The Information Content of Mandatory Disclosures*

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Abstract

The information quality of mandatory financial reporting depends on two factors: (1) Are standards appropriate to produce financial statements that provide investors with sufficient information? (2) Is compliance to standards enforced by appropriate institutions?

This paper addresses the question if firms should be able to create hidden reserves as an example for the effect of standards on information quality. The analysis shows that rational investors are able to correctly decipher financial statements – independent of the standards in use. The question of sufficient enforcement proves to have a deeper impact on the quality of information.

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1 Introduction

Most national Generally Accepted Accounting Principles (GAAP) as well as the International Financial Reporting Standards (IFRS) of the International Accounting Standards Board (IASB) are rejected by the US Securities and Exchange Commission (SEC) as proper accounting rules for mainly two reasons: (1) Institutions to enforce compliance to these rules are not sufficiently strict. (2) Financial reports based on these standards do not provide the capital market with sufficient information to value assets. One important part of this criticism – that applies to German GAAP, for instance – refers to the possibility to create hidden assets: If financial statements may include undisclosed reserves, bad performance might be camouflaged by their amortisation.

In consequence, the SEC denies firms' who do not apply US-GAAP access to American stock exchanges. In addition there is a debate – to a good deal of political nature – among practitioners about the impact of accounting institutions and the best way to design them. However, the effects of accounting institutions on the information content of mandatory disclosures has not been addressed in the theoretical accounting literature.[1] Especially the fact that firms by submission under a set of standards have committed themselves to a certain disclosure pattern has not been taken into account as most papers consider firms' disclosure incentives within a setting of voluntary reporting.

A main part of this literature takes – following Milgrom's (1981) seminal signaling model – as given that firms report in compliance to the standards in force (truthfully) if they report at all. These models focus on the question *which* firms would be willing to disclose information. For this class of models see, for instance, Verrecchia (1983, 1990), Dye (1985, 1986), Wagenhofer (1990), Feltham and Xie (1992) or Shin (1994).

Another part of the literature on voluntary reporting addresses the question of information quality of disclosures if the disclosure's content cannot be checked by third parties. These models are based on Crawford and Sobel's (1982) cheap-talk game and discuss the influence of the receiver of the disclosed information as well as reputational issues (see, for instance, Farrell and Gibbons (1989), Sansing (1992), Gigler (1994), Stocken (2000) or Wagenhofer (2000)).

[1] To a small scale such a discussion started out after prominent cases of fraudulent financial reporting like Enron and Parmalat, but that debate abated before it came to real life.

Only recently the issue of truthfulness of firms' reports has been discussed within models that connect both parts of the literature on voluntary disclosures (see, for instance, Fischer an Verrecchia (2000), Kleinert (2004), or Korn (2004)).

The fact that theorists have not contributed to the explanation of firms' mandatory reporting decisions shows in Fishman and Hagerty's (1998) survey on "mandatory disclosures". Most of the surveyed literature deals with voluntary reporting. The effect of an obligation to provide financial statements is only covered by "reference equilibria". The possibility that mandatory information might be biased is not considered. This state of the literature leads Dye (2001, p. 184) to the deflated perception "...that there is, presently, no received theory on mandatory disclosures in accounting...".

This paper aims at providing a first model of firms' incentives to bias disclosed information under a setting of mandatory reporting. To that end I consider the interaction between an owner of a firm who is willing to sell his firm and potential investors. This interaction is monitored by a regulator who demands that the owner discloses information about the firm's value before the sale and enforces compliance of this disclosure to a certain set of standards. I analyse two different scenarios of compliant behavior:

1. If the regulator wants to cap firms' balance sheet total, disclosures that report the true firm value or less are considered as compliant. Such a standard is likely to be found in a financial system where firms traditionally employ a high debt-equity ratio (for instance, Germany). In that case creditors have to be protected against owners who claim to skim of profits but in fact withdraw capital from the firm. Therefore, keeping the balance sheet total low is a means to curb the amount of money that can be legally taken and, thus, represents creditors' interests. This regime is called "information cap" throughout the paper.

2. If the regulator wants firms to produce an exact statistics of their firm value, only disclosures that reveal the true firm value are considered as compliant. Such a standard is likely to be seen in a financial system with low debt-equity ratios, especially if firms are widely held (for instance, the US). In that case financial statements are the main information source for investor's investment decisions. They should therefore give a clear and reliable account of current performance. To prohibit the creation of hidden assets (that can be secretely released in years of underperformance) is seen as a means to guarantee high information quality. This regime is called "exact information" throughout the paper.

Each of these rules is enforced by imposition of a fine in case of non-compliance. Thus, firm's information policy and firm prices are parts of a perfect Bayesian equilibrium whose structure depends on the regulation in use. The paper addresses two questions: (1) Are there differences in the quality of information provided by both systems? In consequence: What are costs and benefits to be expected from a change of regimes? (2) How does enforcement impact information quality?

The analysis to follow, thus, concentrates on the issue of information content of financial statements. The setting under consideration is therefore kept as simple as possible: I analyse a single transaction between an owner-manager who wants to sell his firm and a group of potential buyers. The owner-manager (compulsorily) provides information to the potential buyers. This setting allows to examine the incentives to choose a biased report under different standards and enforcement institutions – without the additional impact of reputational considerations that have to be taken into account if annual reporting is addressed.

It shows that the information content of financial reports does not materially differ across regimes. If potential investors use information in a rational way, they will be able to evaluate it almost equally well under both scenarios. This result may be applied to the current dispute about financial reporting standards between the IASB (whose standards leave more room for underrepresentation) and the SEC. In the process started out with 2002's Norwalk Agreement both institutions evaluate differences in their standards as well in their enforcement and aim at a convergence of both systems. The analysis suggests that the discussion overestimates the effect of tight standards in relation to the effect of impending sanctions.

2 The Model

Consider an entrepreneur who owns a firm of value zero. There is a profitable investment opportunity that could raise the firm value, but the entrepreneur lacks the necessary capital. Therefore, he decides to sell the firm to more potential investors.

In the beginning, information about the investment opportunity's value is distributed as in classic disclosure models: The owner knows the exact value of the firm x (the owner's "type"). To the potential investors, the firm value is the realization of a random variable X. This random variable follows a distribution F with strictly positive, atomless density f over the interval $[\underline{x}, \overline{x}]$ of possible firm values. The distribution function is common knowledge.

The seller must disclose the value of the firm. Formally, it is assumed that he can select a (possibly false) signal $y \in [\underline{x}, \overline{x}]$. The information is not immediately verifiable to third parties. This assumption has a serious impact on the equilibrium behavior of the owner as well as of potential investors, as overstatement of future profits cannot be excluded.

Assume that a regulator monitors the capital market. The regulator aims at enforcing compliance to a certain set of standards. In what follows I consider two different scenarios: (1) The given set of standards puts a cap on admissible reports of the firm value. In that case the regulator considers any report $y \in [\underline{x}, x]$, where x is the true value of the firm, as compliant reporting. (2) The given set of standards aims at producing the exact value of the firm. In that case the regulator only accepts $y = x$, where x is the true value of the firm as compliant reporting.

To enforce compliant reporting, the regulator checks a random sample of reports in detail. Thus, the owner expects that his report will be checked with (exogenous) probability φ. If he reports in non-compliance to the standards, the regulator can prove the misreporting – although it is not exactly verifiable – by 'circumstantial evidence'. In that case the owner can either be actually convicted of fraudulent behavior, or, if the evidence is not sufficient for a conviction, he may have to meet a payment (to a charitable trust or the like) in the course of a settlement out of court.

The punishment in case of a detection depends on the reporting bias as well as on the set of standards in force. These relations are captured by the definition of a deviation of a compliant report and by the assumption that expected punishments are convex in the deviation. In the scenario of an information cap all (detected) over-reportings $y > x$ are punished and the punishment function is given by $K(y|x) = \varphi k(y - x)^2$ if $y > x$. In the scenario that demands exact information *any* biased report $y \neq x$ is punished according to $K(y|x) = \varphi k(y - x)^2$.

In either case the punishment must be born by the original owner and thus does not reduce firm value. The punishment function consists of two components: The constant k measures the severity the regulator (and the capital market which punishes a misreporting manager by a loss of credibility, for instance) attaches to misreporting as such. Here, any convex function supports the results in the analysis to follow. I choose the quadratic form for sake of tractability.[2] The constant part of the punishment is exogenous to the model. The analysis to follow is based on a comparative statics about the parameter k.

The question arises, why does the defrauded investor not claim damages, at least in those cases in which the seller is convicted? A consideration of damages would not change the equilibrium behavior or results. Thus, I do not consider such payments. For a discussion of that point see Korn (2004, p. 148).

Having received the owner's signal, the potential investors update their beliefs about the firm's value. If investors observe the signal y, they form posterior beliefs: They substitute the prior density by the conditional density $f_h(x \mid y)$ according to Bayes' rule whenever possible. If Bayes' rule does not apply (out of equilibrium), $f_h(x \mid y)$ can be chosen in an arbitrary way. Based on these posterior beliefs the market determines the firm's price $P(y)$. I assume that investors behave rationally and that the capital market is competitive, i.e., the price equals the conditional expected firm value.

This argument follows a rational expectations general equilibrium approach. However, for the game theoretic formulation used in this paper, a detailed description of player's beliefs at any possible path of the game is necessary. Therefore, I assume that potential investors bid for the firm in a sealed-bid second price auction in which bids are based on the investors' posterior beliefs. The resulting equilibrium bids and the equilibrium price are the same as in a rational expectations model.

3 Analysis

This section derives equilibrium reporting and bidding strategies for both information regimes. Afterwards, I compare the information content of the resulting equilibria.

[2]Note that the important feature is the distinction in two regions: For minor false reports the impact of the punishment is smaller than that of a linear function (with slope 1); for higher false reports the impact is higher than that of a linear function. The cut determines the exact values of the thresholds described in the following.

Independent of the punishment in use, the information about the firm's value is not verifiable. Thus, the investors must establish a rule on how to 'read' the owner's signal. I search for rules which lead to consistent behavior, i.e., for beliefs supporting Perfect Bayesian Equilibria. I start with equilibrium properties that are common to both scenarios under consideration.

Korn (2004) shows that in the case of voluntary disclosures a limited punishment for lying destroys the classic disclosure principle. This result remains valid under both scenarios of mandatory disclosure considered here. If investors expect full disclosure, they must bid $P(y) = y$. Anticipating this bidding behavior, the owner can profitably overstate firm value because the cost of lying (the imminent punishment) is (at least for small lies) smaller than the gain from lying. This result is independent of the potential investors' prior information.

Lemma 1 *If the penalty for misreporting is finite, truthful disclosure is not part of an equilibrium.*

Proof: All proofs can be found in the appendix.

Given that truth telling cannot be equilibrium behavior, investors will form beliefs that correct the announced firm value for the expected amount of overstatement. All equilibria that are derived in the following sections consist of pooling as well as separating reporting strategies and the corresponding bidding strategies. They are derived by a two-step procedure:

1. I assume that all types of firm owners overstate their true firm value and use a separating reporting strategy. I derive investors' optimal bidding behavior given such a separating strategy and determine the functional form of the reports and bids.

   As an overstatement is sanctioned by the same punishment function under both regimes, this step is the same for both scenarios.

2. I show that a separating reporting strategy may not be a best response for the best and for the worst firm types. These types prefer to be pooled (with other good resp. bad types). The exact determination of the pooling regions depends on

the punishment function in use. Therefore, step two of the analysis is presented separately for each scenario.

Step1:
If potential investors expect that the firm owner reports according to the separating strategy $y(x)$ and they observe the signal $\hat{y}$, they will bid $y^{-1}(\hat{y})$. If in turn the owner anticipates the investors' bidding behavior, he chooses a signal y^* according to:

$$y^* = \arg\max_{\hat{y}}\{y^{-1}(\hat{y}) - \varphi k(\hat{y} - x)^2\} \tag{1}$$

A solution to this maximization problem solves the differential equation $\frac{\partial y}{\partial x} = \frac{1}{2\varphi k(y-x)}$. This equation has infinitely many solutions that take the form

$$y(x,d) = \frac{1 + LambertW(-2d\varphi k e^{-1-2\varphi kx}) + 2\varphi kx}{2\varphi k}, \tag{2}$$

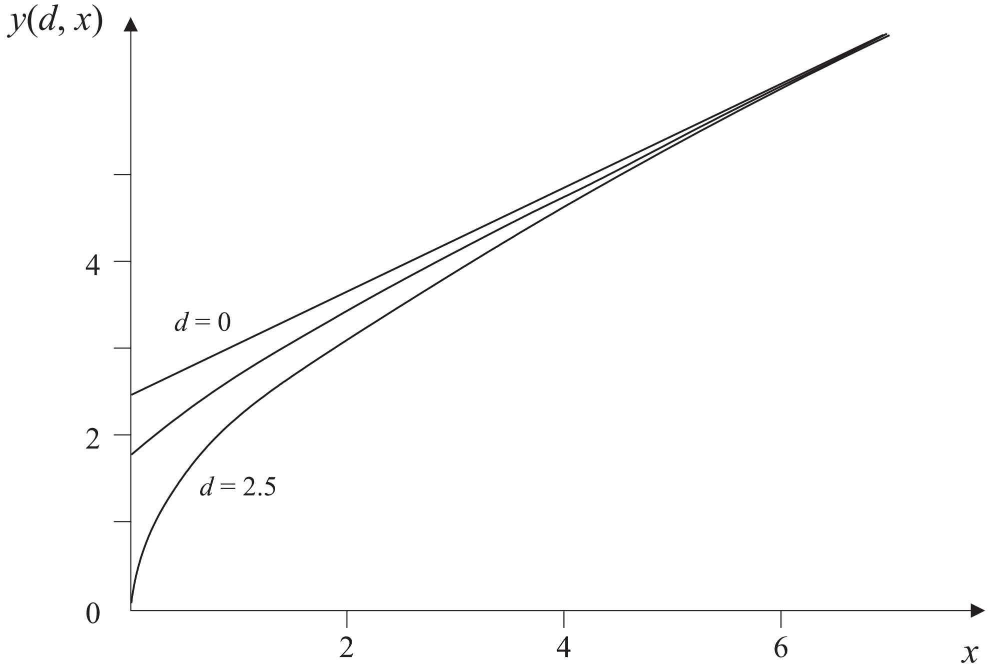
where $d \in [0, \frac{1}{2\varphi k e^{-x 2\varphi k}}]$ is a parameter of integration.[3] For each parameter d there is a separating reporting strategy that maximizes (1) if potential investors expect this reporting strategy. For the parameter value $d = 0$ a linear reporting strategy $y = x + \alpha = x + \frac{1}{2\varphi k}$ results. Figure 1 depicts examples of separating reporting strategies.

The parameter of integration d is a merely technical parameter. Thus, non of the reporting strategies $y(x,d)$ with $d \in [0, \frac{1}{2\varphi k e^{-x 2\varphi k}}]$ can be excluded from the analysis for economic reasons. Therefore, the determination of perfect Bayesian equilibria of the reporting game has to consider multiple (infinitely many) possible reporting strategies. The analysis shows that the game has infinitely many equilibria based on reporting strategies as in (2).

Step 2:
To complete the description of an equilibrium based on the reporting strategy $y(x,d)$, it has to be shown if $y(x,d)$ is a best response for every type of owner. This is not the case as may – as a first example – be seen from the linear reporting strategy.

If the investors and the firm owner coordinated on the linear reporting strategy, an owner of type x would report according to $y(x,0) = x + \frac{1}{2\varphi k}$ and investors would "read" any signal y as "the true firm value is $y - \frac{1}{2\varphi k}$". They would update their

[3]The function $LambertW(x)$ is not a very common function. It is therefore presented in some detail in the appendix (p. 27). Some properties of $y(x,d)$ are given as well.



The figure depicts separating reporting strategies for the following set of parameters: firm values are distributed on $[0, 7]$, the monitoring probability is $\varphi = 0,1$, the punishment parameter is $k = 2$.
A linear reporting strategy results for the parameter of integration $d = 0$. It has the form $y(x, 0) = x + \frac{1}{2\varphi k}$. The maximal value for d in the given setting is $d = 2.5$. If the firm's reporting strategy follows $y(x, 2.5)$, the worst type $\underline{x} = 0$ reports his true value. All other types choose an over-reporting strategy.
The figure does not cover all details of a perfect Bayesian equilibrium as in equilibrium very bad and very good types consider a pooling strategy.

Figure 1: Examples of separating reporting strategies

beliefs accordingly (using Bayes' rule) and bid $P(y) = y - \frac{1}{2\varphi k}$. The firm owner would receive a payment equal to his true firm value x but would have to face an expected punishment $K(x + \frac{1}{2\varphi k}|x) = \varphi k(\frac{1}{2\varphi k})^2$ as he would have over-reported. To show that a report according to $y(x, 0)$ is not a best response for all firm types, I take a closer look at the interval boundaries.

First, consider an owner of type $x \in [\overline{x} - \frac{1}{2\varphi k}, \overline{x}]$. These types of owner cannot report according to $x + \frac{1}{2\varphi k}$ as this report would exceed $\overline{x}$. Thus, they will choose a feasible report that is as close as possible to $x + \frac{1}{2\varphi k}$, which is $y = \overline{x}$. A rational investor takes account of this restriction and updates his belief to the conditional expectation over all types who would be willing to choose $y = \overline{x}$. Thus, in a perfect Bayesian equilibrium the best types report $y = \overline{x}$, obtain a price that equals the average value of all types choosing $y = \overline{x}$, and pay an expected fine $K(\overline{x}|x) = \varphi k(\overline{x} - x)^2$. Only intermediate or low types consider the linear reporting strategy $y(x, d) = x + \frac{1}{2\varphi k}$.

A similar argument applies to any other reporting strategy $y(x, d),\ d \neq 0$. As the over-reporting for good types is close to that under the linear reporting strategy (cf. the characterization of $y(x, d)$ on p. 27), the considerations are almost the same under linear and non-linear reporting strategies. A detailed analysis of the (upper-end) segmentation of the type interval is given in sections 3.1 and 3.2.

Now, consider the worst firm type $\underline{x}$. An owner of this type would obtain an expected overall payment of $\underline{x} - \varphi k(\frac{1}{2\varphi k})^2$ if he followed the linear reporting strategy $y(x, 0) = x + \frac{1}{2\varphi k}$. What would happen if the owner deviated from that strategy and reported $y = \underline{x}$ (the truth)? From the investors' point of view this report would be an unexpected signal (given the assumption that all types of owner report according to the linear strategy). Therefore, they would have to build new beliefs. The worst case from the owner's point of view is that investors assume that the signal $y = \underline{x}$ was sent by the worst firm type. Thus, they, will at least bid $P(\underline{x}) = \underline{x}$. As the owner reported truthfully, he does not have to consider a punishment and obtains an overall payment of at least $\underline{x}$. Consequently, in equilibrium an owner of type $\underline{x}$ does not report according to the linear reporting strategy.

A similar consideration applies to an owner of type $\underline{x} + \varepsilon$. As for this type the signal $y = \underline{x}$ is not a truthful report, the different sanctioning mechanisms under the scenario of an information cap and that of exact information have to be considered to determine a segmentation at the lower end of the type interval. The same applies to equilibria under non-linear reporting strategies. The corresponding analysis is given in sections 3.1 and 3.2.

3.1 Information cap

The above considerations have – by use of the example of $y(x, 0)$ – shown that firm types at the lower and the upper end of the type interval do not report according to $y(x, d) = \frac{1+LambertW(-2d\varphi k e^{-1-2\varphi k x})+2\varphi k x}{2\varphi k}$.

This section gives a detailed description of perfect Bayesian equilibria based on different reporting strategies under the assumption that reports are admissible if they are not higher than the true firm value. Thus, I assume that over-reporting is punished according to $K(y|x) = \varphi k(y-x)^2$ and that under-reporting is considered as compliant reporting. I show that the size of the pooling regions at the lower and the upper end of the type interval depends on the expected punishment (in particular on k) and on the reporting strategy in use.

First, I consider the reporting alternatives of the owner if the value of his firm is close to the lower boundary of the type interval. If the owner reports according to $y = (x, d)$, his overall payment will not depend on other types' behavior. The investors detect the true value of his firm, bid the true value x, and the owner has to pay the expected fine $K(y(x,d)|\, x) = \varphi k(y(x,d) - x)^2$, leading to an expected overall payment of $\pi_{y(x,d)}(x) = x - \varphi k(y(x,d) - x)^2$. If the owner chooses under-reporting, i.e. if he reports $y = \underline{x}$, potential investors will bid the conditional expectation over all types who choose $y = \underline{x}$. In the case of an information cap such an under-reporting remains without punishment. Therefore, if $\hat{x}$ is the best type whom the potential investors expect to report $y = \underline{x}$, the overall payment of the owner given the reporting strategy $y = \underline{x}$ is

$$\pi_{\underline{x}}(x) = E(X|X \leq \hat{x}). \tag{3}$$

Thus, an owner of type x has to compare his payment if he is the best type reporting $y = \underline{x}$ with the payment if he reports according to $y(x, d)$. The size of the lower-end pooling region is determined by the type $x^{1;d}_{k,cap}$ who is indifferent between $y = \underline{x}$ and $y = (x, d)$:[4]

$$E(X|X \leq x^{1;d}_{k,cap}) = x^{1;d}_{k,cap} - \varphi k(y(x^{1;d}_{k,cap}, d) - x^{1;d}_{k,cap})^2. \tag{4}$$

A similar consideration applies to types close to the upper interval boundary. If potential investors expect type $\hat{x}$ to be the worst type who reports $y = \bar{x}$, they will bid $E(X|X \geq \hat{x})$ if they observe $y = \bar{x}$. As $y = \bar{x}$ is an overstatement for all types except $\bar{x}$, an owner of type $x < \bar{x}$ has to face an expected punishment of $K(\bar{x}|x) = \varphi k(\bar{x} - x)^2$

[4]Truthful reporting is not a relevant alternative, as it is excluded as equilibrium behavior by Lemma 1.

if he uses this over-reporting strategy. Thus, the expected overall payment given the reporting strategy $y = \bar{x}$ is

$$\pi_{\bar{x}}(x) = E(X|X \geq \hat{x}) - \varphi k(\bar{x} - x)^2 \tag{5}$$

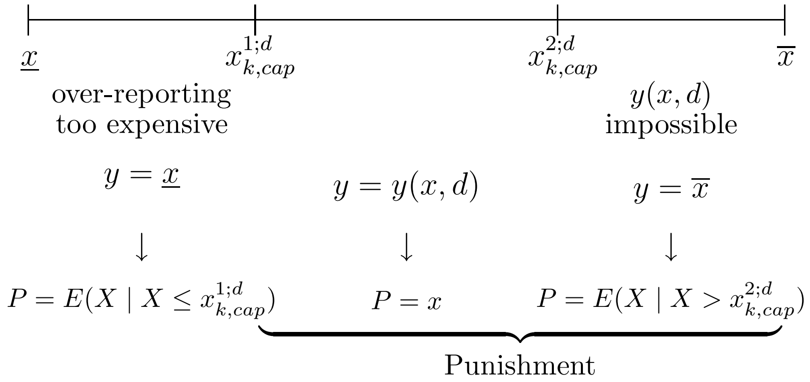
if $\hat{x}$ is the worst type choosing $y = \bar{x}$.

The size of the upper-end pooling region is determined by the type $x^{2;d}_{k,cap}$ who is indifferent between being the worst type who chooses $y = \bar{x}$ and reporting according to $y(x, d)$:

$$E(X|X \geq x^{2;d}_{k,cap}) - \varphi k(\bar{x} - x^{2;d}_{k,cap})^2 = x^{2;d}_{k,cap} - \varphi k(y(x^{2;d}_{k,cap}, d) - x^{2;d}_{k,cap})^2.$$

Thus, the principle structure of an equilibrium under an information cap based on a reporting strategy $y(x, d)$ consists of three layers: Bad types report $y = \underline{x}$ and are pooled, intermediate types choose an over-reporting according to $y(x, d)$, and good types choose $y = \bar{x}$ and are pooled. This structure is represented in Figure 2. The above considerations cannot exclude the case that no type chooses $y = y(x, d)$. If, for instance, the threshold type $x^{1;d}_{k,cap}$ who is indifferent between under-reporting and reporting according to $y(x, d)$ would prefer the signal $y = \bar{x}$ to a report according to $y(x, d)$, investors will only observe $y = \underline{x}$ or $y = \bar{x}$. Which signal can actually be part of a perfect Bayesian equilibrium depends on k an d and is subject to a comparative static analysis to follow.[5]

[5]A comparative static analysis concerning the effect of the punishment should cover φ and k. However, I consider φ as a "long-run variable" and k as a "short-run variable". This is due to the idea that φ covers frictions in the regulator's ability to actually monitor the market like, for instance, personnel capacity. Therefore, I restrict attention to changes in k.



The graphics should be read starting at the subinterval in the middle. All types x belonging to that interval will report according to $y(x,d) = \frac{1+LambertW(-2d\varphi ke^{-1-2\varphi kx})+2\varphi kx}{2\varphi k}$. The capital market will read this behavior and bid x. Due to the misreporting the owner must account for a possible punishment. For types in the subinterval $[\underline{x}, x^{1;d}_{k,cap}]$ the expected punishment if reporting according to $y(x,d)$ would lead to an overall payment smaller than $P(\underline{x})$. Thus, they prefer to claim to be of the worst firm type and to be pooled. Types in the interval $(x^{2;d}_{k,cap}, \overline{x}]$ cannot report according to $y(x,d)$ as this would surpass $\overline{x}$. Thus, they choose the report closest to $y(x,d)$, which is $\overline{x}$. These types are pooled and expect a punishment.

Figure 2: *Generic equilibrium partition under an information cap*

The bidding behavior used in the above equilibrium description rests upon a rational use of information. I assume that potential investors update their beliefs concerning the firm's value using Bayes' rule whenever possible. To complete the description of investors' behavior, I have to describe their beliefs if they observe a signal which should not be part of an equilibrium. This specification is part of a formal presentation of each equilibrium. Such a presentation covers the reporting strategies for all firm types, the equilibrium and out-of-equilibrium beliefs of potential investors, and the corresponding bidding behavior: In an equilibrium based on the reporting strategy $y(x,d)$ an owner of type $x \in [\underline{x}, x^{1;d}_{k,cap}]$ reports $y = \underline{x}$, an owner of type $x \in (x^{1;d}_{k,cap}, x^{2;d}_{k,cap}]$ reports according to $y(x,d)$, and an owner of type $x \in (x^{2;d}_{k,cap}, \overline{x}]$ reports $y = \overline{x}$. Potential investors build the following posterior beliefs:

Equilibrium beliefs:
Potential investors are able to separate "intermediate" types:

$$f_h(x|y \in (y(x^{1;d}_{k,cap}, d), y(x^{2;d}_{k,cap}, d)]) = \begin{cases} 1, & x = y - \frac{1}{2\varphi k} + de^{-y2\varphi k}, \\ 0, & x \neq y - \frac{1}{2\varphi k} + de^{-y2\varphi k}, \end{cases}$$

"Bad" types choose $y = \underline{x}$ and are pooled
(lower-end pooling region):

$$f_h(x|y = \underline{x}) = \begin{cases} \frac{f(x)}{F(\min\{x^{1;d}_{k,cap}, x^{2;d}_{k,cap}\})}, & x \in [\underline{x}, \min\{x^{1;d}_{k,cap}, x^{2;d}_{k,cap}\}], \\ 0, & x \in [(\min\{x^{1;d}_{k,cap}, x^{2;d}_{k,cap}\}, \overline{x}], \end{cases} \tag{6}$$

"Good" types choose $y = \overline{x}$ and are pooled
(upper-end pooling region):

$$f_h(x|y = \overline{x}) = \begin{cases} \frac{f(x)}{1-F(x^{2;d}_{k,cap})}, & x \in (x^{2;d}_{k,cap}, \overline{x}], \\ 0, & x \in [\underline{x}, x^{2;d}_{k,cap}], \end{cases}$$

Out-of-equilibrium beliefs:

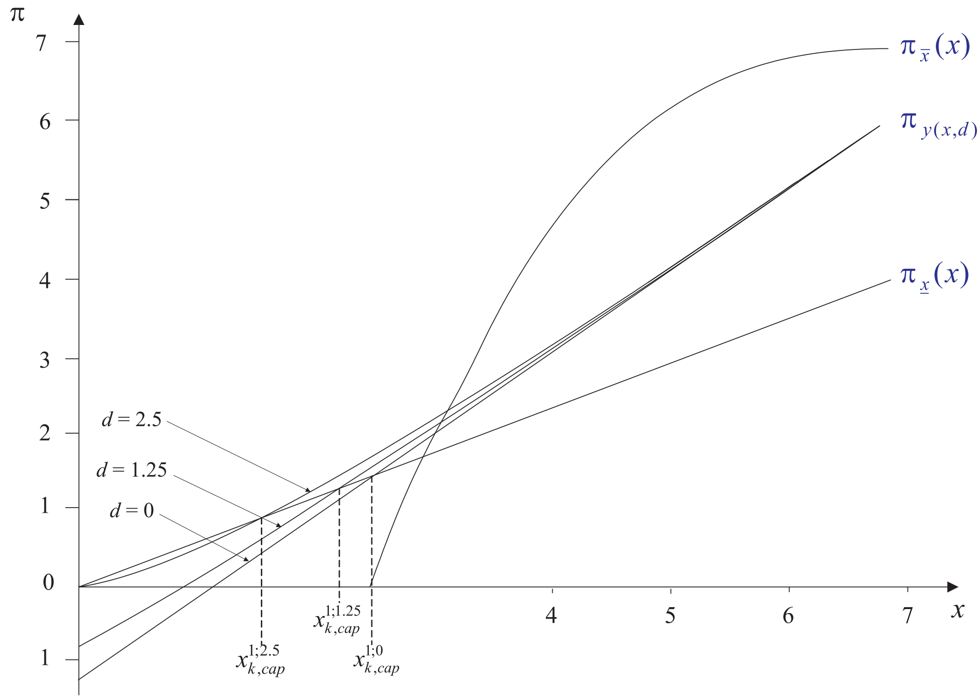
$$f_h(x|y \in (\underline{x}, \min\{y(x^{1;d}_{k,cap}, d), y(x^{2;d}_{k,cap}, d)\}]) = \begin{cases} 1, & x = \underline{x}, \\ 0, & x \in (\underline{x}, \overline{x}], \end{cases}$$

$$f_h(x|y \in (y(x^{2;d}_{k,cap}, d), \overline{x})) = \begin{cases} 1, & x = \underline{x}, \\ 0, & x \in (\underline{x}, \overline{x}]. \end{cases}$$

Investors bid their conditional expectation based on the given posterior beliefs. Depending on the size of k the interval $[x^{1;d}_{k,cap}, x^{2;d}_{k,cap}]$ may be degenerate.

To start a comparative static analysis of the possible equilibrium segmentations of the type interval, I fix the punishment parameter k and compare reporting strategies based on different parameters of integration d. As can be seen from Figure 1, the amount of over-reporting decreases for each firm type x under $y(x, d)$ if d increases. Accordingly, the expected punishment decreases as well. In consequence, the lower-end pooling region in an equilibrium based on $y(x, d)$ is smaller the higher the corresponding parameter d. This relation is shown in Figure 3. For the sake of simplicity the figure is based on a uniform distribution of firm values. As can be seen from the figure as well, the size of the upper-end pooling region is bigger the higher the value of d.

Unfortunately, the comparative statics over d cannot be used for an immediate nor-



The figure depicts the structure of perfect Bayesian equilibria under an information cap based on the reporting strategies shown in Figure 1. Here it is assumed that firm types are uniformly distributed on the type interval $[0, 7]$. The values $x_{k,cap}^{1;0}$, $x_{k,cap}^{1;1.25}$, and $x_{k,cap}^{1;2.5}$ assign the boundaries of the lower pooling regions resulting from the corresponding reporting strategies. Analogous values could be assigned for the upper pooling regions. These values have been omitted in the figure for sake of clarity.

Figure 3: Boundaries of the lower-end pooling regions under an information cap

mative result as d is a technical factor and not a parameter that could be adjusted by one of the players. However, the above consideration will prove to be useful for the comparison of the basic scenarios "information cap" and "exact information".

For a comparative static analysis over k I consider a fixed parameter d and the corresponding reporting strategy $y(x,d)$.[6] For any type $x \in [\underline{x}, \bar{x}]$ the reporting strategy $y(x,d) = \frac{1+LambertW(-2d\varphi ke^{-1-2\varphi kx})+2\varphi kx}{2\varphi k}$ is strictly decreasing in k. For k close to zero the owner would (if he followed $y(x,d)$) choose a very large over-reporting that would exceed $\bar{x}$. Thus, if the type interval – and in consequence the set of possible reports – is bounded from above by $\overline{x}$, the report $y(x,d)$ is no longer an option for any type $x \in [\underline{x}, \bar{x}]$. In that case even the worst type $\underline{x}$ must compare two alternatives only: to bear the risk of paying $k(\overline{x} - \underline{x})^2$ and announce $\overline{x}$ or to choose the under-reporting signal $\underline{x}$ and avoid a punishment. If the worst type (and, in consequence, all firm types) announces $\overline{x}$, the investors disregard the report. Therefore, they will keep to their prior type distribution and bid $E(X)$. This bidding behavior, in turn, makes it useless for the owner to bear the cost of over-reporting. Since he will receive $E(X)$ at no cost if he chooses the compliant signal $\underline{x}$, he will do so. However, if the worst type prefers to choose $\underline{x}$, an equilibrium will result in which some types choose $\underline{x}$ and some $\overline{x}$. Which strategy dominates for type $\underline{x}$, depends on k. Thus, for low k a cheap talk equilibrium results. For "intermediate" k there is a roughly separating equilibrium in which "bad" types choose under-reporting and "good" types over-report $y = \bar{x}$ (in this case, the interval $\left[x^{1;d}_{k,cap}, x^{2;d}_{k,cap}\right]$ is degenerate). For high k the quality of the separation rises. In that case, $y(x,d)$ is sufficiently small such that it is a feasible strategy for those types who are willing to over-report. In consequence, for high punishments, $y = \underline{x}, y = y(x,d),$ and $y = \bar{x}$ can be observed in equilibrium. If k rises, the lower-end and the upper-end pooling regions shrink. Accordingly, the higher the k the more types can be truly recognized *although* they choose a biasing report. The described equilibrium structure is formally presented in the following proposition.

Proposition 1 *For any prior distribution F of possible firm values, the punishment function $K(y|x)$, and for any reporting strategy $y(x,d)$ there are punishment parameters $k^d_l(X)$ and $k^d_h(X)$ such that:*

[6]The following argument holds for any reporting strategy $y(x,d), d \in \left[0, \frac{1}{2\varphi ke^{-\underline{x}2\varphi k}}\right]$, with the qualification that for $\bar{d} = \frac{1}{2\varphi ke^{-\underline{x}2\varphi k}}$ an additional equilibrium exists. In this equilibrium there is no pooling at the lower end of the type interval. Therefore, for $\bar{d} = \frac{1}{2\varphi ke^{-\underline{x}2\varphi k}}$ and a low or intermediate k there is a partially separating equilibrium besides the equilibria characterized below.

1. For all $k < k_l^d(X)$ the system of beliefs (6) leads to a perfect Bayesian equilibrium without information transmission, i.e. all types of owner choose the signal $y = \underline{x}$.

2. For all $k \in [k_l^d(X), k_h^d(X)]$ the system of beliefs (6) leads to a perfect Bayesian equilibrium where the owner reports according to

$$y^*(x) = \begin{cases} \underline{x}, & x \in [\underline{x}, x_{k,cap}^{2;d}] \\ \overline{x}, & x \in (x_{k,cap}^{2;d}, \overline{x}]. \end{cases}$$

The threshold type $x_{k,cap}^{2;d} \in [\underline{x}, \overline{x}]$ is a function of k and d as well as of the prior distribution of firm values. Potential investors will bid $E(X|X \leq x_{k,cap}^{2;d})$ if they observe $y = \underline{x}$, and they will bid $E(X|X > x_{k,cap}^{2;d})$ if they observe $y = \overline{x}$.

3. For all $k > k_h^d(X)$ the system of beliefs (6) leads to a perfect Bayesian equilibrium where the owner reports according to

$$y^*(x) = \begin{cases} \underline{x}, & x \in [\underline{x}, x_{k,cap}^{1;d}] \\ y(x,d), & x \in (x_{k,cap}^{1;d}, x_{k,cap}^{2;d}] \\ \overline{x}, & x \in (x_{k,cap}^{2;d}, \overline{x}]. \end{cases}$$

The threshold types $x_{k,cap}^{1;d}, x_{k,cap}^{2;d}$ are functions of k and d as well as of the prior distribution of firm values. Potential investors will bid $E(X|X \leq x_{k,cap}^{1;d})$ if they observe $y = \underline{x}$, $y - \frac{1}{2\varphi k} + de^{-y2\varphi k}$ if they observe $y \in (y(x_{k,cap}^{1;d}, d), y(x_{k,cap}^{2;d}, d)]$, and they will bid $E(X|X > x_{k,cap}^{2;d})$ if they observe $y = \overline{x}$.

4. For $\bar{d} = \frac{1}{2\varphi k e^{-\underline{x}2\varphi k}}$ there is a perfect Bayesian equilibrium where the lower-end pooling region vanishes.

Discussion of the result:
If a regulation of financial reporting covers the idea that admissible information should be capped the size of the punishment for over-reporting has a material impact. Independent of the punishment, the considered game has multiple equilibria. Therefore, owner and investors have to coordinate on the way the game will be played. A game theoretic analysis cannot predict how such a coordination may be done but the result stresses the responsibility of potential users for the quality of financial reporting. The informativeness of different equilibria – for a fixed punishment – may be measured by the size of the "separating area" of each equilibrium. As Figure 3 shows, this size may substantially vary across equilibria.

The equilibrium structure is exactly the same as under a setting of voluntary disclosures (cf. the results in Korn (2004)). Thus, the quality of mandatory reports materially depends on the punishment following an over-reporting.

3.2 Exact Information

If the regulator wants to enforce financial reporting that provides exact information, he will sanction any report that deviates from the true firm value. Therefore, the punishment function in use is $K(y|x) = \varphi k(y-x)^2$, for all $y \neq x$. Investors' and owner's equilibrium considerations are basically the same as under the case of an information cap with a material exception: The owner cannot send an under-reporting signal at no cost.

Therefore, for any reporting strategy $y(x,d), d \in \left[0, \frac{1}{2\varphi k e^{-\underline{x}2\varphi k}}\right]$, there is a threshold type $x_{k,ex}^{2;d}$ who determines the segmentation at the upper end of the type interval. The indifference condition for this type is analogous to (5) as the punishment for over-reporting is identical in the case of an information cap and the case of exact information.

At the lower end of the type interval pooling cannot be excluded although under-reporting is costly. This can easily be seen if the reporting incentives of type $\underline{x}$ are considered. This type will not choose a signal according to $y(\underline{x}, d)$ as this signal would be read by the investors as "the true firm value is $\underline{x}$" and the owner had to face an expected punishment.[7]

If type $\underline{x}$ chooses $y = \underline{x}$ he will at least receive $P(\underline{x}) = \underline{x}$ and can avoid a punishment. Type $\underline{x} + \varepsilon$ prefers $y = \underline{x}$ to $y = y(x,d)$ as well although this type will have to face a punishment of size $K(\underline{x}|\underline{x}+\varepsilon) = \varphi k \varepsilon^2$ if he reports $y = \underline{x}$.

Again, as in the case of an information cap potential investors build expectations which types are going to report $y = \underline{x}$ and bid accordingly. Due to the expected punishment for under-reporting the overall payment for type x if he reports $y = \underline{x}$ and investors expect type $\hat{x}$ to be the best type to do so is (cf. equation (3))

$$\pi_{\underline{x}}(x) = E(X|X \leq \hat{x}) - \varphi k(x - \underline{x})^2 \tag{7}$$

In principle, the lower-end segmentation of the type interval based on reporting strategy $y(x,d)$ is now determined in the same way as in the case of an information cap: There is a type $x_{k,ex}^{1;d}$ who is indifferent between reporting according to $y = (x,d)$ and being

[7]The reporting strategy $y(x,\bar{d}), \bar{d} = \frac{1}{2\varphi k e^{-\underline{x}2\varphi k}}$ is as before a special case as $y(\underline{x},\bar{d}) = \underline{x}$.

the best type who reports $y = \underline{x}$, i.e., (cf. equation (4))

$$E(X|X \leq x_{k,ex}^{1;d}) - \varphi k(x_{k,ex}^{1;d} - \underline{x})^2 = x_{k,ex}^{1;d} - \varphi k \left(y(x_{k,ex}^{1;d}, d) - x_{k,ex}^{1;d} \right)^2. \tag{8}$$

But, in contrast to the scenario of an information cap it does not suffice to determine the threshold type $x_{k,ex}^{1;d}$. It has also to be checked if $y = \underline{x}$ is a best response for this type – which is not necessarily the case. The fact that under-reporting will be punished if it is detected may lead to an overall payment for type $x_{k,ex}^{1;d}$ that is smaller than $\underline{x}$. By reporting his true type, $x_{k,ex}^{1;d}$ could reach an overall payment that amounts at least to $\underline{x}$ for the following reason: If investors expect all types in $\left[\underline{x}, x_{k,ex}^{1;d}\right]$ to report $y = \underline{x}$ and all types in $\left(x_{k,ex}^{1;d}, \bar{x}\right]$ to over-report, the signal $y = x_{k,ex}^{1;d}$ cannot be part of an equilibrium. Therefore, investors have to build out-of-equilibrium beliefs for this signal. The worst they can assume, is that a type who reports $y = x_{k,ex}^{1;d}$ owns a firm of value $\underline{x}$. Thus, if $x_{k,ex}^{1;d}$ reports the truth, he will at least obtain $\underline{x}$ avoiding at the same time a punishment.

In consequence, if

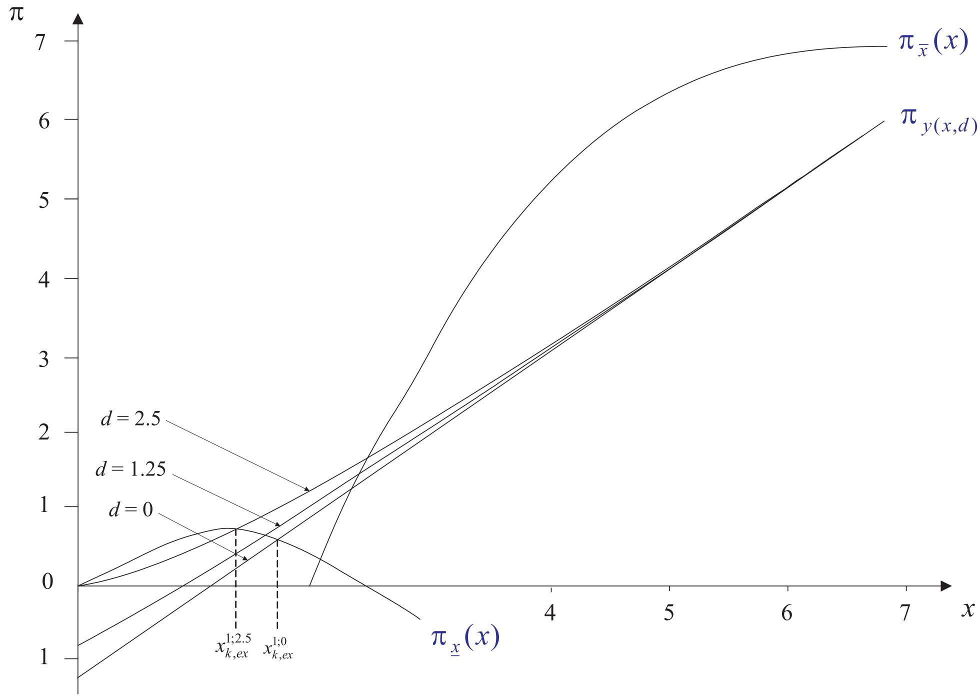
$$E(X|X \leq x_{k,ex}^{1;d}) - \varphi k(x_{k,ex}^{1;d} - \underline{x})^2 \ \leq \ \underline{x},$$

the equilibrium argument breaks down and there is no equilibrium based on $y(x, d)$.[8]

Whether an equilibrium based on $y(x, d)$ exists depends on the prior distribution of possible firm values. Figure 4 depicts equilibrium segmentations for a uniform distribution. Here equilibria exists for all possible values of d. This property is common to all scenarios with uniformly distributed types. If types are, for instance, distributed according to simple other distributions like a combination of two uniform distributions, some reporting strategies $y(x, d)$ may not lead to equilibria.

So, to analyze the setting of exact information, the question remains to be answered if there is an equilibrium for any possible parameter constellation? Existence of an equilibrium is ensured due to the fact that there is an equilibrium where the worst type $\underline{x}$ reports truthfully if the owner and the investors coordinate on the reporting strategy $y(x, \bar{d}), \bar{d} = \frac{1}{2\varphi k e^{-\underline{x}2\varphi k}}$. In that case the lower-end pooling region vanishes and only the signals $y = x(x, \bar{d})$ and $y = \overline{x}$ can be part of an equilibrium.

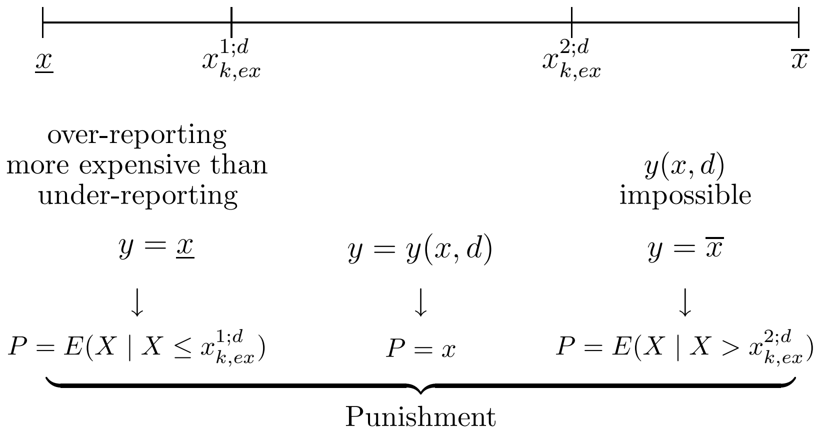
[8] According to Lemma 1 there cannot be an equilibrium with truthtelling at the lower end.



The figure depicts the structure of perfect Bayesian equilibria under the regime of exact information based on the reporting strategies shown in Figure 1. The remaining assumptions equal those from the example in Figure 3.

Figure 4: Boundaries of the lower-end pooling regions under exact informaton

Thus, the principle equilibrium structure is similar to the structure under the regime of an information cap. The owner has to weigh the expected price against impending punishments when deciding about the reporting strategy as is characterized in Figure 5.



The graphics should be read in analogy to Figure 2. The material difference between both figures lies in the overall payment obtained by an owner who claims to be of the worst type. In contrast to the scenario with an information cap under-reporting gets punished if exact information is demanded. If an equilibrium exists that is based on the reporting strategy $y(x, d) = \frac{1+LambertW(-2d\varphi ke^{-1-2\varphi kx})+2\varphi kx}{2\varphi k}$ (i.e., if d is big enough), the lower pooling region is smaller than in the corresponding equilibrium in the case of an information cap.

Figure 5: *Generic equilibrium partition under exact information*

An equilibrium in the scenario of exact information covers the following reporting strategies, equilibrium and out-of-equilibrium beliefs of potential investors, and bidding behavior: In an equilibrium based on the reporting strategy $y(x, d)$ – if it exists – an owner of type $x \in [\underline{x}, x^{1;d}_{k,ex}]$ reports $y = \underline{x}$, an owner of type $x \in (x^{1;d}_{k,ex}, x^{2,;d}_{k,ex}]$ reports according to $y(x, d)$, and an owner of type $x \in (x^{2,;d}_{k,ex}, \overline{x}]$ reports $y = \overline{x}$. Potential investors build the following posterior beliefs:

Equilibrium beliefs:
Potential investors are able to separate "intermediate" types:

$$f_h(x|y \in (y(x^{1;d}_{k,ex}, d), y(x^{2;d}_{k,ex}, d)]) = \begin{cases} 1, & x = y - \frac{1}{2\varphi k} + de^{-y2\varphi k}, \\ 0, & x \neq y - \frac{1}{2\varphi k} + de^{-y2\varphi k}, \end{cases}$$

"Bad" types choose $y = \underline{x}$ and are pooled
(lower pooling region):

$$f_h(x|y = \underline{x}) = \begin{cases} \frac{f(x)}{F(\min\{x^{1;d}_{k,ex}, x^{2;d}_{k,ex}\})}, & x \in [\underline{x}, \min\{x^{1;d}_{k,ex}, x^{2;d}_{k,ex}\}], \\ 0, & x \in [(\min\{x^{1;d}_{k,ex}, x^{2;d}_{k,ex}\}, \overline{x}], \end{cases} \tag{9}$$

"Good" types choose $y = \overline{x}$ and are pooled
(upper pooling region):

$$f_h(x|y = \overline{x}) = \begin{cases} \frac{f(x)}{1 - F(x^{2;d}_{k,ex})}, & x \in (x^{2;d}_{k,ex}, \overline{x}], \\ 0, & x \in [\underline{x}, x^{2;d}_{k,ex}], \end{cases}$$

Out-of-equilibrium beliefs:

$$f_h(x|y \in (\underline{x}, \min\{y(x^{1;d}_{k,ex}, d), y(x^{2;d}_{k,ex}, d)\}]) = \begin{cases} 1, & x = \underline{x}, \\ 0, & x \in (\underline{x}, \overline{x}], \end{cases}$$

$$f_h(x|y \in (y(x^{2;d}_{k,ex}, d), \overline{x})) = \begin{cases} 1, & x = \underline{x}, \\ 0, & x \in (\underline{x}, \overline{x}]. \end{cases}$$

Investors bid their conditional expectation based on the given posterior beliefs. Depending on the size of k the interval $[x^{1;d}_{k,ex}, x^{2;d}_{k,ex}]$ may be degenerate. Whether an equilibrium based on a certain reporting strategy $y(x, d), d \in [0, \bar{d}]$ exists, is described in the following proposition:

Proposition 2 *For any prior distribution F of possible firm values and for any k there is a threshold parameter $d'_k \in [0, \bar{d} = \frac{1}{2\varphi k e^{-\underline{x}2\varphi k}}]$ such that:*

1. *For all $d \in [d'_k, \bar{d}]$ there is a perfect Bayesian equilibrium under the regime of exact information that is based on the system of beliefs (9).*
2. *For $d \in [0, d'_k)$ there is no partially separating equilibrium in pure strategies under the regime of exact information.*

The comparative static analysis with respect to d and k is the same as under an information cap for those reporting strategies $y(x, d)$ supporting an equilibrium.

4 Comparison between "Information cap" and "Exact information"

Now, consider equilibria in both above given scenarios that are based on the same punishment parameter k. If an equilibrium based on a reporting strategy $y(x, d), d \in \left[0, \frac{1}{2\varphi k e^{-\underline{x}2\varphi k}}\right]$ exists for both scenarios (i.e., if the parameter d under consideration is sufficiently high), both equilibria are of the same structure:

Under the regime of an information cap, types in $\left[\underline{x}, x_{k,cap}^{1;d}\right]$ report $y = \underline{x}$ and are pooled, types in $\left(x_{k,cap}^{1;d}, x_{k,cap}^{2;d}\right]$ report according to $y(x, d)$ and are separated (i.e., investors recognize the true firm value x), and types in $\left(x_{k,cap}^{2;d}, \bar{x}\right]$ report $y = \bar{x}$ and are pooled.

Under the scenario of exact information, types in $\left[\underline{x}, x_{k,ex}^{1;d}\right]$ report $y = \underline{x}$ and are pooled, types in $\left(x_{k,ex}^{1;d}, x_{k,ex}^{2;d}\right]$ report according to $y(x, d)$ and are separated (i.e., investors recognize the true firm value x), and types in $\left(x_{k,ex}^{2;d}, \bar{x}\right]$ report $y = \bar{x}$ and are pooled.

Thus, equilibria that are enforced by the same punishment parameter and are based on the same reporting strategy $y(x, d)$ only differ by the threshold types $x_k^{1;d}$ and $x_k^{2;d}$. As the punishment for over-reporting is identical in the case of an information cap and under exact information, it follows that

$$x_{k,cap}^{2;d} = x_{k,ex}^{2;d}.$$

The consideration of the lower-end threshold types differs slightly. A firm type who chooses under-reporting has to face a fine under the regime of exact information but not if information is only capped. The overall payment of a type who chooses $y = y(x, d)$ is equal under both scenarios. Therefore,

$$x_{k,ex}^{1;d} \leq x_{k,cap}^{1;d}.$$

Thus, c.p. under the regime of exact information the set of types that can be truly recognized by the investors is bigger than under the scenario of an information cap. The magnitude of the difference depends on the prior distribution, the punishment parameter k, and the parameter d.

Although a comparison of equilibria based on the same reporting strategy shows that the scenario of exact information provides a better information quality, it cannot be said that this scenario performs unambiguously better.

First, which is a minor issue, for any punishment parameter k there there are infinitely many equilibria that differ in their information quality. It may well be the case that owner and investors coordinate under the regime of an information cap on an equilibrium with high information quality whereas under a regime of exact information they would coordinate on an equilibrium with low information quality.

Second and more important, some of the reporting strategies $y(x, d)$ underlying an equilibrium under the regime of an information cap do not lead to an equilibrium under a regime of exact information. Which are the "missing" equilibria? A presented in the comparative static analysis in section 3.1, with an increase in d the lower-end pooling region shrinks and the upper-end pooling region expands. As the reporting strategies resulting from lower parameter values do not lead to an equilibrium if exact information is demanded, the selection can be described as follows: The scenario of exact information tends to result in a better information provision concerning low firm types and a worse information provision concerning high types.

5 Conclusion

Different sets of accounting standards put different weight on the question if firms should be allowed to under-report their performance. This paper has shown that the handling of under-reporting does not significantly impact the quality of information provided as long as investors know the rules employed. One of the main simplifications the model has used is the assumption that firm value is a single number that can be determined for sure. As the ongoing scientific debate on asset valuation shows this assumption does not reflect reality. Therefore, any conclusion drawn with respect to accounting standards has to be quite careful. But as any set of accounting standards includes rules that are designed to prevent firms from under-representing their performance, the principle considerations can be used.

During the last years financial reporting standards have been undergoing a permanent process of substantial changes and amendments. Especially the fact that European capital market oriented firms have to present their consolidated accounts in accordance with IFRS means a substantial change for firms that hitherto had to comply to national GAAP. In most cases the shift from national GAAP to IFRS led to a stricter demand for exact reports of firm performance. US GAAP put even more emphasis on the need to have a balance sheet that shows the exact value of a firm's activities.

The equilibrium analysis of this paper shows that it is indeed possible to reach a better information quality by a change of accounting standards towards a system that restricts under-reporting. But the analysis shows as well that such an improvement neither is sure nor does it come without a cost.

Independent of the standards in force owners and investors have to coordinate on the way to play the information game. Therefore, in any case a change of the institutional frame may provoke a reorganization that may well end up in an equilibrium with a lower information quality. As seen a change may as well lead *for sure* to a change if owner and investors coordinated under the less demanding system on an equilibrium that is no longer feasible under a regime that demands exact reporting. Again, it is unclear if this change leads to an improvement.

Therefore, the analysis allows for an interpretation that concentrates attention on punishments instead of standards. Any improvement in information quality that can be reached by a change in the set of standards can as well be reached by imposing more severe sanctions on detected misreporting. As this would be a change *within* an existing framework and not a change *of* the framework, the likelihood for a reorganization of the capital market (with the above mentioned risks) is considerably lower.

A byproduct of the analysis results from a comparison between information quality under voluntary disclosures are equivalent to mandatory disclosures under an information cap. A first interpretation of this result suggests that the missing "received theory of mandatory disclosure" is possibly not missing as the achieved results do not rest on the assumption of voluntariness: They can as well result from a system with mandatory reporting and the possibility to under-report performance.

Taking a rather pointed view on the results one might ask why there are accounting standards at all. If investors are aware of their responsibility to read financial statements carefully, there are equilibria that lead to high information quality. Revsine (2002) has discussed that issue as a response to the Enron scandal. He suggests the following simple system of rules that looks appealing in the light of the above analysis.

> "1. Clearly identify what standard your firm selected (i.e., LIFO, straight-line depreciation, operating lease approach, etc.).
> 2. Does the standard you selected best reflect your firm's economic circumstances and performance?
>   a. If "yes", why?
>   b. If "no", what equally acceptable alternative standards were rejected?
>   c. By how much would key financial figures differ using the equally acceptable alternatives not chosen?
> 3. What is the justification for the estimates your firm selected to make the standard operational (e.g., useful life estimates by category for depreciation purposes)? Explain, if applicable, any deviations from prevailing industry norms."

To implement such a simple set of rules is obviously impossible, as it would impose high costs of information acquisition on each individual. But this suggestion highlights the role of the information user in ensuring information quality. It, thus, could contribute to the public debate on the quality of financial statements.

Appendix

Proof of Lemma 1:

In a perfect Bayesian equilibrium with full disclosure, investors must update their beliefs to $f_h(x|y=x)=1,\ f_h(x|y\neq x)=0$. Their bidding price will be $P(y)=y$. Thus, if the owner announces his true type x, he receives x. If he overstates his expected profits by ε, he receives independent of the punishment function in use $x+\varepsilon-\varphi k\varepsilon^2$. Overstating is profitable if

$$\begin{aligned} & \varepsilon \geq \varphi k \varepsilon^2 \\ \overset{(\varepsilon>0)}{\Leftrightarrow} \quad & \varepsilon \leq \frac{1}{\varphi k}. \end{aligned}$$

Thus, for any finite k and positive probability φ there is an incentive to overstate expected profits. □

Proof of Proposition 1:

As the signal $y=\underline{x}$ can be chosen at no cost, equilibria if an information cap is imposed, are equivalent to those under voluntary disclosure – except for the fact that under voluntary disclosure the bad types choose the signal $y=y^0$ instead of $y=\underline{x}$.

Korn (2004, p. 152-158)) gives a proof for the case of the linear reporting strategy. The material property used in the proof is the fact that the reporting strategy is strictly increasing. Thus, the corresponding proof for a comparative statics based on a reporting strategy $y(x,d), d\neq 0$ is analogous to the given proof – with obvious amendments for the threshold values. □

Properties of $\mathbf{LambertW(x)}$ *and* $\mathbf{y(x,d)}$*:*

1. $LambertW(x)$ is defined as the solution of $f(x)\cdot e^{f(x)}=x$ that is analytic in 0. $LambertW(x)$ maps $[0,\infty)$ monotonically increasing and concave to $[0,\infty)$. As Figure 6 shows, it resembles a "compressed" natural logarithm.

2. Any reporting strategy $y(x,d)=\frac{1+LambertW(-2d\varphi k e^{-1-2\varphi kx})+2\varphi kx}{2\varphi k}$ is as well strictly increasing and – with the exception of $y(x,0)$ which is a linear function – strictly concave. $y(x,d)$ is the inverse of $x=y-\frac{1}{2\varphi k}+de^{-y2\varphi k}$. The connection to the exponential function explains some of the following properties.

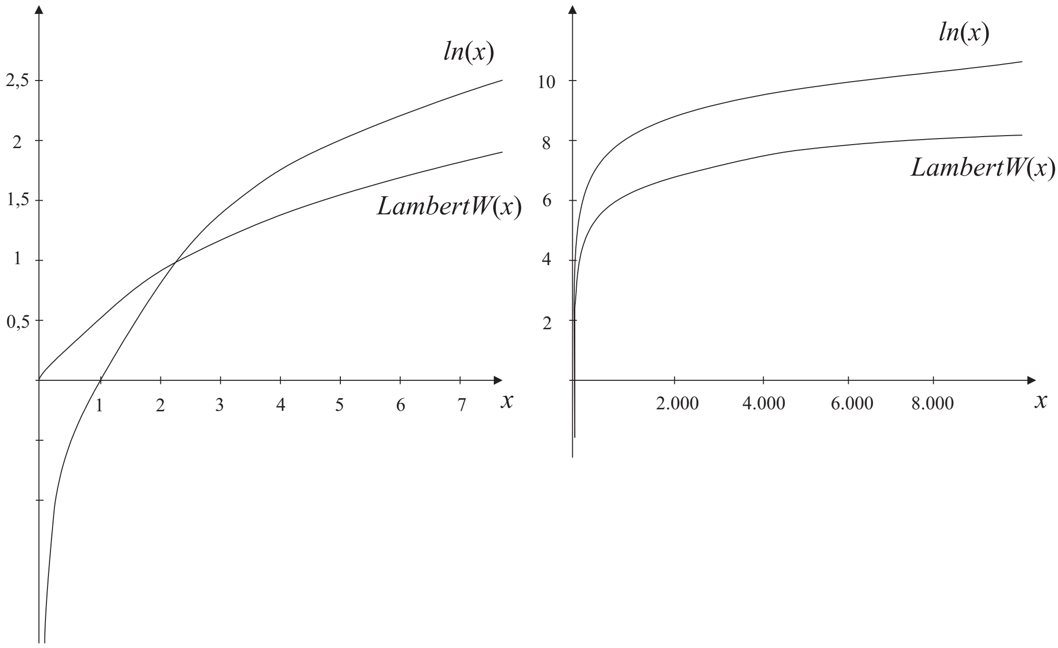


Figure 6: Shape of $LambertW(x)$

3. The parameter d results from the solution of the differential equation $\frac{\partial y}{\partial x} = \frac{1}{2\varphi k(y-x)}$. Its values are drawn from an exponential function. Therefore, d is always nonnegative independent of the set of parameters under consideration.

4. For $\bar{d} = \frac{1}{2\varphi k e^{-\underline{x}2\varphi k}}$ a reporting strategy $y(x, \bar{d})$ results such that the worst type $\underline{x}$ reports $y = \underline{x}$. For any $d > \bar{d}$ the worst type would choose a report $y(\underline{x}, d) < \underline{x}$. As such a report can be eliminated by the assumption of individual rationality, parameter values above $\bar{d}$ are excluded from the analysis.

5. If d decreases, the report of the worst type increases. The linear reporting strategy $y(x, 0)$ leads to the maximal overstatement of $y = x + \frac{1}{2\varphi k}$.

6. For any parameter d the reporting strategy $y(x, d)$ converges for $x \to \infty$ ("exponentially fast") to $x + \frac{1}{2\varphi k}$.

7. Therefore, the material difference between reporting strategies is given by their curvature at the lower end of the type interval (s. Figure 1).

References

Crawford, Vincent P. and Joel Sobel, "Strategic Information Transmission," *Econometrica*, 50 (1982), 1431–1451.

Dye, Ronald A., "Disclosure of Nonproprietary Information," *Journal of Accounting Research*, 23 (1985), 123–145.

—, "Proprietary and Nonproprietary Disclosures," *Journal of Business*, 59 (1986), 331–366.

—, "An Evaluation of "Essays on Disclosure" and the disclosure literature in accounting," *Journal of Accounting and Economics*, 32 (2001), 181–235.

Farrell, Joseph and Robert Gibbons, "Cheap Talk with two Audiences," *American Economic Review*, 79 (1989), 1214–1223.

Feltham, Gerald A. and Jim Z. Xie, "Voluntary Financial Disclosure in an Entry Game with Continua of Types," *Contemporary Accounting Research*, 46–80.

Fischer, Paul E. and Robert E. Verrecchia, "Reporting bias," *The Accounting Review*, 75 (2000), 229–245.

Fishman, Michael J. and Kathleen M. Hagerty, "Mandatory Disclosure," in Peter Newman, ed., "The New Palgrave Dictionary of Economics and the Law," (London: Macmillan Reference Ltd. 1998), 605–608.

Gigler, Frank, "Self-enforcing Voluntary Disclosure," *Journal of Accounting Research*, 32 (1994), 261–279.

Kleinert, Martin, "Reporting Bias and Capital Markets," *mimeo*.

Milgrom, Paul R., "Good News and Bad news: Representation Theorems and Applications," *Bell Journal of Economics*, 12 (1981), 380–391.

Revsine, Lawrence, "Enron: sad but inevitable," *Journal of Accounting and Public Policy*, 21 (2002), 137–145.

Sansing, Richard, "Accounting and the Credibility of Management Forecasts," *Contemporary Accounting Research*, 9 (1992), 33–45.

Shin, H. S., "News Management and the Value of Firms," *Rand Journal of Economics*, 25 (1994), 58–71.

Stocken, Phillip C., "Credibility of Voluntary Disclosure," *Rand Journal of Economics*, 31 (2000), 359–374.

Verrecchia, Robert E., "Discretionary Disclosure," *Journal of Accounting and Economics*, 5 (1983), 179–194.

—, "Information Quality and Discretionary Disclosure," *Journal of Accounting and Economics*, 12 (1990), 365–380.

Wagenhofer, Alfred, "Voluntary Disclosure with a Strategic Opponent," *Journal of Accounting and Economics*, 12 (1990), 341–363.

—, "Disclosure of Proprietary Information in the Course of an Acquisition," *Accounting and Business Research*, 31 (2000), 57–69.