Disclosure of Corporate Tax Reports, Tax Enforcement, and Price Information*

Jordi Caballé[a], Ariadna Dumitrescu[b,*]

[a] *Universitat Autònoma de Barcelona, MOVE and Barcelona GSE, Edifici B, 08193 Bellaterra (Barcelona), Spain*

[b] *ESADE Business School and Univ. Ramon Llull, Av. Pedralbes, 60-62, 08034, Spain*

Abstract

This paper analyzes the effects of disclosing corporate tax reports on both financial markets' performance and tax revenue. To this end, we characterize the optimal auditing policy of the tax enforcement agency and the optimal tax reporting strategy of a firm. The manager of the firm has the possibility of trading in the firm's stock and, therefore, he cares about the information disclosed through the tax report. Our analysis suggests that, despite disclosure of the tax reports being beneficial for market performance (as the spread is 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. We also draw empirical and policy implications about the effect of the tax agency's efficiency on both trading costs and net tax collection. Our results shed light on the debate about the costs and benefits of disclosure.

JEL codes: G12, G14, G18.

Keywords: Disclosure; Corporate Tax; Feedback Effects of Prices

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*Corresponding author

Email addresses: jordi.caballe@uab.es (Jordi Caballé), ariadna.dumitrescu@esade.edu (Ariadna Dumitrescu)

1. Introduction

Corporate disclosure is essential for the good functioning of financial markets as it protects investors and increases both the liquidity and efficiency of the market. If we consider the disclosure of tax return forms, limited disclosure can create divergence between book and tax income because the firm may under-report to the Internal Revenue Service (IRS) whereas it may over-report to the shareholders.[1] Moreover, whereas the IRS's objectives are to reduce the differences between tax and book reports and induce firms to meet their tax responsibilities to maximize tax revenue, the Securities and Exchange Commission's (SEC) main concerns are investor protection and the financial market efficiency, which is characterized by lower transaction costs and lower spreads. Because the objectives of different decision makers vary substantially, their implementation may affect the optimal disclosure policies.

This paper examines whether it is desirable to make firms' tax statements public. Thus, we analyze how disclosure of the tax report affects both the expected revenue raised by the tax agency and the performance of the financial market where the firm's stock is 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, we show that despite disclosure being beneficial for financial market performance, the government might decide not to make the tax report public because the release of this report could have a negative effect on its revenue.

To understand whether it is optimal to implement a tax return disclosure policy, we model the strategic interaction between a tax agency and a firm manager engaged in insider trading when the price of his firm's stock partially reflects information that he possesses. The manager has the opportunity to trade in the financial market using his information about the firm, and, in doing so, reveals some information. The financial market structure in our model is similar to Glosten and Milgrom's (1985), with the difference that the liquidation value of the asset traded is endogenously determined as a result of the interaction between the manager and the tax agency.[2] How much information is revealed depends among other factors on whether the tax return is disclosed or not. When the tax report becomes public, the dealer uses this information when setting the stock prices in the financial market. Because managers are aware of this potential use for pricing they modify their actions, and the market value of the firm is adjusted accordingly. There is an obvious direct effect of taxes on prices in the financial market as the tax report affects the value of the firm both through the amount

[1] "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.*

[2] Diamond and Verrecchia (1981) show that exogenous disclosure policies that reduce the asymmetry of information among investors increase the market liquidity of a security. For detailed surveys on the costs and the benefits of information disclosure by firms, see Core (2001), Healy and Palepu (2001), Verrechia (2001), Leuz and Wysocki (2016).

of taxes paid and through the tax agency's audit intensity. However, there is also a feedback effect of prices as the manager adjusts his actions concerning trading and tax reporting depending on the information that is released, and these actions ultimately affect the value of the firm. Therefore, the use of prices as a source of information has real effects on managers' and dealers' decision-making.[3]

Our paper contributes both to the literature that examines the effects of disclosure and its desirability and to the tax evasion literature, by showing how tax return disclosure may affect both market performance and tax revenue collection. Our motivation comes from the intense ongoing regulatory and academic debate around the desirability of tax return disclosure (Lenter et al., 2003; Hoopes et al., 2018). On the one hand, the disclosure of tax return information is considered beneficial for both financial markets' efficiency and tax compliance because of the reputational implications of disclosure. On the other hand, disclosure may prevent tax enforcement because the tax returns could become less informative. Note that firms have an incentive to dilute the disclosed information because the tax return could contain valuable proprietary information that may be used by their competitors. Moreover, because disclosure may be required only for some firms (for instance, those that are above a certain size), disclosure may disadvantage firms that are forced to disclose information over those that are not (see Lenter et al., 2003).[4]

In the United States, tax return information was public from the time of the Civil War, and it was only made confidential by the Tax Reform Act of 1976. The debate on disclosure of corporate tax return information became more active after Enron, WorldCom and other important U.S. corporation scandals. Several regulatory proposals promoted greater disclosure of annual corporate income tax payments, but they have not materialized.[5]

Whereas the debate in the United States reached a stalemate, the debate is relatively new in the European Union (EU). On February 28, 2013, the EU Parliament approved country-by-country reporting of data on employees, profits, and taxes paid for European banks. Later on, in 2017, both the European Parliament and the European Commission proposed directives emphasizing the role of transparency in fighting against tax avoidance (European Parliament, 2017, and European Commission, 2017).[6] Regardless of these EU initiatives, Nordic countries such as Norway, Sweden,

[3]There is a growing literature that emphasizes the informative content of prices (see among others Kanodia, 2006, Bond et al., 2012, Gao and Liang, 2013, Edmans et al., 2015, Kanodia and Sapra, 2016, Siemroth, 2019).

[4]The items in the tax return that may be used by competitors are the nature, sources and character of firm's revenues and expenses, information about the firm's legal structure, advertising and other selling expenses, and information about the firm's manufacturing costs.

[5]For example, in 2012, the President Obama's Framework for Business Tax Reform called for an increase in disclosure of annual corporate income tax. Other recent regulations in place (for instance, the Dodd–Frank Wall Street Reform and Consumer Protection Act) increase disclosure requirements for specific industries, including taxes.

[6]Those initiatives encouraged country-by-country reporting by large firms so that companies have to publish infor-

Finland and Iceland already have a longer tradition of disclosure of both personal and corporate taxes paid. Furthermore, in the United Kingdom, the Companies Act of 2006 requires firms to disclose the name and location of all subsidiaries, and this may reveal information about corporate tax behavior given the tax consequences associated with the jurisdictions in which firms locate their operations.

Tax return disclosure of foreign-owned and large domestically owned firms took place in Australia in 2015 after the parliament passed a bill aimed at encouraging transparency, accountability, and tax compliance by firms. Hoopes et al. (2018) study empirically the implementation of this regulation and the reaction of both public and private companies to the disclosure of tax information by the Australian Taxation Office. Their results are mixed because public companies reacted to this new disclosure policy by lowering their tax payments, whereas the tax payments of private firms increased even though they took more actions to avoid disclosure. Similarly, Hasegawa et al. (2013) analyze the effect of public disclosure of businesses tax reports in Japan up until the abolition of the regulation in 2005. They conclude that tax disclosure induces a strong change in behavior resulting in insignificant changes in tax collection.

As Hasegawa et al. (2013) point out, the debate around tax return disclosure took place without any 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 effects of tax report disclosure on financial markets, tax compliance and net tax collection. In this respect, our model captures the differences in the IRS and SEC objectives regarding the disclosure of tax returns explained above.

To the best of our knowledge, this paper provides the first model to analyze how tax report disclosure and the strategic interaction between the firm and the tax agency affect the performance of the financial market where the firm's shares are traded. Different from Glosten and Milgrom (1985), where the liquidation value is exogenously given, we show that the market performance depends on the tax agency efficiency which is measured by the value of its auditing costs. Thus, we find that market liquidity (inversely measured by the size of the bid-ask spread) decreases with the auditing cost irrespective of whether the report is disclosed. When the auditing cost becomes high enough (i.e., when the tax agency is inefficient) the manager's strategy is always to misreport under both disclosure regimes. Because the dealer understands that the tax agency is inefficient and that the manager misreports, he is aware that the final after-tax liquidation value of the traded asset representing the

mation for every country they operate in, rather than providing a single set of information at global level. Among the items to be disclosed one may find the profit before tax, the amount of income tax due in each country as a reason of the profit made in the current year, and the actual payments made to each country's treasury during that year.

ownership of the firm is more correlated with the true payoff of the firm before taxes. Therefore, the dealer sets a wider bid-ask spread. This latter result is consistent with the El Ghoul et al.'s (2011) empirical findings on the efficiency of the IRS, which show that more effective IRS auditing is associated with lower cost of capital.

Under our model, we find that the manager always sends false tax reports to the tax agency when the tax report is disclosed. However, when the tax report is not disclosed and the cost of auditing faced by the tax agency is small, the manager has more incentives to submit truthful tax reports, which results in a smaller bid-ask spread as the after-tax liquidation value of the firm will fluctuate less because of the direct tax payment.

Our analysis allows us to answer some of the questions in the debate around the benefits of disclosure. As we have argued, we show that disclosure of an endogenous signal (the tax report) has a beneficial effect on market performance because it reduces the bid-ask spread and, thus, the trading cost. However, it is not always the case that it is beneficial for the tax agency to disclose this information as taxpayers tend to cheat more and, therefore, the government might decide not to make tax reports public. Therefore, our analysis generates several empirical and policy implications for public disclosure of tax information. With regard to market liquidity and trading costs, we find that both the expected spread and trading costs are lower in the disclosure case. With regard to the willingness of the tax authority to make the tax report public, we find that this authority might have incentives not to make the tax report public because the expected net tax revenue collected under the disclosure regime might be smaller. As a result, our model provides guidance for empirical studies that seek to examine the link between the efficiency and motivation of the tax agency and the liquidity provided by financial markets.

Our model builds on a strand of tax evasion literature that considers 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 taxpayer's report (Reinganum and Wilde, 1986; Scotchmer and Slemrod, 1989; Reinganum and Wilde, 1988; Caballé and Panadés, 2005).[7] However, we are interested in understanding how tax report disclosure affects stock valuation and liquidity. Thus, we analyze how the tax report that the manager strategically chooses has an effect not only on the strategy of the tax agency (as in other models of tax evasion) but also on the manager's trading strategy. We show how the double interaction, on the one hand, between the manager and the tax agency and, on the

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

other hand, between the manager and the dealer in the financial market, affects both the liquidation value of the firm and the liquidity of its stock.

Our work is also in line with the stream of literature that is concerned with the role of firms' information disclosure, and the effects of this disclosure on asset prices and traders' welfare. The research in this field focuses on the role played by disclosure in reducing information asymmetry among investors, which can give rise to adverse selection in the financial market, and its effects on firm valuation. These papers are concerned mainly with how information about the firm is disseminated through financial reporting, and how agents in charge of information disclosure affect the information environment and, therefore, the liquidity of the firm's stock. Although the effects of mandatory tax report disclosure on the value of the firm have been studied before, the literature concerned with the effects of tax report disclosure on the performance of financial markets is scant. Recent research has studied the link between tax avoidance and the value of the firm to show that tax avoidance activities can facilitate managerial opportunism, such as earnings manipulation and outright resource diversion, and therefore have an effect on firm value. However, this literature has not studied the effect of tax avoidance on the liquidity of the firm's shares as we do in our model. Desai et al. (2007), Desai and Dharmapala (2009) and Hanlon and Slemrod (2009) study the different effects of tax shelters on firm value. Kim et al. (2011) explore the association between the extent of a firm's tax avoidance and its future stock price crash risk. These studies present theoretical models and empirical evidence challenging the view that postulates that tax avoidance activities enhance the value of the firm because the saving arising from tax avoidance results in an increase of the expected future profits. However, the only studies close to our work, that examine the relation between tax avoidance and the firm's cost of capital, are Goh et al. (2016), Sikes and Verrecchia (2016), and Chen et al. (2019) who empirically find a negative relation between firm-level tax avoidance and cost of capital.

The remainder of this paper is organized as follows. Section 2 presents the model and establishes the information structure. Section 3 characterizes the equilibrium in two situations: when the tax report is disclosed and when it is not. Section 4 analyzes the effects of the public release of the firm's tax reports. Section 5 studies some extensions of the model. In particular, we analyze the implications of introducing a penalty borne by a manager who is caught falsifying the tax report. Finally, Section 6 concludes. The Appendix contains the main proofs.

2. The Model

2.1. Assumptions

Let us consider a firm that runs a project with an uncertain payoff or net cash flow y per share. We assume that the firm's manager is risk neutral, does not face any borrowing or short-selling constraints, and perfectly observes the realization of the payoff associated with the project. The manager uses this information to report a payoff to the tax agency and to trade shares in his own firm. Our modelling of the financial market is based on Glosten and Milgrom's (1985) classical dealer market model where a firm's stock is traded publicly in a financial market. We augment this model with the decisions concerning optimal tax reporting by the firm's manager and auditing by a tax agency. Moreover, to understand the tax return disclosure effect on the manager's optimal tax reporting, tax agency auditing and dealer pricing strategies, we consider two cases: when the tax report is made public (and is therefore used by the dealer when setting prices) and when it is not. To model the strategic interaction between the agents, we consider a game with asymmetric information.

We assume, without loss of generality, that if the firm's project is successful the payoff y per share is equal to one, $y = 1$, with the exogenous probability $s \in (0, 1)$ and if it fails, the payoff per share is equal to zero, $y = 0$, with probability $1 - s$. The manager observes the value of y and optimally chooses to report θ about the value of the project to be submitted to the tax agency. We also assume that the firm has limited liability.

The tax code in our model establishes a flat tax rate $\tau \in (0, 1)$ on the firm's net cash flow. The penalty paid by the firm in the case where the manager misreports and is caught is $f\tau$, where the flat penalty rate f on evaded taxes satisfies $f > 1$ and $f\tau \leq 1$. The latter inequality is imposed because the penalty cannot exceed the project's payoff.

The tax enforcement agency is assumed to be risk neutral. After receiving the tax report, the tax agency chooses its auditing policy based on the information contained in the tax report.[8] When the tax agency inspects the firm, it exerts an amount of effort (or intensity) to maximize its expected net revenue. This costly effort results in a higher probability $\iota \in [0, 1]$ of discovering the true corporate income. Note that the higher the effort (or the resources devoted to auditing), the higher the costs for the tax agency are. We assume that the auditing cost function $c(\iota)$ is quadratic in the probability

[8]The tax report contains information about tax liability and is received by the tax authority with disregard to any other reporting arising from disclosure requirements. Therefore, the tax authority's decision depends on the tax report only.

of discovering the true payoff of the project when the manager hides a high payoff realization,

$$c(\iota) = \frac{1}{2}c\iota^2, \text{ with } c > 0.$$

The cost parameter c measures the degree of inefficiency of the tax administration in discovering false tax reports. Both the auditor and the manager know the cost function.

In the financial market where the firm's stock is traded there are two types of investors: an insider, the aforementioned manager, and noise (or liquidity) traders. To avoid the problem of full information revelation, we follow Glosten and Milgrom (1985) and assume that investors arriving in the market are drawn randomly from the population. Thus the probability that the manager is selected for trading is $a \in (0, 1)$, whereas the probability that a noise trader is selected for trading is $1 - a$. Therefore the higher the a, the lower the information noise in the financial market. Similar to Glosten and Milgrom (1985), we also assume that once an investor is selected for trading with the dealer, he is obliged to trade, that is, no-trade is not allowed. Moreover, he can trade only using market orders for a single share of the firm stock, so that the order size is restricted to the set $\{-1, 1\}$. As it is standard in the Glosten and Milgrom (1985) framework, we also assume that noise traders buy and sell randomly with equal probability. Thus, 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.). The manager, however, uses the information he possesses about the payoff of the project to compute the expected liquidation value of the traded asset and to decide the direction of trade.

Trading in the financial market takes place through a risk-neutral dealer who faces competition from other dealers and, therefore, he makes zero expected profit in equilibrium. The dealer posts ask and bid quotes, A and B, using the information contained in the order flow ω he receives, as well as the tax report θ submitted by the manager if this report becomes public information. We also assume that the dealer cannot cross-subsidize buys with sells or vice versa and thus we can consider buys and sells separately. When an investor buys (trades at the dealer ask price), the dealer's realized profit on the trade is $A - V$ and, when an investor sells, the dealer's profit on the trade is $V - B$, where V is the firm's liquidation value net of taxes and penalties.

2.2. Implications of the Assumptions

The previous modelling assumptions allow us to simplify the extensive form for the strategic interactions between the manager/firm and the tax agency, and between the manager and the dealer.

The following simplifications are a consequence of the assumptions about the firm's limited liability and the manager's perfect information.[9]

When the firm's manager reports a high payoff, $\theta = 1$, the tax agency does not inspect the firm. Because the tax revenue per share in this case would be equal to τ and no additional revenue would arise from the audit, the tax agency does not want to incur the cost of inspection and, therefore, it finds it optimal not to inspect the firm. Note that the manager chooses to report $\theta = 1$ truthfully only if the payoff is high, $y = 1$. Because we assume that the firm has limited liability, if the payoff is $y = 0$, then the firm has no funds to make any tax payment and, therefore, the manager must declare the truth, $\theta = 0$. However, when the project is successful, the manager submits a truthful report θ (i.e., he declares $\theta = 1$) with probability $p \in [0, 1]$ and lies with probability $1 - p$ (i.e., he declares $\theta = 0$).

Furthermore, note that if the manager reported a low payoff $\theta = 0$, while the true payoff was $y = 1$, and the firm was not penalized (because the inspection did not detect the true cash flows), then the tax agency cannot impose any penalty on the firm later on. This may be because, for instance, the legal inspection period has already expired or because the final true profits appear offshore and cannot be tracked by the tax agency any longer.

Using the previous implications, we represent the event tree for the tax agency in Figure 1. In the terminal nodes, we report both the gross government revenue R per share accruing from taxes and potential penalties and the firm's liquidation value V per share. The report sent by the manager affects the inspection decision of the tax auditing agency and thus it also affects the liquidation value V through two channels: the taxes paid and the potential penalty. As a result, the interaction between the manager and the tax agency makes the expected value of the traded security depend on the tax report submitted by the manager, the tax agency's inspection intensities, and the penalties the firm has to pay in case of misreporting and getting caught by the tax agency. When the manager reports $\theta = 0$, the tax agency audits with intensity ι. Then, if the true payoff of the project was $y = 1$, the firm faces a penalty for misreporting because the tax agency discovers with the corresponding probability ι that the payoff of the project undertaken by the firm was $y = 1$ whereas the manager reported $\theta = 0$. Moreover, if the report is $\theta = 0$ but the payoff of the project is $y = 0$, the tax agency also audits the firm with intensity ι, discovers the true low payoff, and no penalty is imposed on the firm.[10] Trade in

[9]Glosten and Milgrom (1985) make this simplification in modelling the strategic interaction between the insider and the dealer. When observes the order flow, the dealer is not able to disentagle whether the order comes from insider or a noise trader. Since the insider's information is always better than the one of the dealer, his estimation of the liquidation value is always more precise and he exploits his informational advantage when trading.

[10]Note that the tax authority in practice might also benefit from a better performance of listed companies. However,

the financial market occurs after the report has been submitted but before the inspection by the tax agency has taken place and, thus, before taxes and potential penalties are paid. Note that, in addition to the effects on the liquidation value of the asset, the tax report affects the firm's stock price through the potential use of the tax report information by the dealer when setting prices if the tax report is publicly disclosed. Because the net liquidation value V of the asset traded in the financial market is the net payoff after taxes and penalties, it is important to emphasize that the firm's true liquidation value is revealed after the tax agency inspection has taken place.

When the manager chooses demand d for the asset, he does not know whether the tax audit will discover the firm's true payoff of the firm. However, he can anticipate the intensity of the tax inspection as a function of the tax report θ that he submits. Therefore, the manager buys the asset, $d = 1$, if his expectation of the firm's net liquidation value V is higher than the price posted in the financial market by the dealer and, conversely, he sells the asset, $d = -1$, if his expectation about V is lower than the posted price. Remember that because the manager has perfect information about the realization of the project, his expectation about the liquidation value V is always closer to the real value than the dealer's. Therefore, if the payoff of the project is $y = 0$, the manager sells at the bid price. In this case the bid price is larger than the liquidation value expected by the manager because of the noise in the financial market associated with the presence of noise traders. Note that this noise prevents the dealer from knowing for sure that the sell order comes from a manager of a firm running an unsuccessful project and, thus, he has to assign a positive probability to the event that the sell order is initiated by a noise trader. Otherwise, when the payoff of the project 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. Finally, if the manager is not selected for trading, then his demand is zero, $d = 0$, and thus he makes zero profit.

Similarly, the event tree for trade in the financial market is represented in Figure 2. In its terminal nodes we report the order flow ω and the asset demand d for the manager, which, as explained above, depends on whether he is selected for trading and on his private information about the project payoff.

since we model the financial markets as a zero-sum game (the expected profits from trading obtained by informed agents are fully offset by the losses incurred by liquidity traders), the taxes on capital gains and losses also offset each other.

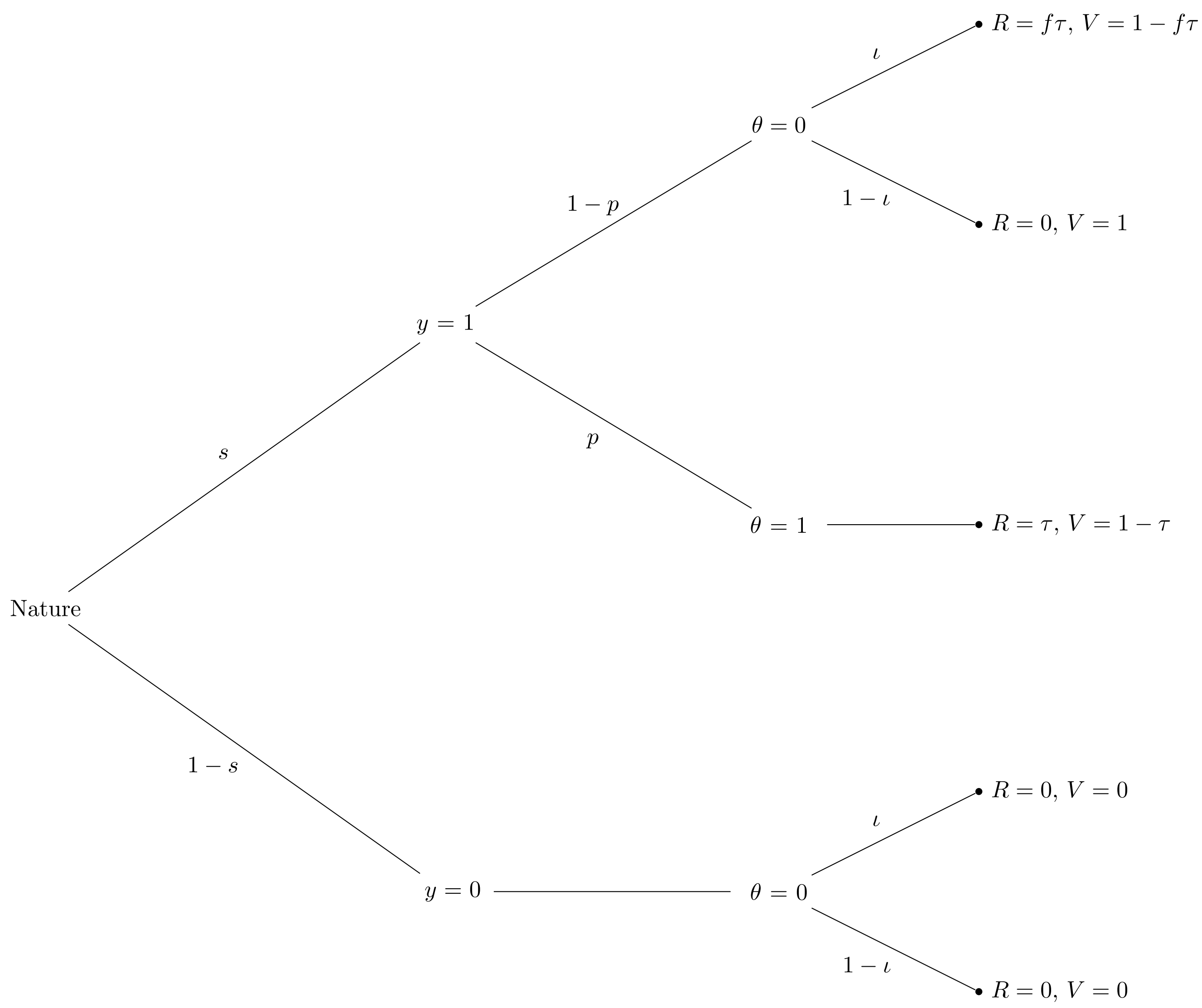

Figure 1: The tree diagram for the interaction between the manager and the tax agency

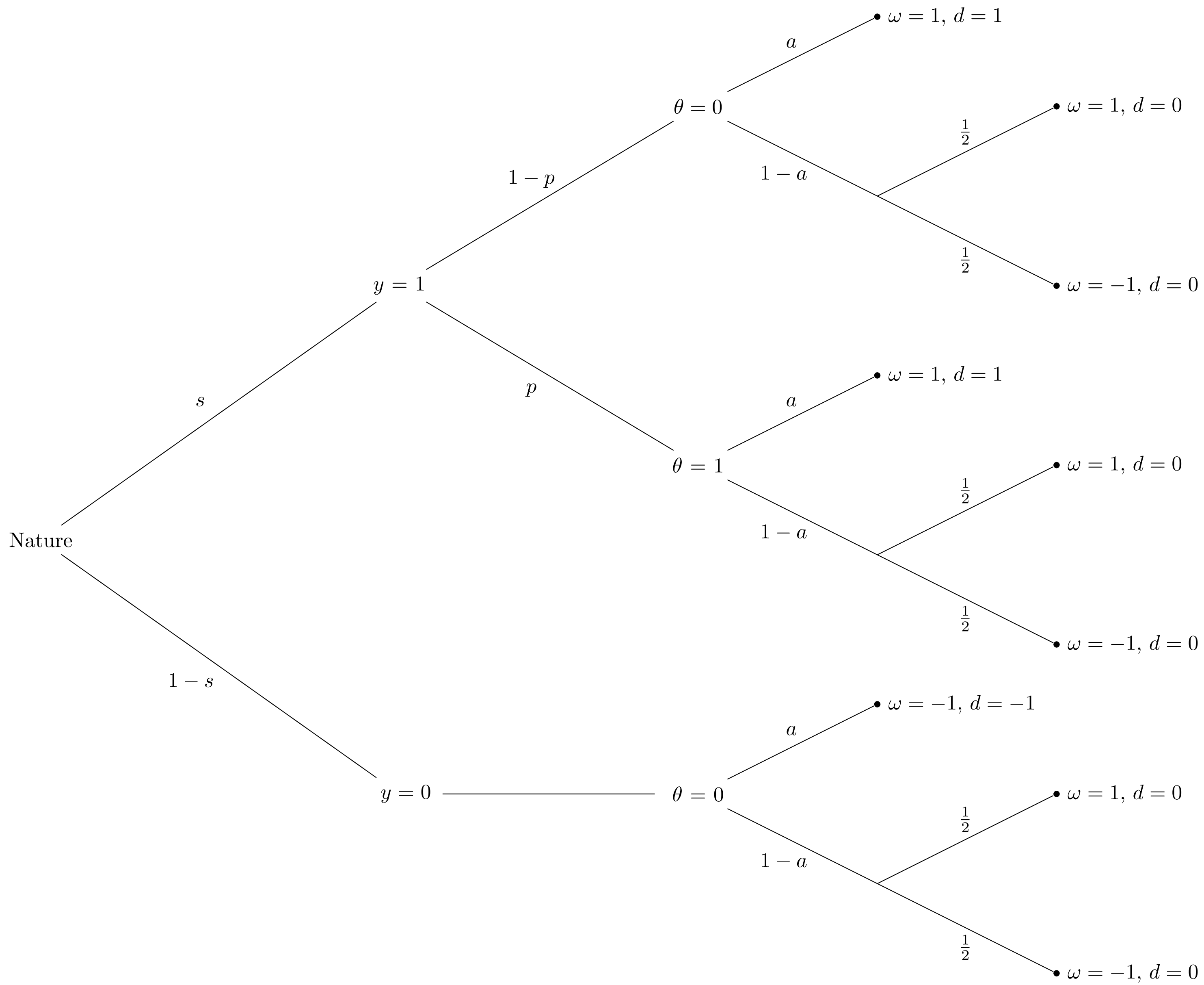

Figure 2: The tree diagram for the interaction between the manager and the dealer

2.3. Timing of the Model and Equilibrium Concept

The strategic interaction between the manager and the tax agency is illustrated in Figure 1, whereas that between the manager and the dealer is presented in Figure 2. Because agents face uncertainty under asymmetric information, we search for a Bayesian Nash Equilibrium (BNE), that is, for the set of strategy profiles that maximize the expected payoff for each agent given their beliefs and given the strategies played by the other agents. In this equilibrium, the agents update their prior beliefs using Bayes' rule. Note that we allow the manager to play a mixed strategy when deciding the truthfulness of the submitted tax report since, as we will see, an equilibrium in pure strategies may fail to exist when the tax report is not disclosed. However, the BNE admits pure strategies for the rest of the players (dealer and tax agency) of this game.

We summarize the timing of the model as follows:

1. Nature draws the realization of the project's payoff y. The project is successful ($y = 1$) with probability s and fails ($y = 0$) with probability $1 - s$.
2. The manager observes his private information about the firm's payoff and chooses the probability p of reporting truthfully if $y = 1$. If $y = 0$, he reports $\theta = 0$.
3. If the report submitted to the tax agency is $\theta = 0$, the tax agency chooses the inspection intensity ι so as to maximize the expected net revenue collected from taxpayers. If the report submitted is $\theta = 1$, the firm is not inspected.
4. The dealer sets bid and ask prices. If the report is made public the dealer sets the bid and ask prices conditioning on the information contained in the order flow ω and the tax report θ submitted by the manager. Otherwise, bid and ask prices do not depend on the value of the tax report but only on ω. Investors trade in the financial market at the prices set by the dealer.
5. The potential inspection by the tax authority takes place and the value of the firm becomes public. Investors receive the corresponding payoffs (the value of the firm net of both taxes and penalties, where the latter may arise if the firm is audited).

3. Equilibrium

3.1. Inspection Policy

To calculate the expected net revenue collected by the tax agency we use the gross revenue and the information in the event tree in Figure 1. The manager reports high profits $\theta = 1$ only if the payoff of the project is $y = 1$ so that $P(y = 1|\, \theta = 1) = 1$, where $P(y|\, \theta)$ is the probability of the project payoff conditional on the report. This implies that the tax agency never inspects a firm reporting high profits as it cannot raise more revenue than the amount τ per share. Note that the manager reports $\theta = 1$ with probability sp.

The expected net revenue per share NR raised by the tax agency when $\theta = 0$ is

$$\mathbb{E}(NR \mid \theta = 0) = \iota f\tau \cdot P\left(y = 1 \middle| \theta = 0\right) - \frac{c}{2}\iota^2. \tag{1}$$

Thus, if the true payoff of the project is $y = 1$, the firm faces a penalty for misreporting because the tax agency discovers with the corresponding probability ι that the payoff of the project undertaken by the firm was $y = 1$ whereas the manager reported $\theta = 0$. Moreover, if the report is $\theta = 0$ but the payoff of the project is $y = 0$, the tax agency also audits the firm with intensity ι. However, because the outcome of the project was indeed low, the tax agency ends up facing the auditing cost but not collecting any penalty. Finally, note that the manager reports $\theta = 0$ with probability $s(1-p)+(1-s)$.

Using the tree of events depicted in Figure 1 and applying Bayes' rule we can compute the probability that the project is successful when a low profit report is submitted,

$$P\left(y = 1 \middle| \theta = 0\right) = \frac{s(1-p)}{s(1-p) + (1-s)}.$$

Because the probability of inspection $\iota \in [0, 1]$ when the manager reports low profits to the tax authority, $\theta = 0$, maximizes (1), the optimal intensity ι of inspection is

$$\iota = \min\left\{\frac{f\tau}{c} P\left(y = 1 \middle| \theta = 0\right), 1\right\} = \min\left\{\frac{f\tau}{c}\left[\frac{s(1-p)}{s(1-p) + (1-s)}\right], 1\right\}. \tag{2}$$

Note that the first term inside the min operator is strictly decreasing in the probability p that the manager tells the truth when the project is successful. The inspection intensity selected by the tax agency decreases with the probability p of a truthful report because a low p value results in a larger expected revenue from penalties on evaded profits accruing from the inspection.

Therefore, the expected net revenue collected by the agency is

$$\mathbb{E}\left(NR\right) = sp\tau + \left(s(1-p) + (1-s)\right)\left(\iota f\tau \cdot P(y = 1 \,|\theta = 0) - \frac{1}{2}c\iota^2\right). \tag{3}$$

The first term in (3) refers to the expected taxes paid. These taxes accrue when the project is successful and the manager reports the truth, which occurs with probability sp. The second term refers to the penalty net of audit costs when the agency inspects a firm reporting low profits with intensity ι, which occurs with probability $s(1-p)+(1-s)$. Note that $s(1-p)$ is the probability that a successful firm falsifies its tax report and the $1-s$ is the probability that the project fails, which results in a truthful low-profit report.

3.2. Disclosure of the Tax Report

Let us consider here the case where the tax agency makes the tax report public. Because the manager's tax report affects the inspection intensity of the tax agency, there are always two channels through which the report affects the firm's net payoff. The first direct channel is associated with the direct 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, and the penalties the firm has to pay if the manager misreports and gets caught.

Moreover, there is a third channel affecting the manager's profits when the tax report is made public. This third channel is associated with the effect that the public tax report has on the dealer's pricing strategies. Note that the firm's liquidation value is affected by the taxes and penalties paid by the firm and, hence, the dealer uses the information contained in the tax report about these payments when setting the asset price. Because the manager trades in the financial market to maximize the expected profit from trading, he has to take into account these three effects when deciding what to report.

Similar 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 for by the losses incurred by the informed trader and vice versa. When the dealer observes a buy he sets an ask price, whereas when he observes a sell he sets a bid price. Note, however, that when the tax report is made public the dealer has an additional piece of information, and he sets the ask price and bid price depending on the realization of the tax report θ. Thus, for a buy order and a high profit tax report the ask price equals

$$A(1) \equiv A(\theta = 1) = \mathbb{E}\left[V \mid \omega = 1,\ \theta = 1\right],$$

whereas for a buy order and a low profit tax report the ask price is

$$A(0) \equiv A(\theta = 0) = \mathbb{E}\left[V \mid \omega = 1,\ \theta = 0\right].$$

Similarly the bid price for a high profit tax report is

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

whereas for a sell order and a low profit tax report the bid price is

$$B(0) \equiv B(\theta = 0) = \mathbb{E}\left[V \mid \omega = -1, \theta = 0\right].$$

To calculate these prices, that is, the corresponding conditional expectations, we need to find the conditional probabilities, which depend on the probability of whether the manager chooses to report truthfully to maximize his expected profit from trading. Evidently, if the manager declares high profits, then $y = 1$ so that the firm's after-tax value is $1 - \tau$ and, thus, the corresponding ask and bid prices satisfy

$$A(1) = B(1) = 1 - \tau. \tag{4}$$

We use the subindex D to denote the disclosure case, that is, the case when the tax report is made public. Let p_D and ι_D denote the probability of submitting a truthful report and the inspection intensity in the disclosure case, respectively. Using the event tree in Figure 2 and Bayes' rule we can compute the following ask and bid prices when the firm declares low profits:

$$A(0) = \frac{s(1-p_D)\left(a + \frac{1}{2}(1-a)\right)(1-\iota_D f\tau)}{s\left(a+\frac{1}{2}(1-a)\right)(1-p_D) + (1-s)\frac{1}{2}(1-a)} = \frac{s(1-p_D)(1+a)(1-\iota_D f\tau)}{s(1-p_D)(1+a) + (1-s)(1-a)} \tag{5}$$

and

$$B(0) = \frac{s(1-p_D)\frac{1}{2}(1-a)(1-\iota_D f\tau)}{s(1-p_D)\frac{1}{2}(1-a) + (1-s)\left(a+\frac{1}{2}(1-a)\right)} = \frac{s(1-p_D)(1-a)(1-\iota_D f\tau)}{s(1-p_D)(1-a) + (1-s)(1+a)}. \tag{6}$$

On the one hand, when the tax report is $\theta = 0$, the firm's expected value is 1 if the project is successful (which occurs with probability s), the manager cheats (which occurs with probability $1 - p_D$), and the tax agency does not discover the truth (which occurs with probability $1 - \iota_D$). On the other hand, because the firm has to pay the fine on the amount of taxes evaded, the value of the firm is $1 - f\tau$ when the project is successful, the manager cheats, and the tax agency discovers the truth (which occurs with probability ι_D). Therefore, the expected value of a firm running a successful project and reporting $\theta = 0$ is $1 - \iota_D f\tau$. Note that the probability that the investor selected for trading is a buyer and, thus, that the transaction will take place at the ask price is

$$s(1-p_D)\left(a + \frac{1}{2}(1-a)\right) + (1-s)\frac{1}{2}(1-a),$$

whose first term is the probability that the project is successful, the manager cheats ($\theta = 0$), and a trader (either the manager or the noise trader) buys. In this case, the manager always buys if he is selected for trading, which occurs with probability a. The second term is the probability of a buy order when the project fails, therefore, this order can only come from a noise buyer.

Similarly, the probability that the agent selected for trading is a seller and, thus, that the transaction will take place at the bid price is

$$s(1-p_D)\frac{1}{2}(1-a)+(1-s)\left(a+\frac{1}{2}(1-a)\right).$$

The first term is the probability of a sell order when the project is successful and the manager cheats ($\theta = 0$). Therefore, this order can only come from a noise seller. The second term is the probability that that the project fails and the trader (either the manager or a noise trader) sells. Note that, in this case, the manager always sells if he is selected for trading, which occurs with probability a.

When the manager reports low profits, both the ask and bid prices $A(0)$ and $B(0)$ are decreasing in the probability p_D of reporting the truth when $y = 1$. This is because all the reported profits are taxed for sure and this results directly in smaller after-tax firm value. Moreover, it is clear from (5) that $A(0) < 1 - \iota_D f\tau$ for all $p_D \in [0, 1]$. This means that the manager decides to buy the firm's share because the price $A(0)$ that he has to pay is strictly lower than the expected firm value $1 - \iota_D f\tau$ after the inspection. Note that this occurs because prices reflect imperfectly the private information of the manager due to the existence of noise trading. In this respect, it is immediate to see that information revelation increases when the probability of selecting a noise investor for trading decreases, that is, when a increases. Similarly, the bid price $B(0)$ is strictly positive when $p_D < 1$ and therefore, in this case, the manager sells the traded asset because he knows that its value is zero.

The manager's trading profit equals the firm's net liquidation value V minus the ask price, when he buys, and the bid price minus the liquidation value V when he sells. Moreover, the manager buys whenever $y = 1$ and sells when $y = 0$. Let Π_D denote the manager's profit in the disclosure case. We can write the total expected profit of the manager when the tax report is disclosed, $\mathbb{E}\left[\Pi_D\right]$, as a function of the probability p_D of truthful reporting when the manager knows that the project is successful,

$$\mathbb{E}\left[\Pi_D\left(p_D\right)\right] = a\left\{s\left(1-p_D\right)\left[1-\iota_D f\tau - A\left(0\right)\right]+\left(1-s\right)B(0)\right\}. \tag{7}$$

Note that the term $1-\iota_D f\tau$ in (7) is the expected liquidation value in case the project is successful, which occurs with probability s; the manager misreports, which occurs with probability $1 - p_D$; and he is selected for trading, which occurs with probability a. In this case, the manager buys the asset at the price $A(0)$. Moreover, if the project is unsuccessful and the manager is selected for trading, which occurs with probability $a(1-s)$, the manager sells at the price $B(0)$ an asset having zero value. When the manager is not selected for trading or when the project is successful and he tells the truth (so that the value of the firm equals the price set by the dealer), the manager obtains zero profits from trading. Note that, as the probability of telling the truth decreases, the manager makes less profit every time he trades (because the ask price decreases with the probability of telling the truth), but he makes these profits more often as the probability of being selected for trading and misreporting a successful project is $as(1-p_D)$.

The optimal probability of reporting truthfully chosen by the manager is thus

$$p_D^* = \arg\max_{p_D} \mathbb{E}\left[\Pi_D\left(p_D\right)\right].$$

As $A(0) < 1 - \iota_D f \tau$ the manager will make a positive profit when he buys the asset after submitting a low profit report. Therefore, the expected profit of the manager in (7) decreases with the probability of telling the truth, p_D when the project is successful. As a result, it is optimal for the manager to choose the probability of telling the truth $p_D = 0$ so that he always reports low profits, $\theta = 0$, regardless of the realization of project payoff y. Therefore, the tax report submitted by the manager and made public by the tax authority is always completely uninformative about the true income of the firm.

Finally, we can find the equilibrium probability ι_D of the tax agency discovering the true corporate income. Evaluating (2) when $p = 0$, we get

$$\iota_D^* = \min\left\{\frac{sf\tau}{c}, 1\right\}. \tag{8}$$

Note that, if the value of the cost parameter c is low, the tax agency faces a low cost associated with the effort geared towards increasing its success in discovering the true income of the firm. In particular, if $c \leq sf\tau$, then the tax agency is very efficient and always discovers the true income of the firm, $\iota_D^* = 1$. However, if $c > sf\tau$ then there is a positive probability that the inspection is unsuccessful when the manager reports low profits, that is, $\iota_D^* = sf\tau/c < 1$.

Because we have characterized the manager's tax reporting, the tax agency's auditing intensity, and the dealers' pricing strategies, we can characterize the equilibrium ask and bid prices, the audit intensity, and the equilibrium tax report, just by evaluating the strategies of the dealer and the tax agency at the manager's optimal reporting strategy, which comprises reporting low profits for all realizations of y. The following proposition characterizes these equilibrium values:

Proposition 1. *If the tax report is publicly disclosed, then the equilibrium probability of the manager telling the truth when the project is successful is* $p_D^* = 0$*, that is,* $\theta = 0$ *either when* $y = 1$ *or when* $y = 0$*.*

The manager buys the asset, $d_D = 1$*, when the project is successful and sells the asset,* $d_D = -1$*, when the project fails.*

The equilibrium inspection intensity set by the tax agency is

$$\iota_D^* = \begin{cases} \dfrac{sf\tau}{c} & \text{if} \quad c \geq sf\tau, \\ 1 & \text{if} \quad c < sf\tau. \end{cases} \tag{9}$$

The equilibrium ask and bid are

$$A_D^* = \begin{cases} \dfrac{s(1+a)}{s(1+a)+(1-s)(1-a)}\left(1-\dfrac{sf^2\tau^2}{c}\right) & \text{if} \quad c \geq sf\tau, \\ \dfrac{s(1+a)}{s(1+a)+(1-s)(1-a)}(1-f\tau) & \text{if} \quad c < sf\tau, \end{cases} \tag{10}$$

and

$$B_D^* = \begin{cases} \dfrac{s(1-a)}{s(1-a)+(1-s)(1+a}\left(1-\dfrac{sf^2\tau^2}{c}\right) & \text{if} \quad c \geq sf\tau, \\ \dfrac{s(1-a)}{s(1-a)+(1-s)(1+a)}(1-f\tau) & \text{if} \quad c < sf\tau. \end{cases} . \tag{11}$$

Note that if $c < sf\tau$ then both prices are non-negative as $f\tau \leq 1$. Moreover, $c \geq sf\tau$ implies that $sf^2\tau^2/c \leq 1$ therefore, the corresponding ask and bid prices are also non-negative in this case. It is clear from the previous expressions that the bid-ask spread $A_D^* - B_D^*$, is always non-negative.

3.3. No Disclosure of the Tax Report

Now we consider the case in which the tax report is not made public and, therefore, the dealer sets the prices independent of the value of the tax report but still dependent on the order flow he receives. Here, we disregard the possibility that the firm discloses the report submitted to the tax agency by assuming that firms commit not to disclose this information. The case where there is lack of commitment (which means that, conditional on observing the payoff of the project, the manager may or may not disclose the tax report) introduces another layer of potential falsification of the submitted report. Because the report cannot be verified, the tax agency cannot comment on the veracity of the report as it would violate the no-disclosure regime in this case.

The ask and bid price in the no-disclosure regime are

$$\begin{aligned} A_{ND} &= \mathbb{E}\left[V \mid \omega = 1\right] = \frac{s\left(a+\frac{1}{2}(1-a)\right)\left[(1-p_{ND})(1-\iota_{ND}f\tau)+p_{ND}(1-\tau)\right]}{s\left(a+\frac{1}{2}(1-a)\right)+(1-s)\frac{1}{2}(1-a)} \\ &= \frac{s(1+a)\left[(1-p_{ND})(1-\iota_{ND}f\tau)+p_{ND}(1-\tau)\right]}{s(1+a)+(1-s)(1-a)} \end{aligned} \tag{12}$$

and

$$\begin{aligned} B_{ND} &= \mathbb{E}\left[V \mid \omega=-1\right] = \frac{s\frac{1}{2}(1-a)\left[(1-p_{ND})(1-\iota_{ND}f\tau)+p_{ND}(1-\tau)\right]}{s\frac{1}{2}(1-a)+\frac{1}{2}(1-s)(1+a)} \\ &= \frac{s(1-a)\left[(1-p_{ND})(1-\iota_{ND}f\tau)+p_{ND}(1-\tau)\right]}{s(1-a)+(1-s)(1+a)}, \end{aligned} \tag{13}$$

respectively, where we use the subindex ND to denote the case where the tax report is not made public.

Similar to the disclosure case, the manager makes a positive profit from buying the asset when the project run by the firm is successful, $y=1$, and from selling the asset when the project fails. Moreover, the expected liquidation value of a share when the project is successful and the manager reports $\theta=0$ is equal to $1-\iota_{ND}f\tau$, where ι_{ND} is the inspection intensity (or the probability of discovering the true income) in the no-disclosure regime when a low profits report is received by the tax agency.

Note that the previous expressions (12) and (13) are remarkably similar to those of (5) and (6) with two differences: the new last term in the respective numerators and the expressions for the denominators. For the ask price A_{ND}, note that when the project is successful and a trader buys, which occurs with probability $a+\frac{1}{2}(1-a)$, the value of the firm is $1-\tau$ if the manager reports truthfully, which occurs with probability p_{ND}. Concerning the bid price B_{ND}, note that when the project is successful and a trader sells, then this trader has to be a noise seller, which is selected with probability $\frac{1}{2}(1-a)$, and the value of the firm is also $1-\tau$. The denominators of (12) and (13) collect the probabilities that a trader buys or sells, respectively.

However, in the no-disclosure regime, because the dealer does not set prices dependent on the report, the manager also makes a profit from trading when the payoff is $y=1$ and he decides to report truthfully. In this case, the liquidation value is $1-\tau$, which is again higher than the ask price set by the dealer because of the existence of noise trading. Remember that when the tax agency receives a high profit report, no inspection takes place and the firm pays the amount τ per share. Finally, when the project is unsuccessful, the existence of noise traders, allows the manager to make a profit by selling the asset (which has zero liquidation value) at a positive bid price. Therefore, the manager's total expected profit is now equal to

$$\mathbb{E}\left[\Pi_{ND}\left(p_{ND}\right)\right]=a\left\{s\left[\left(1-p_{ND}\right)\left(1-\iota_{ND}f\tau-A_{ND}\right)+p_{ND}\left(1-\tau-A_{ND}\right)\right]\left(1-s\right)B_{ND}\right\}. \tag{14}$$

The optimal probability of the manager choosing to report truthfully in the no-disclosure regime is therefore

$$p^*_{ND} = \arg\max_p \mathbb{E}\left[\Pi_{ND}(p_{ND})\right].$$

From the first-order condition of the maximization of the manager's expected profit with respect to p_{ND} we obtain three cases. If the inspection intensity chosen by the tax agency is such that $\iota_{ND} = 1/f$, then the strategic manager is indifferent between telling the truth and falsifying his tax report. Therefore, any value of $p_{ND} \in [0,1]$ is a solution of the problem concerning the reporting strategy. If $\iota_{ND} < 1/f$, then the manager chooses optimally to cheat, $p_{ND} = 0$, as there is a low probability that the tax agency will discover the true profit. Finally, if the probability that the tax agency discovers the truth is sufficiently high, $\iota_{ND} > 1/f$, then the manager decides optimally to declare the true profit, $p_{ND} = 1$.

As in the case with the tax report disclosure, the optimal inspection policy involves the audit intensity (i.e., the probability of discovering the truth) given by (2). Thus, the mixed strategies Nash equilibrium for the the manager and the tax agency results from solving the following system of equations for p_{ND} and ι_{ND} :

$$p_{ND} = \begin{cases} \text{any } p_{ND} \in [0,1] & \text{if} \quad \iota_{ND} = 1/f, \\ 0 & \text{if} \quad \iota_{ND} < 1/f, \\ 1 & \text{if} \quad \iota_{ND} > 1/f, \end{cases} \tag{15}$$

$$\iota_{ND} = \begin{cases} \dfrac{f\tau}{c}\left[\dfrac{(1-p_{ND})s}{(1-p_{ND})s+(1-s)}\right] & \text{if} \quad \dfrac{f\tau}{c}\left[\dfrac{(1-p_{ND})s}{(1-p_{ND})s+(1-s)}\right] \leq 1, \\ 1 & \text{if} \quad \dfrac{f\tau}{c}\left[\dfrac{(1-p_{ND})s}{(1-p_{ND})s+(1-s)}\right] < 1. \end{cases} \tag{16}$$

Lemma 1. *If the tax report is not publicly disclosed, then the equilibrium values for the inspection intensity ι_{ND} and the probability p_{ND} of reporting a high profit when the project is successful are*

$$\iota^*_{ND} = \begin{cases} \dfrac{sf\tau}{c} & \textit{if} \quad c \geq sf^2\tau, \\ \dfrac{1}{f} & \textit{if} \quad c < sf^2\tau, \end{cases} \tag{17}$$

and

$$p^*_{ND} = \begin{cases} 0 & \textit{if} \quad c \geq sf^2\tau, \\ 1 - \dfrac{(1-s)\,c}{s\,(f^2\tau - c)} & \textit{if} \quad c < sf^2\tau. \end{cases} \tag{18}$$

Note that the inspection intensity set by the tax authority in equilibrium when $c < sf^2\tau$ is such that the manager is indifferent between submitting a truthful or false report when the project is successful, because in both cases, the profit arising from buying the asset is $1-\tau-A_{ND}$ as can be seen from (14). This also means that the expected after-inspection tax revenue associated with a low report when $y=1$ is equal to τ per share. Furthermore, note that in this case the probability of submitting a truthful tax report is strictly decreasing in c as the derivative of p^*_{ND} with respect to c when $c<sf^2\tau$ is $-(1-s)f^2\tau \Big/ s\left(f^2\tau-c\right)^2 < 0$. Moreover, the probability p^*_{ND} of reporting truthfully tends to one as the value of the cost parameter c faced by the tax agency tends to zero. The more inefficient the tax agency in auditing the firm, the lower the incentives for submitting truthful tax reports are. Figure 3 displays the reaction functions for the tax agency and for the manager. The reaction function for the manager is given by the solid line. The dotted curve is the reaction function for the tax agency when it faces a high inspection cost so that the manager always chooses optimally to misreport ($p^*_{ND}=0$). The dashed line is the reaction function of a more efficient tax agency, that is, when c is lower. In this latter case, the manager submits truthful reports with positive probability and the point where the dashed line intersects the solid line converges to $\iota^*=1/f$ and $p^*_{ND}=1$ as c converges to zero.

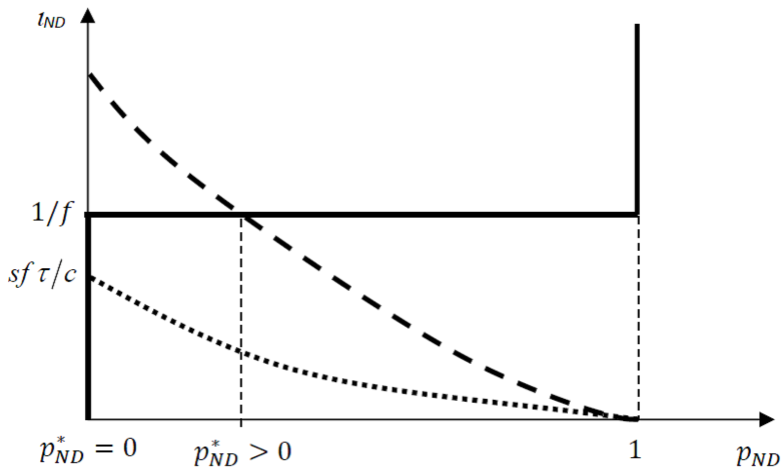

Figure 3: Reaction functions under no-disclosure. Dotted line: reaction function for the tax agency when c is high. Dashed line: reaction function for the tax agency when c is low. Solid line: reaction function for the manager.

Plugging in the ask and bid prices (12) and (13), respectively, the equilibrium expressions for the inspection intensity given by (17), and the probability of a truthful report when the project is successful given by (18), we obtain the equilibrium ask and bid prices under the no-disclosure regime. We summarize the equilibrium under no disclosure in the next proposition:

Proposition 2. *If the tax report is not publicly disclosed, then the equilibrium probability that the manager reports the truth when the project is successful is given by (18). Moreover, when the project* *fails, the manager always reports the truth,* $\theta = 0$.

The manager buys the asset, $d_{ND} = 1$, *when the project is successful and sells the asset,* $d_{ND} = -1$, *when the project fails.*

The equilibrium inspection intensity set by the tax agency when the manager reports low profits is given by (17), whereas the tax agency does not audit the firm if the manager reports high profits.

The equilibrium ask and bid prices are

$$A^*_{ND} = \begin{cases} \dfrac{s(1+a)}{s(1+a)+(1-a)(1-s)}\left(1-\dfrac{sf^2\tau^2}{c}\right) & \text{if} \quad c \geq sf^2\tau, \\ \dfrac{s\,(1+a)}{s(1+a)+(1-s)(1-a)}\,(1-\tau) & \text{if} \quad c < sf^2\tau, \end{cases} \tag{19}$$

and

$$B^*_{ND} = \begin{cases} \dfrac{s(1-a)}{s(1-a)+(1-s)(1+a)}\left(1-\dfrac{sf^2\tau^2}{c}\right) & \text{if} \quad c \geq sf^2\tau, \\ \dfrac{s\,(1-a)}{s(1-a)+(1+a)(1-s)}\,(1-\tau) & \text{if} \quad c < sf^2\tau. \end{cases} \tag{20}$$

From these expressions, it is clear that the bid-ask spread $A^*_{ND} - B^*_{ND}$ is always positive. Moreover, when $p^*_D = p^*_{ND} = 0$, tax reports are completely uninformative under both tax report disclosure regimes so that the auditing intensity under disclosure is identical to the intensity under no disclosure,

$$\iota^*_D = \iota^*_{ND} = \frac{sf\tau}{c}.$$

This equality between the two equilibria concerning inspection intensities and probability of truthful reports holds when the tax agency faces an inspection technology with a high cost, $c \geq sf^2\tau$. In this case, it also holds that $c > sf\tau$ because the penalty rate f is larger than one and thus under both regimes the ask and bid prices coincide, $A^*_D = A^*_{ND}$ and $B^*_D = B^*_{ND}$.

4. The Effects of Disclosure of Tax Reports

The tax report sent by the manager to the tax agency is an endogenous signal about the state of the nature faced by the firm. This signal can be disclosed by the tax agency and, thus, used by the dealer in order to make a better prediction about the firm's value when setting the price. Moreover, when the report is made public 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.

4.1. Market Performance Comparison

In this subsection, we consider two market performance indicators: the bid-ask spread and the insider's expected profit. Note that the spread measures the liquidity (or depth) of the market because a large spread means that prices are sensitive to the direction of trade so that buyers pay a high price whereas sellers get a low price. Evidently, a large spread is detrimental for the noise traders as their expected trading cost also becomes large. Note that the expected profit of a noise trader is simply $-(1-a)(A-B)/2$, which means that the expected trading cost faced by noise investors is proportional to the spread $A-B$.

We have shown above that the dealer sets prices to protect himself against the adverse selection problem caused by the fact that the informed manager buys/sells when he has good/bad information about the realization of the project. Therefore, in the disclosure case, the dealer anticipates that the expected liquidation value of a firm running a successful project is $1-\iota_D f\tau$ because in this case the informed manager always submits a false report, $\theta=0$. In the no-disclosure case, however, the manager trades when reporting both $\theta=0$ and $\theta=1$ and thus the expected liquidation value of a firm running a successful project is $(1-p_{ND})(1-\iota_{ND}f\tau)+p_{ND}(1-\tau)$. These differences in the dealer's expected liquidation value drive the corresponding differences in market performance.

We have already shown that when the inspection cost is high, $c \geq sf^2\tau$, then the ask and bid prices under both disclosure regimes coincide because, in both cases, the manager reports low profits. Consequently, the spreads under tax report disclosure and under no disclosure also coincide and, using (10), (11), (19) and (20), are equal to

$$A_D^*-B_D^*=A_{ND}^*-B_{ND}^*=\frac{4as(1-s)}{[s(1+a)+(1-s)(1-a)]\,[s(1-a)+(1-s)(1+a)]}\left(1-\frac{sf^2\tau^2}{c}\right). \quad (21)$$

Because $sf^2\tau^2/c < sf^2\tau/c \leq 1$, the previous spreads are positive. In this case, the firm always reports low profits and the inspection policy is the same under both regimes, which in turn implies that the market prices of the asset coincide.

When the cost parameter takes intermediate values, $c \in \left[sf\tau, sf^2\tau\right)$, then using (10) and (11), we find that the spread under tax report disclosure is the same as in (21). Similarly, using (19) and (20), the spread under no disclosure of the firm's tax report is

$$S_{ND}=A_{ND}^*-B_{ND}^*=\frac{4as(1-s)\,(1-\tau)}{[s(1+a)+(1-s)(1-a)]\,[s(1-a)+(1-s)(1+a)]}. \quad (22)$$

Because the inequality $sf^2\tau^2/c > \tau$ is equivalent to $sf^2\tau > c$, it can be easily seen that the spread S_D under disclosure is lower than the spread S_{ND} under no disclosure when $c \in \left[sf\tau, sf^2\tau\right)$. Note that, for this range of values for the cost parameter c, the firm is inspected with less intensity under the no-disclosure regime because there is a positive probability that the manager submits truthful tax reports, whereas it always cheats under disclosure,

$$\iota^*_{ND} = \frac{1}{f} < \frac{sf\tau}{c} = \iota^*_D$$

and

$$p^*_{ND} = 1 - \frac{(1-s)\,c}{s\,(f^2\tau - c)} > 0 = p^*_D.$$

As we have already mentioned, the tax agency's inspection policy under no disclosure implies that when the project is successful the firm's expected value is $1-\tau$, which is higher than under disclosure, $1 - sf^2\tau^2/c$. This is because because under tax report disclosure the probability of discovering that $y = 1$ when the manager reports low profits is $sf\tau/c$ and, in this case, the gross revenue to the government is $f\tau$. The dealer adjusts all the asset prices accordingly and this results in spreads being multiplied by the after-inspection value of the firm $1 - sf^2\tau^2/c$ and $1-\tau$ for the disclosure and no-disclosure regimes, respectively. These adjustments result, in turn, in a lower spread under tax report disclosure.

Finally, if the auditing cost is very low, $c < sf\tau$, then the spread under no disclosure becomes the same as when $c \in \left[sf\tau, sf^2\tau\right)$, which is given in (22), whereas the spread under tax report disclosure is

$$S_D = A^*_D - B^*_D = \frac{4as(1-s)(1-f\tau)}{\left[s(1+a)+(1-s)(1-a)\right]\left[s(1-a)+(1-s)(1+a)\right]}, \tag{23}$$

as follows from (10) and (11). Because $\tau < f\tau$ as $f > 1$, we conclude that the spread under disclosure is also lower than under no disclosure. Again, this occurs because the dealer adjusts all the asset prices taking into account that the firm is more likely to be inspected when the tax report is disclosed and, thus, the expected liquidation value will be closer to the true payoff of the firm. We can summarize the previous analysis with the following proposition:

Proposition 3. *If $c \geq sf^2\tau$, then the spreads under tax report disclosure and under no disclosure are equal, whereas if $c < sf^2\tau$, then the spread under disclosure is strictly smaller than that under no disclosure.*

When the auditing cost c is sufficiently high, the manager reports a low profit in both the disclosure and the no-disclosure regimes and, therefore, the spreads coincide. However, when the auditing cost becomes smaller, the asset prices become different under the two disclosure regimes. In this latter case, it is important to point out that when the manager's private information is publicly disclosed, the expected outcome should be a reduction of the information asymmetry between an insider trader and the dealer, which results in a reduction of the spread. Therefore, the result of the previous proposition

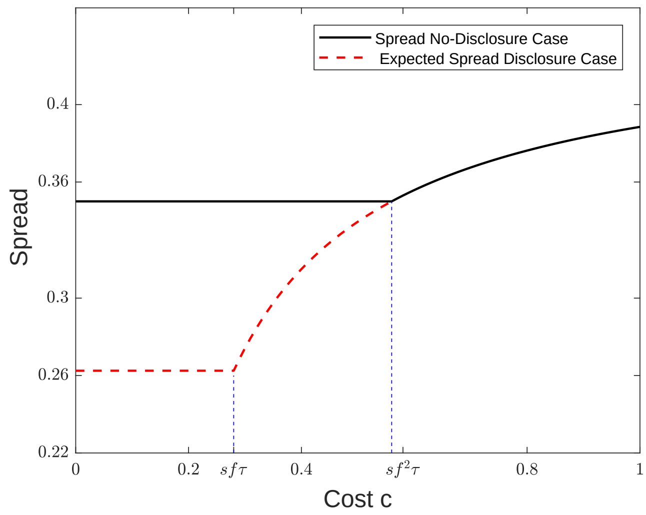

Figure 4: Spreads under disclosure and under no-disclosure. Parameter values: $a = 0.5$, $s = 0.7$, $\tau = 0.2$ and $f = 2$.

should not come as a surprise at first glance. However, because the manager always cheats in the disclosure regime, there is no information content in the tax report. This means that the dealer has the same information under both regimes. Thus, the difference in the spreads arises because, as we have explained above, the dealer adjusts the bid and ask prices to account for the different value of the firm, but not because the information asymmetry becomes smaller.

Figure 4 shows the spreads for the two disclosure regimes. We see that for values of c larger than $sf^2\tau$ the two spreads are equal. However, in the interval $\left(0, sf^2\tau\right)$ the spread under disclosure is lower than under no disclosure. Moreover, for $c < sf^2\tau$ the spread under no disclosure is independent of c, whereas the same occurs for the spread under disclosure for $c < sf\tau$. Therefore, policy makers may conclude that the public disclosure of the firm's tax report is beneficial for market performance because it reduces both the spread and trading costs.

Corollary 2. *(a) If $c \geq sf^2\tau$, then the spreads under no tax report disclosure are increasing in the value c associated with the inspection cost, whereas it is independent of c when $c < sf^2\tau$.*

(b) If $c \geq sf\tau$, then the spreads under tax report disclosure are increasing in the value c associated with the inspection cost, whereas it is independent of c when $c < sf\tau$.

We see thus that the tax report disclosure effect on spreads depends on the tax agency's effectiveness: the lower the tax agency monitoring cost, the lower the spread. Moreover, when the tax agency is very inefficient, there is no difference between spreads when we compare the disclosure case with the no-disclosure case. This is an important implication as it suggests that countries with more efficient tax agencies, have more liquid financial markets.

The expected profit that the manager receives from trading in the financial market is another measure of market performance as it captures the rent that an insider trader can extract from using his informational advantage. Similar to Glosten and Milgrom (1985), this measure can be obtained directly from the spread, because the expected loss of the noise traders equates the expected profit of the insiders. Using the equilibrium values for the probability of sending a truthful report ($p_D^* = 0$), the ask and bid prices A_D^* and B_D^* given by (10) and (11), and the inspection intensity ι_D^* given by (10) in the expression for expected profits $\mathbb{E}(\Pi_D)$ for the insider given by (7), we obtain the following formula for the insider's expected profit under the tax report disclosure regime:

$$\mathbb{E}(\Pi_D) = \begin{cases} \dfrac{2a(1-a)s(1-s)}{[s(1+a)+(1-s)(1-a)]\,[s(1-a)+(1-s)(1+a)]}\left(1-\dfrac{sf^2\tau^2}{c}\right) & \text{if} \quad c \geq sf\tau, \\ \dfrac{2a(1-a)s(1-s)}{[s(1+a)+(1-s)(1-a)]\,[s(1-a)+(1-s)(1+a)]}(1-f\tau) & \text{if} \quad c < sf\tau. \end{cases} \tag{24}$$

Similarly, if the tax report is not disclosed, using the equilibrium values for the probability p_{ND}^* of sending a truthful report given by (18), the ask and bid prices A_{ND}^* and B_{ND}^* given by (19) and (20), and the inspection intensity ι_D^* given by (17) in the expression for expected profits $\mathbb{E}(\Pi_{ND})$ for the insider (14), we obtain the following:

$$\mathbb{E}(\Pi_{ND}) = \begin{cases} \dfrac{2a(1-a)s(1-s)}{[s(1+a)+(1-s)(1-a)]\,[s(1-a)+(1-s)(1+a)]}\left(1-\dfrac{sf^2\tau^2}{c}\right) & \text{if} \quad c \geq sf^2\tau, \\ \dfrac{2a(1-a)s(1-s)}{[s(1+a)+(1-s)(1-a)]\,[s(1-a)+(1-s)(1+a)]}(1-\tau) & \text{if} \quad c < sf^2\tau. \end{cases} \tag{25}$$

It is then evident from (24) and (25) that the comparison between the expected profits from trading obtained by the manager under the two regimes follows the same pattern as the comparison between the spreads, which involves only the comparison of the terms $sf^2\tau^2/c$, $f\tau$, and τ in the corresponding expressions. The comparison between the expected trading profits is presented in the following proposition:

Proposition 4. *If $c \geq sf^2\tau$, then the insider's expected profit under tax report disclosure and under no disclosure are equal, whereas if $c < sf^2\tau$, then the insider's expected profit under disclosure is strictly smaller than under no disclosure.*

This proposition's result agrees with that of Proposition 3: disclosure reduces both the trading cost for the noise traders and the expected profits of insider traders. Note that, even if the tax agency does not disclose the tax report submitted by the firm, it could be optimal for the manager to voluntarily disclose the tax report. In fact, even if in the United States it is illegal to disclose information other than the own information, managers might find it useful to disclose their information about the tax return to the market participants at large. However, ex-ante (before observing the payoff of the firm) the manager does not have any incentive to do so because his expected profit is higher in the non-disclosure case. When we compare the expected profits of the manager under disclosure and no disclosure, we find that the manager obtains higher expected profits under the no-disclosure regime. According to the revelation principle, when the manager discloses the firm's tax report, he reveals whether the project is successful or not. The same occurs if he discloses when the project is successful and does not disclose when the project fails, or vice versa. Because disclosure is always detrimental to the manager's expected profit, he should optimally decide not to disclose the information contained in the tax report.

Another measure of market performance refers to the volatility of prices measured by their variance. Because in the two disclosure regimes the probability of a transaction at the ask price is $\pi = sa + \frac{1}{2}(1-a)$, it is clear that the price variance is $\pi(1-\pi)(A-B)^2$. The comparison of spreads between the two disclosure regimes immediately yields the following result:

Corollary 3. *If $c \geq sf^2\tau$, then the price volatilities under tax report disclosure and under no disclosure are equal, whereas if $c < sf^2\tau$, then the price volatility under no-disclosure is strictly larger than under disclosure.*

Finally, we discuss a measure concerning the amount of information revealed by prices about the true payoff of the project run by the firm. A typical measure for price informativeness is the reduction in the variance of the payoff y when conditioning on prices. Note that in our binary setup conditioning on the price is equivalent to conditioning on the order flow ω. Therefore, the informative contents of prices can be measured by $Var(y) - Var(y|\omega)$. The unconditional variance of y is $Var(y) = s(1-s)$. Because tax reports are completely uninformative in the disclosure case and the (possibly truthful) report is not made public in the no-disclosure case, prices and, thus, order flows cannot embed the potential information that the manager releases through the tax report. The conditional variance $Var(y|\omega)$ depends on the value of ω (either 1 or -1) but it is the same under both regimes for both realizations of ω. This is because because in both disclosure regimes, the manager's trading strategy (buys whenever $y = 1$ and sells whenever $y = 0$) and the noise trading are governed by the same rules. This means that the conditional probability of a given value of y given a realization of ω for $y = 0, 1$ and $\omega = -1, 1$, is the same in both regimes. Therefore, because the conditional distribution of y given ω is the same, the conditional variance $Var(y|\omega)$ under disclosure will be exactly the same as under no disclosure.

4.2. Expected Tax Revenue Comparison

We are now interested in analyzing whether tax report disclosure is also beneficial for the tax agency from the point of view of the expected net revenue that it can collect. We consider all the components of the tax revenue, that is, taxes paid and penalties net of auditing costs, which are given by (3).

Plugging in (3) the equilibrium probabilities of a truthful report for successful projects and the optimal intensities (or probability of discovering the true income) of the inspection conducted by the tax agency obtained in Propositions 1 and 2 for the disclosure and the non-disclosure regimes, respectively, we get the following expected net government revenue when the tax report of the firm is disclosed:

$$\mathbb{E}\left(NR_D\right) = \begin{cases} \dfrac{(sf\tau)^2}{2c} & \text{if} \quad c \geq sf\tau, \\ sf\tau - \dfrac{c}{2} & \text{if} \quad c < sf\tau, \end{cases} \tag{26}$$

and the following when the tax report is not disclosed:

$$\mathbb{E}\left(NR_{ND}\right) = \begin{cases} \dfrac{(sf\tau)^2}{2c} & \text{if} \quad c \geq sf^2\tau, \\ s\tau - \dfrac{c\,(1-s)\,\tau}{2(f^2\tau - c)} & \text{if} \quad c < sf^2\tau. \end{cases} \tag{27}$$

Next, we will explain the trade-off between market performance and the expected net revenue raised by the tax agency. In particular, we show that, if a revenue maximizing tax agency has to decide whether to make tax reports public, it might select a non-disclosure policy despite it being detrimental to the financial market performance. 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 the expected net tax revenue is compatible with an efficient financial market.

The following proposition shows that the expected net tax revenue collected by the tax agency may be smaller or larger when the tax report is disclosed than when it is not disclosed. Therefore, when the tax report is disclosed, the manager's reporting strategy is affected in such a way that the expected net tax collection might be smaller than in a non-disclosure regime:

Proposition 5. *If $c \geq sf^2\tau$, then the expected net tax revenue raised by the tax agency under tax report disclosure is the same as under no disclosure. However, there exists a value $c^* \in \left(0, sf^2\tau\right)$ of the auditing cost c such that*

(a) the expected net tax revenue is higher under no disclosure than under disclosure if $c \in \left(c^*, sf^2\tau\right)$,

(b) the expected net tax revenue is higher under disclosure than under no disclosure if $c \in (0, c^*)$.

This proposition tells us that when the cost of inspection is sufficiently high, $c \geq sf^2\tau$, the manager

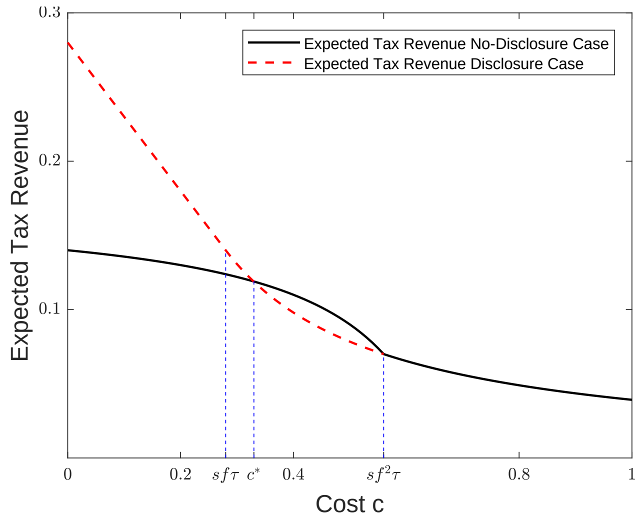

Figure 5: Expected net government revenues under disclosure and under no-disclosure. Parameter values: $a = 0.5$, $s = 0.7$, $\tau = 0.2$ and $f = 2$.

misreports the firm's payoff irrespective whether the tax report is disclosed and all the government revenue takes the form of penalties arising from audits conducted with the intensity $\iota = sf\tau/c$. If the firm's project is successful and c is just below the value $sf^2\tau$, the manager starts submitting truthful reports with positive probability when the tax reports are not disclosed, whereas it keeps hiding its true income under tax report disclosure. Note that when the manager starts telling the truth, the positive direct effect on tax collection (declared and paid) results in larger expected net revenue for the tax authority. In this case, the tax agency does not have incentives to disclose the tax report (because the tax revenue increases with the probability of the manager telling the truth). However, if the value of the auditing cost c is very low then the tax agency audits almost all the tax reports involving low profits (the ones with $\theta = 0$). Under no disclosure, the manager always tells the truth as $p_{ND} = 1$ converges to one as c approaches zero (see (18)) so that the expected net revenue converges to $s\tau$, which is the maximum expected net tax revenue that can be collected under truth-telling. However, under disclosure, the manager always misreports, $\theta = 0$, and if all the low profit reports are audited, the expected net revenue tends to $sf\tau$ as c approaches to zero. As a result, the tax agency might have no incentive to publicly disclose the report for low values of c because in this way it can collect larger tax penalties.

Figure 5 illustrates the comparison between the government's expected net revenue for the two disclosure regimes. We see that for values of c larger than or equal to $sf^2\tau$, the two expected net revenues coincide. However, there is an interval $\left(c^*,\ sf^2\tau\right)$ for the cost parameter c where disclosure is dominated by non-disclosure in terms of the government's expected net revenue. Finally, for $c \in (0, c^*)$, the expected revenue under disclosure is larger than under no disclosure. For values of c smaller than $sf^2\tau$ there is a positive probability that the manager submits truthful reports under no disclosure. Under tax report disclosure, the manager always submits false tax reports, and for $c < sf\tau$, all the tax reports are audited at the maximum intensity so that the probability of discovering a successful project is equal to one. Note that the expected net revenue converges to $sf\tau$ under disclosure and to $s\tau$ under no disclosure when c tends to zero.

A policy implication of this result is that, given that market efficiency and expected net tax revenue maximization may be conflicting objectives, when the efficient functioning of financial markets is the prevalent objective of lawmakers, disclosure of corporate tax reports should not be left in the discretionary hands of the tax agency (or in the hands of the government) but established by law.

4.3. Discussion

Our model allows us to analyze the interaction between a manager engaged in insider trading and the tax authority. The model captures some of the issues in the debate regarding the tax return disclosure and the different objectives of the IRS and SEC. Our results are thus relevant for the current policy and regulatory debate not only regarding the effects of disclosing tax returns, but also for the financial market efficiency.

The comparative statics exercises that we perform in Sections 4.1 and 4.2 give us two types of predictions: cross-sectional implications regarding the effect of tax efficiency on financial markets and implications regarding the tax return disclosure. We show that countries with more efficient tax agencies should also have more liquid financial markets. We find that the spread increases with the tax agency's monitoring cost, whereas the insider trading profit decreases with this monitoring cost. Alm and Duncan (2014) show that there is a large variation in tax agency efficiency across countries. The implications of our model, together with Alm and Duncan's (2014) findings, are that some of the cross-country variation that we observe in the indicators of financial market performance could be explained by the heterogeneity in tax collection efficiency. A cross-country analysis would therefore facilitate understanding of how tax efficiency affects transaction costs, spreads, and the probability of informed trading.

Our model also shows that tax return disclosure is beneficial for financial markets as it decreases spreads and informed traders's profits or, equivalently, the trading cost. This result in general is not new, as the effect of disclosure on reducing information asymmetry in financial markets is widely documented. However, as we have seen, in our model, tax return disclosure does not lead to information asymmetry reduction. Instead, we have shown that the interaction between the manager, tax agency, and financial market participants leads to an endogenous liquidation value, which pays a crucial role in determining the spread.

The existing empirical literature that examines the effect of tax information disclosure on firms' financial market performance is limited. Johannesen and Larsen (2016) and Hoopes et al. (2018) study the implementation of two legislative procedures that introduced new public tax disclosure obligations for companies and document negative stock price reactions in both cases. Johannesen and Larsen (2016) study the Country-by-Country-Reporting in the EU, while Hoopes et al. (2018) study tax information disclosure by the Australian Taxation Office. A similar analysis could therefore be undertaken to analyze the effect of disclosure on financial markets and provide evidence not only on the stock return reaction, but also on the riskiness of the firm's stock using measures of stock liquidity, stock volatility, and price efficiency.

We have also shown that disclosure of tax return information has a positive effect on the financial market performance when the tax agency is more efficient. Goh et al. (2016) and Sikes and Verrecchia (2016) find a negative relation between firm-level tax avoidance and cost of capital.[11] However, our model suggests that this firm-level result can be generalized at the country level as tax agency inefficiency might be an important determinant of firm tax avoidance. As a result, our model draws a new empirical implication regarding the efficiency of the tax agency on the firm's share liquidity: the more efficient the tax agency, the lower the spread. To document this, one could use the introduction of Country-by-Country-Reporting requirements in different countries of the EU, to exploit the heterogeneity in tax efficiency. To test this relationship empirically, one can use Alm and Duncan's (2014) estimation of tax efficiency in OECD countries.

Finally, as mentioned above, there is little empirical evidence regarding the role of tax return disclosure and tax aggressiveness and the results are mixed. Hasegawa et al. (2013) show that the tax reform in Japan in 2004, which consisted of the abolishment of mandatory disclosure of individual and corporate tax returns, did not make companies generally report higher profits once tax returns became confidential again. Moreover, when there is a threshold for disclosure, taxpayers whose tax liability would otherwise be close to the threshold will under-report so as to avoid disclosure. In our model, both disclosure or no disclosure are independent of the level of reported income. However, if disclosure is conditional on the firm's payoff, then the reported income will stay below the threshold that triggers disclosure because disclosure is detrimental for the manager's expected profits.

The empirical evidence that examines the effect of the FIN 48 implementation, which required

[11] Note that in these papers, the cost of capital is measured as the internal rate of return. However, an alternative measure could be stock's liquidity measured for example by the spread.

firms to disclose tax reserves on tax aggressiveness might be somehow related. Blouin et al. (2010) observe that public firms appear to have taken action to avoid mandated disclosure under FIN 48. Note that the implication of our model is that the manager is less likely to report truthfully when the tax report is disclosed.

5. Extensions

5.1. Managerial cost for misreporting

In the model we have considered so far, the manager does not face any direct cost when the tax authority discovers a false tax report because the firm bears all the penalties. Let us now consider the case where the manager faces a penalty $\rho > 0$ for misreporting, which is measured in monetary units. This penalty can take the form of lost wages (as the manager's contract with the firm may be terminated after being caught cheating the tax authority), reputational cost (as he may face lower probability of finding a new job as a manager), or the cost associated with a jail sentence.

When the managerial costs are present in the disclosure regime, the expected profits for the manager given in (7) become

$$\mathbb{E}\left[\Pi_D\left(p_D\right)\right] = a\left\{s\left(1-p_D\right)\left[1-\iota_D f\tau - A\left(0\right)\right] + \left(1-s\right)B(0)\right\} - s\left(1-p_D\right)\iota_D\rho, \tag{28}$$

because the manager pays the cost ρ when the project is successful, he cheats, and is discovered by the tax agency, which occurs with probability $s\left(1-p_D\right)\iota_D$. The maximization of (28) with respect to p_D yields the following solution:

$$p_D = \begin{cases} \text{any } p_D \in [0,1] & \text{if } \iota_D = \dfrac{1-A(0)}{f\tau + \dfrac{\rho}{a}}, \\ 0 & \text{if } \iota_D < \dfrac{1-A(0)}{f\tau + \dfrac{\rho}{a}}, \\ 1 & \text{if } \iota_D > \dfrac{1-A(0)}{f\tau + \dfrac{\rho}{a}}. \end{cases} \tag{29}$$

We can then find the equilibrium values of p_D, $A(0)$, and ι_D by solving the system of equations formed by (2), (5), and (29). Using the equilibrium values of p_D and ι_D we can then compute the equilibrium value of $B(0)$ in (6). Finally, $A(1)$ and $B(1)$ are given in (4). Note that, if there are no managerial costs for misreporting, $\rho = 0$, then $p_D = 0$ because $A(0) < 1 - i_D f\tau$.

In the resulting equilibrium under disclosure that we have just computed, the manager sends truthful reports with positive probability in some cases. This is in contrast to what occurs when the managerial costs are absent as the manager always cheats in this case. More precisely, it can be proved that there exists a value ρ^* of the managerial cost for misreporting such that if $\rho \leq \rho^*$, then the manager always submits false tax reports (as in the case when $\rho = 0$). However, if the managerial costs are sufficiently high, $\rho > \rho^*$, then there exists a threshold value of the cost of auditing $\widehat{c}_D(\rho)$, which is a linear increasing function of the managerial cost ρ, such that the manager sends truthful reports with positive probability if and only if $c < \widehat{c}_D(\rho)$. Therefore, for $\rho > \rho^*$ and $c < \widehat{c}_D(\rho)$, the managerial cost for misreporting and the inspection efficiency of the tax authority are substitutes that induce some honest behavior in the manager. Note, however, that for a range of low managerial costs, $\rho \in [0, \rho^*]$, the model under disclosure behaves exactly as that described in the previous sections.

When managerial costs from misreporting exist, the manager's expected profits in the no-disclosure regime given by (14) become

$$\begin{aligned} \mathbb{E}\left[\Pi_{ND}\left(p_{ND}\right)\right] &= a\left\{s\left[\left(1-p_{ND}\right)\left(1-\iota_{ND} f \tau - A_{ND}\right) + p_{ND}\left(1-\tau-A_{ND}\right)\right]\right. \\ &\quad \left. + \left(1-s\right) B_{ND}\right\} - s\left(1-p_{ND}\right)\iota_{ND}\rho. \end{aligned} \tag{30}$$

The maximization of (30) with respect to p_{ND} gives the following solution:

$$p_{ND} = \begin{cases} \text{any } p_{ND} \in [0,1] & \text{if } \iota_{ND} = \dfrac{1}{f + \dfrac{\rho}{\tau a}}, \\ 0 & \text{if } \iota_{ND} < \dfrac{1}{f + \dfrac{\rho}{\tau a}}, \\ 1 & \text{if } \iota_{ND} > \dfrac{1}{f + \dfrac{\rho}{\tau a}}. \end{cases} \tag{31}$$

The equilibrium values of p_{ND}, A_{ND}, and ι_{ND} are obtained by solving the system of equations formed by (2), (12), and (31). Using the equilibrium values of p_{ND} and ι_{ND} we can then obtain the equilibrium value of B_{ND} given by (13). Similar to the disclosure case, for each value of $\rho \geq 0$, there exists a threshold value of the auditing cost $\widehat{c}_{ND}(\rho)$, which is a linear increasing function of the managerial cost ρ, such that the manager sends truthful reports with positive probability if and only if $c < \widehat{c}_{ND}(\rho)$. Thus, as in the disclosure regime, the managerial cost for misreporting and the inspection efficiency of the tax authority are substitutes that give rise to truthful tax reports. Therefore, the model with no disclosure and positive managerial costs behaves in the same fashion as when $\rho = 0$.

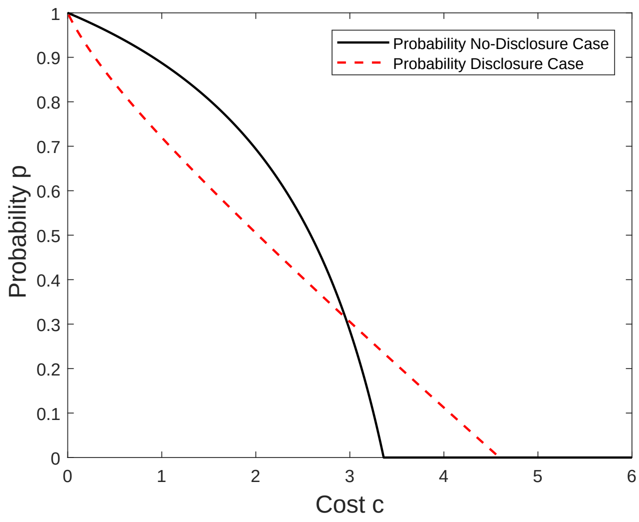

Figure 6: Probability of a truthful report under disclosure and under no-disclosure when there are reputation costs. Parameter values: $a = 0.5$, $s = 0.7$, $\tau = 0.2$, $f = 2$ and $\rho = 1$.

Evidently, $\widehat{c}_{ND}(0) = sf^2\tau$ as follows from (18).

Figure 6 displays the probability of sending a truthful report for the two disclosure regimes as a function of the audit cost parameter c when $\rho = 1$, which is larger than the critical threshold ρ^* in the example we consider. We see that, unlike the case with $\rho = 0$, under tax report disclosure, the manager sends truthful reports with positive probability, $p_D > 0$, for sufficiently low values of c, that is, when the tax agency exhibits a sufficiently high level of efficiency when inspecting tax reports featuring $\theta = 0$.

In this context with a high managerial cost for underreporting, Figures 7 and 8 illustrate again the tension between the objectives of market efficiency and revenue collection. Figure 7 shows the difference between the spreads in the two regimes. Note that under the disclosure regime we need to compute the expected spread because the bid and ask prices vary with the value of the tax report submitted by the manager. When the managerial cost ρ for misreporting is sufficiently low, the manager always submits the tax report $\theta = 0$ so that there is no variation in the stock prices brought about by the value of the publicly released tax report. This is not the case when $\rho > \rho^*$ as the manager submits truthful reports with positive probability when $y = 1$ for sufficiently low values of the audit cost parameter c. We see in Figure 7 that the expected spread under disclosure is strictly smaller than under no disclosure for low values of the audit cost parameter c, whereas both spreads coincide for higher values of c. This spread comparison agrees with our result in Proposition 3 about the lower cost of trading associated with the disclosure regime.

Concerning the tax authority's expected net revenue collected under both regimes, Figure 8 displays

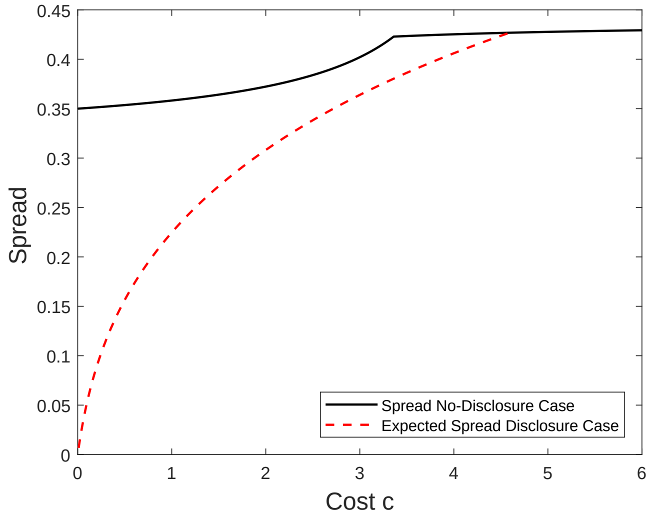

Figure 7: Spread under disclosure and under no-disclosure when there are reputation costs. Parameter values: $a = 0.5$, $s = 0.7$, $\tau = 0.2$, $f = 2$ and $\rho = 1$.

the corresponding comparison for $\rho = 1 > \rho^*$. As in the case with $\rho = 0$, we see that there is a interval of values of c for which a no disclosure policy yields a higher expected net revenue to the tax agency. Moreover, there is a set of values for c where disclosure generates a higher expected net revenue. Therefore, the results concerning the ambiguity of the disclosure policy effects on government revenue are similar to the case discussed in our basic model without managerial costs for misreporting. Note that this ambiguity holds for an interval of values of the inspection cost parameter c where the disclosure regime exhibits a lower expected spread than the no-disclosure regime. Therefore, the objectives of maximization of the expected net revenue by the tax agency and of improving the efficiency of the financial market may yield opposite disclosure policies concerning the tax report submitted by the firm.

Note that we have just considered a cost that is born by the manager but that does not generate any additional revenue to the government. If we consider a penalty ρ imposed on a manager caught misreporting taking the form of a fine to be paid to the tax agency, then the likelihood of truthful reports will also increase in both regimes. However, in this case, when the tax authority discovers a false report, it will raise the additional revenue associated with the fine paid by the manager.

5.2. Inspection policy conditional on stock prices

Another extension of our model refers to the possibility of enlarging the information set of the tax authority when deciding the intensity of its inspection policy with another available piece of public information. In our basic model, we have assumed that the audit intensity only depends on the report

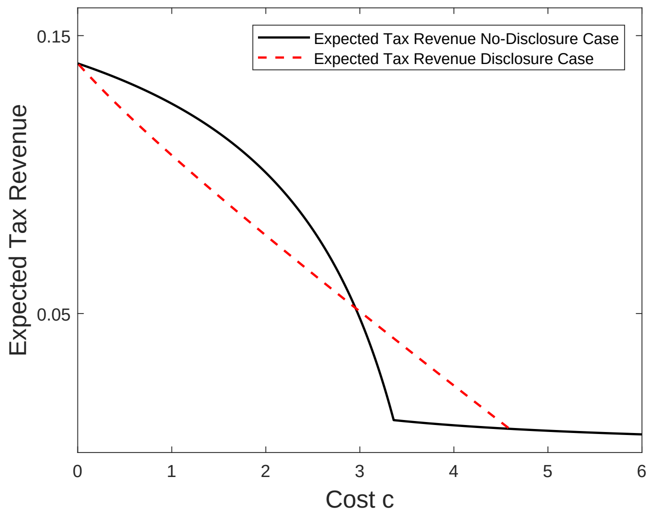

Figure 8: Expected net government revenues under disclosure and under no-disclosure when there are reputation costs. Parameter values: $a = 0.5$, $s = 0.7$, $\tau = 0.2$, $f = 2$ and $\rho = 1$.

θ submitted by the manager. If $\theta = 1$, no inspection takes place. If $\theta = 0$, the inspection intensity depends on the parameters of the model but not on further information. We could change the timing of the model slightly and assume that the decision about the audit intensity ι occurs after trading in the financial market has taken place. In this case, the intensity ι when $\theta = 0$ will take two values $\iota(1)$ and $\iota(-1)$, depending on whether the transaction in the financial market has occurred at the ask or bid price, respectively. Note that a transaction occurs at the ask (bid) price if and only if the trader selected for trading is a buyer (seller), which is equivalent to observing an order flow $\omega = 1$ ($\omega = -1$). Recent empirical evidence shows that tax authorities use public information to improve their inspection policy. This public information can be either purely financial, such as stock prices and financial filings obtained from the SEC's EDGAR server (Bozanic et al., 2016 and Fox and Wilson, 2019), or information scrutiny obtained by another governmental agency (Dyreng et al., 2016, and Kubick et al., 2016).

This extension of our basic model does not qualitatively change our results concerning the comparison of market performance and expected net government tax revenues between the two disclosure regimes, because the main driving force for that comparison relies on whether the dealer is able to condition on the tax report when setting the asset price. The interested reader can find a full analysis of the model when the inspection policy depends on the stock price of the firm in Caballé and Dumitrescu (2016).

6. Conclusions

In this paper, we developed an insider trading model that allows us to analyze how an endogenous public signal resulting from the interaction between a firm's manager 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 real effects 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 volatility 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) even if we obtain the same result for a different reason because tax report disclosure does not result in more information released to the dealer. Our result also implies that the tax agency might have incentives not to disclose the tax report because disclosure could result in a smaller net tax collection as the manager of the firm, who is engaged in insider trading, has more incentives to cheat in the tax report. Thus, given that market efficiency and expected net tax revenue maximization could be conflicting objectives, policy makers should enforce tax report disclosure if they care mainly about the financial market efficiency.

We also show that the effect of disclosure on market liquidity depends on tax agency's efficiency because spreads increase with the tax agency monitoring cost. Because tax agency efficiency varies across countries (Alm and Duncan, 2014), our model predicts that equity markets in countries with less efficient tax agencies, all else being equal, should be less liquid.

A final 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 because in this case the tax agency and the dealer can fully undo the effect of strategic behavior by the manager when he declares a low payoff from the project. However, in the case where the tax report is publicly disclosed, the manager tends to submit a false tax report.

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Appendix

Proof of Lemma 1. As in the case with disclosure of the tax report, the optimal inspection policy involves the audit intensity (i.e., the probability of discovering the truth) given by (2). Note that

$$\frac{f\tau}{c}\left(\frac{s(1-p)}{s(1-p)+(1-s)}\right)\leq\frac{sf\tau}{c},$$

for all $p\geq 0$ as the left hand of the previous inequality is strictly decreasing in p. Therefore, if $sf\tau/c<1/f$ (i.e., if $sf^2\tau<c$) then

$$\frac{f\tau}{c}\left(\frac{s(1-p)}{s(1-p)+(1-s)}\right)<\frac{sf\tau}{c}<\frac{1}{f}<1,$$

for all $p\geq 0$ so that, according to (16),

$$\iota_{ND}=\frac{f\tau}{c}\left(\frac{s(1-p)}{s(1-p)+(1-s)}\right)<\frac{1}{f}$$

and, thus, according to (15) $p^*_{ND}=0$, which implies in turn that the equilibrium intensity of the inspection conducted by the tax agency is

$$\iota^*_{ND}=\frac{sf\tau}{c}.$$

If $sf\tau/c\geq 1/f$ (i.e., if $sf^2\tau\geq c$) then there exists a value of $p\in[0,1]$ sufficiently close to zero for which

$$\frac{f\tau}{c}\left(\frac{s(1-p)}{s(1-p)+(1-s)}\right)>\frac{1}{f}$$

so that, by continuity and the fact that the left hand-side of the previous inequality is strictly decreasing in p, there exists a value of $p\in[0,1]$ for which the previous inequality becomes an equality. Such a value of p is

$$p^*_{ND}=1-\frac{(1-s)\,c}{s\,(f^2\tau-c)}>0$$

and then the inspection strategy of the tax agency is

$$\iota^*_{ND}=\frac{1}{f}.$$

■

Proof of Proposition 5. It is immediate to see from (26) and (27) that the two expected net revenues coincide when $c > sf^2\tau$ since $f > 1$ implies that $sf^2\tau > sf\tau$. It is straightforward to check that the two expected net revenues $E(NR_D)$ and $E(NR_{ND})$ are continuous and strictly decreasing in the cost parameter c. The derivative of $(sf\tau)^2 / 2c$ with respect to c evaluated at $c = sf^2\tau$ is $-1 / 2f^2$ while the derivative of $\frac{\tau}{2(f^2\tau - c)} \left(2sf^2\tau - c(1+s)\right)$ evaluated also at $c = sf^2\tau$ is $-1 / 2f^2 (1-s)$. Since $-1 / 2f^2 (1-s) < -1 / 2f^2$, then we can conclude that there exists a value $\widehat{c} \geq 0$ such that $E(NR_{ND}) > E(NR_D)$ for all $c \in \left(\widehat{c}, sf^2\tau\right)$. The second derivative of $E(NR_{ND})$ with respect to c for $c < sf^2\tau$ is equal to $-(f\tau)^2(1-s) / \left(f^2\tau - c\right)^3$, which is strictly negative since $f^2\tau > c$. Moreover, the second derivative of $E(NR_D)$ with respect to c for $c > sf\tau$ is $f^2 s^2 \tau^2 / c^3 > 0$. Finally, $E(NR_D)$ is linear in c for $c < sf\tau$. The previous facts imply that $E(NR_D)$ is a convex function of the cost parameter c for all $c > 0$, whereas $E(NR_D)$ is convex in c for $c > sf^2\tau$ but concave in c for $c < sf^2\tau$. Note also that $E(NR_D)$ converges to $sf\tau$ when c tends to zero and $E(NR_{ND})$ converges to $s\tau$ when c tends to zero. Therefore, for c sufficiently close to zero, $E(NR_{ND}) < E(NR_D)$. We conclude then that there is a single value of c^* for which $E(NR_{ND}) > E(NR_D)$ when $c \in \left(c^*, sf^2\tau\right)$ and $E(NR_{ND}) < E(NR_D)$ when $c \in (0, c^*)$. ■