The Effects of Managerial Short-termism on Compensation, Effort, and Fraud

James C. Spindler*

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Abstract

I model a firm where shareholders choose the manager's compensation in light of the manager's dual roles of exerting effort and making disclosures regarding the firm's value. Because of limited contracting ability and the divergence of short-term interest between shareholder and manager, shareholders may be unable to obtain their first-best choices of effort and disclosure policy; where agency costs are too large, shareholders will be unwilling to award performance-based compensation, which induces both effort and fraudulent reporting. The principal findings are (1) fraud and effort are positively correlated, and given a poor outcome fraud is more likely to occur when effort is exerted in equilibrium and returns to effort are higher, (2) the incidence of fraud-inducing compensation increases as agency costs decrease, and (3) when agency costs are high, reductions in agency costs actually increase the incidence of fraud. Regulatory implications include that deterring fraud, even absent adjudicatory error, may be socially inefficient; rather, policy should be oriented toward internalizing costs of fraud onto shareholders.

1 Introduction

This paper is motivated by two popular, yet somewhat contradictory, schools of thought regarding securities fraud. The first is that securities fraud is a product of managerial compensation. This line of thinking

*Associate Professor of Law & Business, University of Southern California; Ph.D. candidate, UCLA Department of Economics. For helpful comments, thanks to Bill Zame, Tony Bernardo, Simon Board, Aaron Tornell, Gillian Hadfield, and participants at the USC Center for Law, Economics & Organizations Workshop. For financial support, thanks to the Southern California Innovation Project and the Kauffman Foundation.

arises, perhaps, because it is relatively rare that a complaint of securities fraud alleges that management's motive for the fraud was to steal from the firm in a direct sense, such as actually running off with bags of loot. Rather, the self-serving incentives for fraud are typically thought to be more subtle: "managers hide bad news because they fear loss of their jobs.... and they overstate favorable developments or inflate earnings in order to maximize the value of their stock options and other equity compensation." Coffee (2006 at 39).[1] Managers will maximize the value of their compensation by hook or by crook, leading performance-based compensation to be a significant, if not the principal, motivation for committing fraud.

The second motivating school of thought, also widely expressed, is that fraud is the product of managerial agency costs. This, too, has spawned a significant academic literature.[2] The basic idea is that managers, not firms, commit fraud, but that firms typically bear the costs of the fraud when it ends up being discovered. Hence managers find fraud, under the current system, an attractive activity. As The Economist (2006) put it, "[s]uing companies for their managers' errors ... merely hurts shareholders a second time," and does nothing to address the root cause of fraud.

There is a problem, however, in reconciling these two views. They could be consistent if managerial compensation is exogenous – that is, if managers are awarded a compensation contract randomly or arbitrarily, as by regulatory fiat. But managerial compensation is not random, and in fact it is chosen by the owners of the firm: shareholders set in place the mechanisms, if not the actual contracts themselves, that determine what the manager makes in any state of world, including whether the manager gets to keep her job.[3] So this begs two questions: First, if fraud arises out of managers' compensation contracts, why would shareholders award such contracts in the first place? And second, if managers are committing fraud because shareholders incentivize them to do so, is such fraud a product of agency costs in any meaningful

[1] Arlen and Carney (1992 at 724-7) and Talley and Johnsen (2004) provide empirical support for this assertion. The empricial corporate finance and accounting literature has also sought to demonstrate links between performance based pay and accounting fraud. See, e.g., Johnson, Ryan & Tian (2005) and Erickson, Hanlon & Maydew (2004). Prior theoretical models of fraud/effort tradeoffs include Robison & Santore (2005), Goldman & Slezak (2006), and Tackie & Santore (2008).

[2] Just a few examples are Arlen & Carney (1992), Alexander (1996), Coffee (2006), and the Paulson Committee Report (2007).

[3] Of course, one way of reconciling these views is to argue that both fraud and compensation are products of managerial agency costs. Indeed, an important and influential line of literature argues that shareholders do not, effectively, set managerial compensation; rather, boards of directors are in bed with the managers, who largely get to choose how and how much they will be compensated. This view is most notably expressed by Bebchuk & Fried (2004). While this is a coherent worldview, it does require somewhat controversial assumptions, such as the lack of a meaningful shareholder voting franchise and the inability to contract for ex ante welfare-maximizing governance. In any event, the model presented in this paper constitutes, I believe, a plausible alternative.

sense? Answering these questions is important not just to the challenge of reducing fraud, but also to the more fundamental issue of just how harmful securities fraud is in the grand scheme of things. Further, and perhaps of more immediate importance, these questions bear directly on current reform proposals to make management more "accountable" by virtue of greater pay-for-performance compensation measures.

This paper addresses these questions by modeling formally the relationship between corporate fraud, shareholders' choice of compensation, and the efficient exertion of managerial effort. The crux of the model is that shareholders designing the compensation of the manager may only be able to get some, not all, of what they want: given the limits of contractibility, shareholders can achieve their preferred level of effort or preferred disclosure policy, though not necessarily both. In particular, performance-based compensation – in the form of an equity share in the company – tends to induce managers not just to exert effort, but also to falsely report in the event that the firm does poorly.[4]

As it turns out, if managers were the same as shareholders, awarding managers an equity share would not induce any behavior that shareholders do not like (and shareholders will, in general, prefer some degree of fraud to be committed). Agency costs in this model arise in two ways: from the standard assumption of unobservable effort (which necessitates performance-based pay to avoid moral hazard) and also in the form of managerial short term interests: the manager may be more likely to sell his equity share than are the shareholders. This captures the commonly expressed concern (for example, as in the Enron prosecution against Ken Lay and Jeffrey Skilling) that managers' inflated reports of value are designed to increase the value of short term stock compensation. Shareholders are then faced with a tradeoff: while high equity compensation can induce managers to exert themselves, it also leads to a greater degree of fraud than shareholders would desire.

From this model, I derive the following principal results:

1. Effort and fraud tend to go together. Fraud in the event of poor firm performance is more likely to occur when managerial effort has been exerted. The reason is twofold: intuitively, performance-based compensation rewards the faking of performance, and, less intuitively, there is more to lie about in an equilibrium where managers will exert effort and hence have a higher likelihood of high payoffs. Because of

[4] This characteristic is similar to that of the Robison & Santore (2005), Goldman & Slezak (2006), and Tackie & Santore (2008) models.

this positive correlation between fraud and effort, singlemindedly enacting policies that may limit fraud may also have the effect of suboptimally limiting managerial effort. Conversely, singleminded policies that force performance-based compensation will have the effect of also inducing a greater degree of fraud than optimal.

2. Diminishing agency costs increase use of fraud-inducing equity compensation. When the manager's interests are such that she would commit much more fraud than shareholders desire, shareholders may choose not to award equity compensation, which eliminates fraud at the expense of managerial effort. As agency costs decrease, shareholders will eventually choose to award equity compensation, which induces effort and may also induce fraud. The compensation contract offered to the manager, whether or not it induces fraud, maximizes shareholder payoffs given the limited contracting context of the manager-shareholder relationship. Hence, unless regulatory intervention is somehow able to increase the degree of contractibility between manager and shareholder, such interventions are likely reduce shareholder welfare.

3. When agency costs are high, reductions in agency costs increase the incidence of fraud. In contrast to the conventional wisdom that agency costs promote fraud, when agency costs are high marginal reductions in agency costs will lead to an increase in fraud. This is because shareholders control compensation, and will rein in a manager too predisposed to commit fraud by not awarding equity compensation. This reduces or eliminates the manager's incentive to commit fraud. If agency costs are relatively low, shareholders will award equity compensation to achieve approximately their preferred policies on effort and disclosure. If fraud imposes significant externalities outside of the firm, reducing agency costs may be socially undesirable even though doing so may increase shareholder welfare.

Finally, an intriguing, though less well-fleshed out, result bears on the usage of corporate fines (often referred to as "vicarious liability" in the legal literature, since the firm is vicariously liable for the actions of its managers) as opposed to personal sanctions levied against the manager. To the extent that shareholders desire fraud – which they do because of their short term interests – personal sanctions on the manager are ineffective deterrents because the shareholders can always indemnify the manager ex post or award more stock compensation ex ante. In contrast, fines against the corporation actually decrease equity compensation's efficacy in encouraging fraud at both the manager and shareholder level.

The paper proceeds as follows. Section 1.1 describes the prior securities law literature and the conventional wisdom regarding securities fraud. Section 1.2 presents three examples that illustrate intuitively the main findings and policy implications of the model. Section 2 presents the formal model, styled as a one shot game between strategic players: shareholders, the manager, and purchasers. Section 3 presents a solution in the form of each player's optimal strategies at each stage of the game; this section consists mostly of technical proofs, and the reader may wish to read the propositions and then move on. Section 4 analyzes the solution and presents results, including the results of the model given above. Section 5 concludes.

1.1 Prior literature on securities fraud and compensation

Here, I briefly review how the securities law literature has treated concepts of fraud, agency costs, and the role of executive compensation.

1.1.1 Fraud is bad, market integrity is paramount

A significant branch of the securities law literature deals with the importance of market integrity – the ready availability and veracity of information about securities in the marketplace. Indeed, market integrity is often taken as a sufficient condition for economic efficiency: for instance, Goshen & Parchomovsky (2006) have recently opined that "[s]cholarly analysis of securities regulation must proceed on the assumption that the ultimate goal of securities regulation is to attain efficient financial markets and thereby improve the allocation of resources in the economy." Truthful and abundant information allows investors to invest in good projects, while avoiding bad ones. Equal dispersal of information reduces liquidity costs by reducing investors' fear of an unequal playing field in which they may be expropriated by better-informed traders.[5] In settings where prices are accurate, firms' cost of capital will be determined efficiently,[6] while investors need invest little in wasteful precaution costs (such as personally conducting due diligence on a potential investment). Fraud, the intentional dissemination of incorrect information to the marketplace, can render capital allocation inefficient and creates a need for investors to second-guess the firm's disclosures. Hence, the argument goes, one could maximize allocative efficiency and minimize liquidity costs by compelling the

[5] The economic theory of liquidity costs, as reflected in bid ask spreads, is laid out in the classic work of Copeland & Galai (1983) and Glosten & Milgrom (1985).

[6] While the theory on this point is generally regarded as sound, there is very little empirical data showing that richer informational environments do indeed improve capital allocation and promote economic growth. See Fox, Morck, Young, & Durnev (2003), who describe the empirical literature as "surprisingly small."

disclosure of information and by effectively deterring fraud. This is, indeed, what the Securities Act and Exchange Act – the chief securities statutes in the U.S. system – aim to do, outlining schedules of mandatory disclosure as well as penalties and remedies for inaccurate disclosure. The furtherance of market integrity and investor protection has long been the chief and explicit aim of the SEC.

However, as it turns out, market integrity is only an imperfect proxy for economic efficiency and overall social welfare; in fact, market integrity can come at the expense of efficiency. As pointed out by Easterbrook & Fischel (1984), Gordon & Kornhauser (1985, at 802), Stout (1988), and others, compelling information is costly, and the disclosure of information can in fact destroy its value (as in, for example, the case of a potential takeover plan). As Easterbrook & Fischel (1984, at 696) observe, "[o]ne must be careful... of the fallacy that if some information is good, more is better." Price accuracy and liquidity could be maximized, for instance, by prohibiting the commencement of new and innovative projects: this will reduce the uncertainty surrounding a firm's value, but is clearly a bad idea from a social point of view.[7]

The instant paper carries the efficiency-oriented critique of market integrity and anti-fraud rules a step further: one result of this paper is that fraud is not necessarily bad, in the sense that fraud tends to accompany productive effort. Fraud might be considered an undesirable by-product of an overall desirable activity. So long as the choice of whether to commit fraud or not is made by an actor who internalizes the costs of fraud and the benefits of the productive activity, we should expect the correct decision to be made. This suggests that the role of securities law should not be to prohibit fraud as a final objective, but rather to make sure that the costs and benefits of the activity are internalized by the decisionmakers, namely, the shareholders.

1.1.2 Agency costs lead to fraud

Much ink has been spilt on the issue of deterring fraud and the related issue of who it is that chooses to commit fraud. The typical view in the securities law literature is that fraud is the product of agency costs. Arlen & Carney (1992), in a critique of the U.S. system of vicarious liability for securities fraud, claim that

[7] While the subject of this example may appear so obviously bad as to be trivial, it is actually not that far off from the SEC's position, taken in some briefs, that trading on any non-public information ought to be actionable, whether or not generated by insider access. And SEC rulemaking has taken steps in this direction, as with Rule 14e-3 and Regulation FD, which prohibit trading on non-public information, even if acquired by an outsider from the firm via otherwise legitimate means.

managers benefit from fraud (it can, for instance, save their jobs) while shareholders do not, and conclude that "Fraud on the Market is a product of agency costs" and that "agent liability supplemented with criminal enforcement" is the proper deterrent. Indeed, Arlen & Carney do show that most securities fraud (91.3% of their sample) involves price inflation;[8] this is generally consistent with managers lying to cover up poor performance. Other prominent scholars, such as Coffee (2006), Alexander (1996), Langevoort et al. (2007), and Grundfest (2007) have reached similar conclusions, finding that fraud is a result of managerial agency, and call for abandoning securities class actions in favor of increased sanctions against malfeasant executives. These views have been influential in crafting regulatory policy: the Paulson Committee (2006 at 78) (so-called because of its support by then-Treasury Secretary Paulson), charged with creating a plan to reform the U.S. capital markets, has generally echoed these sentiments.

In contrast, in a prior work (Spindler (2010a)), I show that incentives for fraud quite plausibly exist at the shareholder level, since current shareholders of the firm will be net sellers, as a group, in the future. This creates the conflict of interest between buyer and seller that is endemic to all commercial transactions: sellers prefer higher prices than do buyers. Because current shareholders are in the position of controlling corporate governance, including disclosure policy and executive compensation, shareholders have the means, as well as the incentives, to perpetrate securities fraud. In the instant paper, I continue along these lines to show that fraud is actually more likely to occur where agency costs are lower: the reason is that if agency costs are too great, shareholders will be unwilling to grant performance-based compensation to the manager because the manager will tend to commit more fraud than the shareholders would desire.

1.1.3 Shareholder power and executive compensation

A relatively new, though influential, approach in limiting securities fraud does not apply to disclosure directly, but rather mandates specific corporate governance and other internal controls that are thought to reduce the incidence of fraud by increasing shareholder power and oversight. The new approach, exemplified in the substantive corporate governance requirements of Sarbanes Oxley (discussed in detail in Ribstein (2002)), mandates as prophylactic measures against fraud such governance structures as an independent board of

[8] The relatively few price deflation cases typically involve buyouts by the firm or by management.

directors, auditor oversight, internal controls, and executive pay clawbacks. While not part of the Sarbanes Oxley reforms, increased shareholder proxy access is also seen as a prescription against fraud, as Stout (2007) discusses, and is currently popular with regulators.

One particularly important plank in this platform is to improve the structure of executive pay and incentives. Such improvements would eliminate "stealth compensation" through perks, favorable options, pensions and other measures, which amount essentially to nondisclosure of compensation to shareholders, according to Bebchuk & Fried (2004) and Bebchuk, Fried & Walker (2002). The ability to hide compensation from the market allows executives to determine their own pay. Bebchuk & Fried (2004) find evidence of this in the "decoupling" of pay from performance: if shareholders were really in control of executive pay, more compensation would be meaningfully performance-based. Rather, according to Bebchuk & Fried (2004, at 6) "executive pay is much less sensitive to performance than has commonly been recognized."

Reforming executive pay would combat fraud more generally, as according to Bebchuk (2005, 2006) it would eliminate "perverse incentives... to produce short-term stock price increases instead of long term value" that arise from "broad freedom to unload options and shares" (Bebchuk 2005). According to Coffee (2006 at 39) "managers hide bad news because they fear loss of their jobs.... and they overstate favorable developments or inflate earnings in order to maximize the value of their stock options and other equity compensation." Providing a concrete example, in an examination of the 2004 Fannie Mae scandal, Bebchuk & Fried (2005) find that Fannie Mae's executive pay arrangements "richly rewarded its executives for reporting higher earning without requiring them to return compensation if the earnings turned out to be misstated, thus providing an incentive to inflate earnings." If executive pay that is uncontrolled by shareholders leads to securities fraud, then a proper regulatory anti-fraud response is either to increase shareholder control or else regulate compensation directly.

The instant paper's results agree to some extent with these views. Performance based pay is useful in compelling productive effort, but it has a distinct cost in that it may lead to fraud. The issue then is why might shareholders sometimes choose to award it, and sometimes not, and is this choice socially efficient? The model indicates that shareholders will award it when the benefits outweigh the costs: when their share of productive effort exceeds the penalties and costs associated with fraud. In particular, as agency costs decline, the level of fraud that managers will commit becomes acceptable or even desirable to shareholders, such that shareholders will award the equity compensation. The goal of the securities laws ought to be, in part, to ensure that shareholders properly internalize these costs and benefits to arrive at the correct tradeoff. Prohibiting fraud outright is not necessarily productive, though firm-level liability can play an important role in ensuring that shareholders internalize the costs of fraud.

1.2 Three examples

In this section, I draw on the formal results of the latter part of the paper to illustrate in an intuitive fashion the main points and policy implications of the model. In order to keep things simple and the intuitions clear, the following discussion may skip a few steps, which are elaborated in the subsequent technical portion of the paper.

Consider the effect of performance-based compensation and managerial short-termism in the case of the hypothetical Venture Industries. Venture has an innovative new project, a potentially revolutionary technology that may yield significant cash flows in the future. The efforts of Venture's CEO, Samson, are very important to the ultimate success of the project; among other things, Samson must make key decisions regarding research and development, deal strategically with suppliers and potential clients, and exercise vigilance over the day to day operations of the firm. That is, his effort increases the odds of success. Relatedly, because Samson has the best information regarding the prospects of the company at any given time, Venture's shareholders (and the wider marketplace) are dependent upon Samson to make disclosure regarding the probable future cash flows that Venture will enjoy. In particular, assume that Venture can be either successful or not, and that Samson will know this with certainty once he has exerted his effort and before he makes his disclosure.

Disclosure plays an important role for Venture Industries. Inaccurate disclosure poses costs, some of which are internalized onto the current shareholders, and others that may be externalized onto subsequent purchasers of the firm's shares.[9] First, in an equilibrium in which accurate disclosure is not made, there is a cost in that Venture – even if in possession of a successful project – will not be able to efficiently raise the

[9] As is clear in the formal model, in equilibrium all costs are borne ex ante by the current shareholders of the firm; this must be true since rational purchasers always break even in expectation.

additional capital to scale up a successful project;[10] this cost is borne solely by the current shareholders of successful firms (ex post), as it reduces the price that they may receive for their shares if they sell in time 1 and the cash flows they will receive in time 2 if they do not sell.[11] Second, where value is overstated, purchasers bear the cost of that overstatement, ex post. As it turns out, because the purchasers' loss is the selling shareholders' gain, this gives current shareholders of the firm an incentive to overstate firm value in the absence of an appropriate fraud deterrent. This is true of current shareholders as a group, because shareholders who sell are better off with an overstated price, while shareholders who do not sell are unaffected by the overstatement absent an antifraud mechanism.[12] Finally, as a remedy to this incentive to overstate value, the failure to make correct disclosure has a direct cost in the form of a regulatory sanction imposed upon the firm (that is, the SEC will fine Venture if Samson has lied); this cost is borne ex post in part by the current shareholders (those who do not sell) and the subsequent purchasers of the firm's shares, although the regulator can use the fine to compensate these purchasers.

The game proceeds in the following steps. In time 0, shareholders choose Samson's compensation contract, which may be either salary or stock; assume that this contract is not observable to outsiders.[13] Samson then chooses whether to exert effort or not. Effort increases the odds that Venture's project will be successful, i.e., the probability of success given effort is greater than the probability of success given no effort. In time 1, Samson learns whether Venture's project is successful; Samson then makes a disclosure to the market, where he must choose either to lie or tell the truth about the firm's success or failure. Also in time 1, but after

[10] To provide an example of why this might be so, consider the following situation. Suppose the probability of success given effort is .6, where success yields \$1 and failure yields \$0. Assume arguendo that the equilibrium is such that Samson will exert effort. Suppose further that investors will have the opportunity to double-down on their investment after Samson's disclosure: for an additional investment of \$.7, investors can duplicate the project. For a successful project, this yields a net payoff of \$.3, but for an unsuccessful project, this yields a net loss of \$.7. If Samson can be expected to disclose truthfully in equilibrium, then investors will want to scale up. But if Samson will not disclose truthfully, then investors would not scale up: the expected payoff from the additional investment is negative. Even if the expected payoff were positive, such that investors would scale up, there is an efficiency loss in that investors sometimes scale up unsuccessful projects.

[11] Choosing ex post, or out of equilibrium, to tell the truth would not reduce their costs in this respect.

[12] This intuition is proven more rigorously in Spindler (2010).

[13] This is equivalent to saying that shareholders cannot commit ex ante to any particular form of compensation contract. Note that it is an assumption of the Bebchuk & Fried argument that compensation is not readily observable by the market. Also, the SEC has taken this view in its efforts to mandate greatly expanded disclosure in proxy statements, including recent executive compensation disclosure rules. Finally, it may simply not be possible in a repeated game situation for shareholders not to reward managers for engaging in false disclosure.

However, even if the compensation contract is observable, all this means is that the shareholders' commitment problem has been solved. This effectively takes the shareholders' short term interests (their propensity to sell in time 1) out of the game, but it does not change the dynamics of the effort/fraud tradeoff, where shareholders would still rationally choose equity compensation even where it leads to false disclosure because the payoffs of effort are sufficiently high. The point will still stand, even more strongly, that fraud when it occurs is in a sense efficient, in that regulatory intervention is quite unlikely to improve things. In the game where shareholders cannot commit to a compensation mechanism, liability has at least a chance of allowing commitment; if shareholders can already commit, then liability has little positive function.

Samson's disclosure, some proportion of shareholders (including Samson, if granted stock) will sell their stock, at a price determined by the market's rational expectations of Venture's future cash flows. This proportion of shareholders who sell is exogenously given and represents that some shareholders will experience a need for cash (e.g., paying for children's college tuition) that requires liquidation of their investment portfolio; this is the extent of shareholders' short term interests. Finally, in time 2, Venture's project yields cash flows; if successful, cash flows are $1 per share, if not, cash flows are $0. If it turns out that Samson lied, a regulator (such as the SEC) will assess a fine against Venture.

This game is solved using backward induction: each player makes her choice taking into account what the choices of the subsequent players will be. Consider the shareholders' problem at time 0. Shareholders must figure out how to pay Samson – namely, whether to award him a flat salary or to grant him stock. This problem depends on what Samson will do once the compensation contract is made – whether he will exert effort, then whether he will follow a truthful disclosure policy – and also upon what price the purchasers will pay given what they know about shareholders' and Samson's incentives and disclosure. Samson's effort problem, in turn, depends on what he believes he will do in his subsequent disclosure decision, as well as the price that purchasers will pay given his disclosure. Samson's disclosure problem incorporates how purchasers will interpret the disclosure.

Should shareholders grant Samson stock? If Samson receives no stock or other performance based compensation, he will certainly exert no effort, because, while he bears the cost of effort, he does not share in its benefits. On the other hand, he will also not engage in fraud, since his compensation package is not a function of his time 1 disclosure; assuming even a slight preference for telling the truth, he will always choose to tell the truth.

What happens if he receives stock? Whether Samson exerts effort in time 0 depends in part upon whether he will tell the truth in time 1, and what his likelihood of selling his share is at time 1. To see what exactly will happen requires plugging some numbers into the model.

1.2.1 Example 1: Lower agency costs can lead to more fraud

For instance, suppose that Samson always gets to sell his stock in time 1. In this case, for any grant of stock and regardless of the expected regulatory fine imposed on Venture, Samson will always follow a policy of fraud in time 1. The reason is because he does not bear any of the fine the regulator imposes upon Venture in time 2. As to his choice of effort, Samson would choose not to exert himself: his payoff (all received by selling stock at time 1) is a function only of his time 1 disclosure (which influences time 1 price), not the ultimate cash flows Venture receives in time 2. In this case, would shareholders never award Samson the equity, preferring instead to always pay him in cash? Not necessarily: it depends upon the degree of divergence between the interests of shareholders and Samson. If shareholders always get to sell in time 1, just like Samson does, then there is no divergence of interest, and shareholders will in fact award the equity share even though it does not result in Samson exerting effort; rather, the ex post benefit to shareholders of fraud is fully in line with Samson's interests. On the other hand, if Venture's shareholders never get to sell, then it is clear that they derive no benefit from Samson's fraud, and fully bear the cost of the fraud fine imposed. In such a case, shareholders would choose not to award the equity share. Somewhere in the middle – where the propensity of shareholders to sell in time 1 is between 0 and 1 – exists the cutoff at which shareholders would go from awarding the share to not awarding it.

This example illustrates one important point of the general model: as agency costs as measured by the divergence of interest between Samson and the shareholders go from large to small, fraud actually increases. Where agency costs were extreme, shareholders do not award the equity share, and Samson remains truthful in time 1. Where agency costs are small to non-existent, shareholders do award the equity share, and Samson defrauds purchasers in time 1. This result holds even where the manager's effort is not part of the game. This is in direct contrast to a literature that generally concludes that "Fraud on the Market is a product of agency costs." (Arlen & Carney (1992)). Rather, it is only when agency costs have been mitigated to some extent that securities fraud can come into being.

In the more complex and realistic case where the manager does not always sell, and shareholders do not always retain their shares, there will exist a tradeoff between the supraoptimal level of fraud that the manager commits if awarded the equity share and the gains to shareholders from the manager's exertion of effort. As the gains to effort grow greater, shareholders will be willing to endure an increasing overabundance of fraud. Take a less extreme example, where Samson still has a high propensity to sell out early in time 1, but his likelihood of selling is less than certainty. In such a case, Samson may have enough "skin in the game" that he will choose to exert effort given a high enough equity share. It may also be the case, however, that awarding Samson the equity share will still lead him to choose to lie in time 1. This can be true even if fraud penalties are high enough that shareholders do not want Samson to commit fraud. Does the fact that Samson will commit fraud necessarily mean that the shareholders do not want to award the equity compensation to him? No, it does not: so long as the gains accruing to the shareholders from Samson's exertion of effort outweigh the ex post losses, shareholders will rationally choose to award the equity even though it leads to fraud.

In fact, preventing shareholders from awarding the equity would be unambiguously bad, as would raising fines to the point where shareholders choose not to award it. Rather, as it turns out, fraud and effort tend to go together: where effort is valuable and feasible, there tends to be more to lie about. These points are explored in the next two examples.

1.2.2 Example 2: Fraud deterrence can be inefficient

As it turns out, deterrring fraud may not be socially desirable. To see this requires specifying a few more parameters of the model. Suppose that Samson's opportunity cost of serving as CEO is \$0.68, while the cost of his exerting effort is \$0.32. If Samson is paid only in cash, it is a foregone conclusion that he will not exert effort. The reason is that his payoffs are unaffected by the success or failure of Venture's project, but are reduced by the exertion of effort (by \$0.32). Further, if Samson is paid only in cash, he will have no incentive to lie at time 1: he would be at best indifferent to lying, and if, as seems reasonable, there is even a slight possibility of a personal sanction associated with fraud, then he would prefer to tell the truth. The probability of success given effort is .6, while the probability of success without effort is .2; hence the added value per share of effort is \$0.40. Samson's propensity to sell is .6 (he sells 60% of the time in time 1, and retains his share the other 40% of the time); in contrast, shareholders never sell, and always retain their shares. Suppose that the liquidity cost of the fraud equilibrium is \$0.10 per share, while the regulator can choose any fine up to a maximum of \$1 per share. Awarding Samson 1 share of stock will be sufficient to just cover his costs given effort.

First, consider that if Samson is awarded the stock, there is no feasible fine that can get Samson to disclose truthfully in equilibrium. One can see this from an examination of the condition that he must prefer to tell the truth in order for truthtelling to be an equilibrium. Consider what happens if the regulator imposes the maximal fine of \$1 per share. By disclosing truthfully in the low state, Samson would have a return of \$0 if he sells (the market would price an unsuccessful project at \$0) and \$0 if he does not sell (these are the cash flows of an unsuccessful project). By disclosing falsely, however, Samson would have a return of \$1 if he sells (how the market prices a successful project) and -\$1 if he does not (he will endure the \$1 per share regulatory fine and enjoy the zero cash flows of Venture's unsuccessful project); since he is 60% likely to sell, his expected payoff if he lies is $.6 * \$1 + .4 * -\$1 = \$.20$, which exceeds his expected return from telling the truth of \$0.

In such a case, would the award of a share of stock be sufficient to induce effort? Since in equilibrium Samson will lie about an unsuccessful project, he must be willing to exert effort in time 0 with the knowledge that he will lie in time 1. His expected payoffs given effort must exceed his expected payoffs given non-effort. His expected payoff given effort is a .6 chance of project success multiplied by his payoff from a successful project in a pooling and effort-exerting equilibrium (he sells his share 60% of the time for an equilibrium pooling price of \$0.60, and 40% of the time does not sell and receives cash flows of \$1), plus the .4 chance of failure multiplied by his payoff from an unsuccessful project in a pooling and effort-exerting equilibrium (he sells his share 60% of the time for an equilibrium pooling price of \$0.60, and 40% of the time he does not sell and bears the \$1 fine), minus the cost of his effort. This is $.6*(.6*\$.6+.4*\$1)+.4*(.6*\$.6-.4*\$1)-\$.32 = \$.12$. Samson's payoff from deviating to not exerting effort is the .2 chance of project success multiplied by his payoff from a successful project in a pooling and effort-exerting equilibrium, plus the .8 chance of failure multiplied by his payoff from an unsuccessful project in a pooling and effort exerting equilibrium, without bearing the cost of effort. This is $.2 * (.6 * \$.6 + .4 * \$1) + .8(.6 * \$.6 - .4 * \$1) = \$.12$. Since the payoffs are the same, Samson is willing to exert effort (and shareholders could make him strictly prefer effort by awarding him an additional infinitesimal fraction of a share of stock).

Thus, in sum, if granted a share of stock, Samson's strategy will be to exert effort in time 0 and to disclose that Venture's project has been successful in time 1, without regard to the truth. This is so even though the regulator's maximum fine of \$1 per share is being imposed, and one can verify (which I do algebraically in Sections 3.3 and 3.4) that his behavior remains the same for any lower level of fine.

What, then, will the shareholders choose to do in such a situation? This depends upon the level of the fine. Suppose that the fine is very small, say \$0 per share. In such a case, shareholders will award Samson the equity compensation, because they are made unambiguously better off by his exertion of effort. Once, however, the regulator raises the fine significantly (say, to \$1 per share), shareholders will choose to no longer award the equity share: the \$0.40 gain in production from Samson's effort does not come close to making up for the \$1 fine that the regulator imposes. Shareholders in such a case would prefer not to award the equity share, which leads Samson to slack in time 0 but tell the truth in time 1.

Thus, by raising the fine, the regulator has deterred fraud. However, the regulator has also deterred effort-inducing compensation and, hence, effort. While in some cases, an antifraud fine could conceivably further economic efficiency by enabling shareholders to commit to non-fraud policies, in this case the regulator has destroyed \$0.30 of value per share (there is by assumption a \$.10 gain from avoiding illiquidity in the fraud equilibrium, but a \$0.40 loss from the non-exertion of effort). This is true even though there is no adjudicatory error: there are neither false positives nor false negatives in this model. Nor is it the case that fines are overdeterrent in the sense of being higher than necessary to deter fraud; the minimum fine that deters fraud would still lead to economic loss in this example. Rather, the conceptual problem is that the goal served by fraud deterrence – the increase of price accuracy – is only imperfectly related to economic efficiency. In this sense, my result follows in the tradition of law and economics literature such as Easterbrook & Fischel (1984), Macey (1991), Manne (1972), and Stout (1992), which make it clear that price accuracy and fraud deterrence are not at all the same thing as real economic efficiency. This model shows explicitly how fraud deterrence, even with an omniscient adjudicator of guilt, can be economically harmful; conversely, there is an optimal, non-zero level of fraud given the incompleteness of contracting that exists between shareholders, managers, and secondary market purchasers.

1.2.3 Example 3: Increased productivity leads to increased fraud

Typically, the literature on corporate fraud has associated fraud with poor economic performance. Indeed, since misreporting may be used to cover up bad corporate performance, one would expect there to be a correlation. Going further, however, it has been common to blame poor performance on the fraud itself; for example, the Enron fraud perpetrated by Ken Lay and Jeff Skilling was blamed in part for Enron's collapse. The story that is often told is that misreporting allows disloyal agents to pilfer the company and, in the process, run it into the ground.

Attributing the bad performance to the fraud itself is problematic, however. It is relatively rare that one finds executives who actively stole from the firm; rather, it is more likely that the alleged theft (as in the case of Enron) involves the maximization of manager's performance-based compensation by propping up share price. This begs the question of why shareholders would award such compensation if it harms the firm. My model suggests a somewhat different relationship between fraud and corporate performance: while managers may lie to cover up poor performance, managers are actually more likely to lie where effort is being exerted and where the gains to effort are higher. And shareholders will be more likely to grant performance-based compensation where the gains to effort are higher. So, in this model, instead of fraud causing poor performance, the potential for higher performance leads to a greater likelihood of committing fraud given bad results.

Consider again the example of Samson managing Venture Industries. Consider an equilibrium in which Samson always lies given failure. In order for Samson to prefer to tell the truth, his payoff from doing so must be higher. Truthfulness about failure gives Samson an expected (and actual) payoff of zero, since the market will value an unsuccessful project at \$0, which is also the level of cash flows Venture will produce. Lying, on the other hand, gives Samson an expected payoff equal to the likelihood that he sells multiplied by the market price given his high disclosure, minus the likelihood that he does not sell multiplied by the per share fine. The market, in an equilibrium in which Samson lies, will discount Samson's disclosure, and the market price will be the expected value of the firm given that Samson's disclosure is uninformative, which is equal to the probability of success (given by whether effort is exerted in equilibrium) multiplied by the successful cash flows of \$1. If the probabilities of success given effort and slacking are (as above) .6 and

.2, respectively, this means that in an effort exerting equilibrium, Samson's payoff from lying is .6*.6*$1 - .4*fine, while if Samson will not exert effort, Samson's payoff from lying is only .6*.2*$1 - .4*fine. In the effort case, a fine of at least $.90 is required to cause Samson to abstain from lying, while in the non-effort case a fine of only $.30 will suffice.

What is important to note is that Samson's payoff from lying is a positive function of Venture's likelihood of success, which is in turn a positive function of the returns to effort and a positive function of the exertion of effort. This means that (a) greater returns to effort increase the returns to Samson of lying, and (b) the very fact that the market knows that effort will be exerted in equilibrium also increases the returns to lying. Put another way, there would be relatively little point in Samson lying if the market believed that the odds of success were very low, and similarly if the market believed that Samson was not going to put in the effort to make success more likely. Holding the other parameters of the model constant, then, we should expect to see an increase in fraud as more and better effort is exerted. Hence, it may be that outbreaks of securities fraud are in fact symptomatic of productivity growth, and fraud may be a natural by-product of economic innovation.

2 The model

Here I present the general model of agency costs in a firm with endogenous compensation. There are three aspects to agency costs in this model. First, the manager's effort, which positively impacts the expected value of the firm, is not observable or verifiable. Second, the manager may face costs from securities fraud that shareholders do not; these costs may be reputational, moral, or legal. Third, to the extent that the manager owns shares of the firm, the manager may have shorter term interests with regard to the stock price of the firm than do the shareholders. This assumption is common in the legal literature on securities fraud: it is presumed that managers are not in it for the long term (e.g., Bebchuk and Fried (2009)), and may maximize short term stock price at the expense of long term stock price and performance.

Shareholders can, to an extent, remedy this conflict of interest via contract. Contracting in this model is imperfect, in that shareholders have only one contractual instrument at their disposal: they can award to the manager a number of shares of the company. If the shareholders award zero stock, the manager's preference for sloth and truthtelling prevails. As shareholders award more stock, the manager will be incentivized to exert effort, but also to falsely inflate her report regarding the firm's value.

2.1 The economy

The economy in this model consists of five types of entities:

1. The firm, which has a production technology and N shares of stock outstanding
2. N identical shareholders, who each own a share of stock of the firm and choose the manager's compensation contract
3. The manager, who may exert effort to increases the firm's likelihood of a good outcome, and who also makes a disclosure to the marketplace concerning the firm's value
4. Purchasers, who stand ready to purchase the firm's shares for their conditional expected value, given the manager's report of value
5. A regulator, who assesses a fine of l against the firm in the event that the manager reports falsely

The Firm

The firm can be one of two types: $\eta \in \{H, L\}$. High type firms have cash flows per share of H. Low type firms have cash flows of L, which I let equal 0 without loss of generality. While type is completely deterministic of cash flows, a firm's type is influenced by managerial effort $e \in \{0, 1\}$. I write the general probability of the firm's type as $\gamma_e \equiv \Pr(H|e)$, where $\gamma_1 = \Pr(H|e = 1)$ and $\gamma_0 = \Pr(H|e = 0)$, where $1 \geq \gamma_1 \geq \gamma_0 \geq 0$, and $\Delta\gamma \equiv \gamma_1 - \gamma_0$. The unconditional expected value per share of a firm whose manager exerts effort is $\gamma_1 H$; if the manager does not exert effort, the expected value is $\gamma_0 H$.

Shareholders

There are N shareholders who each own a share of the firm, and are entitled to all of the firm's cash flows. In order to affect the manager's choice of effort and disclosure decisions, the shareholders may choose to award a number α of shares of the firm to the manager; each shareholder then contributes α/N to the manager's equity compensation. I assume that this compensation level α is observable to shareholders and the manager only; this tracks the reality that shareholders can always choose, ex post, to reward the manager, and they cannot commit not to. After choosing the manager's compensation contract, some exogenous proportion π of shareholders will wish to sell their shares, which occurs after the manager chooses effort and makes a disclosure about the firm's type; π is then the degree of shareholders' short term interest, while $(1-\pi)$ is the shareholder's long term interest in the firm's performance and stock price. The market price $p(\eta')$ that shareholders receive for selling their shares is a function of the manager's publicly observable report. If the firm is found by the regulator to have committed fraud, the shareholders who have not sold each bear a fine of l per share, while those who did sell simply keep their sale proceeds; this functions similarly to actual corporate penalties in the U.S. securities antifraud regime.

The expected value of the shareholder's payoff is then

$$EU_s = (1-\alpha/N)[\pi p(\eta') + (1-\pi)\left[\gamma_e(H - l(\eta', H)) + (1-\gamma_e)(L - l(\eta', L))\right]] + w$$

The term w is the flat wage that the manager receives, which may be negative, while α is the amount of stock granted to the manager. Because the cost of paying the manager will only vary with regard to paying for the manager's effort (which costs c), and because by assumption shareholders always want the managers to exert effort, the amount of compensation paid to the manager will not affect the shareholders' decisionmaking because it will be the same on either side of the shareholder's incentive compatibility constraint, aside from the incremental cost of effort, c. Assuming that c is small compared to the magnitude of the firm ($c/N \to 0$), this allows the shareholder's payoff function to be written more simply without the α/N and w term as:

$$EU_s = \pi p(\eta') + (1-\pi)\left[\gamma_e(H - l(\eta', H)) + (1-\gamma_e)(L - l(\eta', L))\right]$$

The Manager

The manager has two sets of actions in this game. He gets to choose whether to exert effort or not $e \in \{0, 1\}$, at personal cost to himself of $c(0) = 0$, $c(1) = c$. Effort increases the likelihood of the firm achieving high cash flows.

The manager observes the firm's type η, and then makes a report η' to the marketplace of the firm's type. In this report, the manager may choose to tell the truth ($\eta = \eta'$), or lie ($\eta \neq \eta'$). After making this report, the manager sells exogenous proportion π_m of his shares, and retains proportion $1 - \pi_m$. If the manager does not sell his stock, he also bears a fine of l per share for fraud. The proportion of stock sold π_m is thus the manager's short term interest, while $1 - \pi_m$ is her long term interest.

In general, I assume that the manager has a slight preference for not overreporting the firm's value. This reflects, perhaps, reputational capital of the manager or the possibility of individual sanctions. Formally, I denote this manager-specific cost of fraud as $R(\eta', \eta)$, where $R(H, L) = R > 0$, while $R(H, H) = R(L, H) = R(L, L) = 0$.

The expected value of the manager's payoff manager's payoff is then:

$$EU_m = \alpha[\pi_m p(\eta') + (1 - \pi_m)\left[\gamma_e(H - l(\eta', H)) + (1 - \gamma_e)(L - l(\eta', L))\right]] + w - c(e) - R(\eta', \eta)$$

In order for the manager to be willing to work, his individual rationality constraint must be satisfied – i.e., his expected payoff must be positive.

Purchasers

Purchasers observe the manager's signal and then pay a price $p(\eta')$ such that, in expectation, they will break even as a result of competition and individual rationality. Purchasers are strategic in the sense that they take into account the incentives of both shareholders in choosing α and the manager in choosing e and η'. The purchaser's individual rationality (IR) constraint is then

$$(\text{IR}) : U_p = \sum_{\eta \in \{H, L\}} \Pr(\eta|\eta')\eta - p(\eta') = 0$$

The regulator

The regulator imposes a fine l against the firm if the regulator determines that there has been fraud, where $0 \leq l \leq \bar{l}$, where $\bar{l}$ is the maximum assessable fine. Because the fine is levied against the firm, it is effectively borne by the shareholders of the firm. I assume, for simplicity, that the regulator ensures that purchasers are left unharmed by the fines (that is, the regulator only fines the non-selling shareholders, which is an approximation of how the current securities fraud class action system works (see Spindler 2010)) and which satisfies a policy preference that defrauded purchasers not be further harmed by punitive action against the firm. This assumption keeps l from affecting the purchaser's IR constraint, but does not affect the overall analysis. I assume that there is perfect enforcement of fraudulent overstatements of value: $l(H', L) = l > 0$, while $l(H', H) = l(L', H) = l(L', L) = 0$.[14]

As a slight digression: because enforcement is perfect in the sense of zero type 1 and type 2 error, one might suppose that the best enforcement strategy is always a maximal fine with minimal expenditure on enforcement. This is actually not true in this model: deterring fraud, as will be apparent, is only somewhat correlated with economic efficiency. Maximum deterrence can, in fact, be an overall harm as it dissuades productive effort.

2.2 The sequence of play

Putting the action sequence of the game in chronological order:

1. The regulator randomly chooses a level of fine per share for fraud, $l > 0$, which is observed by all.
2. Shareholders may choose to award share α shares of the firm to the manager, $\alpha \geq 0$.
3. The manager has the choice to exert effort $e \in \{0, 1\}$, where effort is costly, $c(0) = 0$, $c(1) = c$.
4. The firm's type is realized as a probabilistic function of effort; the manager observes this realization of type, $\eta \in \{H, L\}$.
5. The manager makes a disclosure to the marketplace of the firm's type: $\eta' \in \{H, L\}$. The manager may choose to tell the truth about the firm's type ($\eta' = \eta$) or lie ($\eta' \neq \eta$).
6. Proportion π of shareholders sell their shares, and the manager sells proportion π_m of the manager's shares. Purchasers break even in expectation; that is, the price is determined subject to the purchasers' individual rationality (IR) constraint.

[14] The absence of a penalty for undereporting does not affect the analysis because, given the assumption of perfect enforcement, underreporting of value will never occur. Underreporting could occur when the regulator makes errors in observing firm type η, but I do not consider that here.

7. A fine of l is assessed against each of the firm's non-selling shareholders if the regulator finds that there has been fraud.

Summing up the above in a condensed form, we have the following manager's objective function, manager's incentive compatibility constraints, and purchasers' individual rationality constraint:

$$
\begin{aligned}
\text{Obj} &: \max_{\alpha,e,\eta'|\eta} (1-\alpha)[\pi p(\eta') + (1-\pi)\left[\gamma_e(H - l(\eta',H)) + (1-\gamma_e)(L - l(\eta',L))\right]] \\
&\quad \text{subject to} \\
\text{IC1} &: e = \arg\max_{e\in\{0,1\}} \alpha[\pi_m p(\eta') + (1-\pi_m)[\gamma_e(H - l(\eta',H) + (1-\gamma_e)(L - l(\eta',L))]] \\
&\quad -c(e) - R(\eta',\eta) \\
\text{IC2} &: \eta' = \arg\max_{\eta'\in\{H,L\}} (\alpha[\pi_m p(\eta') + (1-\pi_m)\left[\eta - l(\eta',\eta)\right]]] - R(\eta',\eta)|\eta) \\
\text{IR} &: \sum_{\eta\in\{H,L\}} \Pr(\eta|\eta')\eta - p(\eta') = 0
\end{aligned}
$$

An equilibrium consists of a price given the manager's signal, the manager's choice of disclosure signal given type and share grant α, the manager's choice of effort given α, and the shareholder's choice of α.

3 Solving for equilibrium

I solve for the shareholders' and manager's choices by backward induction. Proceeding from the last stage of the game, the purchaser prices the firm's shares so as to break even in expectation. In the penultimate stage, the manager makes a decision whether to report truthfully or not to maximize her expected payoffs given the firm's type. In the second stage, the manager decides whether to exert effort or not. Finally, in the first stage, the shareholders choose the manager's compensation.

3.1 The purchaser's pricing decision

The purchaser's IR constraint determines the price p for which shareholders and the manager can sell their shares. Given the manager's signal, the price is the conditional expected value of the share – i.e., the purchasers break even in conditional expectation.

While purchasers do not observe share compensation α, the manager's choice of effort, or the manager's disclosure policy, they do anticipate these factors in equilibrium. In pure strategies, the manager either always discloses truthfully or else will disclose a falsely inflated value (i.e., $(\eta', \eta) = (H, L)$). There is also the possibility that managers will employ a mixed strategy, sometimes disclosing falsely and sometimes disclosing truthfully. In both the pooling and the mixing equilibria, the equilibrium price paid will vary depending upon whether the purchasers believe that the manager would have exerted effort.

In a separating equilibrium,

$$\begin{aligned} p(H) &= H \\ p(L) &= 0 \end{aligned}$$

In a pure strategy pooling equilibrium,

$$\begin{aligned} p(H) &= \gamma_e H \equiv p_e \\ p(L) &= 0 \end{aligned}$$

Note that I assume that purchasers interpret a disclosure of L to be informative and hence $p(L) = 0$ (otherwise a pooling equilibrium is problematic since low type managers would prefer to disclose L to avoid the fine of l for disclosing high.)

In a mixed strategy equilibrium, utilizing Bayes' law, we have

$$p(H) = \frac{\gamma_e H}{\gamma_e + x(1-\gamma_e)} \equiv p_{x,e} \tag{1}$$

$$p(L) = 0 \tag{2}$$

where x is the proportion (or likelihood) of managers of low type firms that choose to falsely disclose high.

Finally, there can arise a case where shareholders will mix compensation strategies, although I defer discussion of this to the section on shareholder choice of compensation.

3.2 The manager's disclosure decision

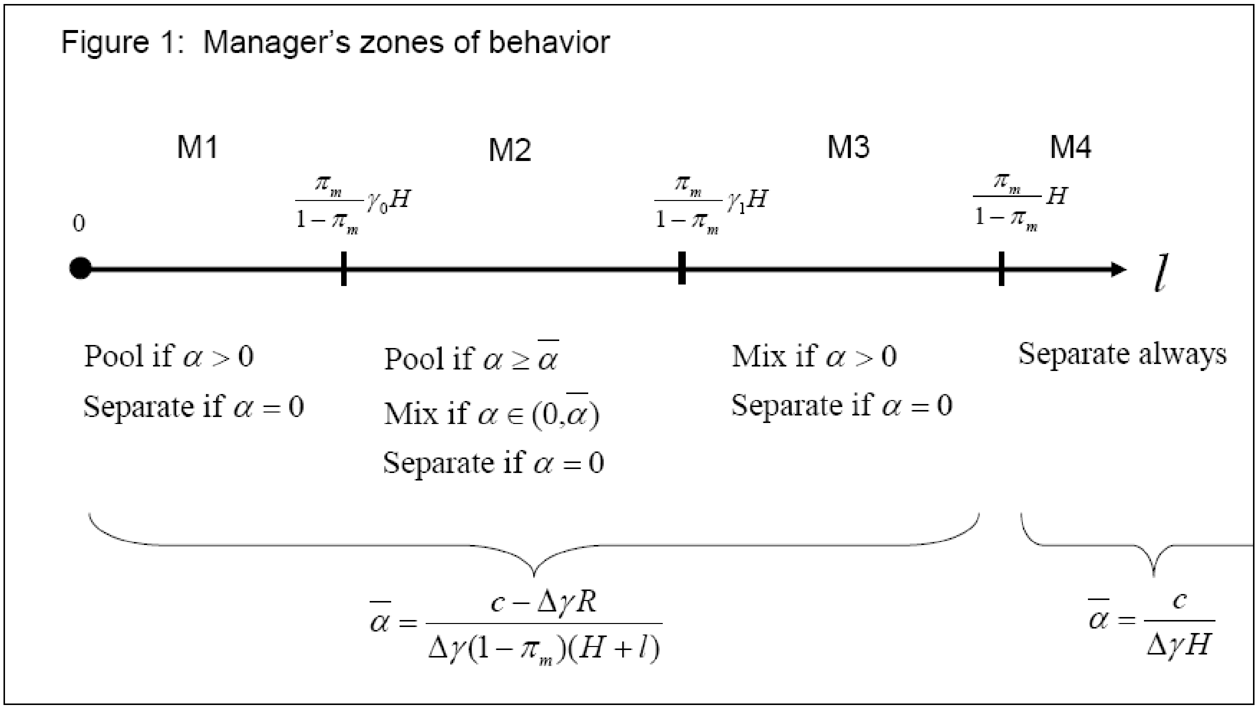
At the time that the manager decides which signal to send to the market, she knows the type of the firm ($\eta \in \{H, L\}$) as well as her share of the firm's ownership, α. Things are relatively simple where equity compensation is not awarded: if $\alpha = 0$, the manager's personal concerns R dominate, and she always reports truthfully. If the fine l is low enough relative to the manager's short term interest π_m, and the equity grant α is high enough, the manager will prefer fraudulent disclosure in the low state ($\eta = L$). As the fine gets higher, the manager will commit less fraud: as l increases relative to π_m, the manager goes from always lying when equity compensation is high, to sometimes lying when equity compensation is low and always lying when it is high, to sometimes lying at all equity compensation levels greater than zero, to never lying when the fine l is very high.

Restating these results more formally, we have the following propositions:

Proposition 1 *There are up to four zones of managerial disclosure behavior, which depend upon the level of compensation and fine. Specifically, depending upon the fine l, there exist up to two cutoff levels of equity compensation, $\alpha_x \equiv \frac{R}{\pi_m H-(1-\pi_m)l}$ and $\alpha_p \equiv \frac{R}{\pi_m \gamma_e H-(1-\pi_m)l}$, where the manager (i) always tells the truth when $\alpha < \alpha_x \vee \alpha_x < 0$, (ii) plays a mixed disclosure strategy (lying in the low state with probability x) when $\alpha \in [\alpha_x, \alpha_p) \wedge \alpha_x, \alpha_p > 0$ or $\alpha > \alpha_x > 0 \wedge \alpha_p < 0$, and (iii) always lies in the low state when $\alpha > \alpha_p \wedge \alpha_p > 0$.*

Proposition 2 *Making the simplifying assumption that $R \to 0^+$, without loss of generality the manager's behavior varies across 4 zones, zone M1 through M4, demarcated by the level of fine l. The manager's behavior in each zone is as follows:*

- *Zone M1: For $l \in (0, \frac{\pi_m}{1-\pi_m}\gamma_0 H)$, the manager will always tell the truth if $\alpha = 0$ and always lie in the low state when $\alpha > 0$.*
- *Zone M2: For $l \in [\frac{\pi_m}{1-\pi_m}\gamma_0 H, \frac{\pi_m}{1-\pi_m}\gamma_1 H)$, the manager reports truthfully if $\alpha = 0$, and for $\alpha > 0$ always lies in the low state where $e = 1$ and mixes disclosure in the low state when $e = 0$.*



- *Zone M3: For $l \in [\frac{\pi_m}{1-\pi_m}\gamma_1 H, \frac{\pi_m}{1-\pi_m} H)$, the manager reports truthfully if $\alpha = 0$, and for $\alpha > 0$ always mixes disclosure in the low state.*

- *Zone M4: For $l \geq \frac{\pi_m}{1-\pi_m} H$, the manager always reports truthfully.*

Figure 1 summarizes the manager's potential disclosure strategies as the fine l changes, with the algebraic simplification that $R \to 0$. This figure characterizes the manager's behavior as a function of l and α. Where $\alpha = 0$ the manager always tells the truth. For $\alpha > 0$, the manager's behavior depends upon l and the equilibrium effort level γ_e. Along the continuum of possible fines, the leftmost region (where l is the lowest), denoted as zone M1, is one of pure pooling behavior, regardless of prior effort level. Moving rightward, the next zone of behavior (zone M2) is where the manager pools if it was not optimal to undertake effort in the prior stage, and mixes if the opposite is true. Moving again rightward, in zone M3, the manager chooses to mix no matter the prior optimal effort choice. Finally, in the rightmost range, zone M4, the manager chooses to disclose truthfully without regard to the prior effort level.

The proof of Propositions 1 and 2 follows.

3.2.1 Separating equilibrium

In order for a separating equilibrium to result, it must be the case that IC2 is satisfied in that the manager of a low type firm must prefer to disclose truthfully:[15]

$$\alpha\left[\pi_m L + (1-\pi_m)L\right] \geq \alpha\left[\pi_m H + (1-\pi)(L-l)\right] - R$$

In the case where $\alpha = 0$ (the shareholders grant the manager no shares of stock), the manager always prefers to tell the truth because R is strictly positive.

If $\alpha > 0$, rearranging yields a lower bound for l :

$$l \geq \frac{\pi_m}{1-\pi_m}H - \frac{1}{\alpha(1-\pi_m)}R$$

Note that if $l \geq \frac{\pi_m}{1-\pi_m}H$, no level of compensation can induce non-separating behavior.

This can be rearranged to given an upper bound for α that maintains separation (assuming $l < \frac{\pi_m}{1-\pi_m}H$):

$$\alpha \leq \frac{R}{\pi_m H - (1-\pi_m)\, l} \equiv \alpha_x$$

The term α_x denotes the level of equity compensation at which a manager will switch from always telling the truth (separation) to sometimes lying (mixing at rate x).

I assume that R is small both in relation to c and the firm's overall value, $N\gamma_e H$. It simplifies things and does not affect the qualitative results. In this case, it allows one to write the separating condition more simply as:

$$\text{Separation: } \; l \geq \frac{\pi_m}{1-\pi_m}H \text{ or } \alpha = 0$$

This assumption also makes it easier to capture the dynamic that equity compensation both encourages fraud and encourages effort, and that encouraging more effort encourages more fraud. This assumption ensures that shareholders cannot, for some values of l, induce effort without inducing fraud. This assump-

[15] A manager of a high type firm always prefers to disclose truthfully, since there is no type 1 error in the model.

tion is not necessary to capture the dynamic, as I show in Appendix A, though it does make it easier to describe. Further, as a justification for this assumption, one can imagine that in reality firms have an array of subprojects i, which each have costs c_i that are randomly distributed, some of which will typically satisfy the relative size condition, such that the effort/fraud tradeoff will, in general, exist.

3.2.2 Pooling equilibrium

In order for pooling to take place, it must be that managers of low type firms prefer to disclose high rather than to tell the truth and receive a payoff of zero:

$$\alpha\left[\pi_m\gamma_e H-(1-\pi_m)l\right]-R>0$$

In the case where $\alpha=0$, the manager's personal cost of fraud R makes truthful disclosure a dominant strategy, and no pooling equilibrium will exist. Following the earlier assumption that R is relatively very small (reflecting only a weak preference on the manager's part), then even a relatively trivial stock grant makes truthful disclosure no longer a dominant strategy. We then obtain the following condition.

$$l<\frac{\pi_m}{1-\pi_m}\gamma_e H-\frac{1}{\alpha(1-\pi_m)}R$$

Or, equivalently

$$\alpha>\frac{R}{\pi_m\gamma_e H-(1-\pi_m)\,l}\equiv\alpha_p$$

Again with the assumption that R is small, this is more simply written as:

$$\text{Pooling:}\;\; l<\frac{\pi_m}{1-\pi_m}\gamma_e H,\; \alpha>0 \tag{3}$$

3.2.3 Mixed strategy equilibrium

For a certain range of l, namely $l+\frac{1}{\alpha(1-\pi_m)}R\in(\frac{\pi_m}{1-\pi_m}\gamma_e H,\frac{\pi_m}{1-\pi_m}H)$ and $\alpha>0$, there exists no pure strategy equilibrium. In such a case, managers will pursue a mixed strategy where they lie with probability x in the low state, and tell the truth with probability $1-x$. In order for managers to be willing to mix, managers of low type firms must be indifferent between disclosing high (which entails receiving the mixed strategy price p_x and bearing the risk of liability l) and disclosing low (and receiving zero). Formally,

$$\begin{aligned} \alpha\left(\pi_m p_x-(1-\pi_m)l\right)-R &= 0 \\ \Leftrightarrow p_x &= \tfrac{R}{\alpha\pi_m}+\frac{1-\pi_m}{\pi_m}l \end{aligned} \tag{4}$$

The purchaser's pricing decision in the mixed strategy case (Eq. 1) gives the condition that, to break even, the price must be $p_x=\gamma_e H(\gamma_e+x(1-\gamma_e))^{-1}$. Combing these yields a solution for x :

$$x=\frac{\gamma_e}{1-\gamma_e}\left(\frac{\alpha\left(\pi_m H-(1-\pi_m)\,l\right)-R}{\alpha\,(1-\pi_m)\,l+R}\right) \tag{5}$$

There are multiple equilibria, since there are potentially infinite (α,x) pairs that solve Eq.5. As $R/\alpha\to 0$, which I generally assume to be the case, $\lim x=\frac{\gamma_e}{1-\gamma_e}\frac{\pi_m H-(1-\pi_m)l}{(1-\pi_m)l}$, which has only one solution.

Remark 3 *The likelihood of disclosing falsely in the low state, x, is increasing in the effort level γ_e. This is because the gains from fraud are higher: where the equilibrium strategy is to exert effort, the pooling/mixing price will consequently be higher.*

While p_x is, in a sense, nailed down by the exogenous parameters π_m and l, it is still a function of the level of effort e and consequent probability of success γ_e in that the range of l in which the manager will mix depends upon whether the manager had earlier undertaken effort (in the sense that it was subgame perfect for her to do so). The range of fine l in which mixing behavior is possible can be further subdivided: for $l+\frac{1}{\alpha(1-\pi_m)}R\in\left(\frac{\pi_m}{1-\pi_m}\gamma_0 H,\frac{\pi_m}{1-\pi_m}\gamma_1 H\right]$, the manager will mix only if it was optimal for her to undertake effort in the prior stage of the game; otherwise, she will play a pure strategy of falsely reporting in the low state. In the higher subdivision of the range, i.e. for $\left(l+\frac{1}{\alpha(1-\pi_m)}R\right)\in\left(\frac{\pi_m}{1-\pi_m}\gamma_1 H,\frac{\pi_m}{1-\pi_m}H\right)$, the manager will always mix, even if it was not optimal to undertake effort in the prior subgame.

3.3 The manager's choice of effort

The manager chooses effort after the fine l and compensation level α are set, but before she has has observed the firm's type and before she makes a disclosure to the marketplace. However, the manager can backward induce both her own disclosure decision and the market's equilibrium response to it in the subsequent stages of the game. The manager, then, will make her choice of effort taking these reactions into account.

The manager's effort exertion behavior may be described in the following proposition:

Proposition 4 *If α and l are such that the manager will separate (i.e., zone M1), the manager exerts effort $e = 1$ if*

$$\alpha \geq \frac{c}{\Delta\gamma H} \equiv \bar{a}_s$$

and chooses $e = 0$ if $\alpha < \bar{\alpha}_s$. Where α and l are such that the manager will not engage in pure separating behavior (i.e., in zones M2, M3, and M4), the manager exerts effort if

$$\alpha \geq \frac{c - \Delta\gamma R}{\Delta\gamma\,(1-\pi_m)\,(H+l)} \equiv \bar{\alpha}_p$$

and chooses $e = 0$ if $\alpha < \bar{\alpha}_p$.

The proof follows.

3.3.1 Effort in the separating case

If the fine l is high enough that the manager will choose to disclose truthfully regardless of the firm's type and regardless of the optimal effort level (Zone M4 in Figure 1), we ask simply whether the manager would do better off incurring the cost of effort and enjoying a higher probability that her equity share is valuable, as opposed to slacking. Formally, the condition for the exertion of effort is:

$$\begin{aligned} & \alpha\left[\gamma_1\left(\pi_m H + (1-\pi_m)H\right) + (1-\gamma_1)\left(\pi_m L + (1-\pi_m)\,L\right)\right] - c \\ \geq \quad & \alpha\left[\gamma_0\left(\pi_m H + (1-\pi_m)H\right) + (1-\gamma_0)\left(\pi_m L + (1-\pi_m)\,L\right)\right] \end{aligned}$$

Solving this for α pins down the minimum equity share for which the manager will exert effort in the separating case:

$$\bar{\alpha}_s = \frac{c}{\Delta\gamma H}$$

3.3.2 Effort in the pooling case

Where the fine l is very low ($l \leq \frac{\pi_m}{1-\pi_m}\gamma H$ in Zone 1 in Figure 1), pooling is always the optimal strategy regardless of the effort choice. Thus, a defection from exerting (or not exerting) effort does not affect the manager's subsequent disclosure behavior. The effect, then, of a defection from a given level of effort is the altered chance of success and whether the cost of effort c is incurred.

The manager will exert effort $e = 1$ if the following is true:

$$\begin{aligned} & \gamma_1 \alpha \left[\pi_m p_e + (1-\pi_m) H\right] + (1-\gamma_1)\left[\alpha\left[\pi_m p_e - (1-\pi) l\right] - R\right] - c \\ \geq \quad & \gamma_0 \alpha \left[\pi_m p_e + (1-\pi_m) H\right] + (1-\gamma_0)\left[\alpha\left[\pi_m p_e - (1-\pi) l\right] - R\right] \end{aligned}$$

This may be rewritten as:

$$\Delta\gamma\alpha\,(1-\pi_m)\,(H+l) + \Delta\gamma R \geq c$$

The first term on the left hand side is the manager's expected increased share payoff from exerting effort: $\Delta\gamma$ is the change in likelihood that the firm's project will be successful due to the manager's effort, α is the manager's share of the firm, $(1-\pi_m)$ is the likelihood that the manager will retain her shares and receive the firm's cash flows and any liability, and finally $(H+l)$ is the marginal pecuniary benefit to a shareholder of the project's success (H is the cash flow received, while l is the liability avoided). The second term on the left hand side is the expected personal benefit to the manager from exerting effort: with increased probability of $\Delta\gamma$, the project will be successful, meaning the manager will not lie and will not incur personal costs of R. On the right hand side, c is the cost of the manager's effort.

Since price as a function of effort, p_e, drops out, there is no need to check separately whether the manager would choose to defect from a state in which managers are not exerting effort, as the conditions will be the same.

Rearranging, this condition also pins down the level of share ownership α necessary for the manager to exert effort in the pooling case (denoted as $\bar{\alpha}_p$):

$$\bar{\alpha}_p \equiv \frac{c - \Delta\gamma R}{\Delta\gamma\,(1-\pi_m)\,(H+l)}$$

3.3.3 Effort in the mixing case (Zone 3)

The following equation defines the condition for the manager to exert effort in Zone 3, with the left hand side giving equilibrium behavior of $e = 1$, and the right hand side giving the payoff for a defection to $e = 0$:

$$\begin{aligned} & \gamma_1\alpha\,(\pi_m p_x + (1-\pi_m)\,H) + (1-\gamma_1)\,(x\,(\alpha\,(\pi_m p_x - (1-\pi_m)\,l) - R)) - c \\ \geq\; & \gamma_0\alpha\,(\pi_m p_x + (1-\pi_m)\,H) + (1-\gamma_0)\,(x\,(\alpha\,(\pi_m p_x - (1-\pi_m)\,l) - R)) \end{aligned}$$

From the manager's mixing condition, Eq. 4, $\alpha\,(\pi_m p_x - (1-\pi_m)\,l) - R = 0$, and the above then reduces to:

$$\Delta\gamma\alpha\,(1-\pi_m)\,(H+l) + \Delta\gamma R \geq c$$

which is the same as in the pooling case. The level of equity compensation necessary to induce effort is therefore the same as well:

$$\bar{\alpha}_x = \bar{\alpha}_p = \frac{c - \Delta\gamma R}{\Delta\gamma\,(1-\pi_m)\,(H+l)}$$

3.3.4 Effort in the mixing/pooling case (Zone 2)

In Zone 2 of Figure 1, where $l \in \left(\frac{\pi_m}{1-\pi_m}\gamma H, \frac{\pi_m}{1-\pi_m}\bar{\gamma} H\right]$, the manager will pool if the equilibrium outcome is to exert effort ($e = 1$) and mix if the equilibrium outcome is to slack ($e = 0$).

Taking first the pooling case, in order for a manager not to defect from exerting effort, the following must be true:

$$
\begin{aligned}
& \gamma_1 \alpha \left[\pi_m p_1 + (1-\pi_m) H\right] + (1-\gamma_1)\left[\alpha\left[\pi_m p_1 - (1-\pi) l\right] - R\right] - c \\
\geq \quad & \gamma_0 \alpha \left[\pi_m p_1 + (1-\pi_m) H\right] + (1-\gamma_0)\left[\alpha\left[\pi_m p_1 - (1-\pi) l\right] - R\right]
\end{aligned}
$$

This is identical to the pure pooling equilibrium (Zone 1), and yields the same minimum level of equity compensation α to induce effort:

$$
\bar{\alpha}_p = \frac{c - \Delta\gamma R}{\Delta\gamma\,(1-\pi_m)\,(H+l)}
$$

In the case where the manager would not exert effort ($e = 0$) and mix her disclosure strategy, the manager will choose not to defect if:

$$
\begin{aligned}
& \gamma\alpha\left(\pi_m p_x + (1-\pi_m) H\right) + (1-\gamma)\left(x\left(\alpha\left(\pi_m p_x - (1-\pi_m)\, l\right) - R\right)\right) \\
\geq \quad & \bar{\gamma}\alpha\left(\pi_m p_x + (1-\pi_m) H\right) + (1-\bar{\gamma})\left(x\left(\alpha\left(\pi_m p_x - (1-\pi_m)\, l\right) - R\right)\right) - c
\end{aligned}
$$

Solving for the maximum bound of equity compensation to induce no effort,

$$
\alpha \leq \frac{c - \Delta\gamma R}{\Delta\gamma\,(1-\pi_m)\,(H+l)}
$$

which again yields the same threshold level of compensation $\bar{\alpha}_p$.

3.4 Shareholder's choice of compensation

In this section, the final step of the backward induction problem is reached: the shareholder's choice of compensation for the manager. Compensation has a dual role: a sufficient grant of equity can induce effort, which we might suppose shareholders generally want, and can also induce fraud in the low state, which shareholders may or may not want depending upon the relative levels of fine l and shareholder short term interest π. Thus, an interesting problem arises when there is a tradeoff of sorts: what if the shareholders want effort exerted, but know that awarding the requisite compensation to induce effort may also result in more fraud than the shareholders prefer?

In choosing compensation, shareholders will consider the joint effect of compensation upon effort and fraud. I therefore divide the analysis by which zone, M1 - M4, the manager is in. The results are summarized in the following proposition:

Proposition 5 • ***In M1 and M2:*** *Equity compensation of $\alpha = \bar{\alpha}_p$ is an equilibrium if*

$$l \leq \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)}H + \frac{\pi}{1-\pi}\gamma_0 H$$

Equity compensation of $\alpha = 0$ is an equilibrium if

$$l \geq \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)}H + \frac{\pi}{1-\pi}H$$

If neither of these conditions are met, there exists a mixed strategy equilibrium where the shareholder mixes at rate s, given as

$$s = \frac{\gamma_0}{1-\gamma_0} \cdot \frac{H\left[\Delta\gamma + (1-\gamma_1)\pi\right] - l(1-\gamma_1)(1-\pi)}{l(1-\gamma_1)(1-\pi) - \Delta\gamma H}$$

with a market price p_s of

$$p_s = \frac{s(\gamma_1-\gamma_0)+\gamma_0}{s(1-\gamma_0)+\gamma_0}H$$

- ***In M3:*** *The shareholder awards equity compensation of $\alpha = \bar{\alpha}_p$ if*

$$k \geq \frac{\gamma_1(\pi_m-\pi) - \Delta\gamma(1-\pi)(1-\pi_m)}{\Delta\gamma\pi(1-\pi_m) + \gamma_1(\pi_m-\pi)}$$

where $l = \frac{\pi_m}{1-\pi_m}kH$, $k \in (\gamma_1, 1)$. The shareholder awards $\alpha = 0$ if

$$l \;\geq \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)}H + \frac{\pi}{(1-\pi)}H$$

If neither condition is met, there exists a mixed strategy equilibrium where the shareholder mixes at rate s and price p_s.

- ***In M4***: *Equity compensation of $\alpha = \bar{\alpha}$ is always an equilibrium.*

The proof follows.

3.4.1 Choice of compensation in zone M1

Assuming that $R/c \to 0$, when the fine $l \in [0, \frac{\pi_m}{1-\pi_m}\gamma H)$, the manager will report truthfully in the low state if $\alpha = 0$, will always lie in the low state given $\alpha > 0$, and will exert effort if $\alpha \geq \bar{\alpha}_p$.[16] Since $\alpha_x < \alpha_p < \bar{\alpha}_p$, the shareholder has three choices: truthful reporting without effort ($\alpha \in [0, \alpha_x)$), mixed reporting without effort ($\alpha \in [\alpha_x, \alpha_p)$), false reporting without effort ($\alpha \in [\alpha_p, \bar{\alpha}_p)$), and false reporting with effort ($\alpha \geq \bar{\alpha}_p$). Hence, to minimize the payment to the manager in each case, the shareholder chooses among $\alpha \in \{0, \alpha_x, \alpha_p, \bar{\alpha}_p\}$.

Lemma 6 *The non-separating, non-effort inducing levels of compensation, $\{\alpha_x, \alpha_p\}$, cannot be equilibria.*

Proof. In order for either α_x or α_p to be an equilibrium, the shareholder must not prefer to defect to $\bar{\alpha}_p$. We have as a necessary condition $\gamma_0 (\pi p_x + (1-\pi) H) + (1-\gamma_0) x (\pi p_x - (1-\pi) l) \geq \gamma_1 (\pi p_x + (1-\pi) H) + (1-\gamma_1) x (\pi p_x - (1-\pi) l)$, $x \in (0,1)$, which can never be true since $\pi p_x + (1-\pi) H > \pi p_x - (1-\pi) l$ and $\gamma_1 > \gamma_0$. ■

Lemma 7 *The non-separating, effort-inducing level of compensation $\bar{\alpha}_p$ is an equilibrium if and only if $l \leq \frac{\Delta\gamma + (1-\gamma_1)\gamma_0 \pi}{(1-\gamma_1)(1-\pi)} H$*

Proof. In order for $\bar{\alpha}_p$ to be an equilibrium, the shareholder must prefer not to defect to $\alpha = 0, \alpha_x, \alpha_p$. It is apparent that defections to α_x and α_p are never feasible since it must always be that $\gamma_1 (\pi p_1 + (1-\pi) H) + (1-\gamma_1)(\pi p_1 - (1-\pi) l) > \gamma_0 (\pi p_1 + (1-\pi) H) + (1-\gamma_0) y (\pi p_1 - (1-\pi) l)$. In the pooling case where $y = 1$, the condition is always true since $\pi p_1 + (1-\pi) H > \pi p_1 - (1-\pi) l$ and $\gamma_1 > \gamma_0$. If $\pi p_1 - (1-\pi) l > 0$, the RHS is maximized if $x = 1$, and hence a defection to mixing is dominated by a defection to pooling.

[16] There is technically another option, which is to award $\alpha \in (\alpha_x, \alpha_p)$, which results in mixed disclosure by the manager and no effort. However, this is dominated by both $\alpha = 0$ when $R/c \to 0$ and by $\alpha = \bar{\alpha}_p$ even if $R/c \not\to 0$.

If $\pi p_1 - (1-\pi)\, l < 0$ (which must always be the case as $R/c \to 0$), then a defection to pooling is dominated by a defection to mixing (α_x, in which $y = x \in (0,1)$), which is in turn dominated by a defection to $\alpha = 0$ (where $y = 0$).

As the only remaining necessary condition for $\bar{\alpha}_p$ to be an equilibrium, then, it must be that the shareholder would not defect to the truthtelling level of compensation ($\alpha = 0$).

$$\begin{aligned} \gamma_1\left(\pi p_1 + (1-\pi) H\right) + (1-\gamma_1)\left(\pi p_1 - (1-\pi)\, l\right) &\geq \gamma_0\left(\pi p_1 + (1-\pi) H\right) \\ \bar{\alpha}_p \text{ in M1} : l &\leq \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)} H + \frac{\pi}{1-\pi}\gamma_0 H \end{aligned} \tag{6}$$

■

Lemma 8 *The necessary condition for $\alpha = 0$ to be an equilibrium is $l \geq \frac{\Delta\gamma + (1-\gamma_1)\pi}{(1-\gamma_1)(1-\pi)} H$.*

Proof. *In order for $\alpha = 0$ to be an equilibrium, it must be preferable to defections to $\alpha_x, a_p, \bar{\alpha}_p$. Defections to α_x, α_p occur if the following does not hold: $\gamma_0 H \geq \gamma_0 H + (1-\gamma_0)\, y\, (\pi H - (1-\pi)\, l)$, where $y = 1$ if $\alpha = \alpha_p$ and $y = x$ if $\alpha = \alpha_x$. If $\pi H - (1-\pi)\, l < 0$, then the inequality must be true. If $\pi H - (1-\pi)\, l > 0$, then a defection to $\bar{\alpha}_p$ would be preferable. This leaves as the necessary condition that a shareholder does not prefer a defection to $\bar{\alpha}_p$:*

$$\begin{aligned} \gamma_0 H &\geq \gamma_1\left(\pi H + (1-\pi) H\right) + (1-\gamma_1)\left(\pi H - (1-\pi)\, l\right) \\ \alpha &= 0 \textit{ in M1} : l \geq \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)} H + \frac{\pi}{1-\pi} H \end{aligned} \tag{7}$$

■

Lemma 9 *There exists a range of $l \in \left(\frac{\Delta\gamma + (1-\gamma_1)\gamma_0\pi}{(1-\gamma_1)(1-\pi)} H, \frac{\Delta\gamma + (1-\gamma_1)\pi}{(1-\gamma_1)(1-\pi)} H\right)$ in which there is no pure strategy equilibrium. In such a case, the shareholder mixes at rate $s = \frac{\gamma_0}{1-\gamma_0} \cdot \frac{H[\Delta\gamma(1-\pi) + (1-\gamma_0)\pi] - l(1-\gamma_1)(1-\pi)}{l(1-\gamma_1)(1-\pi) - \Delta\gamma H}$ and the market price is $p_s = \frac{1-\pi}{\pi} \cdot \frac{(1-\gamma_1) l - \Delta\gamma H}{1-\gamma_0}$.*

Proof. Conditions 6 and 7 are not exhaustive:

$$\frac{\Delta\gamma + (1-\gamma_1)\,\gamma_0\pi}{(1-\gamma_1)\,(1-\pi)} H < \frac{\Delta\gamma + (1-\gamma_1)\,\pi}{(1-\gamma_1)\,(1-\pi)} H$$

If l is in this range, the shareholder will choose to defect from $\bar{\alpha}$ to 0, and also from 0 to $\bar{\alpha}$. In order for the shareholder to not choose to defect either way, the shareholder mix between $\bar{\alpha}$ and 0 at a rate a (where a denotes the probability of awarding $\bar{\alpha}$) such that the market price makes the shareholder indifferent between compensation strategies. This occurs when

$$\gamma_1\left(\pi p_s + (1-\pi) H\right) + (1-\gamma_1)\left(\pi p_s + (1-\pi) l\right) = \gamma_0\left(\pi p_s + (1-\pi) H\right) \tag{8}$$

$$\Leftrightarrow \quad p_s = \frac{1-\pi}{\pi} \cdot \frac{(1-\gamma_1)\, l - \Delta\gamma H}{1-\gamma_0} \tag{9}$$

Because purchasers must always break even in expectation, the price paid will take into account the equilibrium rate at which the shareholder mixes. The price p_a, may be written as a function of α, the rate at which the shareholder employs compensation of $\bar{\alpha}$. The price is then the Bayesian updated of the probability of the firm's being of high type given a high signal, times the payoff (H) when the firm is of high type:

$$p_s = \frac{s\,(\gamma_1 - \gamma_0) + \gamma_0}{s\,(1-\gamma_0) + \gamma_0} H \tag{10}$$

Equations 8 and 10 allow one to solve for the rate of mixing α.

$$s = \frac{\gamma_0}{1-\gamma_0} \cdot \frac{H\left[\Delta\gamma + (1-\gamma_1)\,\pi\right] - l\,(1-\gamma_1)\,(1-\pi)}{l\,(1-\gamma_1)\,(1-\pi) - \Delta\gamma H} \tag{11}$$

With some algebra one can show that the the only way $s > 0$ is for the numerator and denominator to both be positive, which implies as a condition that $l \in \left(\frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)} H, \frac{\Delta\gamma + (1-\gamma_1)\pi}{(1-\gamma_1)(1-\pi)} H\right)$. In addition, one can verify that in order for $s < 1$, it must also be that $l > \frac{\Delta\gamma}{(1-\pi)(1-\gamma_1)} H + \frac{\pi}{1-\pi}\gamma_0 H$. Hence the shareholder mixes when $l \in \left(\frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)} H + \frac{\pi}{1-\pi}\gamma_0 H, \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)} H + \frac{\pi}{1-\pi} H\right)$, the boundaries of which correspond to the upper bound for awarding $\bar{\alpha}_p$ and the lower bound for $\alpha = 0$ as pure strategies, respectively. ■

Remark 10 *Nowhere in zone M1 does the level of the manager's short term interest, π_m, have any effect on either the likelihood of fraud or the likelihood that effort will be exerted.*

3.4.2 Choice of compensation in zone M2

In zone M2, the manager will tell the truth if $\alpha = 0$, will mix disclosure at rate x if $\alpha = \alpha_x$, and will always lie in the low state if $\alpha = \bar{\alpha}_p$. The same logic as in zone M1 holds here to show that α_x cannot be an equilibrium. The shareholder is left to choose between $\alpha = 0$ and $\alpha = \bar{\alpha}_p$, with conditions identical to Eqs. 6 - 11 in the zone M1 analysis.

3.4.3 Choice of compensation in zone M3

In zone M3, managers will play a mixing strategy: given that the firm is of low type, a manager receiving compensation of $\bar{\alpha}$ will falsely disclose high value with probability x, which results in price p_x. If compensation is $\alpha = 0$, the manager always tells the truth, resulting in a price given a high signal of H and zero otherwise. If the level of fine l is high enough, either $\alpha = \bar{\alpha}$ or $\alpha = 0$ may be an equilibrium.

In order for $\bar{\alpha}$ to be an equilibrium in M3, it must be that the shareholder prefers $\bar{\alpha}$ to a defection to any of $\alpha \in \{0, \alpha_x, \alpha_p\}$. That is,

$$
\begin{aligned}
\gamma_1 \left(\pi p_x + (1-\pi) H\right) + (1-\gamma_1)\, x \left(\pi p_x - (1-\pi)\, l\right) &\geq \gamma_0 \left(\pi p_x + (1-\pi) H\right) + (1-\gamma_0)\, y \left(\pi p_x - (1-\pi)\, l\right) \qquad (12) \\
\text{where } y &= \begin{cases} 0 & \text{if defection to } \alpha = 0 \\ x & \text{if defection to } \alpha = \alpha_x \\ 1 & \text{if defection to } \alpha = \alpha_p \end{cases}
\end{aligned}
$$

One can immediately dismiss α_x, since the RHS of the inequality must be maximized at either $y = 0$ or $y = 1$, depending on whether $\pi p_x - (1-\pi)\, l \gtrless 0$. Under the assumption $R/c \to 0$, it must be that $\pi p_x - (1-\pi)\, l < 0$, and consequently it must also be that α_p is not a viable defection, either. It is only left to consider when a shareholder might consider a defection to $\alpha = 0$.

To make this less complicated, I take the limit of the expression as $R/c \to 0$ and plug in terms for p_x and x. It is somewhat easier algebraically to proceed by letting $l = \frac{\pi_m}{1-\pi_m} kH$, where $k \in (\gamma_1, 0)$. In terms of k, we get the following condition:

$$\bar{\alpha}_p \text{ in M3} : k \geq \frac{\gamma_1 (\pi_m - \pi) - \Delta\gamma (1-\pi)(1-\pi_m)}{\Delta\gamma\pi (1-\pi_m) + \gamma_1 (\pi_m - \pi)} \tag{13}$$

This means that the fine must be sufficiently large in order to maintain $\bar{\alpha}_p$ as an equilibrium. This is because net shareholder payoffs, as given in Eq.12, are actually increasing in l because, while an increase in l subjects the shareholder to greater liability in the event of false disclosure, an increase in l has the salutary effect of decreasing the rate x at which the manager mixes and increasing the price p_x that the shareholder receives for selling his share. Note that this the condition is only meaningful agency costs are sufficiently large. Where $\pi_m = \pi$, for instance, the RHS of Eq.13 is negative, and any level of fine l is sufficient to maintain $\bar{\alpha}_p$ as an equilibrium. An intuitive interpretation of this condition is that if the fine is large relative to the degree of agency cost, then shareholder and manager interests are well enough aligned that the manager's mixing strategy x is acceptably palatable to the shareholder. In zone M3, then, it is only when agency costs are relatively high that $\bar{\alpha}_p$ may fail to be an equilibrium. When they are low, shareholders will always award $\bar{\alpha}_p$.

A high enough fine l makes $\alpha = 0$ an equilibrium. The condition for this to obtain is

$$\begin{aligned} \gamma_0 H &\geq \gamma_1 H + (1-\gamma_1)(\pi H - (1-\pi) l) : \text{ (versus } \alpha = \bar{\alpha}_p) \\ \text{and } \gamma_0 H &\geq \gamma_0 H + (1-\gamma_0) y (\pi H - (1-\pi) l) : \text{(versus } \alpha = \alpha_x, \alpha_p) \end{aligned}$$

One can show that α_x, α_p need not be considered, since if $\pi H - (1-\pi) l < 0$, the shareholder would not defect, while if $\pi H - (1-\pi) l > 0$, the shareholder which is identical to the condition (Eq. 7) for awarding zero equity in the pure pooling cases of zone M1 and M2. This gives the equilibrium condition

$$\alpha = 0 \text{ in M3} : l \; \geq \frac{\Delta\gamma}{(1-\bar{\gamma})(1-\pi)} H + \frac{\pi}{(1-\pi)} H \tag{14}$$

The bigger the gain from an exertion of managerial effort ($\Delta\gamma$), the greater must l be in order to sustain the non-effort equilibrium.

What happens in zone M3 when the fine is such that neither $\alpha = 0$ nor $\alpha = \bar{\alpha}$ is an equilibrium? In such a case, there exists no pure strategy equilibrium: shareholders would defect from $\bar{\alpha}$ to 0 and back again. There is, however, at least one mixed strategy equilibrium: the shareholder can mix at rate a between $\alpha = 0$ and $\alpha = \bar{\alpha}$ such that the equilibrium price, p_a, makes the shareholder indifferent between the two compensation strategies. The conditions for shareholder mixing are in fact identical to those in zones M1 and M2 (Eqs. 8 - 11); this is so because the shareholder's mixing has the effect of raising the price above the manager's mixing price, $p_a > p_x$, and for any price greater than p_x, the manager strictly prefers to lie in the low state.

Lemma 11 *When the shareholder mixes between* 0 *and* $\bar{\alpha}_p$*, the manager will always choose to pool when equity compensation is* $\bar{\alpha}_p$ *and will report truthfully when it is* 0*.*

Proof. Given that equity compensation is $\bar{\alpha}$, the manager chooses to report falsely in the low state if the payoff from lying exceeds the payoff from telling the truth (which equals zero). From this, one finds that the manager reports falsely in the low state (and will not mix) if, and only if, the price is above p_x :

$$p > \frac{1-\pi_m}{\pi_m} l = p_x \tag{15}$$

The shareholder mixes only when he is indifferent between awarding $\bar{\alpha}$ and awarding 0, or, formally, when Eq. 8 holds. One can show that 8 implies 15. First, if the shareholder prefers to mix instead of playing a pure strategy (such as $\alpha = \bar{\alpha}$), it must be true that the shareholder's payoff from mixing exceeds the expected payoff from playing pure $\bar{\alpha}$:

$$\begin{aligned} \bar{\gamma}\left(\pi p_a + (1-\pi) H\right) + (1-\bar{\gamma})\left(\pi p_a - (1-\pi) l\right) &= \gamma\left(\pi p_a + (1-\pi) H\right) \\ &> \bar{\gamma}\left(\pi p_x + (1-\pi) H\right) + (1-\bar{\gamma})\, x \underbrace{\left(\pi p_x - (1-\pi) l\right)}_{<0} \end{aligned}$$

Since this is true everywhere, it must also be true when $x = 1$:

$$\bar{\gamma}\left(\pi p_a + (1-\pi) H\right) + (1-\bar{\gamma})\left(\pi p_a - (1-\pi) l\right) > \bar{\gamma}\left(\pi p_x + (1-\pi) H\right) + (1-\bar{\gamma})\left(\pi p_x - (1-\pi) l\right)$$

Rearranging and canceling terms,

$$p_a > p_x$$

That is, the equilibrium price p_a when the shareholder mixes is greater than the equilibrium price when the manager mixes, p_x. Because $p_a > p_x$, it cannot be that the manager will be indifferent between lying and telling the truth when the firm is of low type. In particular, she will strictly prefer lying, since the payoff from lying $(\pi_m p_a - (1-\pi_m) l)$ is strictly greater than the payoff from telling the truth (0). ■

3.4.4 Zone M4

If the fine is high enough such that $l \geq \frac{\pi_m}{1-\pi_m} H$, the manager always prefers to tell the truth when the firm is of low type. Since $\pi_m \geq \pi$, this means that the shareholder must also prefer to tell the truth since $l \geq \frac{\pi_m}{1-\pi_m} H \geq \frac{\pi}{1-\pi} H$. Hence, the shareholder will always award equity compensation of $\alpha = \bar{\alpha}$, and the manager will always exert effort and report truthfully.

4 Analysis: the relationship between fraud, effort, and agency costs

What does this model tell us about the effect of agency costs on fraud, compensation, and effort? While the parameters of the model allow for quite a lot of variation in incentives and behavior, one can still draw several general insights. As I will discuss below in more detail:

1. Fraud and effort are positively correlated, and fraud is more likely to occur as the gains from effort increase.

2. The incidence of fraud-inducing compensation $\bar{\alpha}$ is increasing as agency costs are reduced.

3. A reduction in agency costs leads to an increase in the incidence of fraud when agency costs are high,

and leads to either a decrease or no change in the incidence of fraud when agency costs are low (and any decrease is attributable to a change in managerial preferences, not resolution of the agency conflict).

4. The two separate types of sanctions – corporate fine l and personal managerial penalty R – have distinct effects on the choice of effort, fraud, and compensation. This result is, however, more preliminary.

4.1 The relation between fraud and effort

Fraud and effort are positively correlated. Shareholders never award α_x or α_p, and as a consequence the only time that fraud never occurs is when shareholders award $\alpha = 0$ and $e = 0$, or when the manager happens to be in zone M4.

Further, fraud is more likely to occur when the gains from effort are higher. From an inspection of the manager's disclosure conditions, one can see that a greater fine l is required to induce non-fraudulent behavior as γ_1 increases ($l \geq \frac{\pi_m}{1-\pi_m}\gamma_1 H$); a higher fine is also required when effort is exerted, since $\gamma_1 > \gamma_0$. The rate at which the manager mixes, $x = \frac{\gamma_1}{1-\gamma_1}\frac{k}{1-k}$, is also a positive function of effort and the returns to effort (in equilibrium the only time the manager mixes is when effort is exerted).

Turning to the shareholders' behavior, consider also the conditions for awarding the fraud-and-effort-inducing compensation package $\bar{\alpha}$ in M1/M2 and M3, as given by Eqs.6 and 13. Letting $\gamma_1 = \gamma_0 + \omega$, these may be rewritten in terms of the gain to effort:

$$\begin{aligned} 6' &: \quad l \leq \frac{\omega}{(1-\gamma_0+\omega)(1-\pi)}H + \frac{\pi}{1-\pi}\gamma_0 H \\ 13' &: \quad k \geq \frac{(\omega+\gamma_0)(\pi_m-\pi) - \omega(1-\pi)(1-\pi_m)}{(\omega+\gamma_0)(\pi_m-\pi) + \omega\pi(1-\pi_m)} \end{aligned}$$

Taking the derivatives with respect to ω, one can verify that the RHS of $6'$ is increasing in ω, while the RHS of $13'$ is decreasing, meaning that each condition is getting more slack as the gains to effort increase. (One can also verify that the conditions to maintain the truthtelling equilibria, $\alpha = 0$, of Eqs. 7 and 14 grow more restrictive as ω increases). Hence, holding everything else constant, increases in the marginal product of managerial effort should tend to induce a greater incidence of lying from managers given that firm type is low, and should also tend to increase the propensity of shareholders to award compensation that induces the manager to commit fraud.

This relationship has important regulatory implications. Consider the perspective of an outsider who sees that fraud is committed and the compensation paid to managers, but cannot observe effort. The outsider in this model would see that all firms that commit fraud have fraud-inducing compensation packages ($\alpha = \bar{\alpha}$), and would see that all firms that commit fraud have ex post valuations that are low ($\eta = L$). Because poor performance is correlated both with fraud and high compensation, the outsider may make the additional leap to conclude that high compensation causes fraud (which is true) and that high compensation and fraud cause the low ex post performance (which is false). The outsider may believe that one could increase overall welfare by enacting policies that reduce or eliminate the incidence of fraud; for instance, by prohibiting compensation packages of $\bar{\alpha}$. However, that has the unintended consequence of eliminating effort and reducing overall firm value by a factor of $\Delta\gamma$. While there is likely some offsetting benefit from the elimination of fraud (such as viability of follow-on projects and improved liquidity), such a policy is likely to be an overall detriment.

This same point is true for an outsider who wishes to raise corporate fines l. Suppose that substantial agency costs exist ($\pi_m >> \pi$), and that the outsider can choose one of two fine levels $l_1 < l_2$. Suppose further that $l_1, l_2 \leq \frac{\pi_m}{1-\pi_m}\gamma_0 H$, meaning that the manager will want to commit fraud no matter what the fine level so long as $\alpha > 0$. Finally, suppose that $l_1 < \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)}H + \frac{\pi}{1-\pi}\gamma_0 H < \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)}H + \frac{\pi}{1-\pi}H < l_2$. This means that the shareholder will award $\bar{\alpha}_p$ with l_1 but will award $\alpha = 0$ with l_2. That is, while a move from l_1 to l_2 will eliminate fraud, it will also eliminate effort and destroy $\Delta\gamma H$ of value. If agency costs are high, increases in fines will be relatively ineffective in deterring manager's fraud decision given $\alpha > 0$, but will deter shareholders from awarding the efficient compensation package $\bar{\alpha}$.

4.2 Reducing agency costs increases fraud-inducing compensation

In this model, it is true that large performance-based compensation packages (i.e., $\bar{\alpha}$) lead to fraud. One interesting thing that this model generates, though, is that the incidence of fraud-inducing compensation is actually increasing as agency costs decline. Consider what happens as π_m declines, taking as our starting point when π_m and l are such that the manager is in zone M1/M2. Assume that $\bar{\alpha}_p$ is an equilibrium (Eq.6 is satisfied). The fact that $\bar{\alpha}_p$ is an equilibrium in M1/M2 implies that it must also be an equilibrium in

M3. In fact, one can show formally that, in general, the awardance of $\bar{\alpha}$ is non-declining as π_m declines toward π (i.e., as agency costs decrease), as I do in the following three propositions:

Proposition 12 *As π_m declines to π, if the shareholder awards $\bar{\alpha}$ in zone M1/M2, the shareholder also awards $\bar{\alpha}$ in zone M3 and M4.*

Proof. Eq.6 gives as the condition for $\bar{\alpha}_p$ in M1/M2 that $\Delta\gamma\,(\pi p_1 + (1-\pi)\,H) + (1-\gamma_1)\,(\pi p_1 - (1-\pi)\,l) \geq 0$, while Eq.12 gives as the condition for $\bar{\alpha}_p$ in M3 that $\Delta\gamma\,(\pi p_x + (1-\pi)\,H) + (1-\gamma_1)\,x\,(\pi p_x - (1-\pi)\,l) \geq 0$. Since $p_x > p_1$ and $\pi p_1 - (1-\pi)\,l < 0$ (which must be true since by assumption the manager being in zone M3 means that $l > \frac{\pi_m}{1-\pi_m}\gamma_1 H > \frac{\pi}{1-\pi}\gamma_1 H$), it follows that Eq.6 implies Eq.12. Finally, as π_m decreases to the point that the manager is in zone M4, $\bar{\alpha}_s$ is always an equilibrium. ■

Proposition 13 *As π_m declines to π, if the shareholder played mixed strategy s in M1/M2, the shareholder will either mix at rate s or play a pure strategy of $\bar{\alpha}$ in M3.*

Proof. From Proposition [5], the shareholder mixes in M1/M2 if and only if $l \in \left(\frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)}H + \frac{\pi}{1-\pi}\gamma_0 H, \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)}H + \frac{\pi}{1-\ldots}\right.$ Also from Proposition [5], the shareholder plays a pure strategy of $\alpha = 0$ in M3 only if $l \geq \frac{\Delta\gamma}{(1-\gamma_1)(1-\pi)}H + \frac{\pi}{(1-\pi)}H$. From inspection, then, it must be that if the shareholder mixes in M1/M2, the shareholder must either mix or play pure $\bar{\alpha}$ in M3. ■

Proposition 14 *As π_m declines to π, there is a level of $\pi_m = \pi_m^* > \frac{l}{H+l}$ (i.e., in zone M3) where the shareholder awards $\bar{\alpha}$ for any $\pi_m \leq \pi_m^*$ so long as $\Delta\gamma > 0$. That is, the shareholder always awards $\bar{\alpha}$ at some point in zone M3, and will award $\bar{\alpha}$ for all higher levels of π_m as well.*

Proof. Suppose that $\pi_m = \frac{l}{H+l}$. At this point, the manager is on the border between zones M3 and M4 and hence will commit fraud at the rate $x = 0$. The shareholder always chooses to award $\bar{\alpha}$ at this point since it induces the manager to exert effort but does not change disclosure strategy. Now suppose π_m increases by the very small increment ε. The shareholder's marginal loss from an increase in π_m is $\frac{\partial EU_s}{\delta \pi_m} = \frac{\gamma_1}{1-\pi_m}H$, while the loss from switching to $\alpha = 0$ is $\Delta\gamma H$. The shareholder will continue to award $\bar{\alpha}$ where $\varepsilon\frac{\gamma_1}{1-\pi_m}H < \Delta\gamma H$. It must be the case for ε sufficiently small and $\Delta\gamma > 0$ that $\varepsilon\frac{\gamma_1}{1-\pi_m}H < \Delta\gamma H$, since by assumption $\pi_m = \frac{l}{H+l} < 1$ and hence $\frac{\gamma_1}{1-\pi_m}H < \infty$. ■

What this means is that the incidence of fraud-inducing compensation weakly increases as agency costs decrease (in the sense of $\pi_m \to \pi$). Even if $\bar{\alpha}$ is not an equilibrium in M1/M2, it may become an equilibrium in M3 (for agency costs sufficiently low in M3, $\bar{\alpha}_p$ is always an equilibrium), and $\bar{\alpha}_p$ is always becomes one in M4.

Note that the results of Propositions [12] and [13] above do not rely on the gain from efficiency being greater than zero. In general, the shareholders will play $\bar{\alpha}$ at some point in M3 so long as shareholders prefer some level of fraud, i.e., $l < \frac{\pi}{1-\pi}H$. Suppose $\gamma_1 = \gamma_0 = \gamma$ and π_m,π, and l are such that $\frac{\pi}{1-\pi}\gamma H < l < \frac{\pi_m}{1-\pi_m}\gamma H$ and $l < \frac{\pi}{1-\pi}H$. This means that the shareholder would prefer some fraud but, on the whole, the manager will, if granted equity compensation, commit a super-optimal amount of fraud, such that the shareholder will not choose to award the equity compensation all the time; instead, the shareholder mixes at rate $s = (\pi H - (1-\pi)\, l) \,/\, (1-\pi)\, l$. Consider then what happens as $\pi_m \to \pi$: by continuity of x, there will be a point where the manager mixes disclosure at exactly the same rate that the shareholder would want, and hence the shareholder plays a pure strategy of $\alpha = \bar{\alpha}_p$. If $l \geq \frac{\pi}{1-\pi}H$, then the shareholder will award $\bar{\alpha}$ only when the manager moves into M4 as π_m declines toward π. As in the case where $\Delta\gamma > 0$, the incidence of fraud-inducing compensation $\bar{\alpha}$ is weakly increasing as $\pi_m \to \pi$.

We can sum up Propositions [12]-[14] in the following Corollary:

Corollary 15 *There are three possibilities for changes in shareholder behavior as π_m declines toward π and where $\Delta\gamma > 0$:*

1. *The shareholder awards $\bar{\alpha}$ in M1/M2 and continues to play $\bar{\alpha}$ thereafter,*

2. *The shareholder plays mixed strategy s in M1/M2 and switches to $\bar{\alpha}$ at some point in M3 and plays $\bar{\alpha}$ thereafter,*

3. *The shareholder awards $\alpha = 0$ in M1/M2, switches to $\bar{\alpha}$ in M3 and plays $\bar{\alpha}$ thereafter.*[17]

[17] *It is never the case that shareholders would switch from $\alpha = 0$ to a mixed strategy of s in M3. This is because mixed strategy s achieves the same result in M1/M2 as it does in M3: the manager's disclosure practice is exactly the same. This is also true of pure strategy $\alpha = 0$, and hence changes in π_m cannot switch the shareholder's preference between 0 and s strategies.*

4.3 Reducing agency costs leads to more fraud when agency costs are high

With Corollary [15]'s summary of shareholder behavior as agency costs decrease, one can then map the overall incidence of fraud using the manager's disclosure and effort behavior as given in Propositions [2] and [4].

In general, there are two effects, depending on how great the degree of agency conflict is:

Proposition 16 *When agency costs are "large" in the sense that shareholders choose not to award $\bar{\alpha}$ as a pure strategy, incremental decreases in agency costs can only have the effect of increasing the incidence of fraud.*

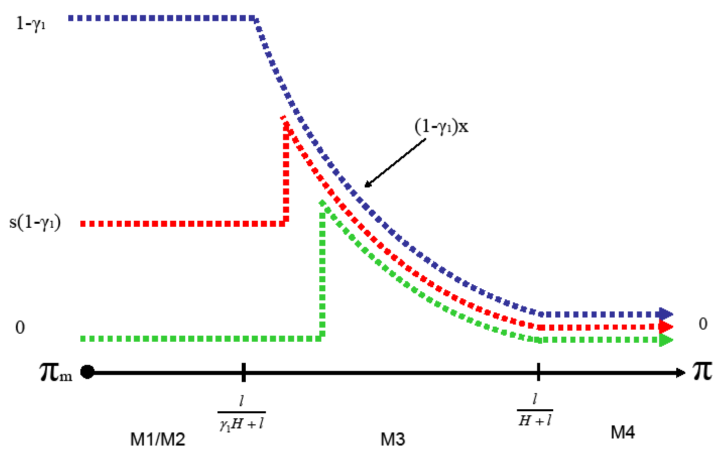
Proof. From Corollary [15], agency costs are large in the cases where the shareholder plays either s or 0 in M1/M2. In these large cases, the shareholder will at some point switch to $\bar{\alpha}$ in M3 as $\pi_m \to \pi$. From Propositions [2] and [4], compensation of $\alpha = 0$ induces no fraud and no effort, while $\bar{\alpha}$ induces both fraud at rate x and effort in M3. Therefore, the only possible effect of a small decrease in π_m when agency costs are large is that the incidence of fraud increases from either 0 or $s(1-\gamma_1)$ to $x(1-\gamma_1)$. This result also holds as $\pi \to \pi_m$ ■

Proposition 17 *When agency costs are "small" in the sense that shareholders play $\bar{\alpha}$ as a pure strategy, incremental decreases in the manager's short term interest have the effect of decreasing incrementally the incidence of fraud, while incremental increases in shareholders' short term interests have no effect on fraud.*

Proof. Once agency costs are "small" such that shareholders have chosen to award the equity inducing compensation $\bar{\alpha}$, decreases in π_m cannot lead to more fraud. Rather, if those decreases occur while the manager is in zone M1/2 or M4, it causes no change in fraud levels. If π_m decreases in zone M3, the manager chooses to commit incrementally less fraud as x, which is a positive function of π_m from Eq.5, declines. ■

Figure 2 below presents these Propositions graphically. The top line represents the case (1) where shareholders award $\bar{\alpha}$ in M1/2 and thereafter, (2) the middle line represents a mixing strategy of s in M1/M2 which switches to $\bar{\alpha}$ in M3 and thereafter, and (3) the bottom line represents a strategy of $\alpha = 0$ in M1/M2 which switches to $\bar{\alpha}$ in M3 and thereafter.

Figure 2: Incidence of fraud as $\pi_m \rightarrow \pi$



One thing to note is that the declines in the incidence of fraud when agency costs are small are not really due to a decrease in agency costs per se. Rather, these declines are due to the change in the manager's preferences, not to any resolution of the divergence of interest between the manager and shareholders. If agency costs were to decrease because the shareholders' short term interest approaches that of the manager $(\pi \rightarrow \pi_m)$, there would be no corresponding decrease in the incidence of fraud.

This result runs counter to the commonly stated assertion that corporate fraud, in the sense of overstating the firm's value by managers, is the product of agency costs as between managers and shareholders, and that reducing agency costs will reduce the incidence of fraud. In the context of the model, this is not generally true. Instead, where agency costs are very high, reducing them can only increase the level of fraud, while the effect of reducing agency costs when they are already small is ambiguous.

4.4 Corporate fines (l) vs. manager penalties (R)

Even if R is large, a large personal fine on the manager succeeds in limiting fraud only to the extent that it makes effort without fraud achievable $(\bar{\alpha} < \alpha_x, \alpha_p)$, and then only to the extent that shareholders do not desire fraud. So long as $N\Delta\gamma H$ is large compared to R, shareholders will simply increase α to achieve the desired effect. Effort will always be exerted (which is a good thing), but to the extent that shareholders desire to incentivize fraud, they can simply increase the level of equity compensation until α_x, α_p is reached. Put another way, so long as R is small relative to the size of the firm, changes in R may affect the bundling of fraud and effort available to shareholders, but changes in R do not affect shareholders' incentives to commit or ability to effectuate fraud via compensation α_x,α_p.

In contrast, changes in the fine l have an effect upon the ability of the shareholders to incentivize fraud by making the manager more fraud averse. For a sufficiently high l relative to π_m, shareholders are unable to induce the manager to commit fraud via equity compensation. Additionally, increases in l affect shareholder incentives directly, which increases in R do not.

5 Conclusion

This model describes the tradeoff inherent when shareholders choose the manager's level of equity compensation. Performance-based compensation induces effort, but also induces fraud. Managers' incentives to commit fraud are higher where effort is exerted and where gains to effort are higher; shareholders' incetives to award fraud inducing compensation are greater when the returns to effort are higher. Hence, fraud and effort may of necessity go together.

While shareholders themselves may desire some degree of fraud in light of their own short term interests, the case where managers' interests are more short term than those of the shareholders presents a conflict where managers will tend to commit more fraud than shareholders would want. Such a conflict may lead shareholders not to award equity compensation, which ensures an equilibrium where the manager commits no fraud.

As agency costs decrease and the interests of shareholders and managers become more aligned in terms of short term interest, shareholders will tend to award a higher level of performance-based compensation. In fact, as the interests of managers approach those of shareholders, shareholders will unambiguously award more performance based compensation. Reductions in agency costs actually increase the incidence of fraud when agency costs are high, but may reduce the incidence of fraud (or have no effect) when agency costs are already low.

Finally, this model has implications for the choice of vicarious liability as opposed to managerial fines.

Managerial fines are unable to deter fraud that arises from the incentives of shareholders, while vicarious liability can be an effective deterrent.

6 APPENDIX A: Assumptions on R and c

I describe in greater detail the assumption regarding the relative sizes of R and $c(e)$. The assumption, briefly stated, is that equity compensation sufficient to induce effort of $e = 1$ will result in:

- pooling in zone M1 and M2 (that is, where $l < \frac{\pi_m}{1-\pi_m}\gamma_1 H$),and
- mixing in zone M3 $\left(l \in [\frac{\pi_m}{1-\pi_m}\gamma_1 H, \frac{\pi_m}{1-\pi_m}H)\right)$

The first assumption requires that $\bar{\alpha}_s > \alpha_x$ and $\bar{\alpha}_x > \alpha_p$, which means that the equity compensation necessary to induce effort in the separating equilibrium ($\bar{\alpha}_s$) is greater than the equity compensation that induces mixing behavior (α_x), and that the equity compensation necessary to induce effort in the mixing equilibrium ($\bar{\alpha}_x$) is greater than the level of equity compensation that induces pooling (a_p). Consider the following example: $l << \frac{\pi_m}{1-\pi_m}\gamma_1 H$. Starting with an equity compensation of $\alpha = 0$, the manager will separate ($\alpha < \alpha_x$), but will not exert any effort ($\alpha < \bar{\alpha}_s$). Since shareholders desire effort, they could incrementally try raising the manager's equity compensation. However, since by assumption $\bar{\alpha}_s > \alpha_x$, before the manager is induced to exert effort, the manager will switch from truthful disclosure to a mixed strategy. Suppose that the shareholders continue to raise the manager's compensation. Once again, before effort is induced, the manager will switch from mixing to purely false disclosure (pooling), since $\bar{\alpha}_x > \alpha_p$. If shareholders continue to raise the manager's equity compensation, they will reach the point, $\bar{\alpha}_p$, where the manager is induced to undertake effort.

The second assumption requires only that $\bar{\alpha}_s > \alpha_x$.

Formally, the first assumption ($\bar{\alpha}_s > \alpha_x$ and $\bar{\alpha}_x > \alpha_p$) requires both the following two conditions to be met:

$$\begin{aligned} 1 \quad &: \quad \bar{\alpha}_s = \frac{c}{\Delta\gamma H} > \alpha_x = \frac{R}{\pi_m H - (1-\pi_m)\, l} \\ &\Leftrightarrow \quad l < \frac{\pi_m}{1-\pi_m} H - \frac{\Delta\gamma H R}{c\,(1-\pi_m)} \end{aligned}$$

$$\begin{aligned} 2 \quad &: \quad \bar{\alpha}_x = \frac{c - \Delta\gamma R}{\Delta\gamma\left(1-\pi_m\right)\left(H+l\right)} > \frac{R}{\pi_m \bar{\gamma} H - \left(1-\pi_m\right) l} = \alpha_p \\ &\Leftrightarrow \quad l < \frac{\pi_m}{1-\pi_m}\gamma_1 H - \frac{\Delta\gamma\left(1-\pi_m\left(1-\gamma_1\right)\right)}{1-\pi_m} \cdot \frac{R}{c} \end{aligned}$$

Suppose that $R/c \not\to 0$. Does that mean that there is no tradeoff between effort and fraud? Rearranging terms in (2), there exists an $l > 0$ such that satisfies condition (2) so long as $\pi_m c \geq \Delta\gamma R\left(1-\pi_m\left(1-\gamma_1\right)\right)\gamma_1^{-1}$. From rearranging (1), there exists an $l > 0$ satisfying (1) so long as $\pi_m c \geq \Delta\gamma R$, which is a less strict condition than (2). Hence, the necessary condition for there to be some tradeoff is $\pi_m c \geq \Delta\gamma R$, and for it to be a greater tradeoff in that the manager fully pools in zone M1/M2 before exerting effort, $\pi_m c \geq \Delta\gamma R\left(1-\pi_m\left(1-\gamma_1\right)\right)\gamma_1^{-1}$, which at its maximum as $\gamma_1 \to 1$ is $\pi_m c \geq \left(1-\gamma_0\right) R$.

7 Appendix B: Type 1 error

One can show that a form of type 1 error can be readily incorporated into the model, and that this does not significantly affect the results. The main effect is to reduce the effective magnitude of the penalty. Suppose, for instance, that $\Pr\left(R|\eta = \eta'\right) = \theta$. Then $E\left[R|\eta' = L = \eta\right] = \theta R$. This models a failure of the punisher to correctly observe that the manager disclosed low when assessing whether to impose a personal sanction on the manager.[18] This is reasonable in light of the complexity of disclosure and the difficulty courts have in evaluating whether firms disclosed accurately given the ultimate outcome. We can write the separating and pooling conditions as follows:

$$\begin{aligned} \text{separation} \quad &: \quad -\theta R \geq \alpha\left[\pi_m H + (1-\pi)(L-l)\right] - R \\ \text{pooling} \quad &: \quad \alpha\left[\pi_m \gamma_e H - (1-\pi_m) l\right] - R > -\theta R \end{aligned}$$

One can then rewrite the conditions utilizing a $\left(1-\theta\right) R$, that is, the effect of the reputational sanction is diminished by the likelihood of type 1 error.

[18] An alternative form of type 1 error would be a failure by the regulator to correctly perceive the firm's type, which could result in overdeterrence in that managers of high type firms may choose to disclose their type as low.

For the effort conditions of the manager, the conditions for separation and mixing effort changes (the possibility of getting wrongly punished creates an additional incentive to exert effort), though the compensation required in the pooling case for effort ($\bar{\alpha}_p$) is unchanged.

$$\begin{aligned}
\text{effort if separating} \quad &: \quad \bar{\alpha}_s \geq \frac{c - \Delta\gamma\theta R}{\Delta\gamma H} \\
\text{effort if pooling} \quad &: \quad \bar{\alpha}_p \geq \frac{c - \Delta\gamma R}{\Delta\gamma \left(1 - \pi_m\right)\left(H + l\right)} \\
\text{effort if mixing} \quad &: \quad \bar{\alpha}_x \geq \frac{c - \left(1 + \theta\right)\Delta\gamma R}{\Delta\gamma \left(1 - \pi_m\right)\left(H + l\right)}
\end{aligned}$$

Overall, the effect of this form of type 1 error is that the incentives to disclose truthfully are reduced, but the incentives to exert effort are increased, since the manager is effectively being punished for low cashflows. None of the shareholder's choice of compensation decisions will be affected.

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