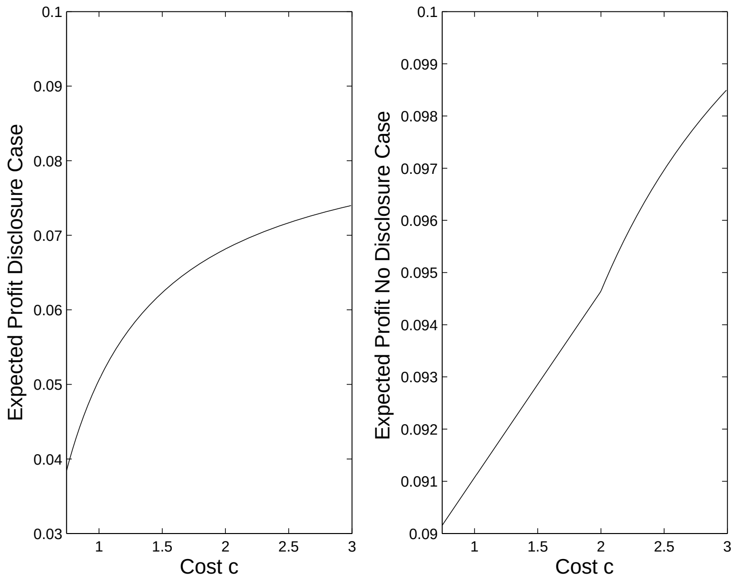

Figure 11: Manager's Expected Profit. Parameter Values: $s = 0.5$, $m = 0.5$, $a = 0.5$, $\tau = 0.3$.

agency to monitor, the manager chooses to report $\theta = 0$, and therefore this report is less informative for the market maker. Consequently, when c increases it is more difficult for the market maker to disentangle the noise traders from the insider manager and therefore he sets a higher spread (see Figure 10, Panel A). In the case $\theta = 1$ the market maker sets the ask price equal to the bid price and, therefore, the spread is always 0. As a result, the expected spread equals the spread when $\theta = 0$ multiplied by the probability θ_0 of having a low tax report and it has the same behavior as the spread arising in the case $\theta = 0$ (see Figure 10, Panel B). Therefore, one testable implications of our model is that economies with inefficient tax auditing systems (i.e., with large values of c) will tend to exhibit larger spreads in their financial market when the firms' tax reports are publicly disclosed.

However, in the no-disclosure regime, we have non-monotonicity of the spread with respect to the auditing cost. Thus for any $c \in (c^*, c^{**})$, the ask price is constant and the bid price increases with the auditing cost c, and this implies that the bid-ask spread decreases. However, when c becomes larger than c^{**}, we are in a situation similar to the disclosure case as the tax agency is inefficient and, thus, the optimal strategy of the manager is to misreport always, $p_{ND} = 0$. The market maker understands that the tax agency is inefficient, the manager can misreport more often, and in this case he is more likely to trade against the informed trader. Therefore, the market maker sets a wider bid-ask spread. Since the ask price increases faster than the bid price with the auditing cost, we observe that the spread increases (see Figure 10, Panel C).

Finally, we obtain that the expected profit of the manager increases with the auditing cost both under disclosure and under no disclosure (see Figure 11). In the disclosure regime higher auditing cost increases the expected profit of the manager because the profit from trading increases with the auditing cost c, both when the manager is strategic and declares $\theta = 0$ (since $(1 - \iota_D(1)) - A(0)$ is a decreasing function of $\iota_D(1)$) and when the manager is honest and sells (as $B(0)$ increases with the auditing cost). In the no-disclosure regime, despite the fact that the spread is U-shaped, we find that the expected profit of the manager increases with the auditing cost. The bid increases with the auditing cost and therefore the profit when the manager sells increases. However, the market maker is able to cancel out any inefficiency introduced by the cost of auditing if the manager buys and the auditing cost is small. Therefore, in this case the profit of the manager does not depend on the auditing cost. When the auditing cost is high, the manager is able to introduce noise by misreporting and he trades very aggressively on his private information in the financial market.

4.2 The Effect of Market Noise on Market Performance

We next study how the amount of noise in the market affects the performance of the financial market. In their seminal paper, Glosten and Milgrom (1985) analyzed the relationship between the size of the bid-ask spread and the amount of noise in the market. They found that, as the noise of the market decreases (i.e., the probability of the insider trader being selected to trade increases), the size of the spread set by the market maker increases as this allows him to partially protect himself against bad trades with the insider. As we will see next, in our model where the insider interacts with the tax enforcement agency, that monotonic relationship between amount of market noise and spread does not longer holds when the tax report is publicly disclosed.

The less noise there is in the market (i.e. the higher the probability a is), the more often the informed trader is selected to trade. Therefore, the market maker's expectations about facing the manager when trading always increase with a. In the disclosure regime, the tax agency understands that when it sees a buy order it is more likely that the firm is good and that the order to buy comes from the informed manager and therefore it increases its auditing intensity $\iota_D(1)$. Similarly, when it sees a low report $\theta = 0$ and a sell, it infers that it is more likely to have a bad firm and an order coming from a noise trader so that its auditing intensity $\iota_D(-1)$ decreases with a. The dealer also understands this and wants to set higher ask prices and lower bid prices in the case of a low report, $\theta = 0$. However, the liquidation value of the firm when $\theta = 0$ decreases with a due to the higher expected penalties faced by the manager. Therefore, concerning the ask price, the market maker faces a trade-off between lower liquidation value and higher probability of trading against the manager. Consequently, unlike in Glosten and Milgrom (1985), the ask

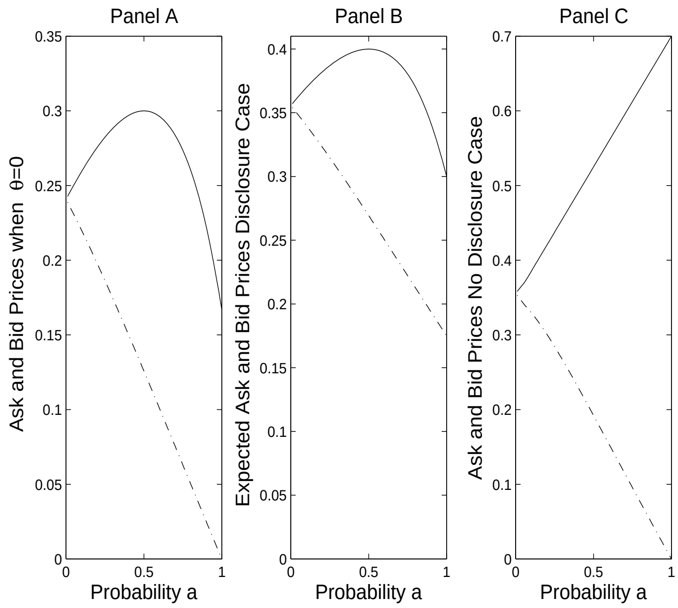

Figure 12: Ask and Bid Prices. Parameter Values: $s = 0.5$, $m = 0.5$, $c = 1.2$, $\tau = 0.3$.

price $A(0)$ has an inverted U-shape with respect to a (see Figure 12, Panel A). Since the ask price when $\theta = 1$ and the probability of having a low report $\theta = 0$ do not depend on a, the expected ask has a similar shape (see Figure 12, Panel B). In the no-disclosure regime, the ask price is only exposed to the first effect, because, independently of which are the parameters values, the liquidation value is equal to $1 - \tau$, which does not depend on a. Therefore, in this case, as in the original Glosten-Milgrom model, the ask price increases with a and the bid price decreases with a since the market maker expects to trade more often against the informed manager (see Figure 12, Panel C). When we analyze the spread, in both regimes the market maker's expectations of facing the manager when buying increases faster than the market maker's expectations of facing the manager when selling. However, in the disclosure regime, as a becomes larger we find the same trade-off in the spread since the bid always decreases with a and the ask price increases initially faster but eventually decreases (see Figure 13).

We can also analyze how the insider's expected profit changes when the noise trading varies. We obtain that the expected profit in both the disclosure and the no-disclosure regime has an inverted U-shape with respect to a, which is similar to the comparative statics arising in the original Glosten-Milgrom model (see Figure 14). This is so because of the trade-off faced by the manager: the higher a, the higher are his chances of being selected to trade but also the lower his profit in each instance of trading because the market maker can more easily understand that his order is informed. This trade-off applies even when we introduce the strategic interaction between the manager and the tax enforcement agency.

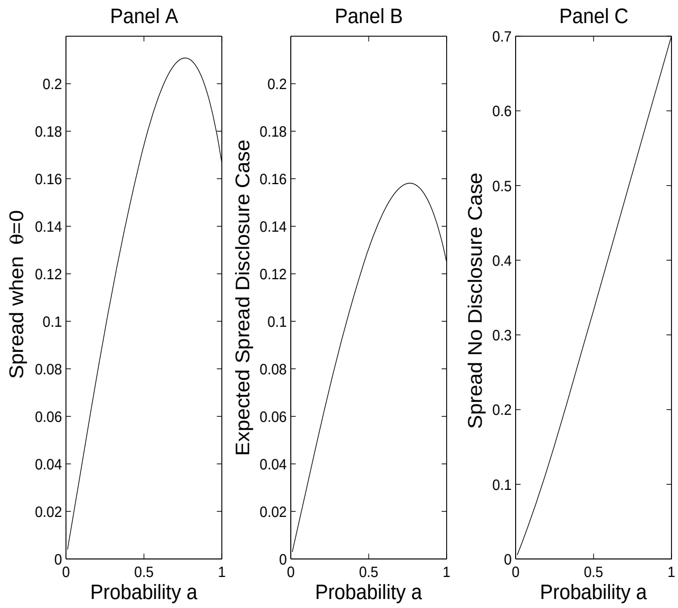

Figure 13: Spreads. Parameter Values: $s = 0.5$, $m = 0.5$, $c = 1.2$, $\tau = 0.3$.

4.3 The Effects of Auditing Cost and Noise Trading on the Tax Agency's Expected Revenue

In the next corollary we perform the corresponding comparative statics for the expected net revenue of the tax agency with respect to the parameter values of the model:

Corollary 6 *(i) The tax agency's expected net revenue, both in the disclosure and in the no-disclosure regime, decreases with the auditing cost, c.*

(ii) The tax agency's expected net revenue, both in the disclosure and in the no-disclosure regime, increases with the probability a of informed trading.

In the disclosure regime, the expected net revenue of the tax agency is affected by changes in the auditing cost only through the collected penalties as the taxes voluntarily paid do not depend on c. Therefore, since the auditing intensities $\iota_D(1)$ and $\iota_D(-1)$ both decrease with c, the total net tax revenue collected in case of inspection decreases with c so that the total expected net revenue decreases with c. However, in the no-disclosure case, we have a trade-off. On the one hand, the higher the auditing cost, the lower the probability p_{ND} of the manager telling the truth and, thus, the lower the expected revenue collected by the tax agency from voluntarily reported taxes. On the other hand, the higher auditing cost, the higher the amount the tax agency collects from penalties, since the probability of collecting penalties increases with the auditing cost. However, this last effect does not dominate the negative direct effect on voluntary tax collection and, therefore, we also find in this case that the expected tax net revenue decreases

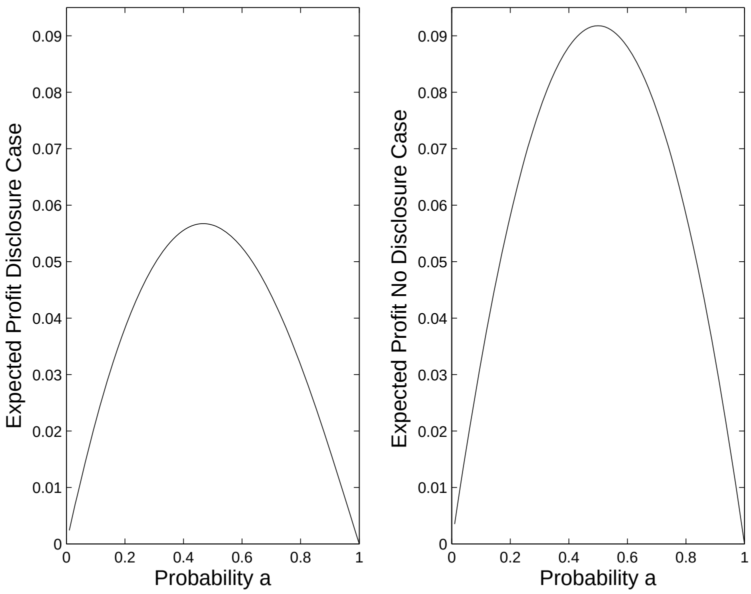

Figure 14: Manager's Expected Profit. Parameter Values: $s = 0.5$, $m = 0.5$, $c = 1.2$, $\tau = 0.3$.

with the auditing cost.

When we study how the expected tax net revenue changes when the probability of informed trading a, changes, we also see that, in the disclosure case, this change only has an effect through the amount of penalties collected and not through the taxes honestly paid. In this case, the auditing intensities $\iota_D(1)$ and $\iota_D(-1)$ increase and decrease, respectively, with a. However, since they enter quadratically in the calculations of the penalties, they do not drive the behavior of the expected tax revenue. What drives this behavior are the probabilities of collecting these penalties, i.e., how often the manager is inspected and caught. As explained above, we have two situations when this can happen. The probability of tax agency observing a low report $\theta = 0$ and a buy is $P(\theta = 0, \omega = 1) = \frac{1}{2}((1+a)(1-m)s + (1-a)(1-s))$, and this probability increases with the probability of the manager being selected to trade, a. This is so because the tax agency believes is more likely to face an informed trader when the firm is good and $\omega = 1$. Similarly, when the tax agency observes a low report $\theta = 0$ and a sell we have that the probability of this event is $P(\theta = 0, \omega = -1) = \frac{1}{2}((1-a)(1-m)s + (1+a)(1-s))$ and this probability decreases with the probability a of the manager's being selected to trade because the tax agency believes that in the case of a bad firm it is more likely that the order to buy was placed by a noise trader). However, since the intensity of auditing in the case of observing a buy is higher than the intensity in the case of observing a sell, $\iota_D(1) > \iota_D(-1)$, the penalties collected in the first case dominate the effect of the penalties in the second case. As a result, the expected net tax revenue if the tax report is disclosed increases with a. In the case where the tax report is not disclosed, both the penalties when observing a buy and a sell decrease with a because the higher the probability a of the manager's being selected to trade, the higher the probability p_{ND} that the manager tells the truth and, hence, the less often the manager pays these penalties. However, this decrease is always offset by the taxes voluntarily paid since these taxes increase with the probability p_{ND} of the manager telling the truth

5 Conclusions

In this paper, we have developed an insider trading model that has allowed us to analyze how an endogenous public signal resulting from the interaction between a firm and a tax auditing agency may affect trading in the financial market. We show that uncertainty regarding a firm's payoff realization, together with the endogeneity arising during the reporting stage, has a sizeable impact on the reporting strategy of the firm, the auditing policy of the tax agency, and the pricing policy adopted by the dealer in the financial market. Thus, the disclosure of the tax report produced by a firm, not only affects the liquidation value of the firm but also brings about substantial changes in the behavior of the market liquidity, the profits of the market participants, and the informativeness of prices.

Our results are consistent with the empirical literature that shows that disclosure of information is beneficial for market performance (Healy et al., 1999; Leuz and Verrecchia, 2000). However, it also implies that the tax agency might have incentives to not disclose the tax report because that disclosure could result in a smaller net tax collection. In addition, our model gives raise to some cross-country empirical implications about the disclosure of the tax report by suggesting that in countries with less efficient tax agencies the liquidity of the shares traded in the financial markets is lower.

Another interesting implication of our model refers to the strategic choice made by the manager. As we mentioned above, when the tax report is not disclosed the manager tends to tell the truth more often since in this case the tax agency and the market maker can fully undo the effect of strategic behavior by the manager when he declares a low payoff from the project. However, in the case that the tax report is disclosed, it is optimal to cheat always.

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Appendix

Proof of Proposition 1. As in Glosten and Milgrom (1985), the dealer cannot distinguish the informed trader from liquidity traders and he must break even on average due to the assumed risk neutrality and the Bertrand competition he faces. The novelty here is that when he posts the ask and bid prices he observes now two signals. He observes the order flow so he can tell if it is a buyer initiated trade or a seller initiated trade. The order flow ω observed by the dealer can take two values: $\omega = -1$ when it is a seller initiated trade or $\omega = 1$ when it is a buyer initiated trade. In addition, he can observe the tax report, which has been publicly released. In order to set the prices, the dealer computes the expected value of the asset conditional on the information he has. For a buy order when the report is high, $\theta = 1$, the ask price is

$$A(1) \equiv A(\theta = 1) = E\left[V|\ \omega = 1 \text{ and } \theta = 1\right],$$

while for a buy order and low report, $\theta = 0$, the ask price is

$$A(0) \equiv A(\theta = 0) = E\left[V|\ \omega = 1 \text{ and } \theta = 0\right].$$

Similarly the bid price for high report, $\theta = 1$, is

$$B(1) \equiv B(\theta = 1) = E\left[V|\ \omega = -1 \text{ and } \theta = 1\right],$$

while for a sell order and low report, $\theta = 0$, the ask price is

$$B(0) \equiv B(\theta = 0) = E\left[V|\ \omega = -1 \text{ and } \theta = 0\right].$$

Using the event tree in Figure 1 and Bayes rule we calculate first the probabilities of each of this state occurring, conditional on the two signals received by the dealer. Let $\widehat{\iota}(1)$ and $\widehat{\iota}(-1)$ be the probabilities of discovering the truth when the tax authority observes a buy and a sell, respectively. Then, the ask price when the tax report is high, $\theta = 1$, equals

$$\begin{aligned} A(1) = 1 \cdot \Pr\left[V = 1|\ \ \{\omega = 1\} \cap \{\theta = 1\}\right] + (1-\tau)\Pr\left[V = 1-\tau|\, \{\omega = 1\} \cap \{\theta = 1\}\right]) \\ +(1-f\tau)\Pr\left[V = 1-f\tau|\, \{\omega = 1\} \cap \{\theta = 1\}\right] + 0 \cdot \Pr V = 0|\, \{\omega = 1\} \cap \{\theta = 1\} = 1-\tau, \end{aligned}$$

while the ask price when the tax report is low, $\theta = 0$, is

$$\begin{aligned} A(0) &= 1 \cdot \Pr\left[V = 1|\, \{\omega = 1\} \cap \{\theta = 0\}\right] + (1-\tau)\Pr\left[V = 1-\tau|\, \{\omega = 1\} \cap \{\theta = 0\}\right] \\ &\quad +(1-f\tau)\Pr\left[V = 1-f\tau|\, \{\omega = 1\} \cap \{\theta = 0\}\right] + 0 \cdot \Pr\left[V = 0|\, \{\omega = 1\} \cap \{\theta = 0\}\right] \\ &= \frac{\left[1-\widehat{\iota}(1) + \widehat{\iota}(1)(1-f\tau)\right](1-p)(1-m)\,s\,(1+a)}{s\,(1-p)(1-m)(1+a) + (1-s)(1-a)} \\ &= \frac{\left[1-\iota(1)\right] s\,(1-p)(1-m)(1+a)}{s\,(1-p)(1-m)(1+a) + (1-s)(1-a)}, \end{aligned}$$

where for the last equality we have used the fact that $\iota = \widehat{\iota} f\tau$. Similarly, for a sell order we have two bid prices the bid in case of high report, $\theta = 1$,

$$B(1) = 1 \cdot \Pr\left[V = 1 | \ \{\omega = -1\} \cap \{\theta = 1\}\right] + (1-\tau) \Pr\left[V = 1-\tau | \ \{\omega = -1\} \cap \{\theta = 1\}\right]$$
$$+(1-f\tau) \Pr\left[V = 1 - f\tau | \{\omega = -1\} \cap \{\theta = 1\}\right] + 0 \cdot \Pr\left[V = 0 | \ \{\omega = -1\} \cap \{\theta = 1\}\right] = 1-\tau,$$

and the bid in case of low report, $\theta = 0$, is

$$\begin{aligned} B(0) &= 1 \cdot \Pr\left[V = 1 | \{\omega = -1\} \cap \{\theta = 0\}\right] + (1-\tau) \Pr\left[V = 1-\tau | \{\omega = -1\} \cap \{\theta = 0\}\right] \\ &+(1-f\tau) \Pr\left[V = 1 - f\tau | \{\omega = 1\} \cap \{\theta = 1\}\right] + 0 \cdot \Pr\left[V = 0 | \{\omega = -1\} \cap \{\theta = 0\}\right] \\ &= \frac{\left[1 - \widehat{\iota}(-1) + \widehat{\iota}(1)(1-f\tau)\right](1-p)(1-m)s(1+a)}{s(1-p)(1-m)(1+a) + (1-s)(1-a)} \\ &= \frac{\left[1 - \iota(-1)\right] s(1-p)(1-m)(1-a)}{s(1-p)(1-m)(1-a) + (1-s)(1+a)}. \end{aligned}$$

The expected profit of the manager under disclosure is

$$E\left[\Pi_D(p)\right] = a\left\{(1-p)(1-m)s\left[\left[1 - \iota_D(1)\right] - A(0)\right] + (1-s)B(0)\right\}.$$

The manager chooses the probability p to maximize the expected profit, and consequently, the optimal probability of telling the truth is $p_D = 0$ since $\left[1 - \iota(1)\right] - A(0) > 0$. Therefore, the prices set by the market maker in the regime with disclosure of the tax report are equal to

$$\begin{aligned} A(0) &= \frac{\left[1 - \iota(1)\right] s(1-m)(1+a)}{s(1-m)(1+a) + (1-s)(1-a)}, \\ A(1) &= 1-\tau, \\ B(0) &= \frac{\left[1 - \iota(-1)\right] s(1-m)(1-a)}{s(1-m)(1-a) + (1-s)(1+a)}, \\ B(1) &= 1-\tau. \end{aligned}$$

Finally, using (1) and (2), the equilibrium auditing intensities under disclosure are the following:

$$\begin{aligned} \iota_D(1) &= \frac{P(y = 1 | \theta = 0, \omega = 1)}{c} = \frac{1}{c}\left[\frac{s(1-m)(1+a)}{s(1-m)(1+a) + (1-s)(1-a)}\right], \\ \iota_D(-1) &= \frac{P(y = 1 | \theta = 0, \omega = -1)}{c} = \frac{1}{c}\left[\frac{s(1-m)(1-a)}{s(1-m)(1-a) + (1-s)(1+a)}\right]. \end{aligned}$$

■

Proof of Proposition 2. In the case where the market maker cannot see the tax report, he sets prices conditioning only on the order flow that he observes. Consequently, the ask price is

$$\begin{aligned} A &= E[V|\ \omega=1] = 1\cdot\Pr[V=1|\ \omega=1] + (1-\tau)\Pr[V=1-\tau|\,\omega=1] \\ &\quad +(1-f\tau)\Pr[V=1-f\tau|\,\omega=1] + 0\cdot\Pr[V=0|\,\omega=1] \\ &= \frac{(1+a)\{[1-\iota_{ND}(1)](1-p)(1-m)s + (1-\tau)s(p(1-m)+m)\}}{(1+a)[(1-p)(1-m)s + s(p(1-m)+m)] + (1-a)(1-s)} \\ &= \frac{(1+a)\{[1-\iota_{ND}(1)](1-p)(1-m)s + (1-\tau)[p(1-m)+m]s\}}{(1+a)s + (1-a)(1-s)}. \end{aligned} \tag{9}$$

Similarly, when the market maker observes a sell order he sets the price

$$\begin{aligned} B = E[V|\ \omega=-1] &= 1\cdot\Pr[V=1|\ \omega=-1] + (1-\tau)\Pr[V=1-\tau|\ \omega=-1] \\ &\quad +(1-f\tau)\Pr[V=1-f\tau|\,\omega=-1] + 0\cdot\Pr[V=0|\ \omega=-1] = \\ &= \frac{(1-a)\{(1-p)(1-m)s[1-\iota(-1)] + [p(1-m)+m]s(1-\tau)\}}{(1-a)((1-p)(1-m)s + (p(1-m)s+ms)) + (1+a)(1-s)} \\ &= \frac{(1-a)\{[1-\iota(-1)](1-p)(1-m)s + (1-\tau)[p(1-m)+m]s\}}{(1-a)s + (1+a)(1-s)}. \end{aligned} \tag{10}$$

The expected profit of the manager under no disclosure is

$$E[\Pi_{ND}(p)] = a\{s(1-p)(1-m)([1-\iota(1)]-A) + s[p(1-m)+m](1-\tau-A) + (1-s)B\}.$$

The first-order condition with respect to p in order to maximize $E[\Pi_{ND}(p)]$ is

$$-(1-m)s\{[1-\iota(1)]-A\} + sm(1-\tau-A) = 0,$$

so that $p\in(0,1)$ if $\iota(1)=\tau$. If $\iota(1)>\tau$, then the optimal probability of reporting the truth under no disclosure is $p_{ND}=1$, whereas, if $\iota(1)<\tau$, the optimal probability becomes $p_{ND}=0$. Under no disclosure the auditing intensity when the trader buys is according to (1) equal to

$$\iota_{ND}(1) = \frac{1}{c}\left[\frac{(1-p_{ND})(1-m)s(1+a)}{(1+a)(1-m)s + (1-a)(1-s)}\right], \tag{11}$$

and, if we make $\iota(1)=\tau$, we solve for the optimal value p_{ND} of the probability of reporting high profits by a strategic manager and we get

$$p_{ND} = 1 - c\tau\left[1 + \frac{(1-a)(1-s)}{(1-m)s(1+a)}\right], \tag{12}$$

provided that $p_{ND}\in(0,1)$. Therefore, using (2) and the previous expression for p_{ND}, the auditing intensity when the trader sells is in this case equal to

$$\begin{aligned} \iota_{ND}(-1) &= \frac{1}{c}\left[\frac{(1-p_{ND})(1-m)s(1-a)}{(1-a)(1-m)s + (1+a)(1-s)}\right] \\ &= \tau\frac{(1-a)}{(1+a)}\left[\frac{(1+a)(1-m)s + (1-a)(1-s)}{(1-a)(1-m)s + (1+a)(1-s)}\right]. \end{aligned} \tag{13}$$

Replacing the probability p and the auditing intensities $\iota(1)$ and $\iota(-1)$ in (9) and (10), by its optimal values given (12) and (11) and (13), we get the following ask and bid prices:

$$\begin{aligned} A_{ND} &= \frac{(1+a)\{(1-\iota_{ND}(1))(1-p)(1-m)s+(1-\tau)(p(1-m)+m)s\}}{(1+a)s+(1-a)(1-s)} \\ &= \frac{(1+a)(1-\tau)s}{(1+a)s+(1-a)(1-s)} \end{aligned}$$

and

$$\begin{aligned} B_{ND} = {} & \frac{(1-a)}{(1-a)s+(1+a)(1-s)}\left\{\left(1-\tau\frac{(1-a)}{(1+a)}\left[\frac{(1+a)(1-m)s+(1-a)(1-s)}{(1-a)(1-m)s+(1+a)(1-s)}\right]\right)\times\right. \\ & \times c\tau\left(1+\frac{(1-a)(1-s)}{(1-m)s(1+a)}\right)(1-m)s \\ & \left.+(1-\tau)\left[\left(1-c\tau\left[1+\frac{(1-a)(1-s)}{(1-m)s(1+a)}\right]\right)(1-m)+m\right]s\right\}. \end{aligned}$$

Notice that, if $\iota_{ND}(1)<\tau$, then $c\tau\left[1+\frac{(1-a)(1-s)}{(1-m)s(1+a)}\right]>1$, and, therefore, we have a corner solution, $p_{ND}=0$. In this case, we have the following equilibrium prices:

$$A_{ND} = \frac{(1+a)[1-\iota_{ND}(1)](1-m)s+(1-\tau)ms}{(1+a)s+(1-a)(1-s)},$$

$$B_{ND} = \frac{(1-a)[1-\iota_{ND}(-1)](1-m)s+(1-\tau)ms}{(1-a)s+(1+a)(1-s)},$$

and the following auditing intensities in equilibrium:

$$\iota_{ND}(1) = \frac{1}{c}\left[\frac{s(1-m)(1+a)}{s(1-m)(1+a)+(1-s)(1-a)}\right],$$

$$\iota_{ND}(-1) = \frac{1}{c}\left[\frac{s(1-m)(1-a)}{s(1-m)(1-a)+(1-s)(1+a)}\right].$$

■

Proof of Corollary 3. We define the following probabilities

$$\theta_0 \equiv \Pr(\theta=\theta_0)=(1-p)(1-m)s+(1-s),$$

$$\theta_1 \equiv \Pr(\theta=\theta_1)=p(1-m)s+ms.$$

When $p=0$, we have $\theta_0=(1-m)s+(1-s)$, $\theta_1=ms$ and, therefore, the expected prices are equal to

$$\begin{aligned}
E\left(A_D\right) &= A\left(0\right)\theta_0 + A\left(1\right)\theta_1 \\
&= \frac{\left[1-\iota_D\left(1\right)\right]\left(1-m\right)s\left(1+a\right)}{\left(1-m\right)s\left(1+a\right)+\left(1-s\right)\left(1-a\right)}\left[\left(1-m\right)s+\left(1-s\right)\right]+(1-\tau)ms,
\end{aligned}$$

$$\begin{aligned}
E\left(B_D\right) &= B\left(0\right)\theta_0 + B\left(1\right)\theta_1 \\
&= \frac{\left[1-\iota_D\left(-1\right)\right]\left(1-m\right)s\left(1-a\right)}{\left(1-m\right)s\left(1-a\right)+\left(1-s\right)\left(1+a\right)}\left[\left(1-m\right)s+\left(1-s\right)\right]+(1-\tau)ms.
\end{aligned}$$

Therefore, the expected spread is

$$\begin{aligned}
E\left(S_D\right) &= E\left(A_D\right)-E\left(B_D\right) = \frac{\left[1-\iota_D\left(1\right)\right]\left(1-m\right)s\left(1+a\right)}{\left(1-m\right)s\left(1+a\right)+\left(1-s\right)\left(1-a\right)}\left[\left(1-m\right)s+\left(1-s\right)\right] \\
&\quad +(1-\tau)ms-\left[\frac{\left[1-\iota_D\left(-1\right)\right]\left(1-m\right)s\left(1-a\right)}{\left(1-m\right)s\left(1-a\right)+\left(1-s\right)\left(1+a\right)}\left[\left(1-m\right)s+\left(1-s\right)\right]+(1-\tau)ms\right] \\
&= \left(\frac{\left[1-\iota_D\left(1\right)\right]\left(1+a\right)}{\left(1-m\right)s\left(1+a\right)+\left(1-s\right)\left(1-a\right)}-\frac{\left[1-\iota_D\left(-1\right)\right]\left(1-a\right)}{\left(1-m\right)s\left(1-a\right)+\left(1-s\right)\left(1+a\right)}\right). \\
&\quad \times\left(1-m\right)s\left[\left(1-m\right)s+\left(1-s\right)\right].
\end{aligned}$$

■

Proof of Corollary 4. The expected revenue collected by the tax agency in the disclosure regime is

$$\begin{aligned}
E\left(R_D\right) &= P\left(\theta=1\right)\tau+P\left(\theta=0,\omega=1\right)\frac{\left(P\left(y=1\middle|\,\theta=0,\omega=1\right)\right)^2}{2c}+ \\
&\quad +P\left(\theta=0,\omega=-1\right)\frac{\left(P\left(y=1\middle|\,\theta=0,\omega=-1\right)\right)^2}{2c} \\
&= ms\tau+\frac{1}{4c}\left[\left(1+a\right)\left(1-m\right)s+\left(1-a\right)\left(1-s\right)\right]\left[\frac{\left(1-m\right)s\left(1+a\right)}{\left(1+a\right)\left(1-m\right)s+\left(1-a\right)\left(1-s\right)}\right]^2 \\
&\quad +\frac{1}{4c}\left[\left(1-a\right)\left(1-m\right)s+\left(1+a\right)\left(1-s\right)\right]\left[\frac{\left(1-m\right)s\left(1-a\right)}{\left(1-a\right)\left(1-m\right)s+\left(1+a\right)\left(1-s\right)}\right]^2 \\
&= ms\tau+\frac{1}{4c}\frac{\left[\left(1-m\right)s\left(1+a\right)\right]^2}{\left(1+a\right)\left(1-m\right)s+\left(1-a\right)\left(1-s\right)}+\frac{1}{4c}\frac{\left[\left(1-m\right)s\left(1-a\right)\right]^2}{\left(1-a\right)\left(1-m\right)s+\left(1+a\right)\left(1-s\right)}.
\end{aligned}$$

The expected revenue of the tax agency under no disclosure equals to

$$
\begin{aligned}
E\left(R_{ND}\right) &= P\left(\theta=1\right)\tau + P\left(\theta=0,\omega=1\right)\frac{\left[P\left(y=1|\,\theta=0,\omega=1\right)\right]^2}{2c} + \\
&\quad + P\left(\theta=0,\omega=-1\right)\frac{\left[P\left(y=1|\,\theta=0,\omega=-1\right)\right]^2}{2c} = \left[m+p\left(1-m\right)\right] + \\
&\quad + \frac{1}{4c}\left[\left(1+a\right)\left(1-m\right)s+\left(1-a\right)\left(1-s\right)\right]\left[\frac{\left(1-p_{ND}\right)\left(1-m\right)s\left(1+a\right)}{\left(1+a\right)\left(1-m\right)s+\left(1-a\right)\left(1-s\right)}\right]^2 \\
&\quad + \frac{1}{c}\left[\left(1-a\right)\left(1-m\right)s+\left(1+a\right)\left(1-s\right)\right]\left[\frac{\left(1-p_{ND}\right)\left(1-m\right)s\left(1-a\right)}{\left(1-a\right)\left(1-m\right)s+\left(1+a\right)\left(1-s\right)}\right]^2 \\
&= \left[m+p_{ND}\left(1-m\right)\right]s\tau + \frac{1}{4c}\frac{\left[\left(1-p_{ND}\right)\left(1-m\right)s\left(1+a\right)\right]^2}{\left(1+a\right)\left(1-m\right)s+\left(1-a\right)\left(1-s\right)} + \\
&\quad + \frac{1}{4c}\frac{\left[\left(1-p_{ND}\right)\left(1-m\right)s\left(1-a\right)\right]^2}{\left(1-a\right)\left(1-m\right)s+\left(1+a\right)\left(1-s\right)}.
\end{aligned}
$$

■

Proof of Corollary 5. Let us define the function $g(p,c)$ giving the expected net revenue collected by the tax agency as a function of both the probability p of submitting true reports in case of positive profits and the auditing cost c when the tax report is not disclosed. According to Corollary 4, the function g is given by

$$
\begin{aligned}
g(p,c) &= E\left(R_{ND}\right) = \left(m+p\left(1-m\right)\right)s\tau \\
&\quad + \frac{\left[\left(1-p\right)\left(1-m\right)s\left(1+a\right)\right]^2}{4c\left(\left(1+a\right)\left(1-m\right)s+\left(1-a\right)\left(1-s\right)\right)} + \frac{\left[\left(1-p\right)\left(1-m\right)s\left(1-a\right)\right]^2}{4c\left(\left(1-a\right)\left(1-m\right)s+\left(1+a\right)\left(1-s\right)\right)}.
\end{aligned} \tag{14}
$$

Similarly, we define the function $f(c)$ giving the expected net revenue collected by the tax agency as a function of the auditing cost c when the tax report is disclosed. Again, according to Corollary 4, the function f is given by

$$
\begin{aligned}
f(c) &= E\left(R_D\right) = ms\tau \\
&\quad + \frac{\left[\left(1-m\right)s\left(1+a\right)\right]^2}{4c\left(\left(1+a\right)\left(1-m\right)s+\left(1-a\right)\left(1-s\right)\right)} + \frac{\left[\left(1-m\right)s\left(1-a\right)\right]^2}{4c\left(\left(1-a\right)\left(1-m\right)s+\left(1+a\right)\left(1-s\right)\right)}.
\end{aligned} \tag{15}
$$

We clearly see that $f(c) = g(0,c)$, which is a consequence of the fact that the strategic managers always report low profits under disclosure. Moreover $\frac{df(c)}{dc} < 0$ for all c.

Let us define the function $p(c)$ relating the probability of reporting high profits with the the auditing cost c as follows:

$$
p(c) = 1 - c\tau\left[1+\frac{\left(1-a\right)\left(1-s\right)}{\left(1-m\right)s\left(1+a\right)}\right]. \tag{16}
$$

According to (6), there exists a value $\overline{c}$ of the auditing cost,

$$
\overline{c} = \frac{1}{\tau}\left[\frac{s\left(1-m\right)\left(1+a\right)}{s\left(1-m\right)\left(1+a\right)+\left(1-s\right)\left(1-a\right)}\right],
$$

such that for all $c < \overline{c}$, $p_{ND} > 0$ and for all $c > \overline{c}$, $p_{ND} = 0$. Therefore, $p(\overline{c}) = 0$ and $p(c) > 0$ for all $c < \overline{c}$. Moreover, $f(c) = g(p(c), c)$ for all $c > \overline{c}$, that is, the expected net revenues collected by the tax agency are the same under disclosure and under no disclosure when the cost c of auditing is sufficiently large since in this case the strategic managers always cheat under the two disclosure regimes.

We next compute the derivative of the expected net revenue under no disclosure evaluated at the threshold value $\overline{c}$ of the auditing cost,

$$\left.\frac{dg(p(c),c)}{dc}\right|_{c=\overline{c}} = \left.\frac{\partial g(0,c)}{\partial c}\right|_{c=\overline{c}} + \left.\frac{\partial g(p,\overline{c})}{\partial p}\right|_{p=0} \cdot \left.\frac{dp(c)}{dc}\right|_{c=\overline{c}} \tag{17}$$

$$= \left.\frac{df(c)}{dc}\right|_{c=\overline{c}} + \left.\frac{\partial g(p,\overline{c})}{\partial p}\right|_{p=0} \cdot \left.\frac{dp(c)}{dc}\right|_{c=\overline{c}}. \tag{18}$$

After some tedious algebra, we get

$$\left.\frac{\partial g(p,\overline{c})}{\partial p}\right|_{p=0} = \frac{2as\tau(1-a)(1-m)(1-s)}{(1+a)\left((1-m)s(1-a)+(1-s)(1+a)\right)} > 0$$

and

$$\frac{dp(c)}{dc} = -\tau\left[1+\frac{(1-a)(1-s)}{(1-m)s(1+a)}\right] < 0 \text{ for all } c.$$

Therefore,

$$\left.\frac{\partial g(p,\overline{c})}{\partial p}\right|_{p=0} \cdot \left.\frac{dp(c)}{dc}\right|_{c=\overline{c}} < 0,$$

which according to (17) implies that

$$\left.\frac{dg(p(c),c)}{dc}\right|_{c=\overline{c}} < \left.\frac{df(c)}{dc}\right|_{c=\overline{c}} < 0.$$

Therefore, since $f(\overline{c}) = g(p(\overline{c}), \overline{c})$, there exists an interval $(\widehat{c}, \overline{c})$ such that

$$E\left(R_{ND}\right) = g(p(c),c) > f(c) = E\left(R_D\right) \quad \text{for } c \in \left(\widehat{c}, \overline{c}\right).$$

Let us now define the function $j(c) = g(p(c), c) - f(c)$ so that, using (14) and (15), we get

$$j(c) = p(c)(1-m)s\tau - \frac{\left[p(c)(1-m)s(1+a)\right]^2}{4c\left((1+a)(1-m)s+(1-a)(1-s)\right)} - \frac{\left[p(c)(1-m)s(1-a)\right]^2}{4c\left((1-a)(1-m)s+(1+a)(1-s)\right)}.$$

We use (16) to substitute for $p(c)$ in the previous expression to obtain,

$$j(c) = \left(1-c\tau\left[1+\frac{(1-a)(1-s)}{(1-m)s(1+a)}\right]\right)(1-m)s\tau - \frac{\left[\left(1-c\tau\left[1+\frac{(1-a)(1-s)}{(1-m)s(1+a)}\right]\right)(1-m)s(1+a)\right]^2}{4c\left((1+a)(1-m)s+(1-a)(1-s)\right)} - \frac{\left[\left(1-c\tau\left[1+\frac{(1-a)(1-s)}{(1-m)s(1+a)}\right]\right)(1-m)s(1-a)\right]^2}{4c\left((1-a)(1-m)s+(1+a)(1-s)\right)}.$$

Note that $j(c)$ can be written as a fraction of polynomials in c, where the numerator will be quadratic in c. Therefore, $j(c)$ has at most two roots. We know that one of the roots is $c = \overline{c}$ as $f(\overline{c}) = g(p(\overline{c}), \overline{c})$. Note that the other root $\underline{c}$ of $j(c)$ is smaller than $\overline{c}$. This is so because we know from our previous argument that there exists an interval $(\widehat{c}, \overline{c})$ such that $j(c) = g(p(c), c) - f(c) > 0$. However, as we argue in the main text, if the auditing cost c is sufficiently low, then all low reports are inspected. Therefore, under no disclosure the manager always tells the truth as p_{ND} converges to 1 as c tends to 0 so that the expected tax revenue tends to $s\tau$. However, under disclosure the manager always reports $\theta = 0$ and, if all those reports are audited then the expected tax revenue becomes $ms\tau + (1-m)sf\tau$, where the first term of the sum is the amount of taxes paid by the honest manager and the second is the amount of fines paid by the strategic manager. Since $f > 1$, then a disclosure policy dominates a no-disclosure policy from the tax agency viewpoint as the former generates larger expected revenues when the auditing cost c is close to zero. That is, $j(c) = g(p(c), c) - f(c) < 0$ for an auditing cost c sufficiently small. ■

Proof of Corollary 6. (i) The derivative of the expected revenue in the disclosure regime with respect to the auditing cost is

$$\frac{\partial E(R_D)}{\partial c} =$$
$$-\frac{s^2(1-m)^2\left[s - s(1-m) + 3a^2 s - 3a^2 + a^2 s(1-m) - 1\right]}{2c^2\left[-a - s + s(1-m) + as + as(1-m) + 1\right]\left[-a + s - s(1-m) + as + as(1-m) - 1\right]} \leq 0,$$

for all $0 \leq m, a, s \leq 1$.

Similarly, the derivative of the expected revenue in the no-disclosure regime with respect to the auditing cost c is

$$\frac{\partial E(R_{ND})}{\partial c} =$$
$$-\frac{\tau^2}{2}\left[\frac{(a-1)(s-1) + s(1-m)(a+1)\left[-4a + sm - a^2 s + 4as + a^2 + a^2 s(1-m) - 1\right]}{(a+1)^2\left((a+1)(s-1) + s(1-m)(a-1)\right)}\right] \leq 0,$$

for all $0 \leq m, a, s \leq 1$.

(ii) We next perform the comparative statics with respect to the probability a of the informed trader being selected to trade,

$$\frac{\partial E(R_D)}{\partial a} = \frac{4as^2(1-m)^2(1-s)^2\left[1 - s + s(1-m)\right]}{c\left[(a-1)(s-1) + s(1-m)(a+1)\right]^2\left[(a+1)(s-1) + s(1-m)(a-1)\right]^2} \geq 0$$

and

$$\frac{\partial E(R_{ND})}{\partial a} = \frac{4ac\tau^2(1-s)^2\left[a - 2s + 2s(1-m) + a^2 s - as - a^2 - as(1-m) + a^2 s(1-m) + 2\right]}{(a+1)^3\left[(a+1)(s-1) + s(1-m)(a-1)\right]^2} \geq 0.$$

■